electronics

A McGRAW-HILL PUBLICATION • PRICE 75 CENTS

FEBRUARY • 1956

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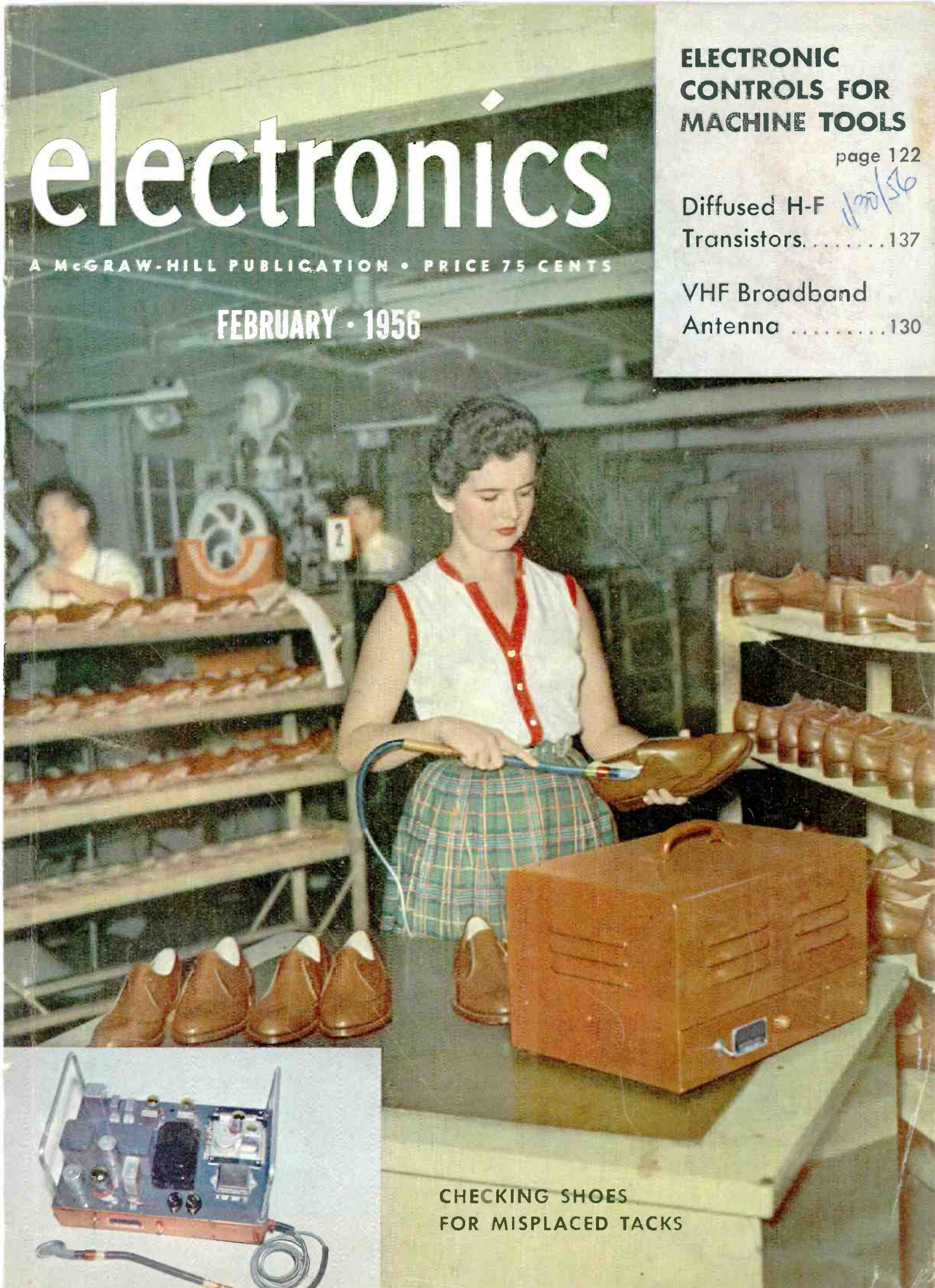
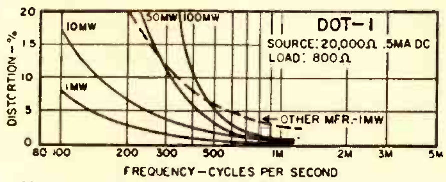


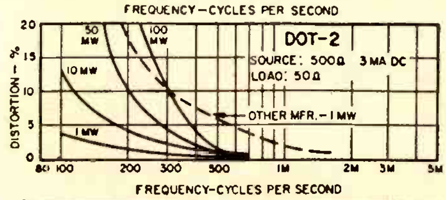
CHECKING SHOES FOR MISPLACED TACKS

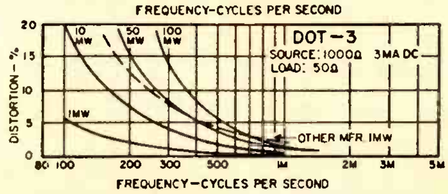
Deci-Ouncer Transformers

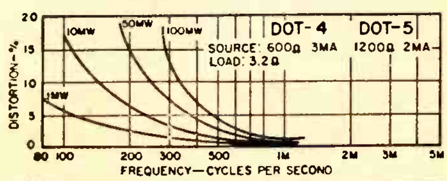
DOTS for short

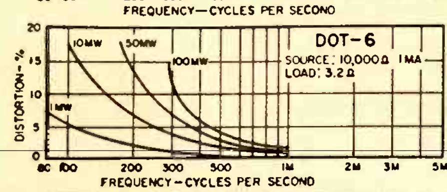
REVOLUTIONARY TRANSISTOR* TRANSFORMERS

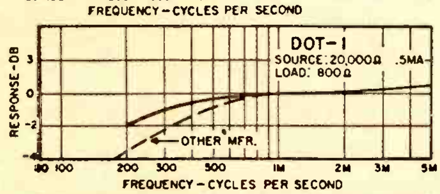


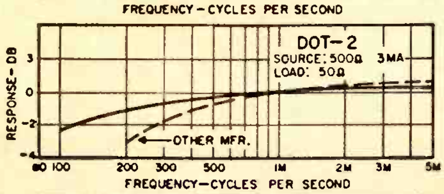


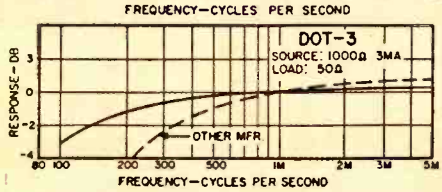


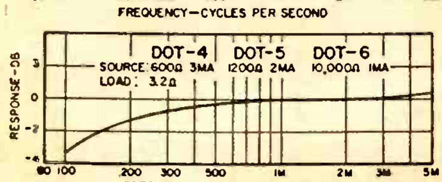












UTC has been the leader in miniaturization for over twenty years. In view of this, it was surprising to many people that UTC did not quickly bring out a series of transformers designed for use and comparable in size to transistors. Unfortunately, extremely miniature transistor transformers of standard construction had poor general characteristics, poor reliability characteristics, and were woefully inadequate for a large number of applications. Instead, UTC started a development program to evolve a new transistor transformer structure designed to provide full performance in extremely miniature size. The culmination of this development is found in the new DOT series**. Listed below are the standard types of DOTS now being made and curves showing their general characteristics in typical transistor application. To fully appreciate the unprecedented performance of these revolutionary transistor transformers, the curves also show characteristics of similar size units now on the market.

Special DOT units (some even smaller in size) are available on production order.

High Power Rating . . . up to 100 times greater.
DOT-1 has 5% distortion at 100 mw, other mfr. 6% at 1 mw.

Excellent Response . . . twice as good at low end.
DOT-3 is down 1 db at 200 cycles, other mfr. is down 4 db.

Low Distortion . . . reduced 80%.
DOT-1 shows 3% distortion where other mfr. shows 20%.

High Efficiency . . . up to 30% better.
DOT-1 has 850 ohm pri. resistance, 125 ohm sec.; other mfr. approx. 1200 and 200.

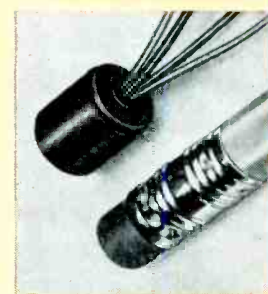
Moisture Proof . . . processed to hermetic specs.
DOT units are hermetic sealed compared to other mfr. open structures.

Rugged . . . completely cased.
DOT units can withstand all mechanical stresses.

Anchored leads . . . will withstand 10 pound pull test.
Lead strain completely isolated from coil winding.

Printed Circuit Use . . . plastic insulated leads at one end.
Other variations available.

1.3 X ACTUAL SIZE



DOT CASE
Diameter . . . . . 5/16"
Length . . . . . . 13/32"
Weight . . . . . . 1/10 oz.

Type No.	Application	Level Mw.	Pri. Imp.	D.C. Ma. In Pri.	Sec. Imp.	Pri. Res.	Sec. Res.
DOT-1	Interstage	50	30,000 20,000	.5 .5	1200 800	850	125
DOT-2	Output	100	600 500	3 3	60 50	60	8
DOT-3	Output	100	1200 1000	3 3	60 50	115	8
DOT-4	Output	100	600	3	3.2	60	.5
DOT-5	Output	100	1200	2	3.2	115	.5
DOT-6	Output	100	10,000	1	3.2	1000	.7
DOT-7	Input	25	200,000	0	1000	3700	100
DOT-8	Reactor	3.5 Hys. at 2 Ma. DC, 630 ohms. DC res.					

*DOT units have been designed for transistor applications only . . . not for vacuum tube service **Pats. Pending

UNITED TRANSFORMER CO.
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electronics

A McGRAW-HILL PUBLICATION

FEBRUARY • 1956

CONTINUED ON NEXT PAGE

contents

continued

SHOP

► **THIS MONTH** . . . Operating transistors at high frequencies has usually meant sacrificing power-handling ability. Manufacturers designed transistors that represented a compromise between frequency and power.

Some time ago we started to hear about transistors that might offer both high-frequency operation and satisfactory power-handling ability. Associate editor Carroll saw one such device, the diffused junction transistor, under development at Bell Telephone Laboratories.

The engineers working on it were still too deeply engrossed to spare the time for writing it up. But they made information on its characteristics and fabrication available to Jack. See page 137.

► **SOME PROGRESS** . . . For several months we have been watching the upward climb of the Electronics Output Index (curve on page 6). Not as it is usually watched, however.

Our concern has been caused by the mechanics of the publishing business. In the January issue the curve went to 276, and the top line is 275. No serious problem.

But the thermometer broke in the February issue. We didn't do as someone in the office suggested, run the curve off the top of the page. A new grid line has been added and the matching headpiece of Industry Report on page 7 has been made 2.5 inches high instead of the 2.25 inches it has always been.

electronics

FEBRUARY, 1956 Vol. 29, No. 2

Member ABC and ABP

TALK

It would have been much simpler if the industry had held back a few months, until all of the 1955 statistics are in. Then we drop out the whole year 1949 and move the curve down to start at 100 instead of 75.

The electronics industry moved upward a quarter inch faster than was expected.

▸ **PROBLEMS** . . . In studying manuscripts for future articles editors ask themselves many questions, seek to find the answers in many places, often "feel the direction of the wind" to determine technical trends and other intangibles. Some of the answers are hinted at in the author's letter accompanying the manuscript.

We appreciate the opportunity we get to have the "first look" at many manuscripts.

Such letters often say,

"I would appreciate having your comments at your earliest convenience. I should like to know your decision BEFORE contacting other periodicals in this field."

▸ **REACTIONS** . . . In our contacts with readers we often get suggestions for additions to the magazine. One such suggestion comes in increasing numbers during the last few months of each year.

"You should publish an index to the articles annually."

This puzzles us, because we *do*. Every year, in the December issue.

For instance, the December 1955 issue has an eleven-page index to the technical articles of the year, starting on page 434. For the business-minded reader, the index to Industry Report appears on page 30 of the same issue.

▸ **THANKS** . . . Some of the holiday greeting cards we received at the office have an electronic motif.

Tube and component symbols have been popular for some years, but the modern trend is emphasized by one card. It contains etched lettering on a printed circuit board.

An editor's contacts in the field are cumulative. Early in his career he is embarrassed to find that they already number in the hundreds and that it is not feasible to acknowledge individually all cards received.

To all, however, our sincere appreciation.

▸ **SPEED UP** . . . In keeping with the crowded tempo of modern living, we feel that the average reader doesn't have very much time. He wants to be informed quickly as to the contents of a technical article so that he can decide whether he should read it entirely now or put it off for a more appropriate leisure moment.

That's why we go to a lot of extra trouble to make the headline, the summary and the illustrations tell the salient features of the article. If these tell the engineer that he needs the details for his current project, he reads on.

To present the highlights quickly, each item in the New Products department has a headline that reads into another line (called a bankhead) and contains bold-face sideheads in the text. Studies of reading habits and use of such techniques show that reading time is speeded up. We hope it does it for you.

▸ **NEXT MONTH** . . . The electronics engineering fraternity encompasses many specialists. To mention only a few diverse ones, there are tv designers, computer experts, microwave specialists and the itinerant engineer who is ruled by a magpie-like curiosity that takes him into many corners of the field.

Whatever his specialty, the electronics engineer works with information, and information exists only to the extent that a signal can be distinguished from the irreducible level of electrical noise.

Noise is a problem common to all branches of our business. To help the readers of ELECTRONICS better understand and deal with noise Bill Bennett of Bell Telephone Labs was asked to bring our readers up to date on this subject.

His first article, "Characteristics and Origins of Noise" begins in the March issue. Subsequent articles will discuss noise-generating devices that put noise to constructive use, scales for measuring noise and ways to avoid its deleterious effects.

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FEATURES

- No internal oscillator—eliminates drift
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- Choice of 4 bandwidth characteristics: In-tune High, In-tune Medium, Narrow Band and 1/3 Octave.
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SPECIFICATIONS

- Frequency range—19 c/s to 21 kc (extendable down to 2 c/s)
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- Measurement Accuracy—± 1 db over several days
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- Input Voltage—1 mv to 300 v rms (FSD)
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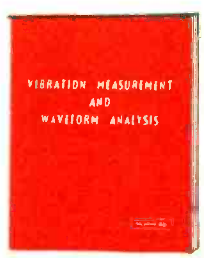
- Hum and Noise Level—Equivalent to .05 mv input at maximum gain
- Power Supply (external)—100/120 v, 60 or 400 cycles, 130 w
- Dimensions—12¾" x 13½" x 17½"
- Weight—55 pounds



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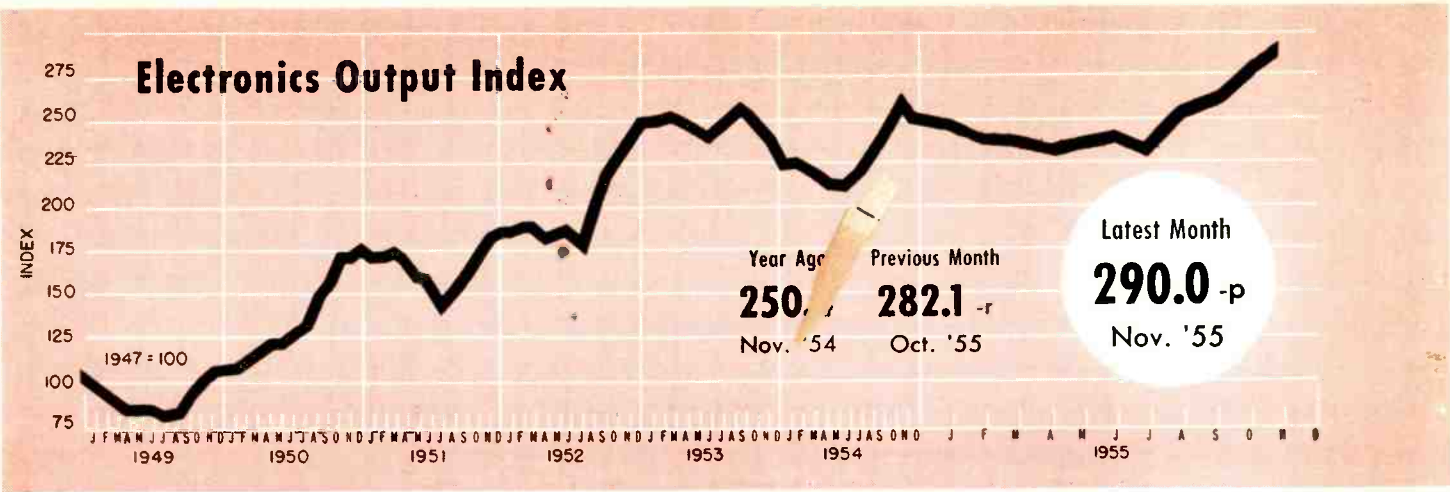


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month Nov. '55	Previous Month Oct. '55	Year Ago Nov. '54
Television sets, total	631,654	759,735	858,501
With UHF	114,645	109,574	168,563
Color sets	nr	nr	nr
Radio sets, total	1,580,797	1,500,206	1,098,725
With F-M	44,357	38,920	17,364
Home sets	389,316	398,087	327,973
Clock radios	276,049	282,393	272,583
Portable sets	181,573	168,709	93,716
Auto sets	733,859	651,017	404,453

RECEIVER SALES

(Source: RETMA)	Nov. '55	Oct. '55	Nov. '54
Television sets, units	591,366	746,274	779,105
Radio sets (except auto)	865,602	724,305	669,166

RECEIVING TUBE SALES

(Source: RETMA)	Nov. '55	Oct. '55	Nov. '54
Receiv. tubes, total units	45,965,000	48,119,000	38,781,863
Receiv. tubes, value	$34,788,000	$35,105,000	$27,618,868
Picture tubes, total units	1,086,999	1,224,990	1,157,866
Picture tubes, value	$20,894,647	$23,507,620	$27,140,693

SEMICONDUCTOR SALES

	Oct. '55	Sept. '55	Oct. '54
Germanium diodes, units / Silicon diodes, units	2,000,000	1,850,000	1,500,000

INDUSTRIAL TUBE SALES

Source: NEMA)	Quarterly Figures — Latest Quarter 3rd '55	Previous Quarter 2nd '55	Year Ago 3rd '54
Vacuum (non-receiving)	$9,027,845	$8,933,453	$8,803,740
Gas or vapor	$3,438,835	$3,365,008	$3,570,586
Magnetrons and velocity modulation tubes	$10,998,967	$13,193,395	$13,112,244
Gaps and T/R boxes	$1,421,138	$1,677,574	$1,476,407

BROADCAST STATIONS

(Source: FCC)	Latest Month Dec. '55	Previous Month Nov. '55	Year Ago Dec. '54
TV stations on air	482	477	439
TV stations CPs—not on air	108	109	137
TV stations—new requests	29	28	19
A-M stations on air	2,824	2,808	2,669
A-M stations CPs—not on air	111	115	105
A-M stations—new requests	229	217	172
F-M stations on air	540	536	552
F-M stations CPs—not on air	17	20	7
F-M stations—new requests	3	4	8

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Nov. '55	Oct. '55	Nov. '54
Aeronautical	43,939	43,648	40,737
Marine	53,622	53,426	48,255
Police, fire, etc.	19,637	19,377	16,757
Industrial	27,427	27,091	22,742
Land transportation	8,381	8,216	7,127
Amateur	142,408	140,799	126,021
Citizens radio	14,147	13,862	9,116
Disaster	319	319	306
Experimental	666	662	636
Common carrier	2,056	2,040	1,771

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Oct. '55	Sept. '55	Oct. '54
Prod. workers, comm. equip.	406,100-p	389,100-r	370,100
Av. wkly. earnings, comm.	$75.12-p	$74.16-r	$70.88
Av. wkly. earnings, radio	$71.40-p	$69.95-r	$69.32
Av. wkly. hours, comm.	41.5 -p	41.2 -r	40.5
Av. wkly. hours, radio	40.8 -p	40.2 -r	40.3

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Dec. '55	Nov. '55	Dec. '54
Radio-tv & electronics	451.5	438.4	409.3
Radio broadcasters	519.1	502.7	449.0

p—provisional; r—revised
nr—not reported

FIGURES OF THE YEAR

	TOTALS FOR FIRST ELEVEN MONTHS 1955	1954	Percent Change	1954 Total
Television set production	7,151,895	6,513,292	+ 9.8	7,346,715
Radio set production	13,108,365	9,138,955	+43.4	10,400,530
Television set sales	6,487,617	6,223,332	+ 4.2	7,317,034
Radio set sales (except auto)	5,532,583	5,272,155	+ 4.9	6,430,743
Receiving tube sales	441,752,000	347,180,000	+27.2	385,089,458
Cathode-ray tube sales	9,992,769	8,904,106	+12.2	9,913,504

INDUSTRY REPORT

electronics—February • 1956

Government Outlines Electronics Spending

Guided missile money increases by one-third with about half going into electronics

EXPENDITURES for electronics and communications in fiscal 1957 will be higher than 1956, according to the President's budget message.

The category designated electronic and communications equipment will remain high.

However, large expenditures for electronic equipment are hidden in other categories. For example, expenditures for guided missiles will increase by more than one third over 1956. About half the tab will go for electronics.

▶ **Radar** – The Continental Defense System will increase during fiscal 1957. Much of the increase will be earmarked for electronics. The number of radar stations in the U. S. will increase. Work will go ahead on the Mid-Canada warning line and on the Distant Early Warning (DEW) line in the far north. SAGE soon will be in operation.

▶ **Dollars** – The breakdown of the budget is as follows (all figures in millions of dollars):

EXPENDITURES	Fiscal Year 1957	1956	1955
Missiles	$1,276	$ 917	$ 569
Elec. & Comm.	745	671	637
R & D	1,430	1,370	1,364
Total	$3,451	$2,958	$2,570
APPROPRIATIONS			
Guided Missiles	$1,776	$ 938	$ 345
Elec. & Comm.	1,009	347	414
R & D	1,532	1,420	1,297
Total	$4,317	$2,705	$2,056

Long-range search radar at South Truro, Mass. was used in initial tests of SAGE in the Cape Cod system

SAGE Readies Sunday Punch

Communications, radar, computers constitute fast defense umbrella

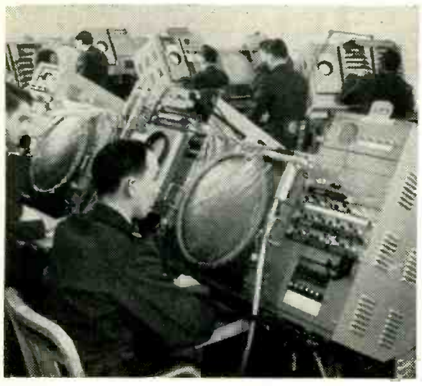
REVEALED at MIT's Lincoln Laboratory, SAGE (semiautomatic ground environment) proves to be the method of directing air defense of the North American continent. While few engineers will be surprised, the military has, for the first time, spelled out the interrelation of defense projects long talked about piecemeal.

▶ **What It Does**—In a word, SAGE would make available to defense personnel comprehensive and detailed information about enemy air attacks if the outer defense ring is breached. Sources may be land-based radar (like Dewline), Navy picket ships, Texas Towers or Early Warning planes.

Telephone lines or uhf radio link these radars to a high-speed digital computer. Information is continuous and automatic. Other data comes from Ground Observer Corps, height-finding stations, flight plans and weather stations. Automatic, tv-like displays show development of an air battle.

▶ **Scramble**—With the computer calculating best application of defense weapons, the officer in charge of the Direction Center (heart of the operational unit) sets into flight interceptor planes and long-range missiles that are guided automatically by the system to targets.

▶ **Pushbutton Warriors** – Shock troops in the new type of defense include scientists and technicians



Data received at the Barta Building in Cambridge, Mass. is processed by Whirlwind I computer and displayed

from Lincoln Lab, from IBM, Bell Labs, Burroughs and the Rand Corp. Air Force is the contracting agent.

Quiet Motors, Shield Receivers, FCC Warns

Scope of Commission authority is widened to cover motors, tv receivers and other devices

ACCORDING to recent FCC interpretation any device that sends out a radio-frequency emanation is a radio transmitter. This takes in a lot of territory. Specifically mentioned as incidental radiation devices are electric motors, switches and automotive ignition systems.

If interference is caused to authorized radio services, says FCC, the operator of the device must promptly take steps to eliminate interference. The deadline is Feb. 1.

There is a limitation to the amount of radiation to be permitted from radio receivers operating between 30 and 890 mc, which takes in f-m and tv sets. Receivers manufactured after Mar. 1, 1956 will be required to bear a seal stating that they comply.

►**Voluntary Compliance** — A majority of set manufacturers is already meeting the requirements, according to James Secrest of RETMA. Television sets for uhf placed in production after Dec. 31, 1956 and all such receivers manufactured after June 30, 1957 must comply.

Industry's Future Grows Brighter

Dollar volume estimates are revised upwards as business increases

ELECTRONICS industry dollar volume will rise to $10.8 billion in 1956, nearly a billion dollars more than the 1955 level, according to Sylvania Electric's latest appraisal of future business prospects.

The firm estimates that the industry's volume will exceed $15.6 billion by 1960 and $22 billion by 1965.

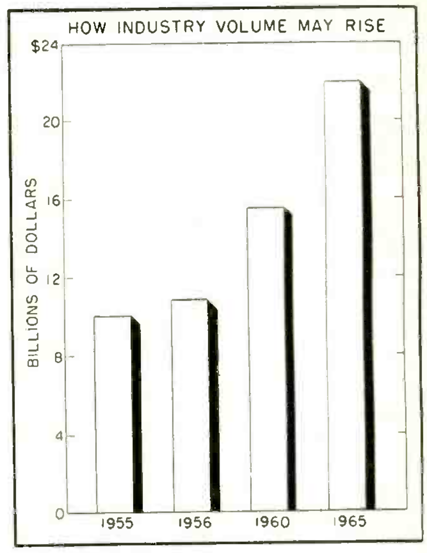
The new estimates are substantially larger than those made about a year ago by the firm. At that time 1955 volume was estimated at $9 billion and was seen reaching $15 billion by 1958-1960 and $20 billion by 1964. (ELECTRONICS, May 1955 p 12). Major revisions were in tv set sales, industrial electronics, distribution revenues and broadcasting volume estimates.

► **TV**—Television set sales to the public in 1956 are estimated at 7.5 million, about 200,000 being color sets, with a total factory value around the billion dollar mark. In 1960 color and monochrome sales combined are expected to total about 9.6 million with a dollar value of $1.5 billion.

In 1965 a volume of 11.6 million sets sold for a factory volume of nearly $2 billion is foreseen. An estimated 31 percent of all sets sold to the public in 1960 will be color sets rising to 72 percent in 1965, according to the firm. Previous total tv sales estimates were $1.2 billion for 1958-60 and $1.5 billion for 1964.

► **Equipment** — Dollar volume of electronics products for industry and commerce such as computers, closed-circuit tv and other nonentertainment applications totaled about $670 million in 1955 according to the company and is expected to reach nearly $800 million in 1956.

In 1960 the total will be around $1.2 billion and reach nearly $1.9 billion by 1965. Previous estimates



were $900 million for 1958-60 and $1.4 billion for 1964.

► **Defense** — Sylvania estimates that 1955 government purchases of electronics totaled just under $2.5 billion and will go well over that figure in 1956. It sees government purchases reaching $3.3 billion by 1960 and nearly $4 billion in 1965.

► **Radio**—In radio, sales of 6 million sets valued at $120 million in 1956, 7 million sets at $133 million in 1960 and 7.3 million sets for $140 million by 1965 were foreseen.

Auto set sales were predicted at 6 million worth $150 million in 1956, 5.5 million at $137 million in 1960 and 6 million at $150 million in 1965.

Records and phonograph volume was seen rising from $121 million in 1955, $123 million in 1956, $135 million in 1960 to $144 million in 1965.

► **Parts**—Sales of tubes and components for repair were predicted as $680.4 million in 1955, $800 million in 1956, $1.2 billion in 1960 and over $2 billion in 1965.

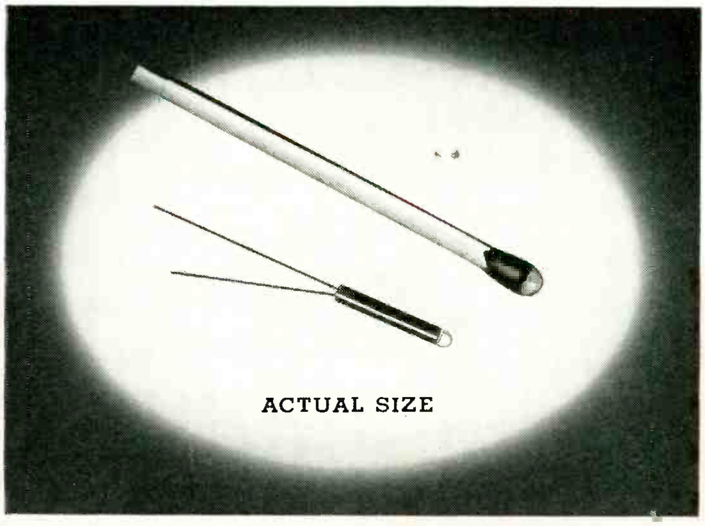
► **Distribution** — Revenues from sales of parts and end products through distribution channels were estimated at $2.2 billion for 1955, $2.3 billion for 1956, over $3.3 billion in 1960 and over $4.8 billion in

(Continued on page 10)

HIGHLY SENSITIVE . . . COMPACT IN SIZE!

SYLVANIA PHOTODIODE

1N77A



THE Sylvania 1N77A is a highly sensitive compact junction photodiode.

Its useful sensitivity covers the visible spectrum and extends into the infrared region where it peaks at approximately 15,000 Angstrom Units.

Consider these advantages:

1. Hermetically sealed in glass.
2. Extreme stability in operation.
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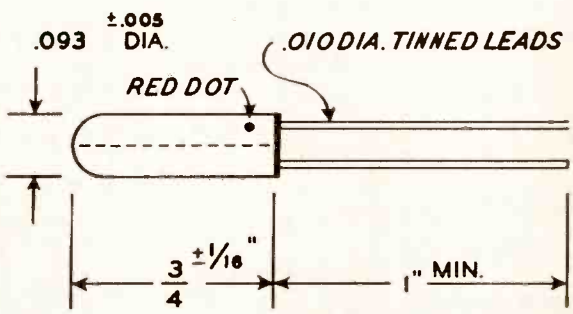
4. Low dark current (100ua @ -50 volts).

The high sensitivity and compact packaging of the 1N77A should provide the answer to many light-sensing application problems. *"Still more reasons why it pays to specify Sylvania."*

DETAIL DRAWING



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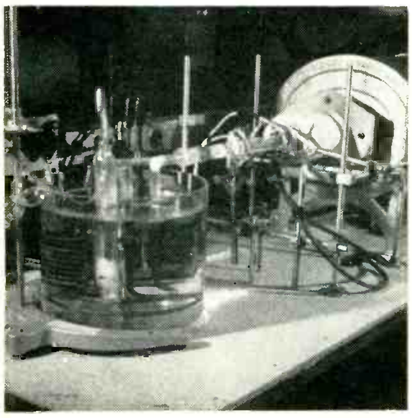
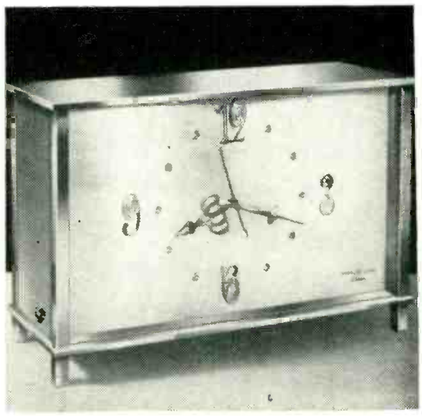
1965. Previous distribution estimates were $2.8 billion in 1958-60 and $4.2 billion in 1964.

▶ **Service**—Repairmen's revenue is expected to rise from $930 million in 1955, nearly $1 billion in 1956, over $1.2 billion 1960 to about $1.7 billion in 1965. Previous estimate for 1964 was $1.4 billion.

▶ **Broadcasting** — Television and radio broadcasting revenues in 1955 were estimated at $1.4 billion and were seen going to $1.9 billion in 1956, $3.4 billion in 1960 and over $5.4 billion in 1965. Previous 1964 estimate was $5 billion.



Bell Labs diffusion oven,



GE electronic clock and

Japanese tape recorder show how . . .

Transistors Progress, Applications Multiply

New fabricating techniques and circuit applications mean more business in 1956

THIS year may be a big one for transistor manufacturers. Several firms are talking about transistors with frequency and power-handling ability equal to or better than many commonly used electron tubes. Meanwhile, several companies have announced transistors selling retail around one dollar.

▶ **High Frequencies**—A contribution to high-frequency transistors has been made by Bell Labs with the diffused junction transistor. (See page 137.) Extremely thin base layers result when vapor impurities diffuse into a solid crystal.

Both germanium and silicon units have been made. Germanium units operate up to 600 mc with 150 mw permissible collector dissipation. Silicon units attain only 120 mc but can dissipate up to 500 mw.

Germanium transistors are in pilot-plant production at Murray Hill with full-scale production of silicon and germanium types for military applications slated for later this year.

▶ **Processes** — Fused-junction *pnp* silicon transistors have been produced by Raytheon. Most silicon units are grown-junction *npn*. The *pnp* transistors provide current gains up to 24 with 50 mw collector dissipation at 135 C.

A variation of the *pnp* fusion technique, announced by Westinghouse, has paid off in high-frequency transistors and sensitive photodiodes. A cooling period is introduced to provide controlled uniform regrowth at junctions.

▶ **Electronic Clock** — A cordless electronic clock announced by GE keeps time using 60-cps inductive pickup to synchronize a tuned oscillator which in turn powers a low-friction p-m motor. A ferrite antenna picks up the a-c; three 2N43 transistors and one 1N67A germanium diode on a printed wiring board comprise the electronic elements. The clock runs off flashlight cells.

▶ **Auto Radio**—GM's Delco Radio Division has announced a hybrid radio for the Chevrolet Corvette. Power transistors made by Delco will be used in the output stage and as an oscillator to replace the vibrator in the power supply.

Reportedly under development are transistor auto radios that can either run off a 12-v storage battery or from a self-contained mercury battery when removed from the car's dashboard.

▶ **Tape Recorder**—A transistorized tape recorder announced by Tokyo Tsushin Kogyo of Japan uses eight *npn* alloyed germanium transistors. The recorder provides one hour recording time at slow speed. It utilizes a special magazine that accommodates ¼-in. tape. Tape speed is 1⅞ or 3¾ in. a second. Designed for professional use, the unit will sell for about $300.

Three transistors are used in separate record and playback amplifiers. The arrangement permits monitoring the tape while recording. Two transistors are used in the 25-kc bias oscillator. The recorder will operate 40 hours on mercury cells. Input is a small dynamic microphone; output is a crystal headphone.

▶ **Production**—Two junction transistors announced by RCA are aimed specifically at the auto-radio market. The 2N139 is a 455-kc i-f amplifier that provides 30-db gain.

(Continued on page 12)

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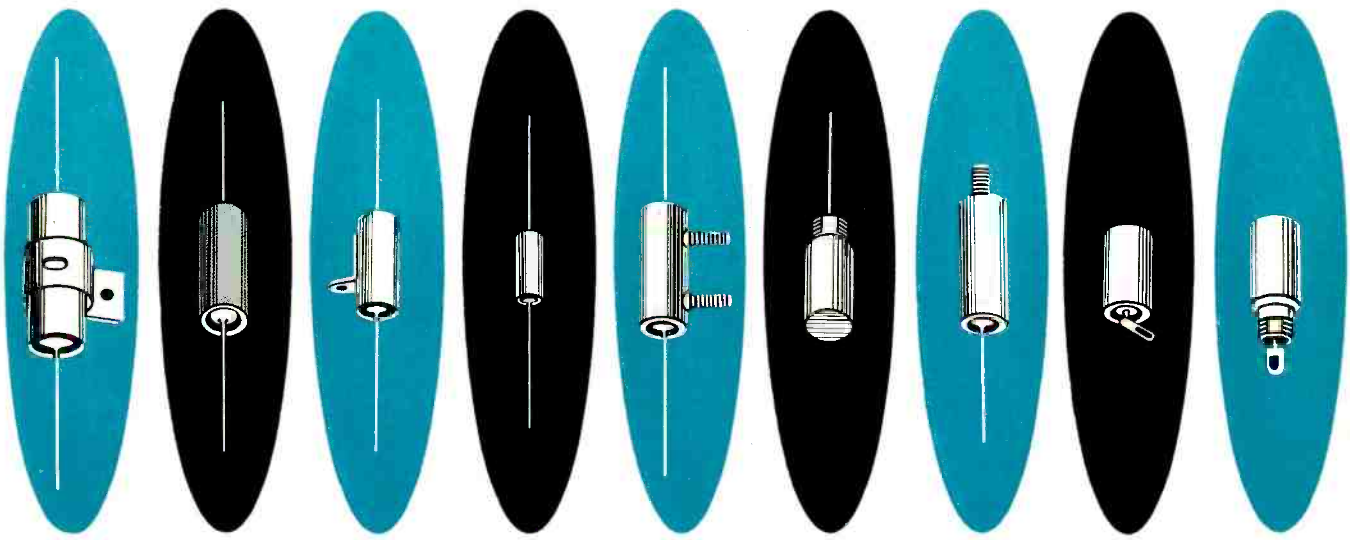

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The 2N140 is a mixer that provides a conversion power gain of 27 db.

Germanium power transistors in pilot-plant production by Mallory may be useful as single-ended output stages in auto radios. The 441 operates at 12 v and provides a grounded-emitter current gain of 90 with 5 w permissible collector dissipation. It sells for $12.50 in lots of 50 or more. Another unit can handle 30 w with a current gain of 30. Cut-off frequency is below 15 kc.

Sun powered GE radio receiver

► **Sun Power**—Experimental sun-powered radio receiver developed by GE will run continuously in daylight and up to 500 hours in darkness without recharging. The pocket-sized unit weighs 10 oz, contains four transistors, seven selenium solar cells and other components in a transparent plastic case. Output is to an earplug. In the absence of sunlight, the radio will operate from a 100-w bulb.

Commercial Scatter Circuit Authorized

A NONGOVERNMENT long-distance radio circuit employing ionospheric scatter techniques will be set up by Aeronautical Radio, Inc. Designed to handle fixed communications between Miami, Florida and San Juan, Puerto Rico, the link stretches 1,040 miles.

► **Assignment**—FCC has no frequencies specifically set aside for circuits employing ionospheric scatter. The aeronautical fixed stations KIC32 and WWQ78 will be granted modification of license to employ 29,820 and 24,940 kc. Power of 20 kw will be used.

Research And Development Gains

Research and development costs and employment are highest in electronics

THE electronics-electrical equipment industry leads all other U. S. industries in the scale of its research and development activities. Costs totaled about $778 million in 1953, more than 20 percent of the grand total of $3.7 billion for all U. S. industry. The aircraft industry, which is heavily engaged in electronics research and development, ranked second with costs of $758 million.

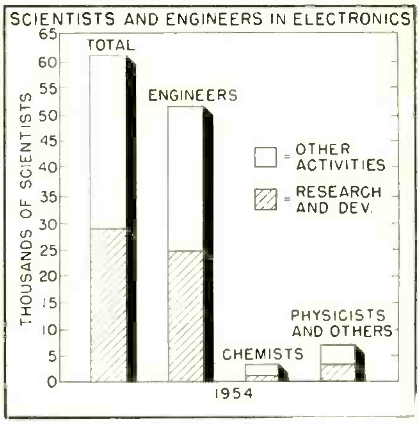
Number of firms in the industry conducting r & d totaled 1,140 or 7.3 percent of the nation's 15,560 r & d firms. These were some of the conclusions of the recently released National Science Foundation preliminary report on research and development costs.

► **Manpower**—The survey showed that there were 61,000 scientists and engineers employed in the industry in 1954, representing 11 percent of the country's 553,800 engineers and scientists. Of the 61,000, 51,000 were engineers, 3,000 were chemists; 900 were metallurgists, 2,200 were physicists, 700 were mathematicians and 3,200 were in other classifications.

The electronics-electrical industry had more scientists and engineers in research and development work than any other industry. Of the total of 61,000 in the field, 28,800 or 48 percent were so engaged. Of these, 24,600 were engineers, 1,100 were chemists and 3,100 were in other classifications.

► **Size**—Small firms in the electronics-electrical field accounted for more research and development in terms of cost than small companies in any other industry. For firms in the industry with less than 500 employees, r & d costs totaled about $96 million in 1953. Next highest, the machinery industry, had costs of $73 million.

Nevertheless, the bulk of the money for electronics was spent by large companies with 5,000 and



more employees. These firms accounted for $516.9 million or 66 percent of the industry's total $778 million. Small firms accounted for only 12 percent. Medium-size companies accounted for the rest.

► **Basic Research** — The study shows that the industry spent $18.7 million on basic research in 1953, representing 2.4 percent of its total r & d cost. But as a proportion of the industry's total r & d cost, it was among the lowest of any industry.

Basic research, for the purposes of the survey, was defined as projects which are not identified with specific product or process applications, but rather have the primary objective of adding to the overall scientific knowledge of the firm.

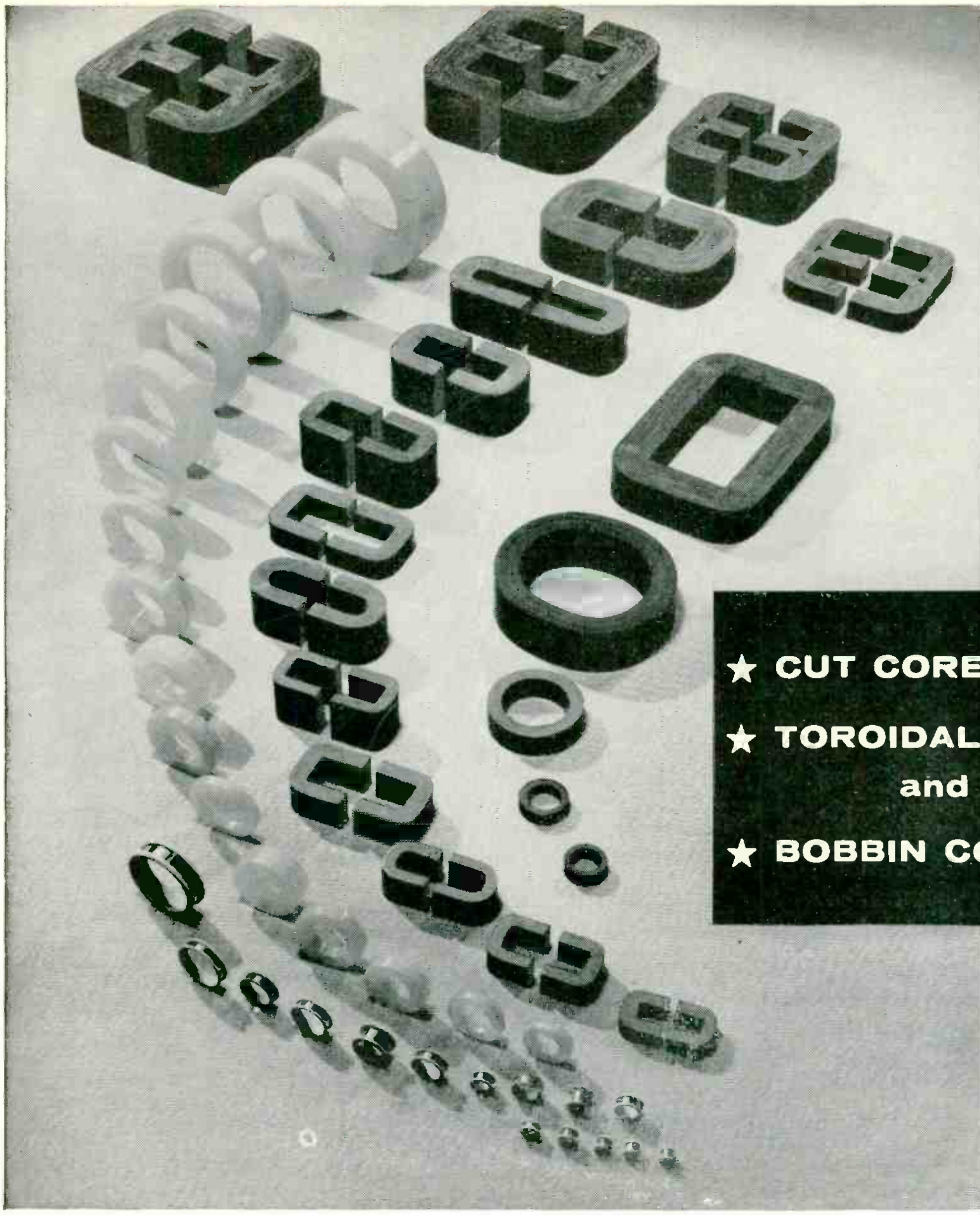
F-M Stations Take On New Business

Two services are helping to arrest the downward trend in f-m broadcasting

NUMBER of f-m broadcasting stations on the air in the U. S. has declined steadily in the past five years. In the past 12 months the number dropped from 554 to 536 stations. However, f-m broadcasting has made gains in noncommercial education stations and in the functional music field.

► **School**—There are 125 noncom-

(Continued on page 14)



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MATERIALS: Deltamax, 4-79 Mo-Permalloy, Supermalloy, Mumetal, 4750, Monimax, Silectron, Permendur: all are available for tape wound core applications. The choice of material will depend upon the specific properties required.

GAUGES: The following standard tape thicknesses are available for Arnold tape wound cores in most of the magnetic materials mentioned above: .012″, .004″, .002″, .001″, .0005″, or .00025″. Bobbin cores are made from tape .001″ to .000125″ thick.

SIZES: Cores weighing from a fraction of a gram to many hundreds of pounds can be supplied. Toroidal cores are made in 27 standard sizes with nylon cases. Types "C" and "E" cut cores are made in a total of 530 standard sizes. Many special sizes and shapes of both gapless and cut cores are manufactured for unusual requirements. ● *Let us work with you.*

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mercial educational f-m stations on the air today compared to 117 a year ago. Leading states with school f-m are California and Indiana, with 11 stations authorized, followed by Ohio with 9, Wisconsin with 8, and Texas and Pennsylvania with 7 each. Philadelphia, Boston, Dallas and Louisville each have three educational f-m authorizations.

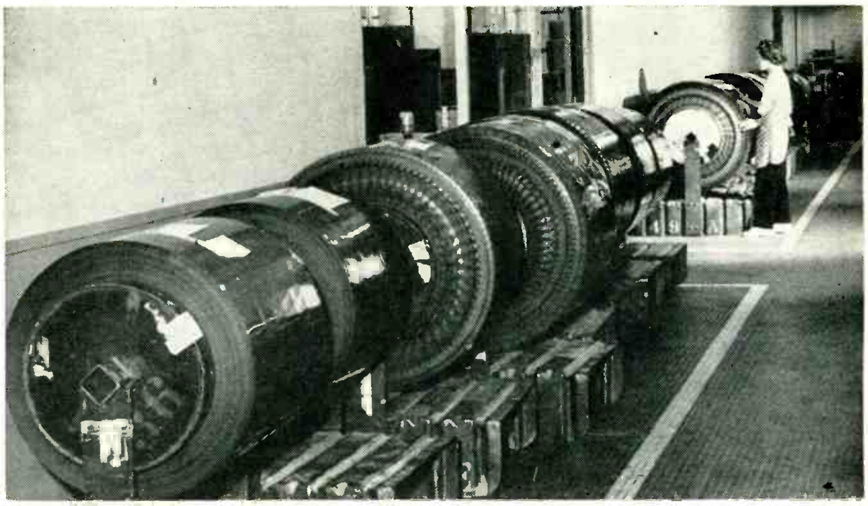
▶ **Background Music**—Last March, FCC amended its rules to permit f-m stations to enter the functional music field as an addition to their regular f-m broadcasting service. The service is limited to background music furnished to commercial and industrial organizations, storecasting and transitcasting to passengers on public vehicles.

Under a subsidiary communications authorization an f-m station may transmit functional music on a multiplex basis at any time. Until July 1, 1956, stations may broadcast functional music on a simplex basis during the time not devoted to the required 36 hours a week of f-m broadcasting. Formerly, all f-m stations were required to broadcast a minimum of 42 hours a week with at least 6 hours broadcasting daily.

▶ **Growth** — The first subsidiary communications authorizations for f-m stations were made last October. Now there are about 44 f-m stations in the functional music field. All of them operated on a simplex basis until January, when two began commercial multiplex.

By the July 1, 1956 deadline, it is expected that at least 40 or 50 stations will be on multiplex. Nine or ten multiplex stations are expected by mid-February.

▶ **Equipment** — Multiplex Services Corp. of New York City has a basic multiplex transmitter available for $4,500. Receivers and adapters sell for $169, including crystal. The firm estimates that in early January, about 50 multiplex receivers were in use but expects more when more transmitters go on the air. Its transmitters are being built by Gates Radio and its receivers by Browning Laboratories.



JUMBO rolls of magnetically coated acetate film, ready for slitting, are produced at Minnesota Mining as . . .

Magnetic Recording Sales Rise

Volume in 1955 exceeds mid-year estimates. Tape sales gain sharply

SALES of magnetic tape recorders and of magnetic tape in 1955 topped many of the most optimistic estimates. Latest estimate by Minnesota Mining and Manufacturing shows that some 360,000 recorders of all types were sold in 1955, exceeding 1954 sales by nearly 100,000 units.

▶ **Gains**—Major increase was made in sales to the home market in which recorders selling for under $300 make up the bulk. An estimated 300,000 units priced under $300 were sold in 1955 compared to about 255,000 units in 1954. Sales of recorders in the $300 to $600 price class reached about 50,000 units in 1955.

In the professional tape recording equipment field, units selling for more than $600, some 10,000 units were sold last year, the only segment of the business that did not exceed expectations. About the same number were sold in 1954.

Based on an average price for each category, total tape recording dollar volume probably exceeded $77.5 million in 1955, not including recording tape or accessory sales. Minnesota Mining estimates that sales of magnetic tape alone reached $8.1 million last year compared to $7.2 million in 1954.

▶ **Expansion**—There are about 100 companies in the field compared to 75 a year ago. Tape recorder manufacturers are making expansion plans. RCA recently announced a $2.7 million plant expansion for the production of tape recorders and hi-fi instruments.

Magnetic tape is used to call floors and make other announcements in a Westinghouse automatic elevator. Tape units have been adapted for supermarkets to tell shoppers where to find food items. Three Atlantic Coast Line trains have magnetic tape systems to provide background music for passengers.

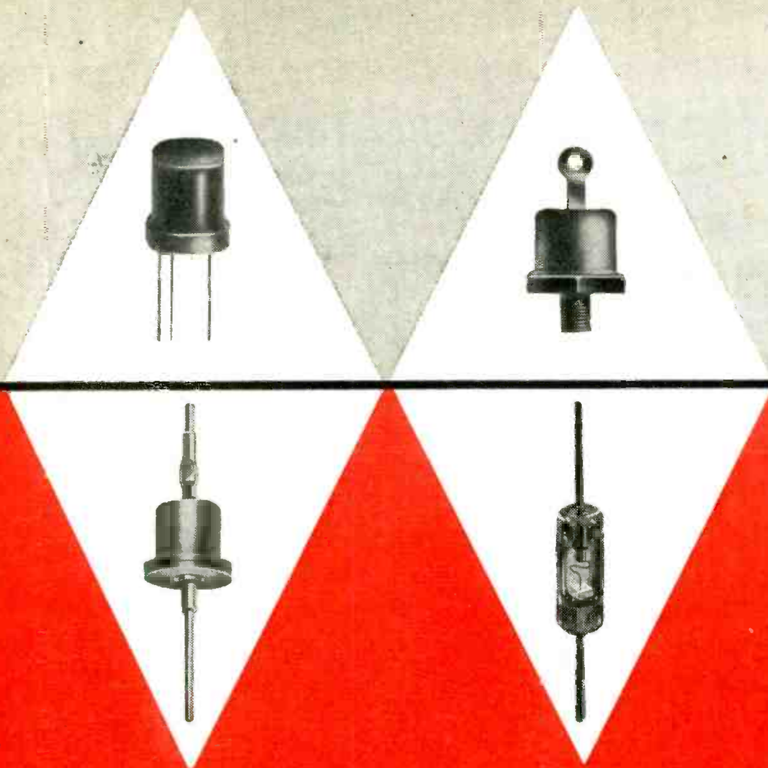
Television Networks Swing To Microwave

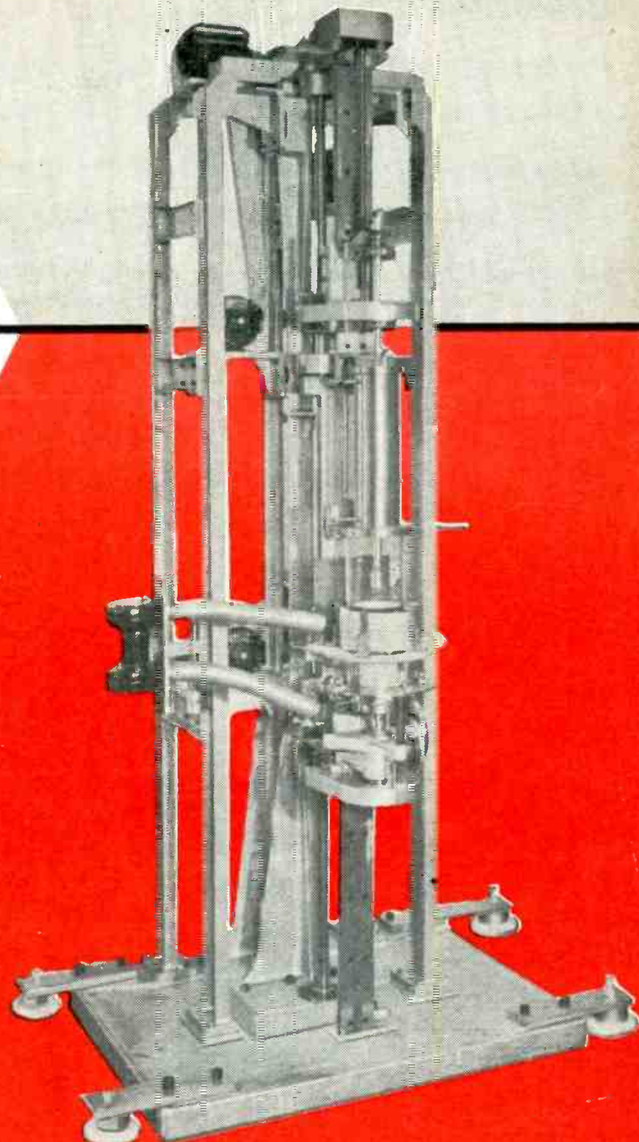
Facilities are revamped for color as intercity cable-radio relay system expands

SEVEN-YEAR progress report by the Bell System shows television intercity network facilities have expanded from 900 channel miles in 1948 to 70,000 channel miles today.

Channel miles is the distance between points multiplied by the number of tv channels available. Facili-

(Continued on page 16)





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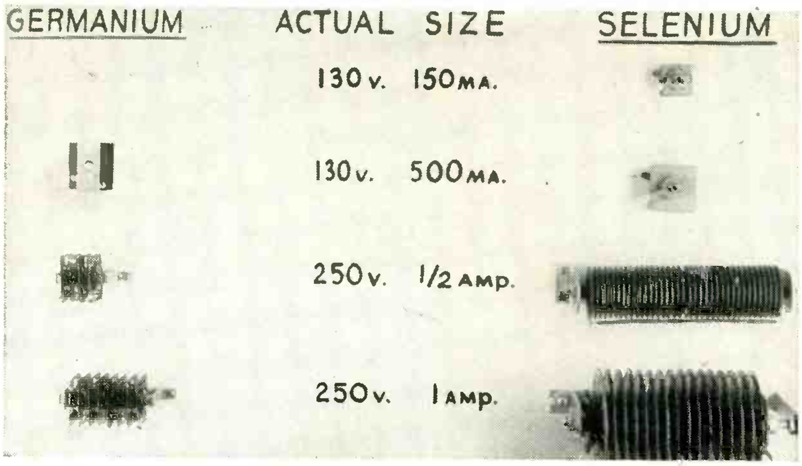
ties link 391 stations in 262 cities.

▶**Color**—Additional channel bandwidth and increased transmission fidelity is required for handling color television signals. Intercity tv facilities suitable for color transmission number 51,000 channel miles and link 190 stations in 134 cities.

The requirements of color may have stimulated the change from coaxial cable to microwave radio relay. At the end of 1948, 77 percent of tv network facilities was coaxial cable and 23 percent radio relay. By the end of 1954 the balance was 70-30 in favor of microwave.

▶**Investment** — The Bell System has $250,000,000 invested in tv network facilities. Operation and maintenance require 1,000 engineers and technicians. Coordination requires 24,000 miles of telephone and 20,000 miles of teleprinter service. The system includes about 1,500 microwave stations.



Size comparison between equivalent GE germanium and GE selenium rectifiers indicates how . . .

Germanium Rectifiers Save Space

Production moves ahead faster to meet increased industrial and military needs

OUTPUT of germanium power rectifiers was negligible before 1952 and gained relatively slowly in the next two years due mainly to production problems. In the past year, gains have been made in breaking the production bottleneck and output has increased substantially. General Electric estimates that cumulative industry production reached about 6 million units in 1955.

▶**Firms**—A handful of firms are responsible for 90 percent of the output. The amount of development required for the units is large and the facility investment is substantial.

▶**Application** — Although germanium rectifiers can be used for almost any application where d-c is required, most of the units have been used in military and commercial equipment. They have found increasing application in military gear because they are lighter in weight, in some cases 100 times lighter, than rectifiers of other types.

▶**Gain**—Aiding the increasing use of germanium rectifiers has been the continuing selenium shortage. Also, silicon rectifier production has remained relatively small although higher production is expected in 1956. For germanium units, GE estimates that the market will more than double this year over 1955.

Increasing output of the units has helped to decrease prices. For large quantities, they range in price from about $1 to $25 each. Germanium power rectifier stacks, in large quantities, range from about $8 to $50 each.

Automatic Production Creates New Jobs

Labor Department describes six job types for the electronics industry

INCREASING use of automatic production techniques in the electronics industry has created new jobs for production workers. Here are descriptions of some of the new jobs as listed by the U. S. Department of Labor.

▶**Automation Machine Operator**—Operates radio or tv automatic machines to insert and fasten parts on circuit boards. Requisitions and expedites production parts. Receives production orders and allocates machine time to produce required units. Tabulates production records and arranges for lot shipment to other areas. Requests machine adjustments to correct substandard work.

▶**Automation Assembler** — Loads parts into automatic feed channels of automatic machines. Checks completed circuit boards for missing or loose parts and makes insertions or repairs as necessary. Matches color codes, reads production part numbers and uses simple hand tools.

▶**Automation Machine Tender**—Operates automatic machines to insert and fasten tube sockets, resistors, jumper wires and capacitors on circuit boards. Clears operating mechanisms, removes jammed parts and restarts machine making simple adjustments as required. Rethreads machine with jumper wire.

▶**Stager**—Checks prepared plates for bubbles, blisters and unexposed areas prior to etching operation. Touches up imperfections using paint and brush. Scrapes excessive printing as necessary.

▶**Printed Circuit Sprayer** — Sets up and operates spray gun to lacquer surfaces. Cleans and adjusts spray gun. Assists in other produc-

(Continued on page 20)

Automatic Sweep

for *Any* of your Manually-Operated Devices

Used in combination with G-R's popular line of Unit Oscillators, the Sweep Drive makes available sweep generators for the frequency ranges: 500 kc to 50 Mc, 50 Mc to 250 Mc, 65 Mc to 500 Mc, 250 Mc to 920 Mc, or 900 Mc to 2000 Mc. The device can be coupled to either the generator, slow-motion drive for sweeping over small ranges or coupled directly to the main shaft to take advantage of the extremely wide frequency ranges of G-R Unit Oscillators.

Would you like to be able to take any one of your manually-driven oscillators off the shelf and convert it to a sweep device, as the need arises? The instrument is now available which permits you to do this. *One* instrument, G-R's Type 1750-A Sweep Drive, makes it possible for you to have as many sweep generators as you have hand-operated oscillators.

The Sweep Drive readily attaches to a wide variety of shafts, knobs or dials for automatic mechanical sweeping of a wide variety of equipment. Sweep Arc, Speed and Center Position are all continuously variable, even while the Drive is in motion.

While the display of amplitude-frequency characteristics on an oscilloscope has proven an important use for the Sweep Drive operating a signal source, this versatile device is not by any means limited to this application. The Drive can be used to turn shafts automatically for almost any purpose . . . for driving a receiver or analyzer to obtain panoramic response . . . to open or close a shutter or switch . . . to modulate light, sound or heat.

The uses for this instrument in engineering or production-test department are countless. The wide variety of data which can be conveniently displayed on a CRO as a continuous function of an independent variable, makes the Sweep Drive an invaluable time saver for the engineer.

G-R Type 1750-A Sweep Drive $400

Wide Range of Speeds — 0.5 to 5 cps, reciprocating motion.

Sweep Arc — adjustable from 30° to 300°

Center-Position of Sweep Arc — adjustable to any position; on reduction drives, may be set to any point within eight full turns — is not affected by arc of sweep.

Universal Coupling System — four adjustable spider-like arms readily attach to knobs and dials, 1″ to 4″ diameter and shafts ¼″ and ⅜″ — shaft height also adjustable.

Limit-Switch Circuit — disconnects and brakes the motor if preset limits of shaft travel are accidentally exceeded.

CRO Deflection Circuit — provides a voltage proportional to shaft angle for application to the horizontal deflection plates of an oscilloscope.

Blanking Circuit — eliminates the return CRO trace and produces a reference base line.

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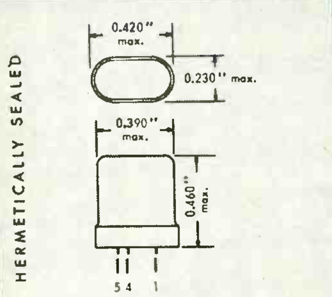
PNP HIGH TEMPERATURE SILICON TRANSISTORS

RAYTHEON now offers PNP Silicon Transistors having these outstanding advantages:

- **Collector Saturation Voltage** — averages 1 volt or less at 20 mAdc collector current.
- **Reverse Emitter Voltage** — 22 volts
- **Rugged and Reliable** — manufactured by Raytheon's dependable fusion-alloy method!

The improved electrical performance, reliability and mass production advantages of Raytheon's fusion-alloy process are now available in silicon transistors. Raytheon PNP High Temperature Silicon Transistors are ideal for use in low frequency amplifiers, switching circuits and as replacements for relays in airborne electronic equipment operating at high ambient temperatures.

The superiority of the Raytheon perfected fusion-alloy process has been proved through the successful manufacture of several million PNP Germanium Transistors by Raytheon, the largest manufacturer of transistors. The new plant of the Raytheon Semiconductor Division is ready to mass produce both Silicon and Germanium Transistors to meet your needs.



ABSOLUTE MAXIMUM RATINGS

Types: **CK790 • CK791 • CK793**

Collector Voltage (diode)	—100 Vdc
Emitter Voltage (diode)	—22 Vdc
Emitter Current	50 mAdc
Collector Dissipation at 135°C	50 mw

AVERAGE CHARACTERISTICS

Type	Reverse Current at —24V Collector µA (max.)	Reverse Current at —24V Emitte µA (max.)	Beta	Base Resistance ohms	Collector Resistance kilohms	Noise Factor db (max.)	Collector Capacity µµf	Alpha Freq. Cutoff KC
CK790	0.2	0.2	14	1200	500	30	30	400
CK791	0.2	0.2	24	1400	500	30	30	600
CK793	0.2	0.2	16	1300	500	15	30	500

Above characteristics are average except where noted and are taken at I_E = 1 mAdc; V_C = −6 Vdc; Ambient temp. 25°C.

RAYTHEON TRANSISTORS

more in use than all other makes combined

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tion operations as required.

▶**Printed Circuit Machine Operator**—Operates a variety of short-cycle machines to prepare, expose and etch production parts for pre-designated lengths of time. Scrubs, sensitizes and etches parts with nontoxic solutions of prepared strength. Assists in other printed circuit operations as required.

Finance Firms Take To Electronics

Growth of the field and attendent money problems bring specialized lenders

WITHIN the past three years the number of new companies entering the electronics field has increased steadily. In California alone at least one new electronics company a week has been formed in the past year.

Many new firms unable to obtain bank credit have turned to commercial financing companies. A number of commercial financing companies now specialize in electronics financing.

▶**Volume** — Coastal Commercial Corp. of New York reports that its business is nearly 60 percent composed of small electronics firms.

The firm estimates that approximately $100 million will be needed by some 10,000 small companies in the electronics, metal machine work and sheet-metal parts business in the next 12 months.

▶**Need** — Often applicants for loans are referred to the specialized lender by banks, although some are referrals from larger manufacturers seeking to help put subcontractors and suppliers on a financially sound basis.

About 26 months is the average period of relationship between borrower and specialized lender. By then a firm can usually operate through ordinary banking circles. Loans range between $5,000 and $100,000 with the average outstanding balance running about $36,000.

New Models Ready For '56

Color sets, transistorized radios and remote controlled black-and-white sets shown

MANY major radio and television receiver manufacturers have announced new models. New color sets and more transistorized portables high-light the new sets. Many black-and-white receivers introduced incorporate remote and automatic tuning devices.

▶**Color**—Admiral, Emerson, Philco and RCA were among the manufacturers introducing new color receivers. Sylvania has announced plans to begin production on two or three models with 28 to 30 tubes in April. Capehart and Hoffman are presently producing their own color sets. New plans of Motorola have yet to be announced. CBS-Columbia, GE and Zenith have not announced new color production plans.

Most of the manufacturers who introduced new color sets limited them to one or two models. RCA offered three new models bringing the number in its color line to five sets ranging in price from $695 to $995. The sets all have 21-inch picture tubes and 26-tube circuits.

Cordless, all transistor home radio that operates on six transistors and a self-contained battery is CBS-Columbia chairside model

▶**Transistors**—In the past month Emerson introduced two transistor portables, one using 6 transistors and the other using 3 transistors and 3 tubes. CBS-Columbia displayed a battery-operated home radio using 6 transistors and a personal portable using five.

▶**Monochrome**—The Zenith line of 45 models represented perhaps the largest new tv line introduced. Most other manufacturers introduced fewer sets as fill-in models. Major changes in the new sets were in automatic and remote control tuning devices.

GE introduced three new portable tv receivers that use aluminum in the cabinet and chassis pan instead of steel for a 20-percent reduction in weight. Fifty percent of all circuits in the sets are printed and 80 percent of the connections are made by automatic dip-soldering. The CBS-Columbia line featured two new chassis, one with 30 tube functions and the other with 23.

Will Sun Spots Boost Mobile Sales?

Increased reflection from ionosphere beginning to disrupt vhf communications

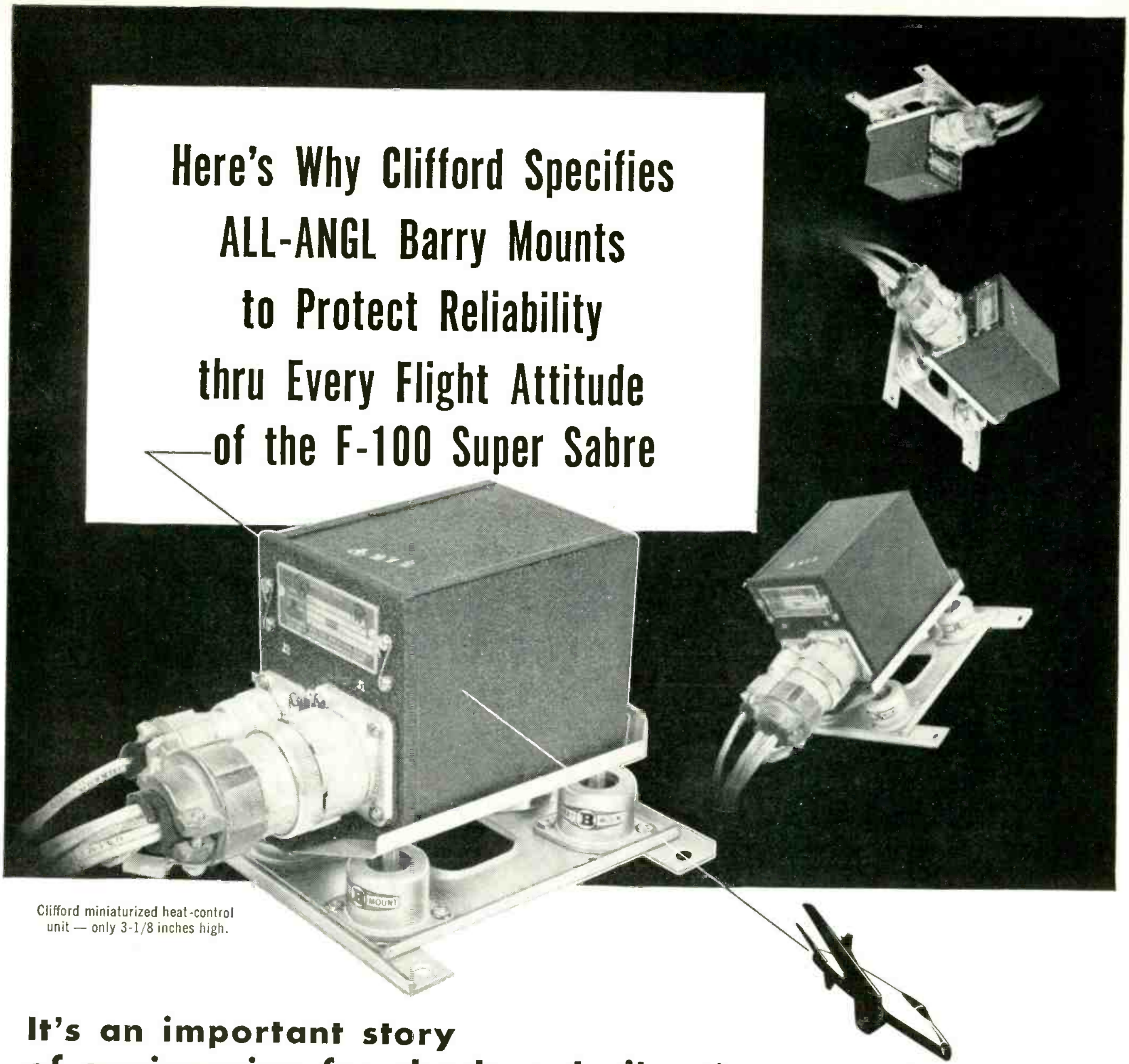
OPERATORS of communications services are being urged by FCC to consider moving out of the 25-to-50 mc region into the higher bands.

Reason for the warning is the upswing in the sunspot cycle that improves the ability of the upper layer of the ionosphere to reflect signals. An 11-year peak is expected to occur during the winter of 1956-57.

▶**Sales Potential**—Not all users of the principally affected frequencies will need to move—only those requiring nearly complete protection from interference. According to a recent survey, special industrial radio users already encounter occa-

(Continued on page 22)

Here's Why Clifford Specifies ALL-ANGL Barry Mounts to Protect Reliability thru Every Flight Attitude of the F-100 Super Sabre



Clifford miniaturized heat-control unit — only 3-1/8 inches high.

It's an important story of engineering for shock and vibration control

North American Aviation, builders of the F-100 Super Sabre, specify that the control box must be able to mount at any angle. MIL-E-5272A requires the mount to operate under vibration as high as 0.080″ double amplitude. Temperature requirements preclude the use of rubber mountings. And experience demands that the mounting system handle the load bias added by large connectors and cables — often a serious problem with miniaturized equipment.

Because they are specifically designed for jet and missile service, ALL-ANGL Barry Mounts meet all these requirements. So Clifford's choice of this mount assures the protection of their new miniaturized heat control under every operational condition.

The ALL-ANGL Barrymount® isolators used in the Clifford base are standard miniature size. These advanced-design mountings are also available in MIL-size 1 and (Feb. 1) MIL-size 2. Write for data sheets.

When your problem is protection through all flight attitudes, your answer is ALL-ANGL Barry Mounts. For recommendations, call your Barry Sales Representative.

BARRY B MOUNT

BARRY CONTROLS
INCORPORATED
SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

New engineering opportunities are open in Barry's expansion program, at all levels in all departments. Send resumé.

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sional cochannel interference that completely disrupts communications. Relative percentages for the different bands are: under 30 mc, 27; 30-40 mc, 18; 40-50 mc, 11; 152-174 mc, 8.

There are reports of police radio systems jammed for hours at a time. Since it is impracticable to convert 50-mc equipment to 150 mc or higher, nature's freakishness may prove a business bonanza.

TV Stations Equip For Color

Network affiliates and owned stations continue to gird for color

As of the end of 1955 there were approximately 225 tv stations equipped to broadcast network color shows. Fifty-five had color film and slide equipment and 17 had "live" color equipment. The total represents a minimum equipment investment of some $10 million.

▶ **Network** — Currently 106 of NBC's affiliates are equipped to transmit network color shows, 32 have slide and film equipment and 11 can originate live color shows. At the beginning of 1955 only 81 of its stations were equipped for network color.

RCA plans to lease color tv mobile units to its color stations.

▶ **Gain**—CBS in a December status report of equipment for network and local color shows reported that 110 affiliates were equipped for network color, 6 with studio, film and slide equipment, 24 with film and slide equipment and 1 with slide equipment only. Eleven additional CBS affiliates were definitely scheduled for color in 1956.

▶ **Others**—ABC reports that it does not plan to equip its owned stations for color until there are a sufficient number of color tv receivers in use.

Du Mont's New York outlet is equipped for color but as yet, its station in Washington, D. C. is not.

General Teleradio reports that although some of its stations have experimented with color equipment, none of them is currently equipped for color transmission.

Color tv mobile units such as this will be leased by RCA to tv broadcasters for local events

Small-Boat Electronics Gets Industry Nod

RCA groups take over additional duties to serve $1-million dollar market

Over 20 million Americans use some 5 million pleasure boats. About 4.5 million of these are power craft, a potential haven for broadcast, communications and direction-finding equipment. The owners of such craft and owners of commercial boats provide a market for lightweight developments in the field of radar, sonar, depth-finding and safety-at-sea.

▶ **Reorganizing** — Recognizing a trend, RCA is streamlining its functions to provide marine equipment and services most economically. Functions of Radiomarine Corporation of America may be distributed throughout other RCA subsidiaries.

With approval of FCC, marine radio traffic will be handled by RCA Communications, service will be performed by RCA Service Co. while engineering, manufacture and sales of equipment will be taken into RCA manufacturing divisions.

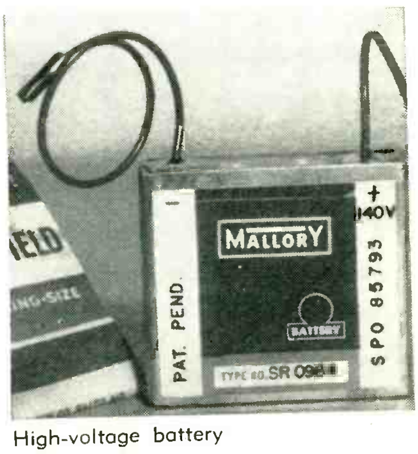
Recent Equipment Emphasizes Batteries

Military electronics and test equipment markets up sales of small batteries

Sale of all types of batteries, dry and storage, is running at $75 million annually according to estimates by one large manufacturer. The dry-battery market amounts to $35-40 million of which $16 million goes to the military.

▶ **Dry Batteries**—In some applications the common dry cell, which uses an electrochemical couple of zinc and manganese dioxide, is being supplanted by cells using silver or mercuric oxide. These latter cells are higher priced but feature high ampere-hour capacity and small size.

The mercury cell is used in hearing aids and as a reference in measuring instruments. Use as an auxiliary supply for transistor auto radios is under study. Market for mercury cells is $9-10 million of which 30 percent is military. Sales include many for air-sea rescue work.



High-voltage battery

▶ **High-Voltage** — A pile developed by Mallory puts out 200 v a cubic inch. Its current output is about 0.1 microampere. Shelf life is 18-24 months. Use is foreseen in ion chambers, Geiger counters, scintillation counters, bias cells and in charging capacitors to detonate fuzes.

The battery comes in sizes up to

(Continued on page 24)

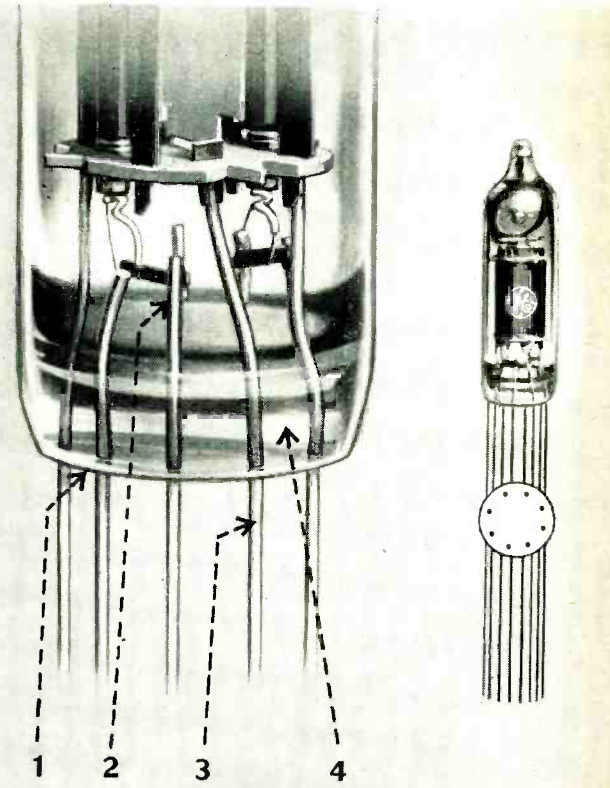
BUTTON-STEM BASE OF G-E 5-STAR SUBMINIATURES INCREASES RELIABILITY... LENGTHENS TUBE LIFE!

1 G-E 5-Star subminiature leads—spaced out circumferentially—are more than twice as far apart as with pressed-stem base construction, where the leads are in line. Also, spacing is more accurate and uniform. These widely-spaced leads help ward off glass electrolysis (which increases rapidly with higher temperatures) in the area where leads pass through the seal of the tube envelope. *Means a longer-life seal and tube,* since electrolysis, a result of electrical leakage, breaks down the glass to a point where vacuum is impaired and tube failure can occur.

2 5-Star leads within the tube and seal are short, and parallel one another for a minimum distance—unlike pressed-stem internal leads, which are long and extend side-by-side. Result: *5-Star tube capacitance is lower,* giving improved circuit performance, especially at high frequencies.

3 8 external leads in all are available with 5-Star subminiatures, against a maximum of 7 for pressed-stem tubes. With many tube types, this *provides increased flexibility for the circuit designer.* For example, only button-stem subminiature twin triodes can offer the designer separate cathode connections!

4 Button-stem base construction makes 5-Star subminiatures *nearly 10% shorter (approx 1/8 inch) than pressed-stem tubes.* Equipment designers who face strict space limitations, benefit from G-E 5-Star compactness!



Right: actual size. Seated height of tubes is only 1.375 inches (max). Circular diagram over base pins shows how circumferential arrangement of leads in G-E 5-Star subminiatures, spaces them more widely apart than the in-line leads of pressed-stem tubes.

Add to these advantages of button-stem base construction, special 5-Star design throughout—sturdy, shock-resistant, electrically efficient and dependable! Add painstaking tube manufacture by selected, trained G-E 5-Star workers, in a separate 5-Star building where employees wear lint-free garments, and the air is pressured, filtered, and dehumidified to keep out dust!

General Electric 5-Star tubes are the most reliable subminiatures you can install. Specify them for critical military and commercial applications! *General Electric Company, Tube Department, Schenectady 5, New York.*

18 G-E 5-Star subminiatures are available, for a comprehensive range of circuit applications:

5718	5896	6021
5718-A	5896-A	6021-A
5719	5899	6111
5719-A	5899-A	6111-A
5840	5902	6112
5840-A	5902-A	6112-A

Progress Is Our Most Important Product

GENERAL ELECTRIC

162-181

150 v which size is designed for charging a 0.1-microfarad capacitor. Voltage is developed by a couple consisting of a chrome-plated copper disk and a pressed-powder disk of barium permanganate with lead dioxide. This couple gives 1.62 v. Other combinations can achieve higher voltage or lower voltage and higher permissible current drain

▶ **Low Temperature**—The pile uses a solid ionic conductor as electrolyte. This is a pressed disk of amorphous stannous sulphate powder. The battery delivers stable open-circuit voltage at ambient temperatures from 70 to −40 C.

The battery at present would sell from 2 to 3 cents a volt. Target price is one cent a volt.

Transmitter Antenna Sales Up

TV stations seek more coverage with higher towers. Forward-scatter antennas take hold

CONTINUING growth in the number of tv, radio and communications stations has increased the business volume of antenna makers. In fiscal 1955, the number of antenna applications processed by FCC exceeded all previous years, with a total of 9,131, an increase of some 100 applications per month over 1954. However, fewer tv antenna applications were processed.

The number of antenna applications filed also reached a record high during fiscal 1955 totaling 9,856, an increase of more than 200 applications per month over fiscal 1954. Antenna applications for broadcast and common carrier services decreased slightly while safety and special radio proposals increased from 5,357 to over 8,000.

▶ **Television Skyhooks**— At the close of fiscal 1955, 28 tv towers 1,000 feet in height or higher, were in operation and construction permits for 13 additional towers over 1,000 feet high were outstanding.

Among the higher towers are: WFAS-TV and KRLD-TV in Dallas, Tex., with a height of 1,521 feet; KSWS-TV, Roswell, N. Mex., 1,610 feet; and KGEO-TV, Enid, Okla., 1,356 feet.

FCC made an initial decision approving the move of KGEO-TV to the 1,356-foot tower but the Defense Department asked for reconsideration of the decision. Also awaiting approval by the FCC are WSLA, Selma, Ala. for a 1,993-foot tower and WHAS-TV, Louisville, Ky., for a 2,003-foot tower, which would be the world's highest structure.

▶ **Distance Increases** — Forward-scatter developments have spurred antenna sales activity in the communications field. A number of antenna fabricators now have forward-scatter antennas on the market and more companies are planning to make them. One manufacturer reports that it has sold about fifty 28-foot transhorizon antennas.

Another manufacturer has announced plans to produce forward-scatter equipment. Equipment for 2,000 mc is expected to be available in five to ten months at a total cost of $42,000 to $52,000. Transmitting and receiving 28-foot parabolas, including tower and ground mounts, would cost about $12,000.

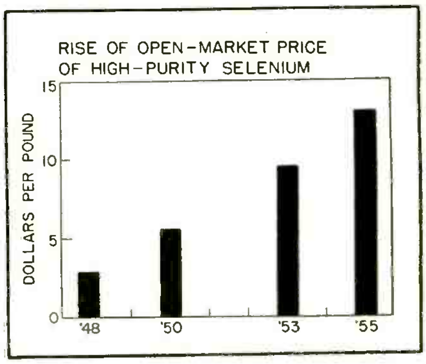
Conelrad Extends Radio Blackout Regulations

DENIAL of direction-finding transmissions to hostile aircraft has been insured through the Conelrad program that rotates operation of a-m broadcast stations during an alert. Requirement of radio silence during alert periods has been gradually extended to other radio services.

▶ **Hams and Cops**—Latest groups expected to go off the air at a moment's notice are amateurs and the public safety radio services. According to FCC's latest annual report there were more than 132,000 amateur transmitters licensed, but the number is growing (see latest Figures of the Month, p 6).

Public safety services include more than 200,000 transmitters in police, fire, highway maintenance and similar functions. Unless otherwise directed, this class of station must cease operation upon receipt of a radio alert.

Selenium Shortage May Be Eased



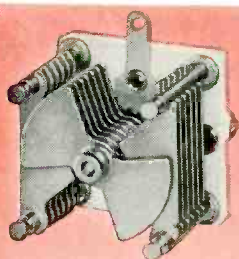
Production from Wyoming deposit may double world supply by midyear

DAILY production of 1,200 to 2,000 pounds of commercial-grade selenium is the goal of the Shawano Development Corp., operators of a Baggs, Wyoming selenium deposit. Discovered last fall, the deposit contains ore assayed to be 0.69-percent selenium, which is roughly equivalent to 13 pounds of commercial grade per 100 pounds of ore. A plant is being erected and pilot production is expected by May. Full daily production would approximately double the present world supply.

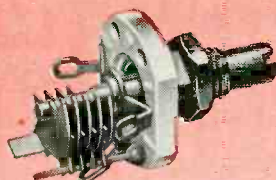
▶ **Current Situation**—Demand for high-purity selenium by rectifier manufacturers has caused prices to quadruple within the last five years to a high of about $13 a pound, as shown in the graph. The economic feasibility of refining the selenium ore is based on these high market prices. Shawano estimates that it can make a profit on its operation if the commercial-grade selenium sells for a minimum of $8.00 a pound. Commercial-grade material requires additional refining to qualify as high-purity selenium.

(Continued on page 26)

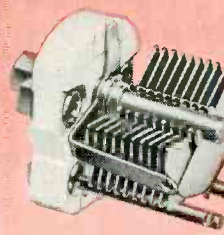
For VARIABLE CAPACITORS...



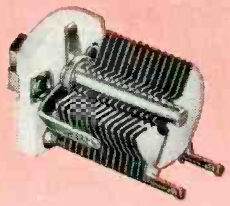
"BFC" butterfly-type capacitor with isolated rotor, very low minimum capacity and low inductance. For VHF applications as series capacitor with no rotor connection.



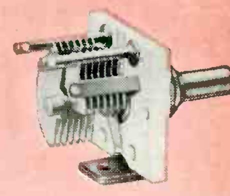
"MAC" Low minimum capacity and very low inductance. Ideal for VHF-UHF applications. Designed for use in miniaturization. Also available as butterfly type "MACBF".



"APC" A compact, high quality air dielectric trimmer. Extremely high resistance to temperature changes, moisture and vibration.

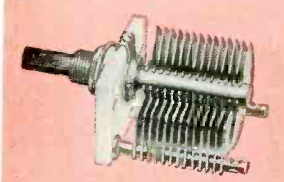


"MAPC" A scaled down version of the "APC". Designed to fill the needs of miniaturization. Suitable for VHF use.

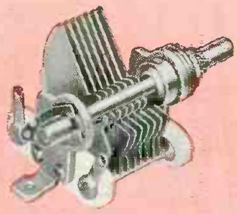


"HF" A high frequency design featuring extra long sleeve bearing and positive contact nickel-plated phosphor bronze wiper. Also available as a dual unit.

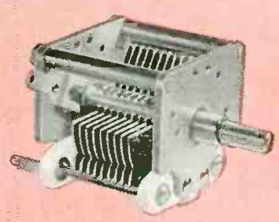
naturally,



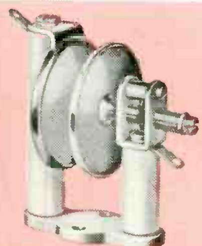
"HFA" Similar to "HF" model, but with larger air gaps for higher breakdown ratings. Used for high-frequency, low-power transmitting. Also available as dual unit.



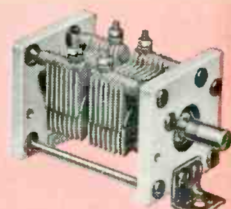
"MC" Designed for maximum versatility in mountings, connections and capacity characteristics. Rotor stop permits 180° clockwise rotation with increasing capacity. Also available as dual unit.



"RMC" Similar to "MC-S" but featuring extra rigid design. Heavy frame of aluminum tie rods and end plates.



"NZ" Compact transmitting neutralizing capacitor designed for easy and accurate adjustment. Long leakage paths to ground from both rotor and stator.



"VU" Permits use of "lumped constant" circuits up to 500 MC. Two sections in series eliminate rotor wiper. Pyrex glass ball bearings eliminate noise from usual metal-to-metal bearings.

it's HAMMARLUND

For commercial, military and industrial applications, you just can't beat Hammarlund Variable Capacitors for uniformly high quality design, materials and workmanship. The capacitors illustrated here are just a small representative portion of the complete Hammarlund line. In addition to stock designs, Hammarlund offers you unparalleled variable capacitor know-how in development, design and production. Whatever your needs, when it comes to special or standard variable capacitors, naturally, come to Hammarlund.

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Financial Roundup

More companies report on 1955 net profits, make security offerings

MANUFACTURERS reporting net profits in the past month showed mixed results compared to 1954. Several firms announced security offerings.

Following are the net profits for 9 firms for the fiscal periods indicated:

Company	Net Profit 1955	1954
Aeroquip 12m	$1,425,303	$1,115,092
ACF Industries 6m	3,874,775	2,528,554
Am. Electronics 9m	177,377	190,186
Consolidated Electronics Ind. 12m	861,989	*202,190
Electronic Engineering 9m	45,698	
General Inst. 9m	241,994	*158,207
W. L. Maxson 12m	1,498,000	1,496,000
Raytheon 6m	1,368,000	2,396,000
Westinghouse 9m	43,839,000	62,644,000

*loss

► **Securities**—Electronics Corp. of America placed $2 million of subordinate convertible notes, due Dec. 1, 1975. Proceeds will be used for general corporate purposes and additional working capital.

Varian Associates offered $2 million in debentures, due Dec. 1, 1970 at 100½ percent and accrued interest. Proceeds are to be used for general corporate purposes including purchasing land, building and equipment and for other expansions and working capital.

Marines Land Radar

U. S. Marines are now using the Army's special radar system for detection of enemy mortars. Device was a joint development of Army Signal Corps and Sperry Gyroscope

FUTURE MEETINGS

JAN. 30-FEB. 3: Winter General Meeting, AIEE, Hotel Statler, New York, N. Y.

FEB. 2-3, 1956: IRE National Symposium on Microwave Techniques, University of Pennsylvania, Philadelphia.

FEB. 7-9: 1956 Western Joint Computer Conference & Exhibit, Fairmount Hotel, San Francisco, Calif.

FEB. 9-11: Annual Southwestern Regional IRE Conference and Electronics Show, Oklahoma City, Okla.

FEB. 15-17: 1956 Conference On High-Speed Computers, Louisiana State University, Baton Rouge, La.

FEB. 16-17: IRE, AIEE, Univ. of Pa. Conference on Transistor Circuits, University of Pennsylvania, Philadelphia, Pa.

FEB. 27-29: Second Annual Electronic Conference & Exhibit, AMA, Hotel Commodore, New York, N. Y.

FEB. 28-29: Scintillation Counter Symposium, IRE, AIEE, Shoreham Hotel, Washington, D. C.

MARCH 6-7: Conference on Radio Interference Reduction, Armour Research Foundation, Chicago, Ill.

MAR. 15-16: AIEE Fifth Annual Spring Conf., Cleveland, Ohio.

MAR. 19-22: IRE National Convention, Waldorf-Astoria Hotel, Kingsbridge Armory, New York, N. Y.

APRIL 2-4: Harvard University, Air Force Cambridge Research Center, IRE Symposium on Microwave Properties and Applications of Ferrites, Harvard University, Cambridge, Mass.

APRIL 5-6: IRE, AIEE, ISA, Magnetic Amplifier Conference, Hotel Syracuse, Syracuse, N. Y.

APRIL 9-22: International Exhibition on Instrumentation-Automation, Oslo, Norway.

APRIL 10-12: Twelfth Annual Meeting and Metal Powder Show, Hotel Cleveland, Cleveland, Ohio.

APRIL 11-13: 1956 IRE 7th Region Technical Conference, Hotel Utah, Salt Lake City.

APRIL 13-14: Tenth Annual Spring Television Conference, IRE, Engineering Society Building, Cincinnati, Ohio.

APRIL 23-24: New England Radio Engineering Meeting, IRE, Sheraton Plaza, Boston, Mass.

APRIL 23-25: International Conference on Electron Physics, NBS, College Park, Md.

APRIL 25-27: Symposium On Nonlinear Circuit Analysis, II, Polytechnic Institute of Brooklyn, New York, N. Y.

APRIL 26-27: Conference On Recording and Controlling Instruments, AIEE, ASME, ISA, Bradford Hotel, Boston, Mass.

APRIL 29-MAY 3: Fourth Annual Semiconductor Symposium, Electrochemical Society, Mark Hopkins Hotel, San Francisco, Calif.

Industry Shorts

► **Breakdown** of Army's electronic test equipment at White Sands Proving Ground shows $21,500,000 worth belongs to Ordnance and $24,000,000 to Signal Corps.

► **Denying** application to split channels in the industrial radio service, FCC says technical parameters are now well documented and no further developmental grants to test the technique will be made except on designated channels.

► **Number** of closed-circuit tv installations made by the end of 1956 will total at least 5,000 compared to 1,500 at the end of 1955, according to Dage Television. The firm plans to install about 1,700 cameras this year.

► **Americans** will spend $300 million to replace picture tubes in 6 million tv sets in 1956. More than 150 million vacuum tubes in radios and tv will also be replaced during the year, according to GE. Average picture tube life was estimated at four years by the firm.

KAY

NOISE FIGURE MEASUREMENT 10-3000 MC

SPECIFICATIONS

Frequency Range: 10 mc to 3,000 mc

Output Impedance: 50 ohms unbalanced into Type N Connector

Noise Figure Range: 0 to 20 db

Filament Voltage Supply: From regulated supply

Meter Calibration: Linear in db noise figure; logarithmic in D.C.M.A.

Fuse Protection: One Type 3AG, 2 amps

Tubes: 1 Eclipse Pioneer TTI Diode

Power Supply Source: 117 Watts ± 10% 60 cps A.C. Available for 50 cps

Power Consumption: 130 Watts

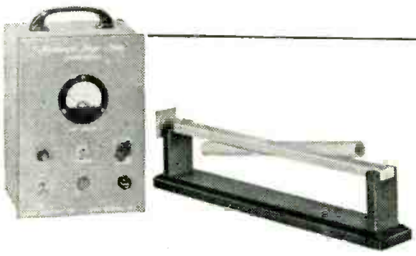
Price: $790.00 FOB Plant

NEW! . . . KAY *Mega-Node-Sr.*

- **Absolutely no modulation on noise output**
- **Built-in stability**
- **Longer life on noise diode**
- **Ease of operation due to front panel design**
- **All power supplies regulated.**

A calibrated random noise source providing an output from 10-3,000 mc, the Mega-Node Sr. may be used to measure noise figure and receiver gain and for the indirect calibration of standard signal sources.

At the lower end of the frequency range noise figure may be obtained directly from the meter. For greater accuracy at higher frequencies, corrections for diode transit time and termination mismatch are available from charts supplied with each instrument.



KAY *Microwave Mega-Nodes*

Calibrated random noise sources in the microwave range, used to measure noise figure, and receiver gain and calibrate standard signal sources in radar and other microwave systems. Available in following waveguide sizes to cover range of 960-26,500 mc.

RG-69/U	$400.	†RG-51/U	$195.
†RG-48/U	195.	†RG-52/U	195.
†RG-49/U	195.	RG-91/U	250.
†RG-50/U	195.	RG-53/U	250.

Available with fluorescent or inert gas (argon or neon) tubes. Noise output fluorescent tubes, 15.8 db ±.25 db; argon gas tubes, 15.2 db ±.1 db*; neon tubes, 18.0 db ±.5 db*.

*Noise output of inert gas tubes independent of operating temperature.

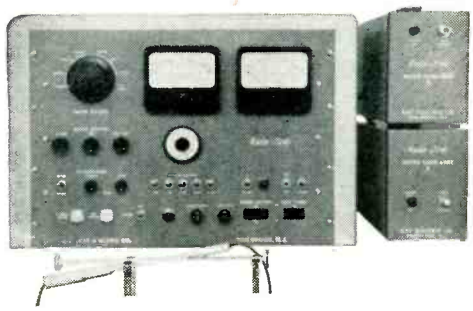
Universal Power supply for both fluorescent or argon gas and all wave-guide sizes: $100. †$167. per Guide when 3 or more are purchased with $100. Power Supply.

NEW! WR-770; WR-650—$595.00 each; WR-510; WR-430; WR-340—$495.00 each. All WR numbers fluorescent only.

KAY *Mega-Node*

Calibrated random noise source reading direct in db, for measurement of noise figure, receiver gain and for indirect calibration of standard signal sources. Frequency range, 5 to 220 mc; Output impedances, unbalanced—50, 75, 150, 300, Infinity; balanced—100, 150, 300, 600, Infinity; noise figure range, 0-16 db at 50 ohms 0—23.8 db at 300 ohms.

Price . . . . $295. FOB plant



KAY *Rada-Node*

Complete radar noise figure measuring set for IF and RF, including attenuators, detector and noise sources. Complete with power supplies. Frequency range: 5 to 26,500 mc; noise figure range, up to 21 db, in lower part of spectrum. *Prices on request.*

IRE Show Booths 207, 242, 244, 246 Instruments Avenue

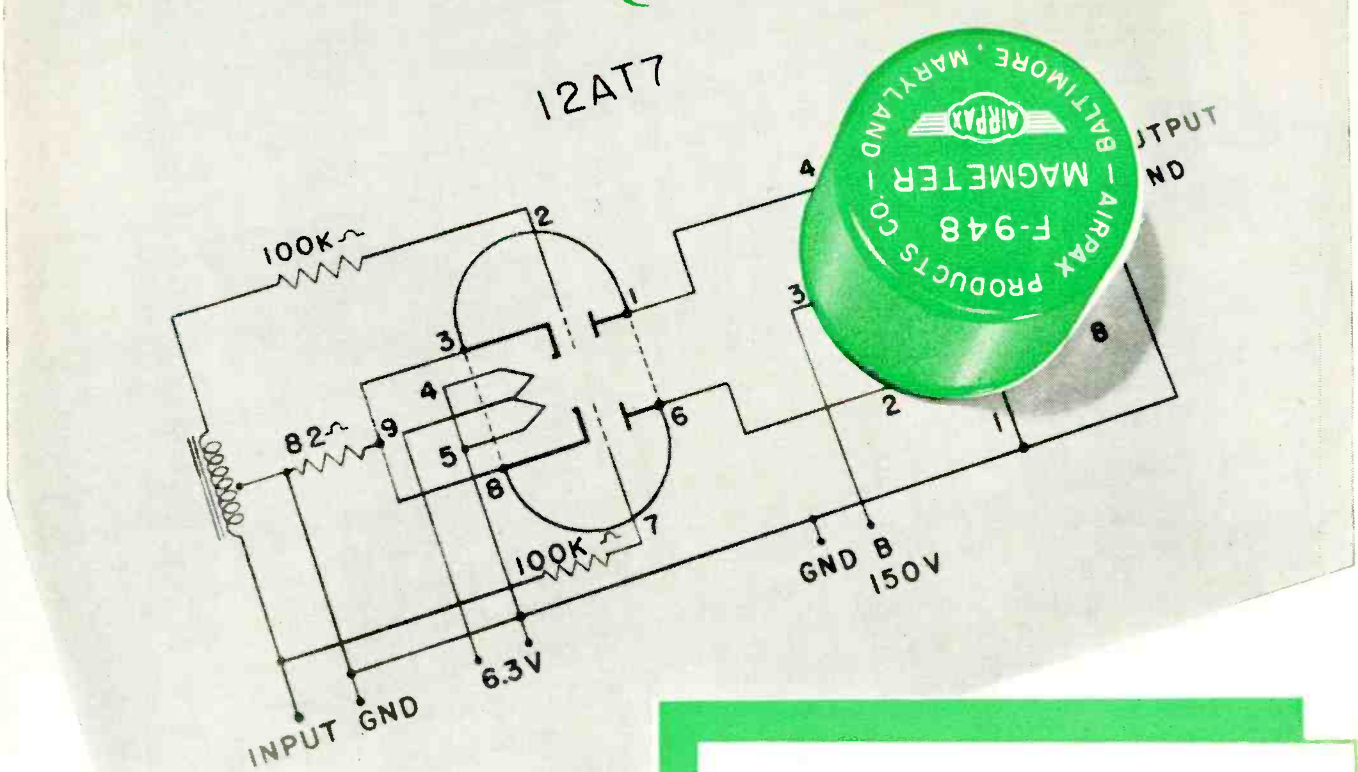
For Complete Information Regarding These, and Other Kay Instruments, Write:

KAY ELECTRIC COMPANY

DEPT. E-2, 14 MAPLE AVENUE PINE BROOK, N. J.

CAldwell 6-4000

MAGNETIC FREQUENCY DETECTOR



Measures Audio Frequencies Directly

Magmeter is an entirely new product—the result of Airpax leadership in developing magnetic components. The Magmeter produces an output signal directly proportional to the input frequency.

In the circuit shown, the 12AT7 dual triode drives the Type F-948 Magmeter over the rated frequency range of 0 to 500 CPS. A 0-500 microampere meter, connected to the Airpax Magmeter, indicates frequency directly. A resistor in series with the meter calibrates the circuit when it is installed. Once adjusted, the Magmeter holds the calibration for long periods of time to at least 2% of full scale.

The Magmeter is completely contained in a can 1¼ inches high and 1½ inches in diameter with a standard octal base. This compact component weighing only 3.4 oz. can be used wherever frequency is measured: in test equipment, AC servos, speed indicators and controls, and power frequency regulators.

You probably have an application in which this one component can replace considerable circuitry. We have a detailed data sheet ready for you, just write to

CHARACTERISTICS

RANGE: 0 to 500 CPS (other ranges available on special order)

ACCURACY: ±2% of full scale plus temperature variation of 500 ppm/C

WAVEFORM SENSITIVITY: less than 1% change in indication for sine, triangular, and square waves of same rectified average value

SHOCK: 30g shocks of 11± 1 milliseconds duration in each plane, case clamped

VIBRATION: 10g in each plane at 10 to 55 CPS, case clamped

TEMPERATURE: —55C to +72C operate; —65C to +85C storage

LIFE: comparable to that of a well made transformer

ENCLOSURE: hermetically sealed

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Sure, you could pay less for an ordinary knob, but the premium price of the Raytheon Standard Control Knob is well worth the difference! Here's why:

Raytheon knobs conform to government specifications for material, high and extreme temperature, humidity, salt spray, vibration, impact and torque. They are handsomely designed and molded of "Tenite II." They have anodized aluminum inserts with dual Allen head set screws. Most important, Raytheon knobs offer the smartly turned professional look that adds so much to the fine appearance of your product.

You put time, skill, money *inside* your equipment. You incorporate the finest circuitry; you select each component with care—your goal is quality in every detail. Naturally, this means quality *outside*, too. The right knobs, the finest knobs give the important finishing touch. They help convince your customers that yours is thoughtful, thorough craftsmanship.

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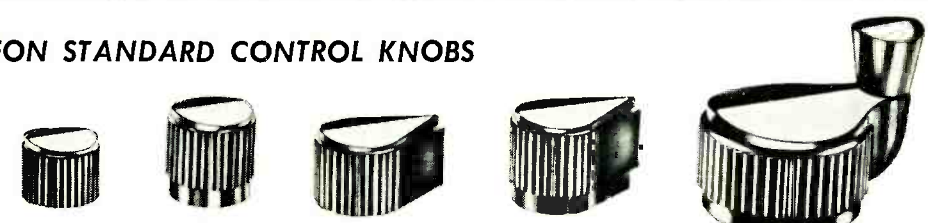
Prices range from 69¢ to $3.10



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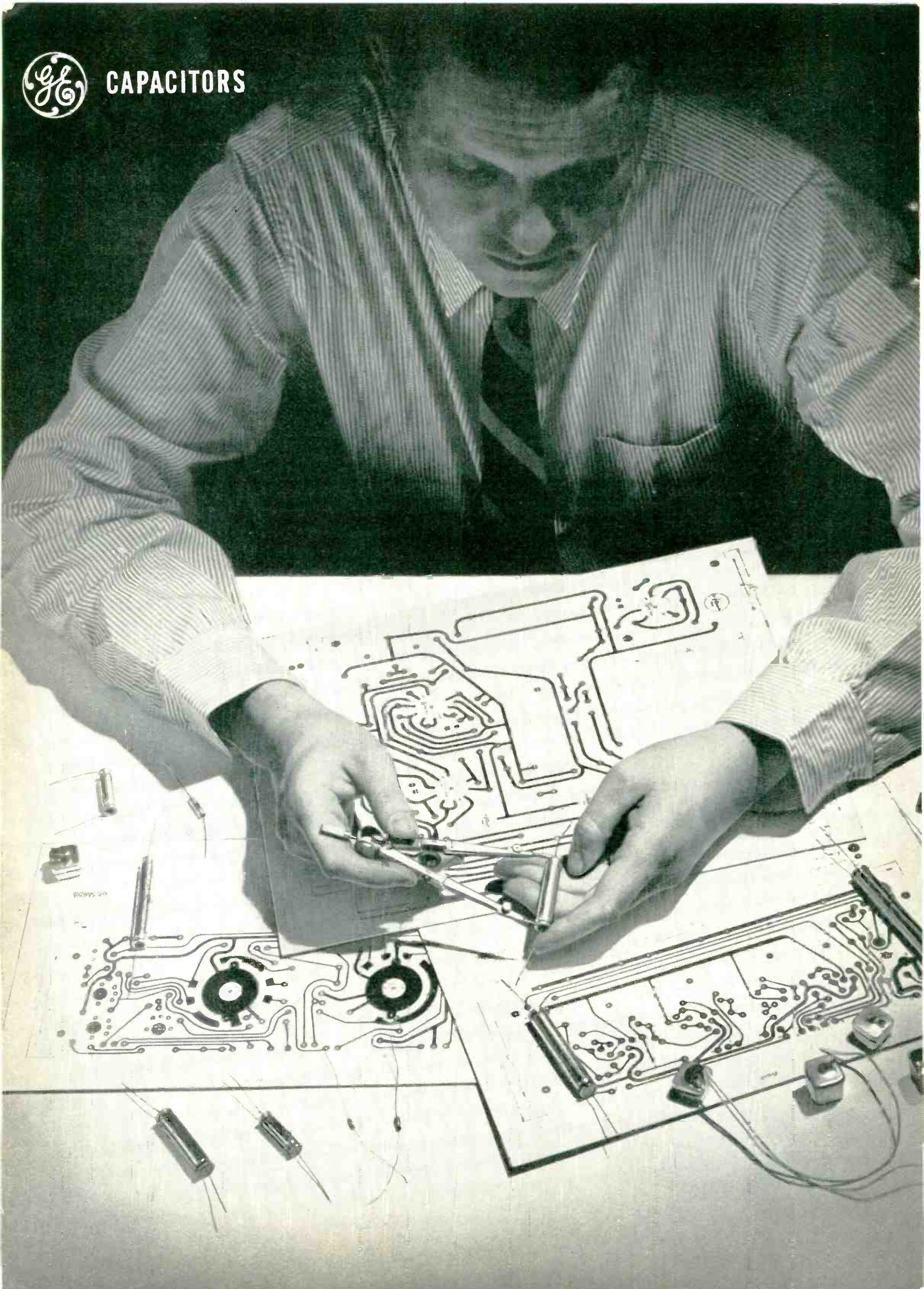
CAPACITORS

How G-E Tantalytic* Capacitors help solve your critical design problems

Three separate lines of G-E tantalum electrolytic capacitors to meet your size and temperature needs

No matter what capacitor problems you face in your most critical electronic applications, you're almost sure to find an answer in the three proven lines of Tantalytic capacitors now offered by General Electric.

Is size your problem? G-E Tantalytic capacitors carry extremely high uf ratings per cubic centimeter, especially in the 0–150 VDC range. In some ratings, Tantalytic capacitors are actually less than 1% the size of comparably rated paper capacitors.

Is high reliability your problem? Where small size and high reliability are "musts," as they are in communications equipment for example, G-E Tantalytic capacitors meet the challenge. Their high quality assures long, more reliable operation —at a real saving in circuit space.

Is high temperature your problem? For extremely high ambient temperatures, as found in high-speed aircraft and guided missile applications, you can count on G-E high-temperature Tantalytic capacitors. They operate at full rated voltage from −55C to +125C. Rectangular and tubular designs are available to meet the varying requirements of modern electronic design.

General Electric engineers have accumulated a wealth of life test and other data through a long period of testing tantalum capacitors under every conceivable condition of operation. As a result, G-E Tantalytic capacitors may be relied upon for mechanical and electrical stability and maximum efficiency in operation.

Let your G-E Apparatus Sales Representative show you how these capacitors can answer your particular problems. Or, if you would like further information (ratings and specifications) on G-E Tantalytic capacitors write directly to the General Electric Company, Section 442-30, Schenectady 5, N. Y.

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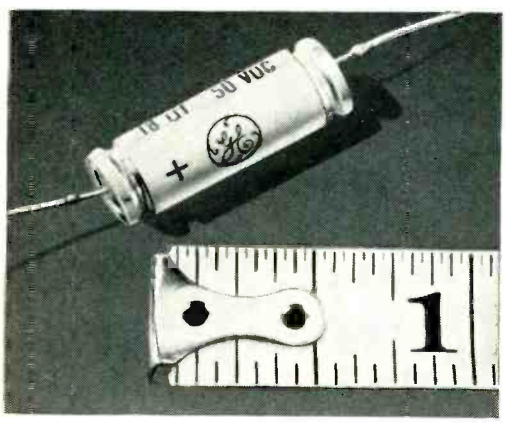
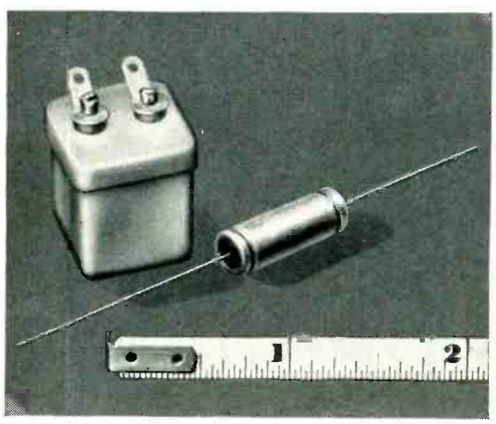
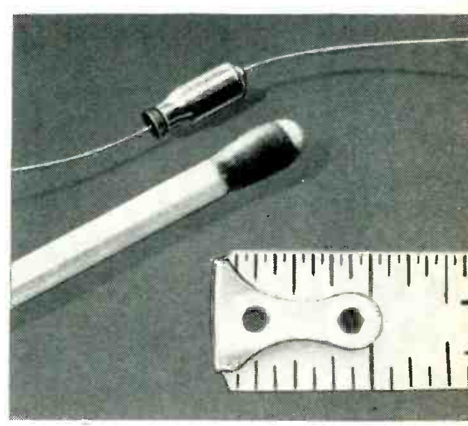


85 C TANTALYTIC CAPACITORS for circuits requiring low leakage current, long shelf life. Available in polar or non-polar types for a-c and d-c. Ratings 0.25–580 uf, 3.75–150 v. Tol. ±20% (plain foil), −15 to +75% (etched). Temp. range −55 to +85 C. Write for Bulletins GEC-808 and GET-2333.



125 C TANTALYTIC CAPACITORS for high-speed aircraft and guided missile electronic systems where quality, long life, small size are main requirements. Available in plain or etched foil, in rectangular or tubular designs. Ratings 0.25–180 uf, 10–100 v. Tol. ±20% (plain foil), −15 to +75% (etched). Temp. range −55 to +125 C. Write for Bulletins GEA-6258, GET-2502, and GET-2513.



MICRO-MINIATURE TANTALYTIC capacitors for low-voltage d-c, transistorized electronic equipment such as hearing aids, pocket radios. Ratings 1–8 uf at 4 VDC, 1 uf at 8 VDC, 0.5 uf at 16 VDC. Tolerance −0 to +200%. Temperature range −20 to +50 C. Bulletins GEA-6065 and GET-2405.

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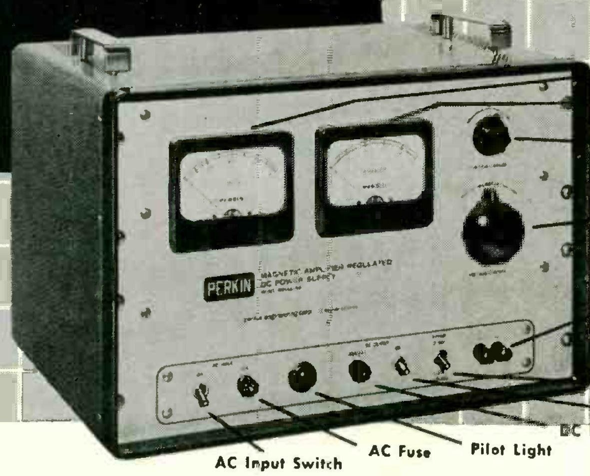

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2-5V Range: ± 2% for combined line changes of 105-125VAC and load changes of 0-15A. DC.
32-36V Range: ± 2% for combined line changes of 110-125VAC and load changes of 0-15A. DC.

RIPPLE: 1% rms max. @ 36 volts and full load. Increases to 2% @ 2 volts and full load.

AC INPUT: 105 to 125 volts, 1 phase, 60 cps. (8 amps, Input)

RESPONSE TIME: 0.1 to 0.2 seconds maximum.

DIMENSIONS: 19½" wide x 15½" deep x 13¼" high with cabinet. (19" wide x 14¾" deep x 12¼" high rack panel construction)

FINISH: Gray Hammertone **WEIGHT:** *Approx. 135 lbs.*

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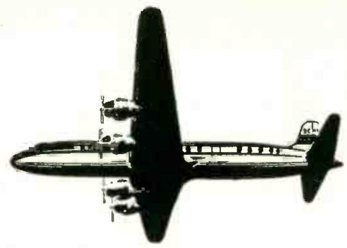

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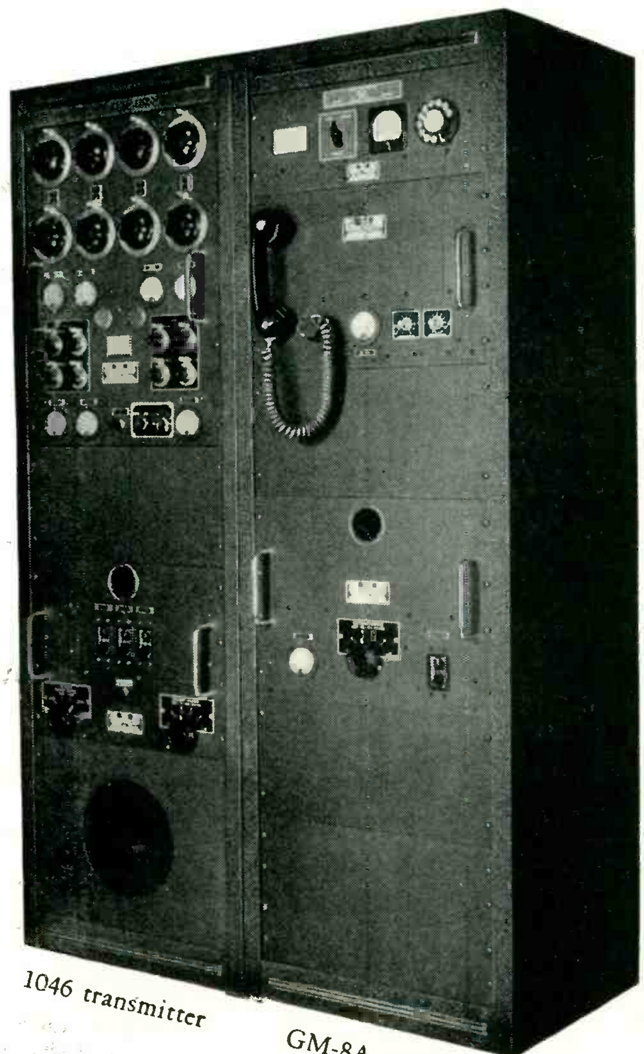
1000 WATTS WITH .003% STABILITY



1046 transmitter

GM-8A modulator

Rugged, versatile general purpose H. F. transmitter—Aerocom's 1046 packs 1000 watts of power and high .003% stability under normal operating conditions (0° to + 50°C.). Excellent for point-to-point or ground-to-air communications.

Multi-channel operation on telegraph A1, or telephone A3 with GM-8A modulator . . . new Aerocom 1046 can be *remotely controlled* with TMC-R at control position and uses only one pair of telephone lines. In A3 operation, the local dial control panel is located in modulator cabinet.

Transmitter cabinet has 8¾ inch panel space available for either local dial control panel or frequency shift keyer.

Model 1046 operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.0—24 Mcs. Operates on one frequency at a time; channeling time 2 seconds. Operates into either balanced or unbalanced loads. Operates in ambient -35° to +50° C. Power supply: nominal 220 volts, 50-60 cycles, single phase.

Complete technical data on request

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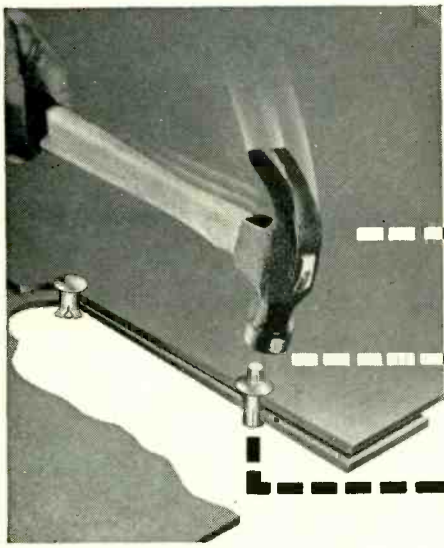

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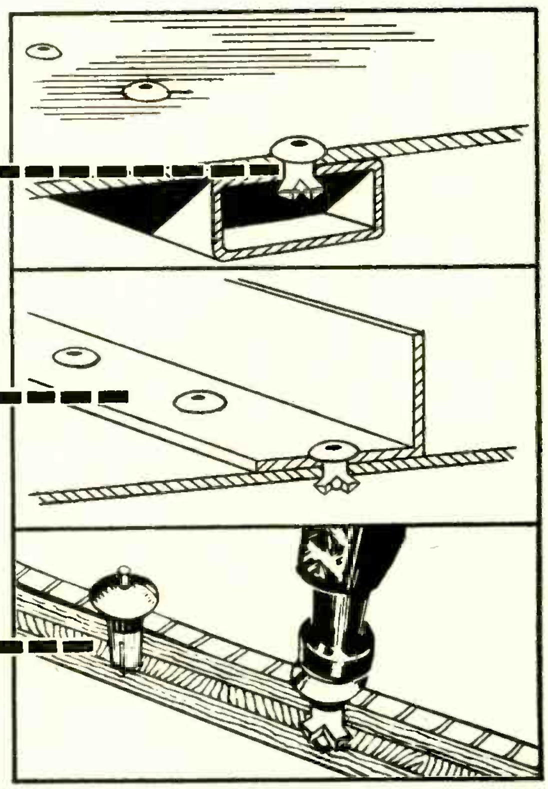

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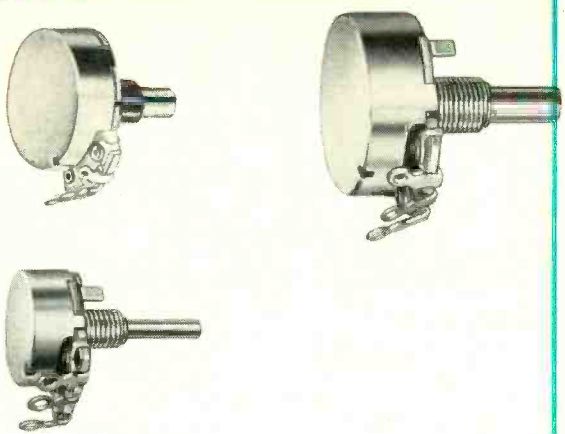

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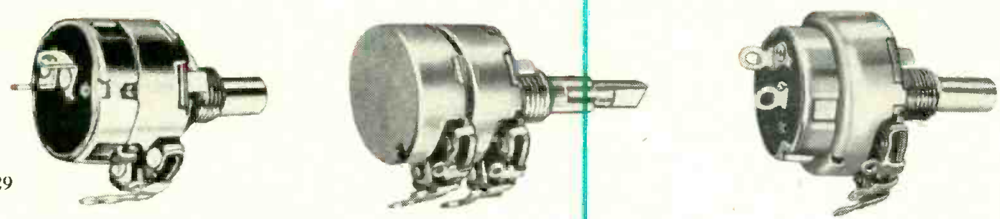

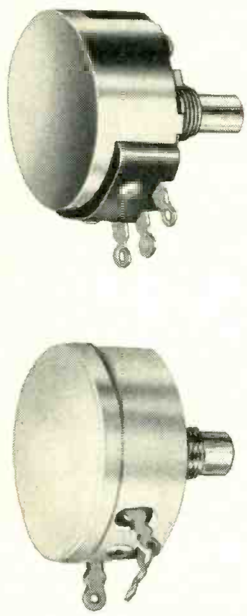

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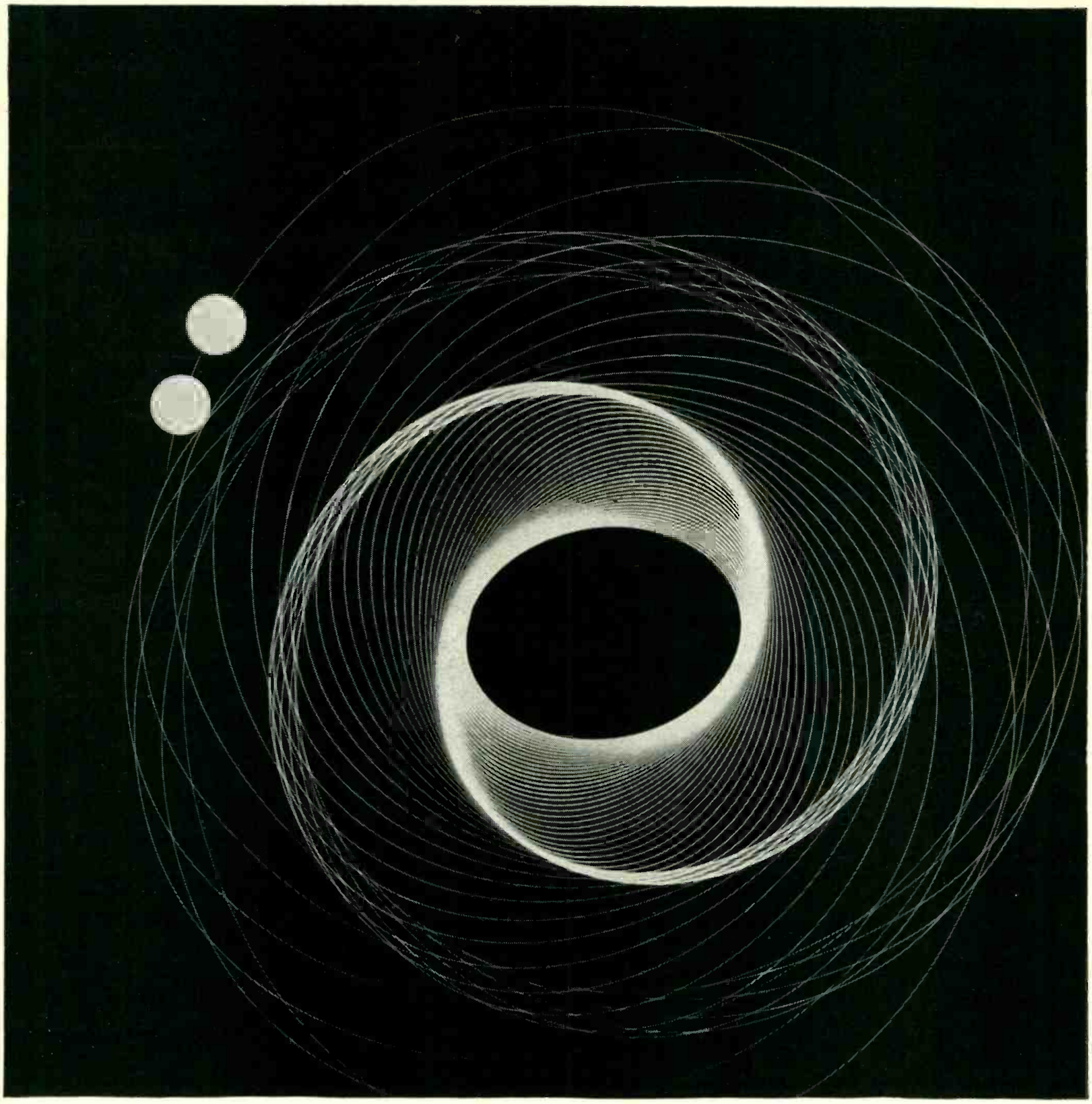

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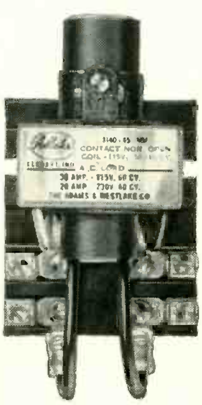

Adlake mercury relays

The new Adlake Mighty Midget relay, like *all* Adlake relays, requires no maintenance whatever . . . is quiet and chatterless . . . free from explosion hazard. Dust, dirt, moisture and temperature changes can't affect its operation. Mercury-to-mercury contact gives ideal snap action, with no burning, pitting or sticking. Write for catalog and information.

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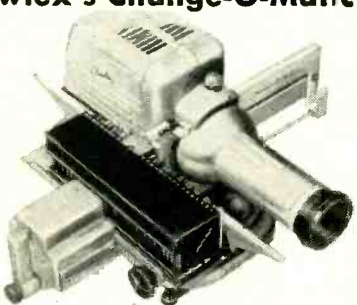
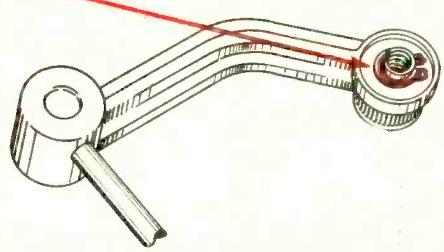
Waldes Truarc Rings Permit Better and More Economical Design—Fewer Parts, Faster Assembly, Minimal Rejects!

Viewlex's Change-O-Matic



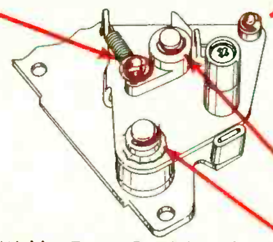
Viewlex, Inc., L. I. C., N.Y. solves a variety of fastening problems in their new model Change-O-Matic automatic slide changer. Assembly time is speeded, parts eliminated, rejects lowered, and compact, economical product design achieved.

Connecting Arm Assembly



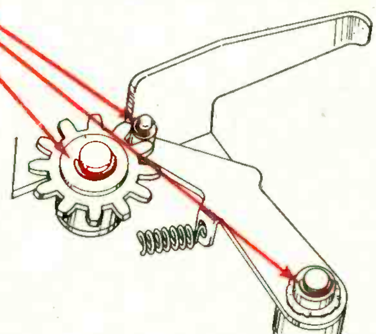
Use of one Waldes Truarc Ring (Series 5100) eliminates time-consuming riveting over the flange, retains and holds the connecting knob captive. A compact, neat design is made possible, rejects caused by poor riveting eliminated.

Actuating Plate and Pawl Assembly



Three types of Waldes Truarc Retaining Rings are used in this assembly. One circular self-locking ring (Series 5105) retains pawl return spring. One external E-ring (Series 5133) retains roller used to prevent gear motion during transport cycle. One crescent ring (Series 5103) retains pawl which indexes gear. Second crescent ring retains sub-assembly. Truarc Rings speed assembly, cut rejects, eliminate parts.

Detent Lever Assembly



Truarc E-ring (Series 5133) eliminates use of tapped hole and shoulder screw, retains roller which prevents over-travel of gear. Assembly is rapid.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

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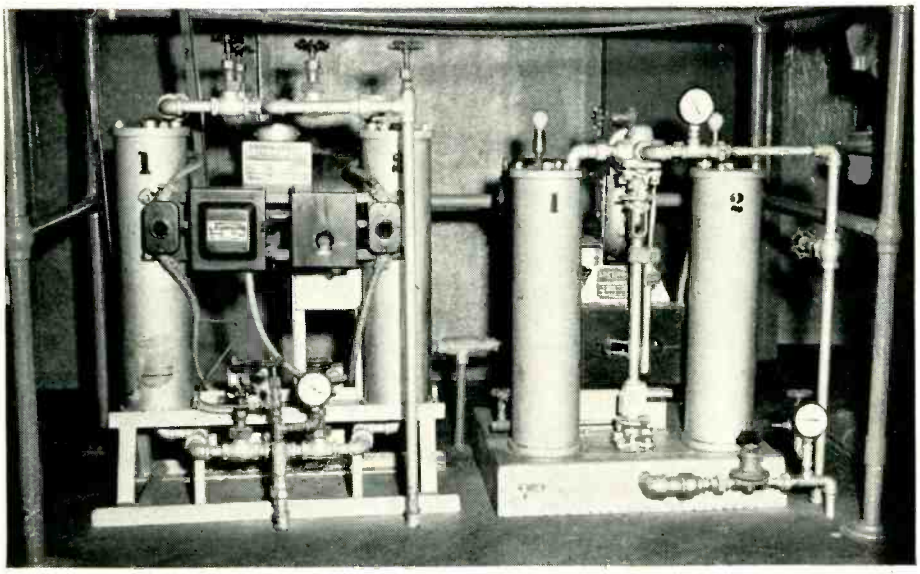
filled with DRY oxygen...



dried to -70° dewpoint

DRY air and DRY oxygen are supplied to Flashbulb filling machines at Sylvania Electric Products, Inc., Montoursville, Pa., by these two BAC-O Lectrodryers.

THE PROMINENT POSITION occupied by these two Lectrodryers* in the heart of this Sylvania plant is evidence of the importance of DRYing in this process. The air with which Flashbulbs are flushed, and the oxygen with which they are filled, are dried to –70°F. dewpoint. Thus Sylvania makes certain of the high quality demanded in these products.

DRYing, as here at Sylvania, is an ingredient in certain processes; air, gases and organic liquids are specified to be free of all entrained and vaporous moisture. DRYing is a production tool in many manufacturing operations. It speeds up the coating of television tubes, for example, and the curing of transformer insulation. Stockrooms, where finished products are stored, must be kept DRY to safeguard their quality.

Whatever your troubles with unwanted moisture, Lectrodryer engineers can help you solve them. The book, *Because Moisture Isn't Pink,* tells how they've helped others. For a free copy, write Pittsburgh Lectrodryer Corporation, 359 32nd Street, Pittsburgh 30, Pennsylvania.

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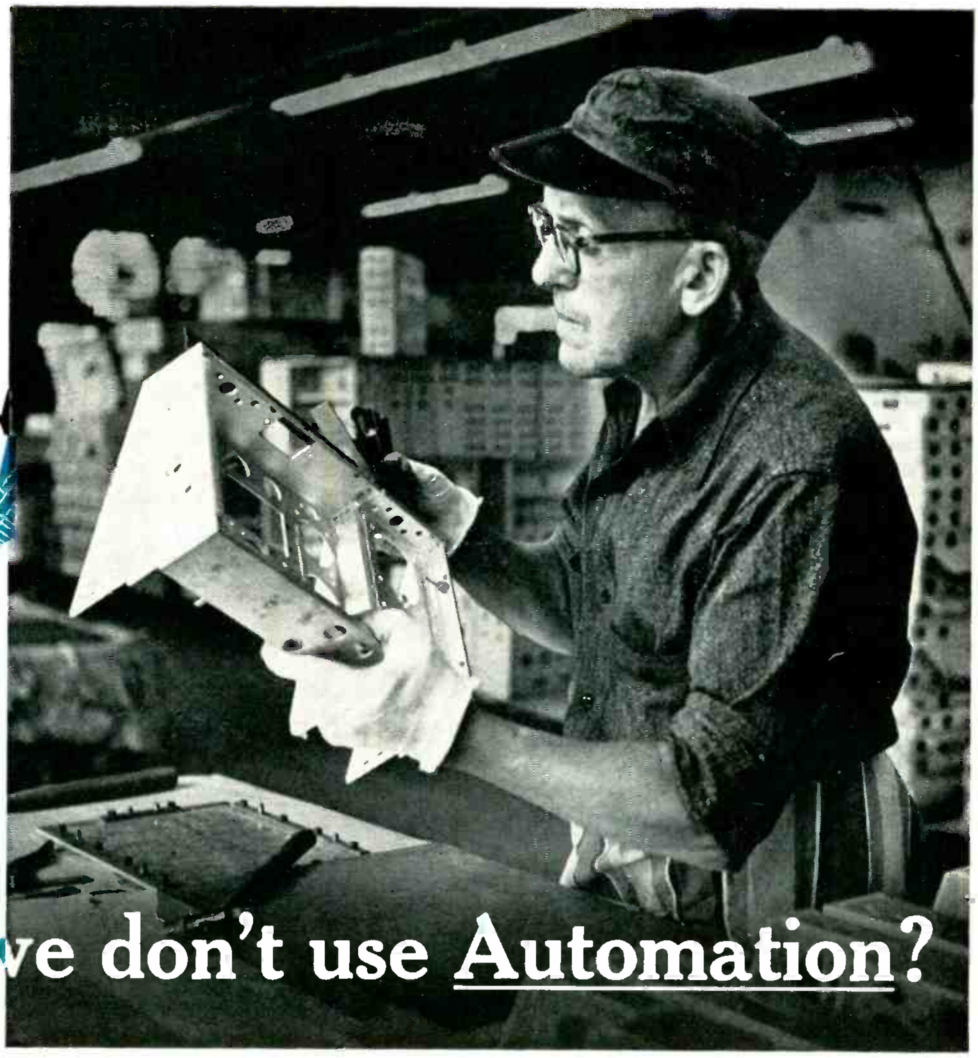

See why we don't use Automation?

It's not that we are old-fashioned, here at Karp. Far from it. We have one of the best tooled and equipped sheet metal fabrication plants in the world. Many of our machines, indeed, are equipped with electronic timing controls.

If the time ever comes when we feel that automation can give you finer work than our several hundred skilled craftsmen . . . we'll install automation. But that time is not now—nor in the foreseeable future.

You see, Karp was founded upon a perfectionist's idea about custom craftsmanship. Our methods are paying off because our painstaking work to exact specifications results in quality products to you, often at "ready-made" economies. And remember—our men who were skilled craftsmen ten or twenty years ago are even more highly skilled craftsmen today.

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Why do so many Leading Industries Specify STANDARD PRECISION TIMING INSTRUMENTS for test cell, control room and laboratory?

Whether you are counting revolutions per minute, or measuring time, you can rely on the split-second precision of Standard Timers and Chrono-Tachometers for accurate, reliable readings.

Engineer checks action of automatic transmission, with water simulating the flow of oil. His hand rests on a Standard timing instrument in the background.

Left: In this interesting test cell control room photograph a Standard Chrono-tachometer is located in the right foreground.

"Precision and accuracy, plus simple, rugged, trouble-free construction" is the policy which has guided us for over 70 years in the design and manufacture of instruments for indicating and measuring time.

With the increasingly rigid requirements for precision in every phase of research and development, this policy of the Standard Electric Time Company assumes greater importance than ever before . . . If yours is a problem of extremely close tolerances in the measurement of time or in the checking of R.P.M.'s . . . let our engineers help you.

The complex instrument panel in the control room of Control Point, Yucca Pass, Nevada Proving Grounds . . . The Precision Timers on the fourth and seventh sections are by Standard.

SINCE STANDARD 1884

The STANDARD ELECTRIC TIME CO.

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PRECISION TIMERS • CHRONO-TACHOMETERS • LABORATORY PANELS • PIPELINE NETWORK ANALYZERS

Olympic Television

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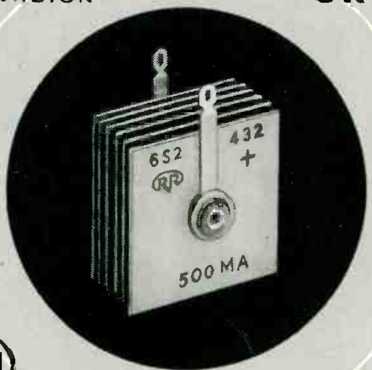

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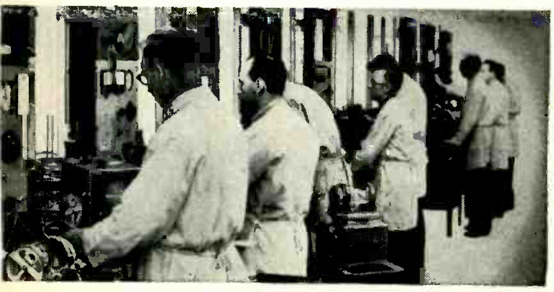

LEAR PRODUCES

This roster of Lear aviation products is, of necessity, incomplete. Many of these products are frequently combined to form an infinite variety of additional products or systems. Only enough typical devices are shown here to demonstrate Lear's mastery of a field of science and technology that uses thousands of such building blocks for meeting the highly specialized requirements of modern aircraft and missiles.

δ *flight control systems*

Automatic altitude controllers
Automatic approach couplers
Automatic Mach number controllers
Automatic pilots (lightplane)
Automatic pilots (high-performance)
Automatic pitch, yaw, and roll dampers
Automatic rudder controllers
Automatic wing flap systems
Missile control systems
Test equipment

σ *flight reference systems*

No-gimbal-lock vertical gyro indicators
Stable platforms
Test equipment
Three-axis gyro indicators
Vertical gyro indicators

γ *navigational systems*

Automatic radio direction finders
Glide slope receivers
High-latitude gyro compass systems
Integrated ADF-magnetic compass systems
Localizer receivers
Marker beacon receivers
VHF Omnirange receivers

ξ *electro-mechanical systems*

Artificial feel systems
Camera positioners
Canopy control systems
Carburetor air door controllers
Convertiplane rotor positioning systems
Cowl flap positioners
De-icing valve positioners
Engine throttle controllers
Gas, hydraulic, fuel, valve positioners
Inlet screen retraction systems
Inlet vane angle controllers
Jettison systems
Landing gear lock systems
Mechanical advantage ratio changers
Oil cooler flap controllers
Parachute door systems
Precision remote positioning systems
Supercharger blower shifters
Test equipment
Throttle friction controllers
Trim tab positioners
Turbo-prop clutch valve controllers
Wing flap positioning systems

λ *electro-mechanical components*

Linear actuators
Rotary actuators
Servo actuators
Power units
Actuator controls
Alternators
Capstans
Freewheeling clutches
Friction clutches
Magnetic clutches
Slip overload clutches
Electromagnetic brakes
Flex drive H's, hex's, L's, and T's
Flexible shafts
Gearboxes
Handcranks
Motors (AC and DC)
Enclosed fan motors
Explosion proof motors
Gearhead motors
High frequency motors
High temperature motors
Miniature motors
Pneumatic motors
Servo motors
Torque motors
Screwjacks
Load limit switches
Position limit switches
Programming switches

ζ *instruments*

ADF indicators
Attitude indicators, 2-axis
Attitude indicators, 3-axis
Directional indicators
ILS indicators
Integrated ADF-magnetic indicators
Trim indicators
Tuning meters
Omnirange indicators

μ *instrument components*

Altitude transducers
Vacuum tube amplifiers
Magnetic amplifiers
Printed and etched circuit amplifiers
Transistor amplifiers
Displacement gyros

Executive Offices: Santa Monica, Calif. • Grand Rapids Division: Grand Rapids, Mich.

for the precision needs of aviation

Dynamic pressure transducers
Gravity-sensing switches
Magnetic modulators
Magnetic powder clutches
AC and DC servo motors
Electric gyro motors
Flag motors
High-frequency motors
Torque motors
Power converters
Rate generators
Rate gyros
Resolvers
Synchros
Synchro repeaters

ψ *communications systems*

UHF, VHF, HF, MF, and LF receivers
VHF transceivers
VHF, HF, and MF transmitters
ADF receivers
Airport traffic transceivers
Monitoring transceivers
Portable transceivers
Telemetering receivers
Test equipment

ε *communications components*

Audio frequency amplifiers
Vacuum tube amplifiers
Magnetic amplifiers
Power amplifiers
Printed and etched circuit amplifiers
Transistor amplifiers
Aircraft broadband antennas
Ground plane antennas
LF-MF whip antennas
Loop antennas
Mobile antennas
Trailing wire antennas
UHF-VHF whip antennas
VHF Omnirange antennas
Antenna fairleads
Antenna reels
Antenna tuning coils
Cable assemblies
Coil assemblies
Crystals
Dynamotors
Headsets
Loudspeakers
Amplifying loudspeakers
Noise-cancelling microphones
Radio noise filters

φ *test equipment*

Bench test cable assemblies
Electronic test sets
Field strength meters
Pressurizing test kits
Universal electro-mechanical test stands
Universal motor test stands

η *fluid handling equipment*

Absolute pressure switches
Bombsight and instrument desiccators
Canopy seal pressurizing kits
Cooling units for electronic assemblies
Dehydrators
Fuel flow dividers
Pneumatic actuators
Pressurizing control panels
Alcohol pumps
Anti-detonant injection pumps
Ballast pumps
Bilge and refueling pumps
Dry air pumps
Electric motor driven pumps
Ethylene glycol and coolant pumps
Ethylene oxide pumps
Fuel pumps
Fuel booster pumps
Fuel filter de-icer pumps
Fuel transfer pumps
Hand operated pumps
Heater fuel pumps
Hydraulic pumps
Hydraulic oil booster pumps
Hydrogen peroxide pumps
Lube oil and scavenge pumps
Multiple-element pumps
Oil transfer pumps
Scavenge pumps
Smoke pumps
Submerged fuel booster pumps
Vacuum pumps
Water pumps
Radar pressurizing kits
Rocket engine fueling nozzles
Air relief valves
Check valves
Hydraulic valves
Hydraulic servo valves
Isobaric relief valves
Pressure regulating valves
Vacuum valves

π *miscellaneous*

Airborne television installations
Airplane brake modernization kits
Auxiliary power supplies
Electronic chassis assemblies
Executive airplanes
Periscope prism selectors
Precision remote positioners
Printed circuits
Radomes
Wire harnesses

LEAR Lear

CP-13

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There is still room on the A-MP TAPER TECHNIQUE Band Wagon for you to join the leaders. You, too, can increase speed of assembly, improve reliability, and save money by using A-MP TAPER PINS, TAPER TAB RECEPTACLES, TAPER BLOKS and TAPER TIPS.

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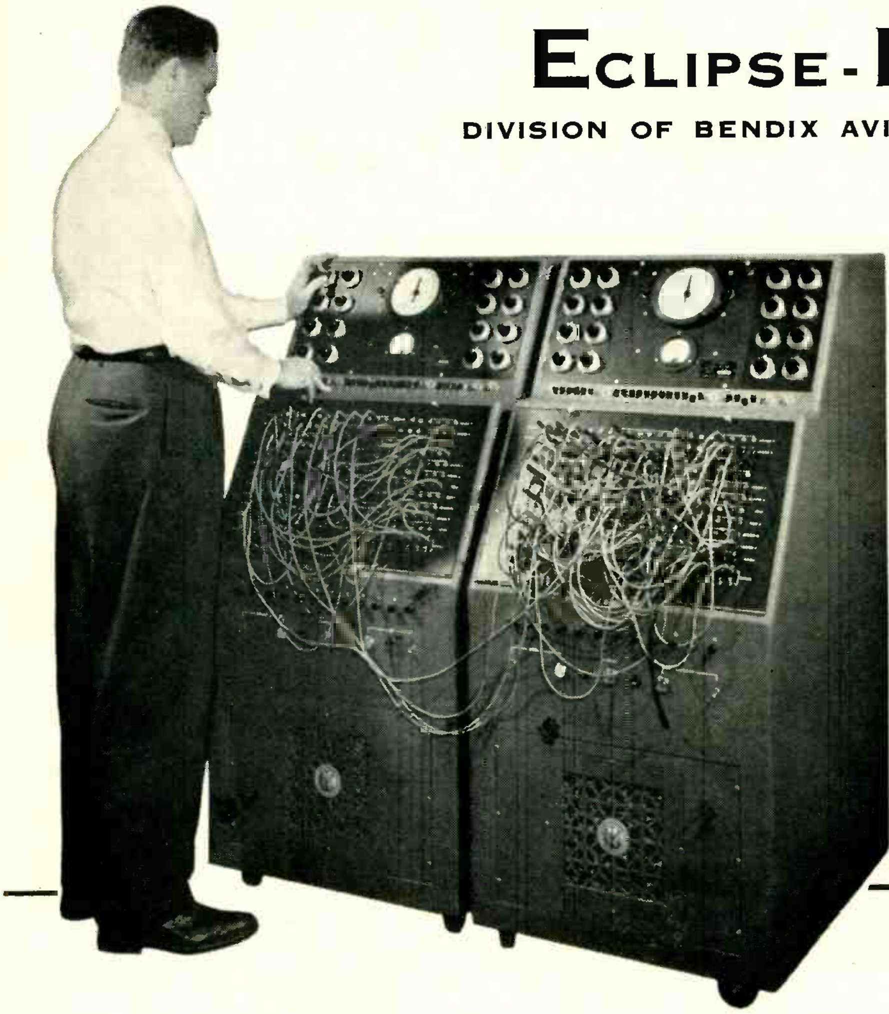
Mid-Century's MC-400 Computers Star at

ECLIPSE-PIONEER

DIVISION OF BENDIX AVIATION CORPORATION



Because they are ideal, low-cost laboratory tools!

These small, compact computers were especially designed to meet the requirements of a desk-side computer, training device, dynamic tester, laboratory tool, or as a building block which may be either expanded or appended to other equipment. And, they have all of the quality, amplifier precision and power supply to make them equal to and, in some cases, better than the larger machines now available.

The MC-400 Portable Computer contains:

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- Six chopper stabilized summing amplifiers.
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- Sixteen scale factor potentiometers.
- One multiplying servo with indicator dial.
- Four diode limiters.
- All necessary power supplies for independent operation (line voltage 110 volts 60 cycles).

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MID-CENTURY INSTRUMATIC CORP.

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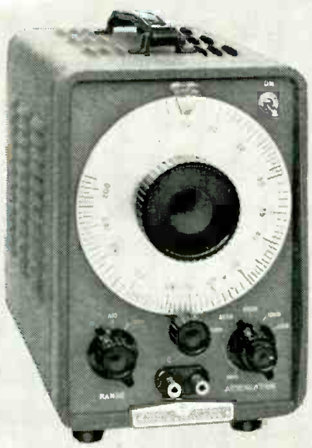
3 NEW hp OSCIL

6 cps to 6 KC. *-hp-* 200J replaces *-hp-* 200I, for interpolation, frequency measurement, etc., where frequencies must be known precisely. New 160 mw balanced output, less than 0.5% distortion, frequency stability ± 2% or 0.2 cps. Six spread-scale frequency ranges, effective scale length 80″ for maximum resettability. Calibration accuracy is ± 1%, frequency response ± 1 db full range. Output 160 mw or 10 v into 600 ohms, or 20 v open circuit, balanced to ground. Hum voltage less than 0.1% of output. $275.00.



20 cps to 20 KC. *-hp-* 201C. Like popular *-hp-* 201B but more accurate attenuator, compact cabinet, lower price. Provides low distortion, high accuracy output for amplifier, loudspeaker, frequency comparison and other high fidelity measurements. Frequencies covered in 3 bands, calibration accuracy ± 1%, frequency stability ± 2% or 0.2 cps, frequency response ± 1 db full range. Output 3 watts or 42.5 v into 600 ohms. Distortion less than 0.5% above 50 cps. Output attenuator adjusts voltage 0 to 40 db, provides either low or constant 600 ohm impedance. $225.00.

1 cps to 100 KC. *-hp-* 202C. New, multi-purpose instrument replacing *-hp-* 202B. Excellent wave-form for subsonic, audio, supersonic measurements in laboratory, field, factory. New broad frequency range, 160 mw balanced output, less than 0.5% distortion, high frequency stability, short recovery time (5 secs. at 1 cps), lowered price. Frequencies covered in 5 bands; frequency response ± 1 db full range, output 160 mw or 10 v into 600 ohms, 20 v open circuit, balanced to ground. Hum voltage less than 0.1%. $300.00.

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LATORS

finest built, reasonably priced

Utmost convenience and precise accuracy. Low distortion, high stability, wide frequency range, simple operation without resetting or adjustment. Attractive new cabinets, light and portable, yet rugged and compact.

The famous RC oscillator circuit, pioneered by *-hp-*, today refined to a high new level of performance and capability.

-hp- quality construction. Long-life electrolytic condensers, premium cost surface treated insulators, precision mechanical assemblies, specially built, 100% inspected transformers. All are standard in *-hp-* instruments to insure freedom from electrical and mechanical trouble, or the effects of dust, humidity and hard use.

These are the basic features of the three new *-hp-* oscillators now joining the 60,000 other *-hp-* RC oscillators in use throughout science, the military and industry.

These same features are fundamental in every *-hp-* oscillator. Every instrument bearing the Hewlett-Packard name is designed for the utmost in convenience, dependability, accuracy—the standard of quality in instrumentation, the very finest of its type made anywhere—yet available to you at a reasonable price.

hp provides complete coverage of your oscillator requirements

Oscillators—.008 cps to 10 MC

Instrument	Primary Uses	Frequency Range	Output	Price
-hp- 200AB	Audio tests	20 cps to 40 KC	1 watt/24.5 v	$120.00
-hp- 200CD	Audio and ultrasonic tests	5 cps to 600 KC	160 mw/20 v open circuit	150.00
-hp- 200J	Interpolation, frequency measurements	6 cps to 6 KC	160 mw or 10 v/600 ohms; 20 v open circuit	275.00
-hp- 200T	Telemetry, carrier current tests	250 cps to 100 KC	160 mw or 10 v/600 ohms; 20 v open circuit	350.00
-hp- 201C	High quality audio tests	20 cps to 20 KC	3 watts or 42.5 v/600 ohms; one terminal grounded	225.00
-hp- 202A	Low frequency measurements	.008 to 1200 cps	20 mw/10 v	465.00△
-hp- 202C	Low frequency measurements	1 cps to 100 KC	160 mw or 10 v/600 ohms; 20 v open circuit	300.00
-hp- 205AG	High power tests, gain measurements	20 cps to 20 KC	5 watts	440.00△
-hp- 206A	High quality, high accuracy audio tests	20 cps to 20 KC	+ 15 dbm	565.00△
-hp- 233A	Carrier test oscillator	50 cps to 500 KC	3 w/600 ohms	475.00
-hp- 650A	Wide range video tests	10 cps to 10 MC	15 mw/3 v	490.00△

△ Rack mounted instrument available for $15.00 less.

Data subject to change without notice. Prices f.o.b. factory.

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CABLE "HEWPACK" DAvenport 5-4451

WORLD'S MOST COMPLETE LINE OF HIGH QUALITY ELECTRONIC MEASURING INSTRUMENTS

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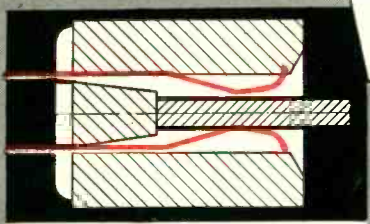
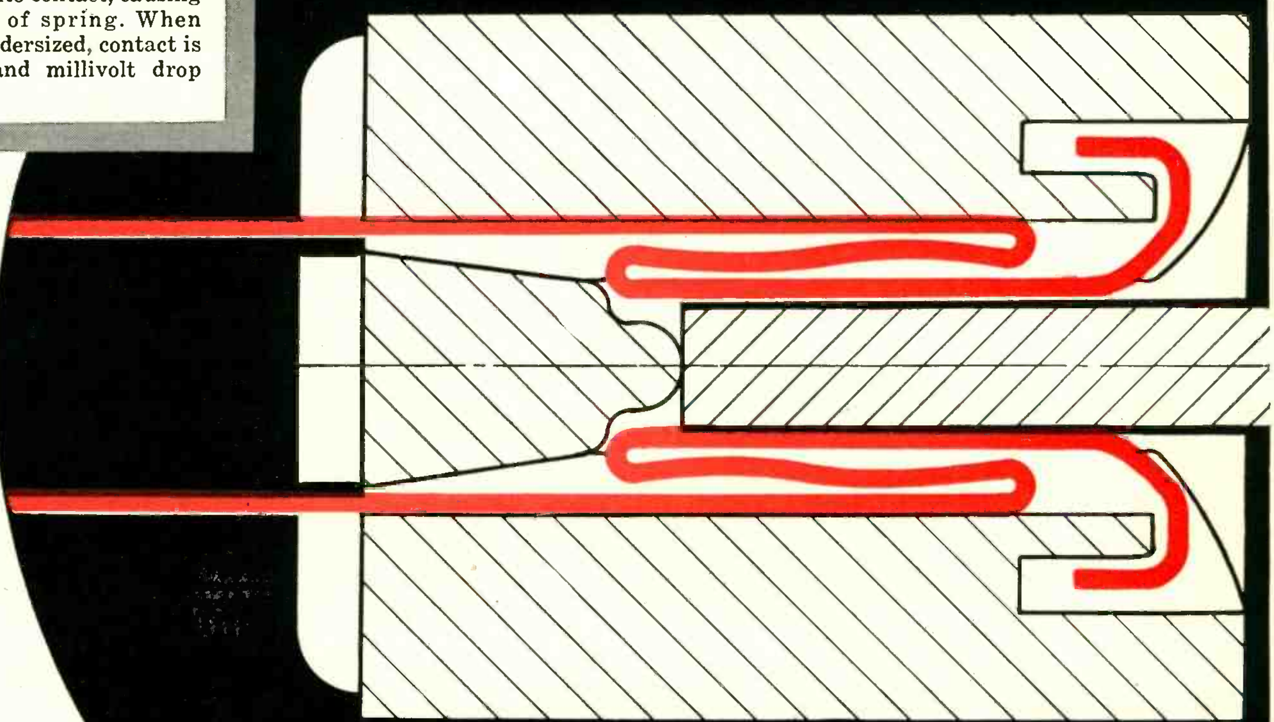
"Bellows Action in Printed Circuit

OLD

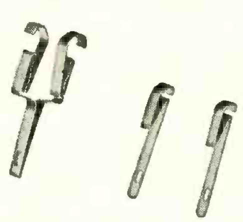


Conventional Contact merely grips board at a single point. Oversized board has to be forced into contact, causing distortion of spring. When board is undersized, contact is not firm and millivolt drop is high.

NEW!



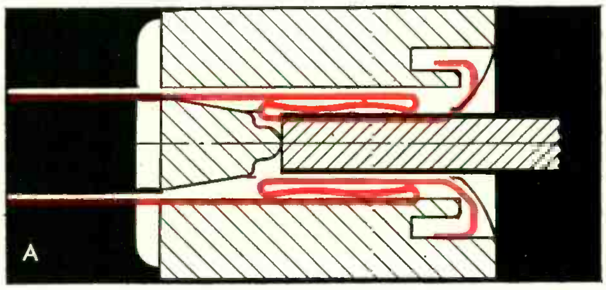
Continental "Bellows Action Contact" with coil spring action grip, clasps board firmly over 100% of printed circuit board contact area. Gold-plated phosphor bronze spring retains tension, allows use of undersized or oversized board while maintaining low contact resistance—less than 10 millivolts at 5 amps!

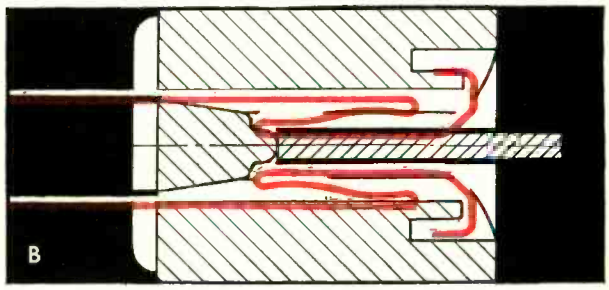


"Bellows Contacts" Actual photograph of single and dual "Bellows Contacts."

Patent Pending

Contact"...now Connectors by Continental Connectors

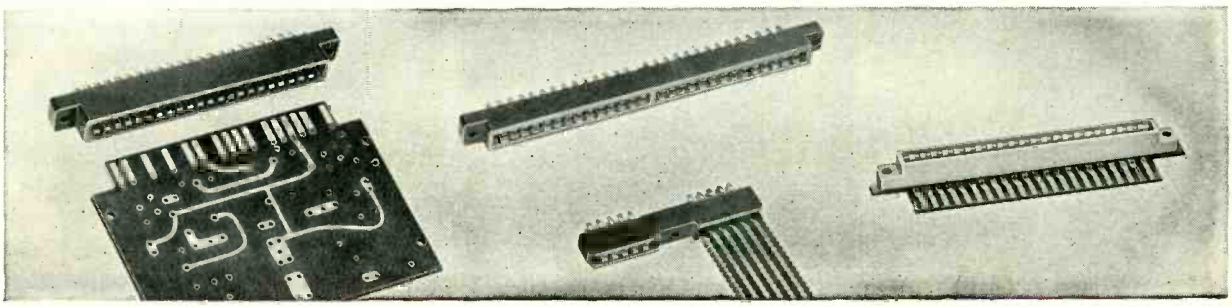




Illustrations demonstrate how "bellows contact" eliminates board tolerance problems

(A) Illustration shows how .135" board is gripped firmly by new Continental "Bellows Type Contact." No distortion or stress occurs because of bellows action.

(B) Same contact springs back to maintain retention for minimum board thickness of only .115". Bellows spring-grip action gives equal contact surface area for minimum board thickness.



New Continental "bellows type contacts" available for for 1/8", 3/32" and 1/16" size boards...3 molding compounds ...three wiring styles...and 6 to 28 contacts

Shown above are four of many styles available in the new "Bellows Type Contact" Printed Circuit Receptacles.

CONTACTS: 6, 10, 15, 18, 22, 28 contacts in either single or double rows. (Double row of 28 permits 56 separate connections.)

WIRING STYLES: Available with eyelet lug for soldering, lugs for wire wrap, or contacts can be dip soldered directly to board by bending soldering leads 90° (see photo).

MOLDING COMPOUNDS: Moldings can be ordered in Mineral filled Melamine, Plaskon reinforced (glass) Alkyd 440A, or Orlon filled Diallyl Phthalate.

Additional technical data on these connectors, and special designs requiring the use of sub-miniature, hermetic seal, pressurized, high voltage or power connectors are available on request. Write today on your company letterhead for complete catalog.

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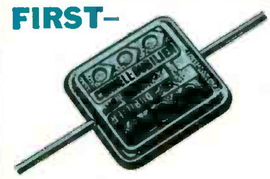
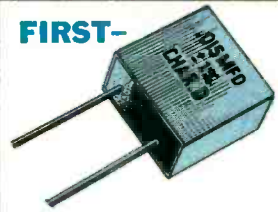
FIRST–



"Silver-Mike"* capacitors.

FIRST–



Super-Micadon* mica capacitors.

In the parade of progress as in the manufacture of capacitors it takes vision to lead. That is why, we, at Cornell-Dubilier, have proven our leadership with constant foresight . . . by always being first to develop new and more efficient capacitors to meet tomorrow's demands. Too, this vision has given

C·D...45 YEARS OF FAMOUS FIRSTS

Shown here are three examples of C-D's "Famous Firsts" – *proof* that whatever your capacitor requirements, a C-D engineer can show you money saving answers. Write to Cornell-Dubilier, Dept. K-26, South Plainfield, N. J.

FIRST–

postage stamp (Micadon*) mica capacitors.

CONSISTENTLY DEPENDABLE CORNELL-DUBILIER CAPACITORS

PLANTS IN SO. PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER AND CAMBRIDGE, MASS.; PROVIDENCE AND HOPE VALLEY, R. I.; INDIANAPOLIS, IND.; SANFORD AND FUQUAY SPRINGS, N. C.; SUBSIDIARY, RADIART CORP., CLEVELAND, OHIO.

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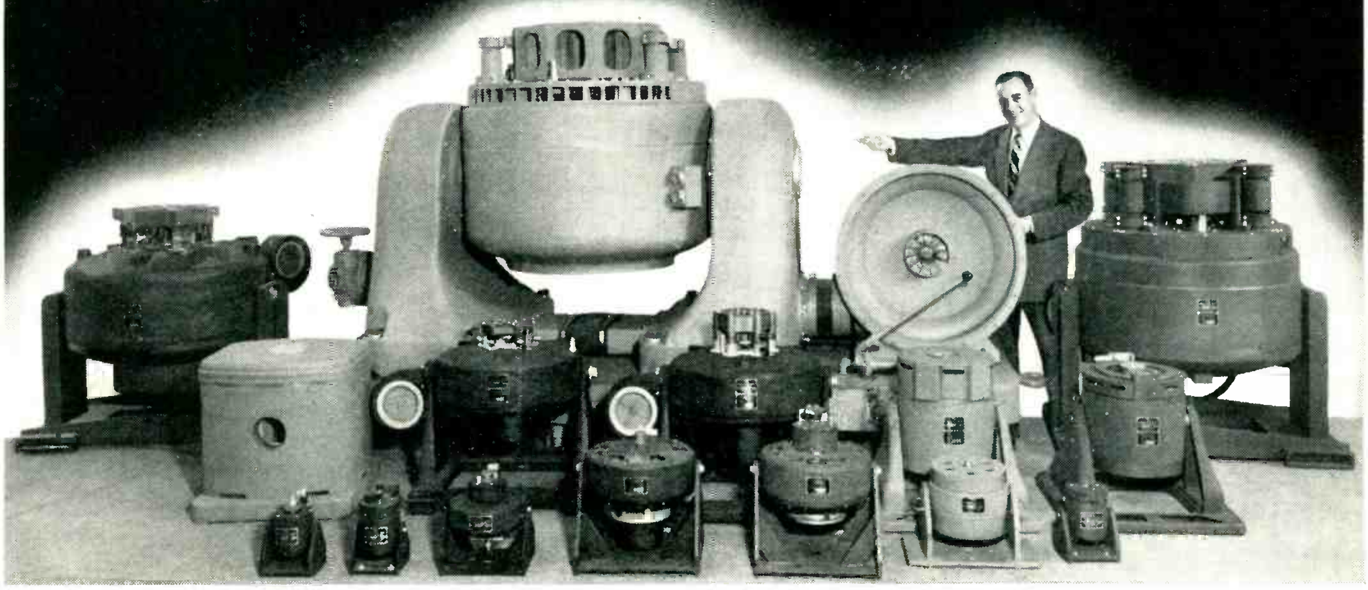
THERE ARE MORE C-D CAPACITORS IN USE TODAY THAN ANY OTHER MAKE

Look at this progress in vibration exciters



A whole range of MB Shakers developed to handle any vibration testing program ... deliver reliable, quantitative data

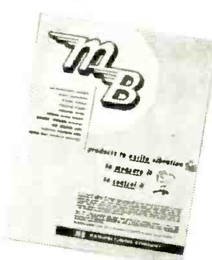
One pound to over twelve thousand pounds . . . that's the range of force outputs in this group of MB electrodynamic vibration exciters. On the way are shakers for 25,000, 50,000 and even 100,000 pounds! All operate over substantial frequency range. What a far cry from the limited scope of mechanical shakers . . . the only type available just a short ten years ago.

But force and frequency range are not the only improvements. MB has long recognized the need for *pure* table motion if test results were to be quantitative and reliable.

Thus, in MB Shakers, moving-element structures are very rigid. This minimizes table motion distortion in the testing range. Also, because MB power supplies are designed for negligible harmonic distortion, table waveform is pure over the whole frequency range.

There's more. MB has designed complex wave testing systems that shorten test time and give truer reproduction of actual service conditions. Also oil-filled exciters capable of operation at "100,000 ft. altitude," −100 to +200°F, and 20 to 95% relative humidities. Also cycling systems that do time-consuming test procedures *automatically.*

If you're working on projects that call for environmental testing, or fatigue testing, or noise determinations...you can benefit from vibration testing with MB shakers. Work with a leading source of help and information in this growing field . . . contact MB. For details and specifications on MB Exciters, send for Bulletin **420-5.**

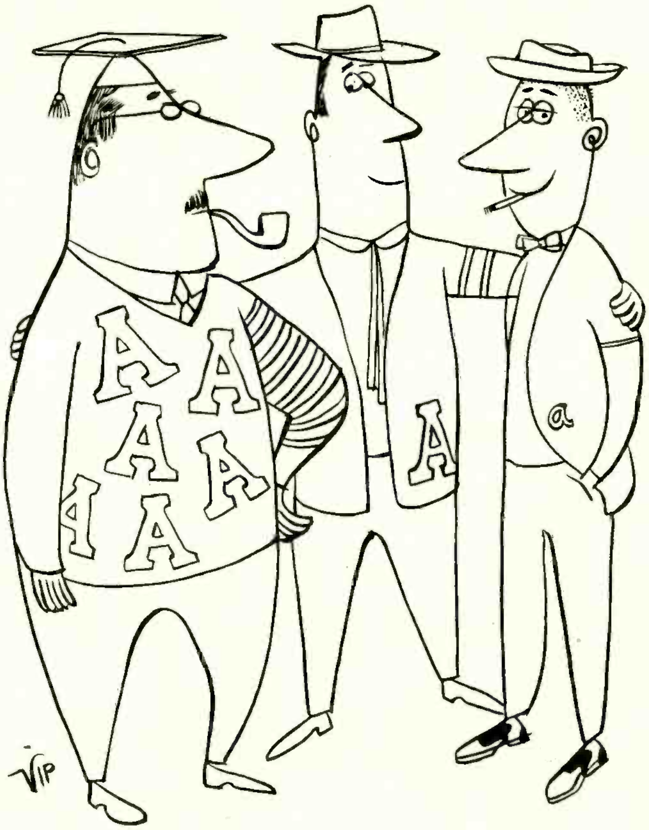


MB *manufacturing company* **1060 State Street New Haven 11, Conn.**

A division of Textron American, Inc.

HEADQUARTERS FOR PRODUCTS TO ISOLATE VIBRATION ... TO EXCITE IT ... TO MEASURE IT.

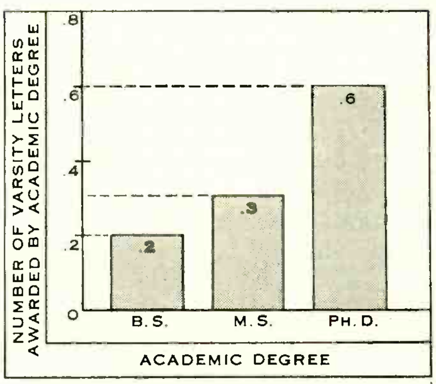
SIDELIGHTS ON THE SCIENTISTS *number* **3** *of a series*



Brain and Brawn

Some of the young fellows on our staff have been analyzing our files of personal data regarding scientists and engineers here at Hughes. What group characteristics would be found?

With additional facts cheerfully contributed by their colleagues they have come up with a score of relationships—some amusing, some quite surprising. We shall chart the most interesting results for you in this series.



Contrary to popular belief, higher academic study goes hand in hand with increased school athletic activity—as shown in the above chart. This is based on data obtained from a 20% random sample of the 2,200 professional engineers and scientists of Hughes Research and Development Laboratories.

In our laboratories here at Hughes, more than half of the engineers and scientists have had one or more years of graduate work, one in four has his Master's, one in 15 his Doctor's. The Hughes research program is of wide variety and scope, affording exceptional freedom as well as exceptional facilities for these people. Indeed, it would be hard to find a more exciting and rewarding human climate for a career in science. Too, the professional level is being stepped up continually to insure our future success in commercial as well as military work.

Hughes is pre-eminent as a developer and manufacturer of airborne electronic systems. Our program includes military projects in ground and airborne electronics, guided missiles, automatic control, synthetic intelligence. Projects of broader commercial and scientific interest include research in semiconductors, electron tubes, digital and analog computation, data handling, navigation, production automation.

SCIENTIFIC STAFF RELATIONS

Hughes

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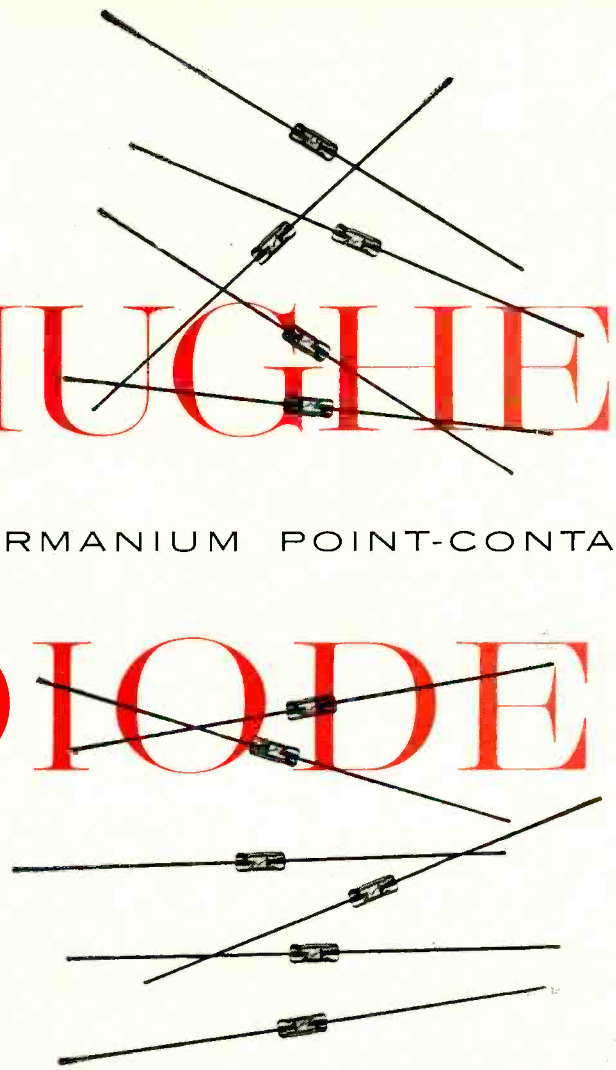
DUE TO THE *expanding use of Hughes electronic systems, new positions are open for engineers who have demonstrated ingenuity and inventive ability in the areas of product design.*



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Hughes Semiconductors offers an extensive selection of standard diode types—both germanium point-contact and silicon junction. Available too are more than two hundred special types. Most electronic circuit requirements can be met by diodes selected from among these existing devices of standard manufacture.

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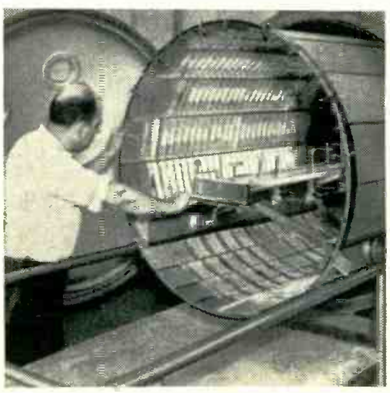
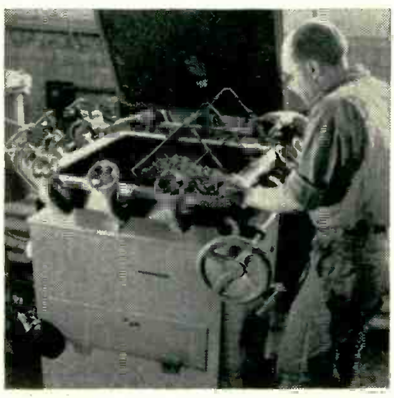
New Stokes dual-tube in-line aluminizing system is setting high standards of economy and productivity at Thomas Electronics, Inc., Passaic, New Jersey.

Electronic equipment manufacturers are profiting from other STOKES Vacuum Equipment...

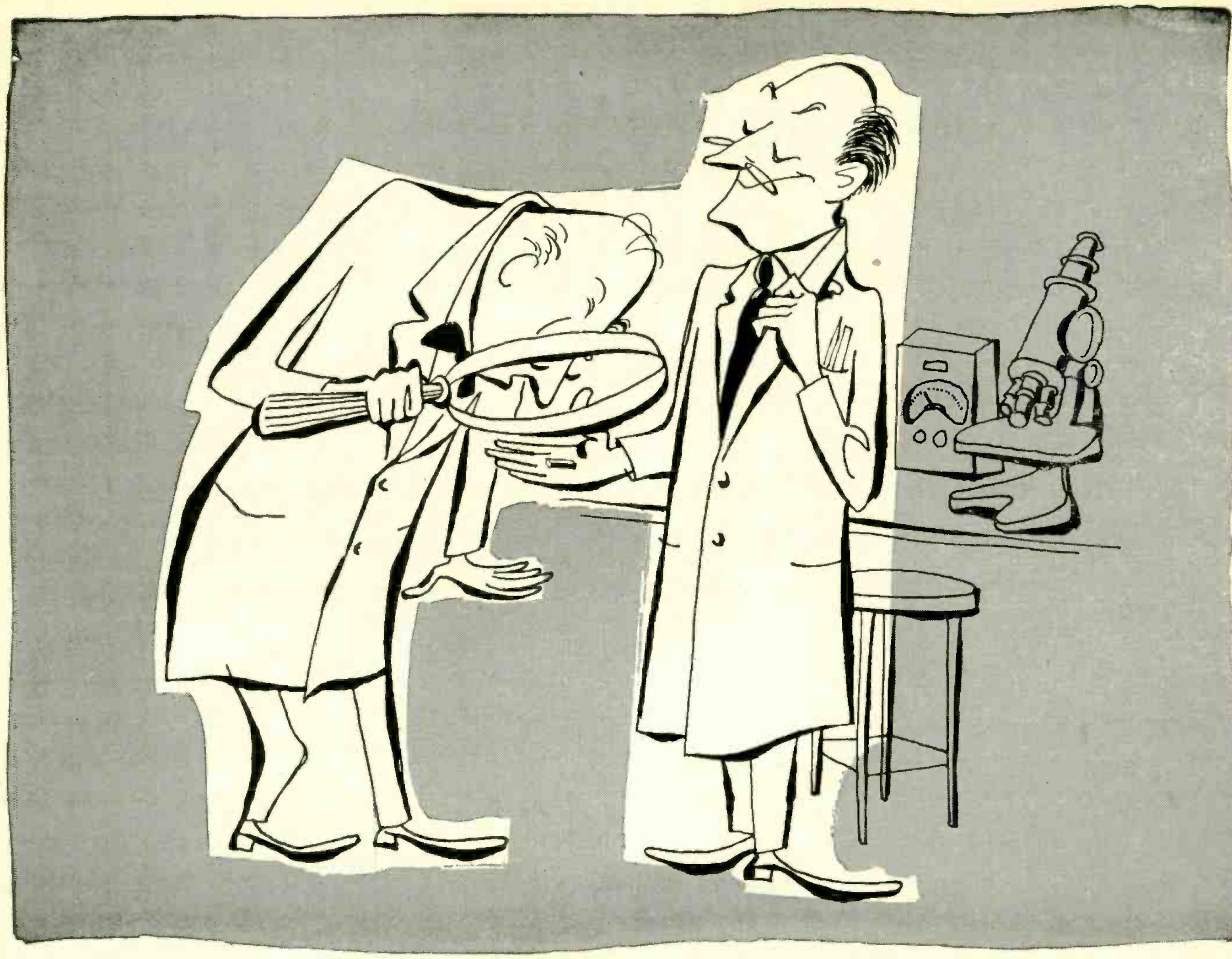


Vacuum Metallizers. Stokes manufactures a complete line of vacuum metallizing equipment to plate selenium rectifiers, printed circuits and other conductive coatings on non-conductive materials.



Vacuum Impregnators. Manufacturers of electronic equipment use Stokes vacuum impregnation systems to obtain improved characteristics of coils, condensers, capacitors and other components.

Vacuum Furnaces. Stokes melting and heat-treating furnaces permit electronic manufacturers to pre-process raw and semi-finished materials with less contamination, for increased life and performance.



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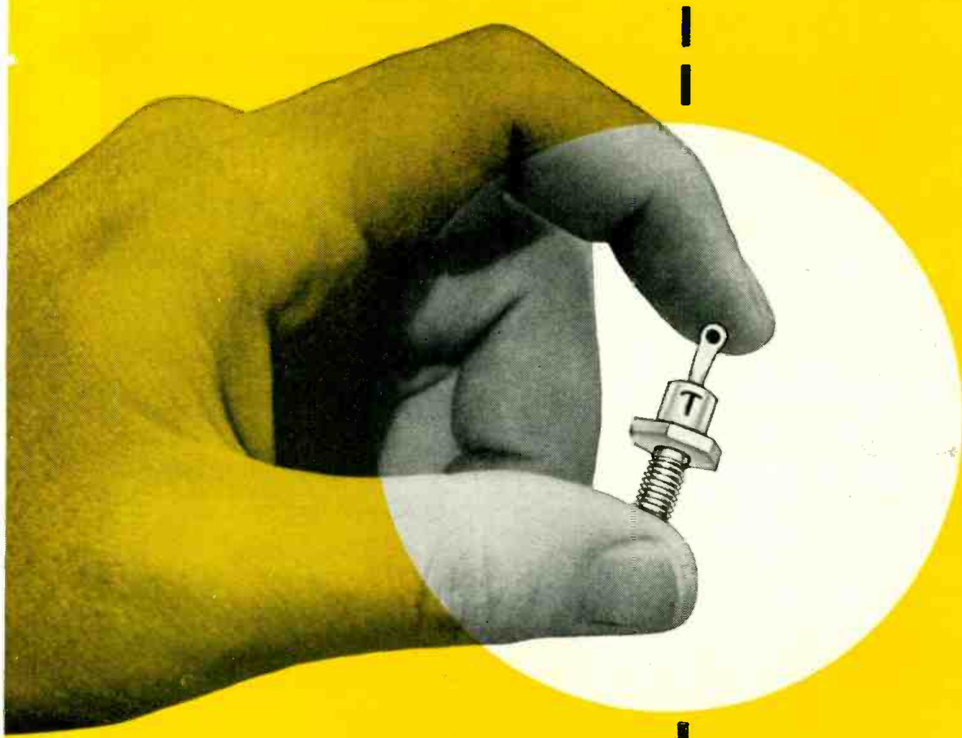

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Ratings at 100° C

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1N332	400	400	.1
1N341	400	400	.5
1N334	300	400	.1
1N343	300	400	.5
1N336	200	400	.1
1N345	200	400	.5
1N338	100	1000	.1
1N347	100	1000	.5

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Business Investment Holds Key To Both Growth and Stability

What federal tax policy will best promote both growth and stability in the American economy? The Joint Economic Committee of Congress has been asking this crucially important question in public hearings. This editorial suggests one vital part of the answer.

The proposition advanced here is that—

> Tax policy must encourage a continuing high level of business investment in new plant and equipment, because such investment makes a special contribution to *both* economic growth and economic stability.

Growth Needed for Security

We must have both growth and stability.

A vigorous economic growth is essential to our national security. As Congressman Wilbur D. Mills said in launching the Joint Committee's hearings, "The present complexion of world affairs places a premium upon strength and growth in our national economy." Growth is likewise a major ingredient of a healthy domestic economy. Growing enterprises and growing communities offer far more opportunities for satisfying careers than those which are not growing.

A reasonably stable economy, without violent ups and downs, is also essential to our national welfare. Extravagant booms and their more or less inevitable result, severe depressions, waste labor and resources and cause great human misery. Both major political parties have accepted the obligation imposed by the Employment Act of 1946, that the federal government work to maintain high and stable employment.

There is general agreement that **the key to economic growth is investment in new plant and equipment.** Growth depends decisively on new facilities to increase production, and also to produce new and better products in new and better ways. At the same time, new plant investment provides employment for the important, and well-paid, one-fourth of our industrial workers who manufacture and build new production facilities. So if the process of business investment is kept on an even keel, the result is not only growth but also stability in a substantial sector of our economy.

But authorities disagree on the possibility of maintaining a high level of business investment for any great length of time. Some fear that it will lead to an excess of producing capacity and the glutting of markets, with recession or depression not far behind

The history of our country offers some basis for the fear that it is dangerous to maintain a very high level of business investment. There have been times when the economy has suffered under the weight of excess producing capacity. **This fear, however, has been made obsolete by the recent course of our economic history which, in its earlier phases, nourished the fear.**

The World Has Changed

Here are some of the major considerations, cited at the Joint Committee hearings, which support the conclusion that we not only *can have* a high level of business investment and economic stability but that we actually *need* a high level of such investment to assure stability.

(1) Over the next 20 years our population is expected to increase by about one-third. But most of the population increase will come in age groups younger or older than normal working ages, and people will probably work fewer hours per week. Thus hours worked are not expected to increase more than 15%. Consequently, we must have a relatively large increase in the amount of production equipment per worker if our standard of living is not to suffer. This means a high level of new investment.

(2) About half of our present business investment goes to replace worn-out equipment, rather than to expand capacity as was true during the early stages of our industrial development.

(3) Thanks largely to the impact of organized research—for which we as a nation now spend about $4 billion a year—a large share of capital investment now goes to provide new products and new processes, rather than to expand existing capacity.

These developments make it unlikely that we shall develop the burden of excess capacity that plagued the economy in earlier periods. **Moreover, most capital investment plans are now made on a long-range basis. Companies are building facilities to anticipate their needs for several years ahead.** This increase in long-range planning has reduced the disturbing effects of temporary shortages and excesses in producing capacity.

The record of recent years speaks for itself. Business spending for new plant and equipment in 1955 was over $29 billion. This continued the high level of investment that has been maintained for the past ten years—a decade remarkable for both impressive growth and gratifying stability. A McGraw-Hill survey of preliminary plans for 1956 indicates another year of increasing investment, and expanding business activity.

Tax policy, to be successful, must consider this impressive contribution of business investment to both growth and stability.

Of course, the level of investment depends on many factors other than federal tax policy. The degree of business confidence is important. So is the strength of consumer markets. So is the attitude of organized labor toward the use of more efficient machinery. But tax policy is a crucially important factor. And it is becoming more so with new developments in our changing economy. These developments indicate that tax policy **must be geared to foster a high level of business investment, if the dual objectives of economic growth and economic stability are surely to be attained.**

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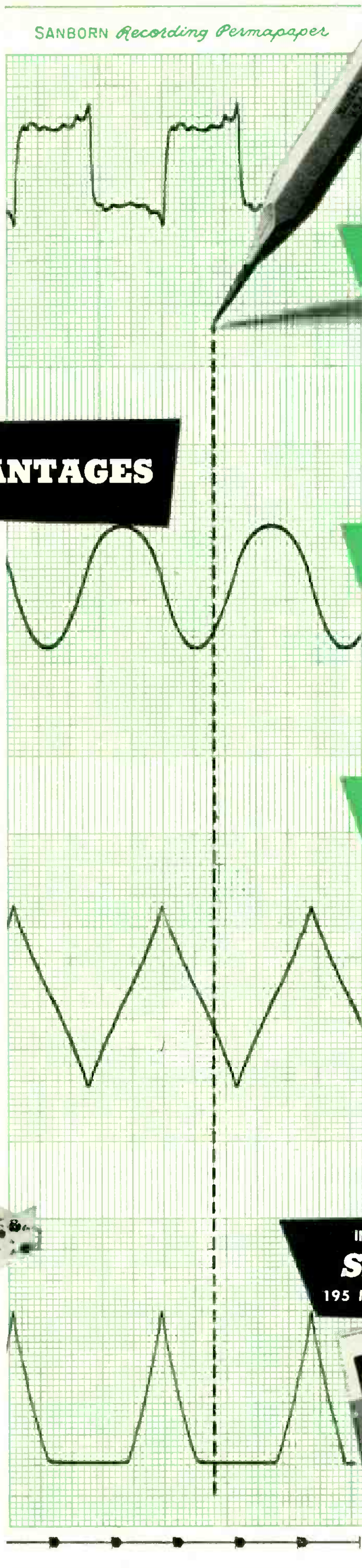
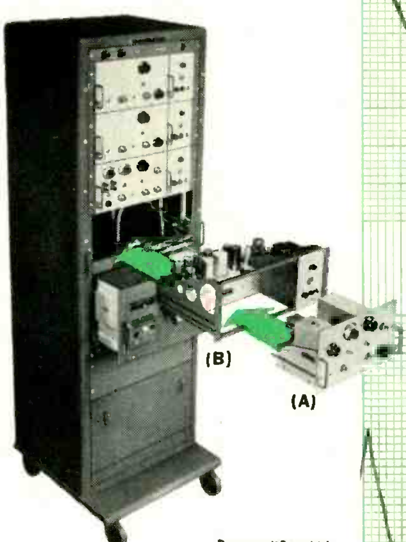


THE three foremost operating advantages of a Sanborn "150" are evident in the record, and are given at the right. Equally popular with industrial users is the *wide versatility* of these systems. Each one comprises a basic assembly to which the user adds his choice of an interchangeable, plug-in type preamplifier for each channel. Presently available different preamplifiers now number *eleven.*



Preamplifier (A) shown in position to plug into a Driver Amplifier with Power Supply (B) which are normally already in place in the Basic Cabinet Assembly

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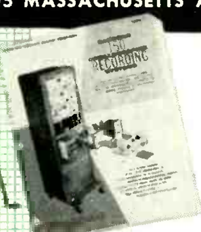
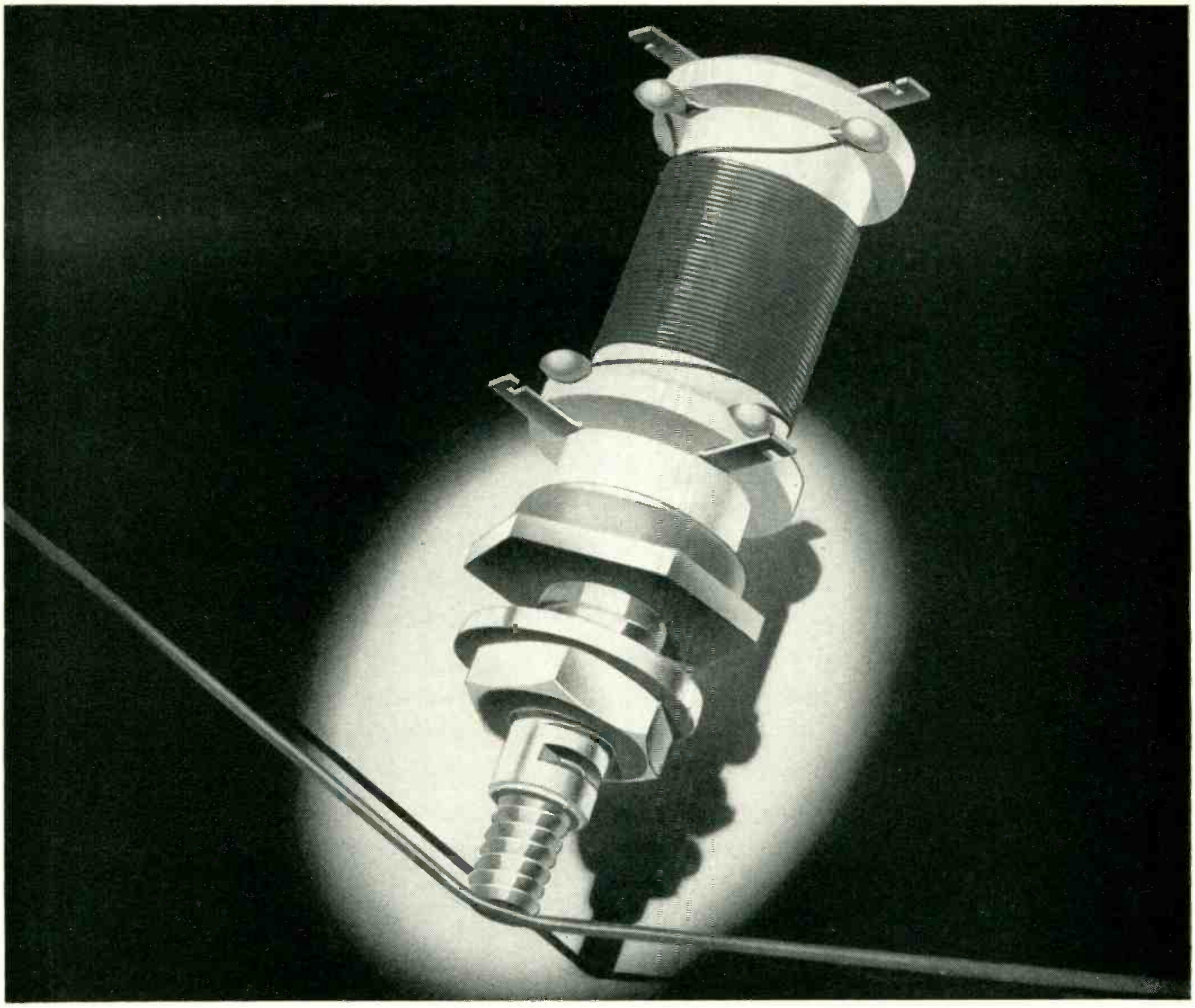


A new "150" Catalog provides complete descriptive data, specifications and prices on all 150 Systems, Accessories and Cabinets. A copy will be sent on request.



CTC Slug Tuned Coils are made in single layer or pie type windings to your specifications. Forms are of grade L-5 silicone impregnated ceramic. Mounting studs are cadmium plated brass; silicone fibreglas collars facilitate termination of simple or multiple windings.

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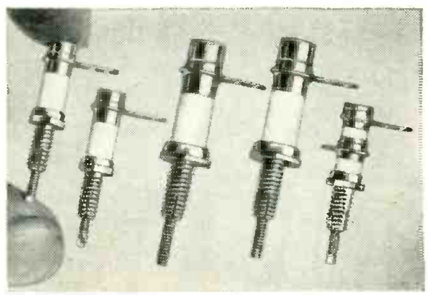

CTC Capacitor family: Metallized ceramic forms. From left to right — CST-50, in range 1.5 to 12.5 MMFD's. CST-6, in range 0.5 to 4.5 MMFD's. CS6-6, in range 1 to 8 MMFD's. CS6-50, in range 3 to 25 MMFD's. CST-50-D, a differential capacitor with the top half in range 1.5 to 10 MMFD's and lower half in range 5 to 10 MMFD's.

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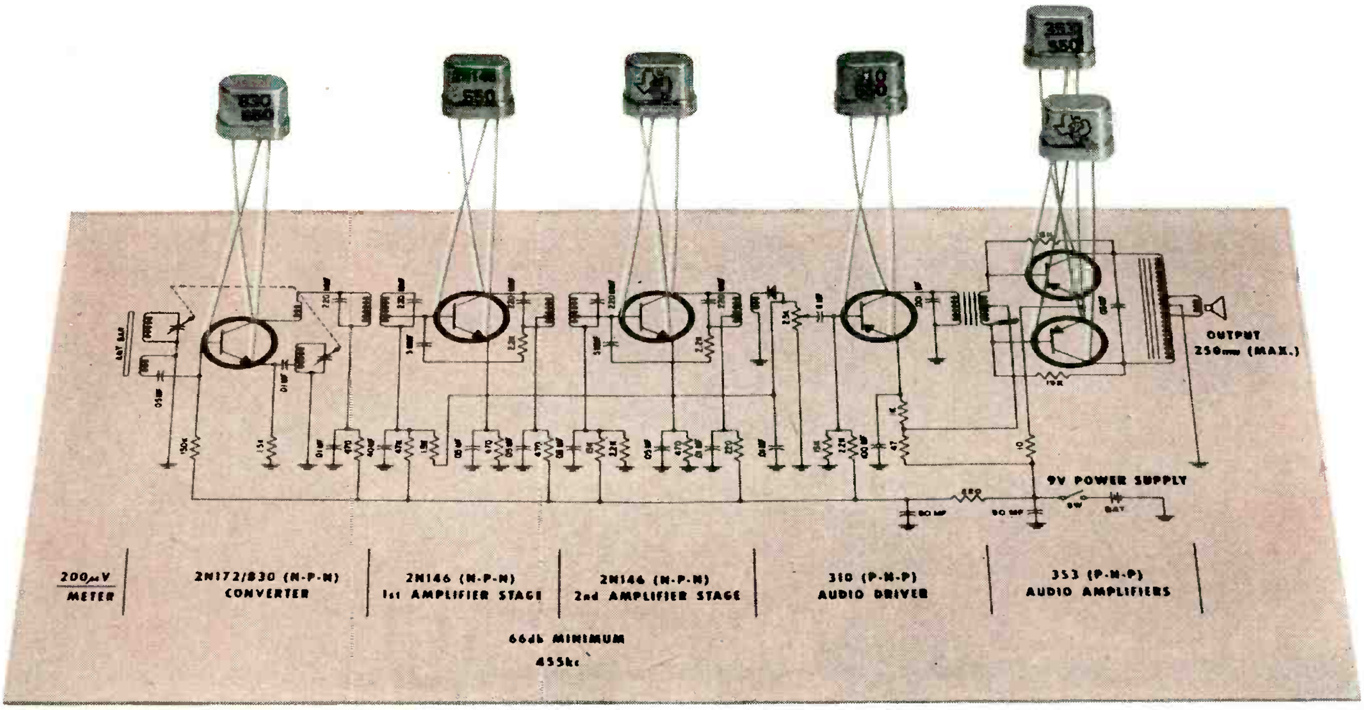

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Left to right: a 2N172/830 germanium N-P-N graded junction converter, two 2N146 germanium N-P-N graded junction IF amplifiers, a 310 germanium P-N-P fused junction driver, and two 353 germanium P-N-P fused junction outputs. This is a typical TI circuit designed for optimum performance.

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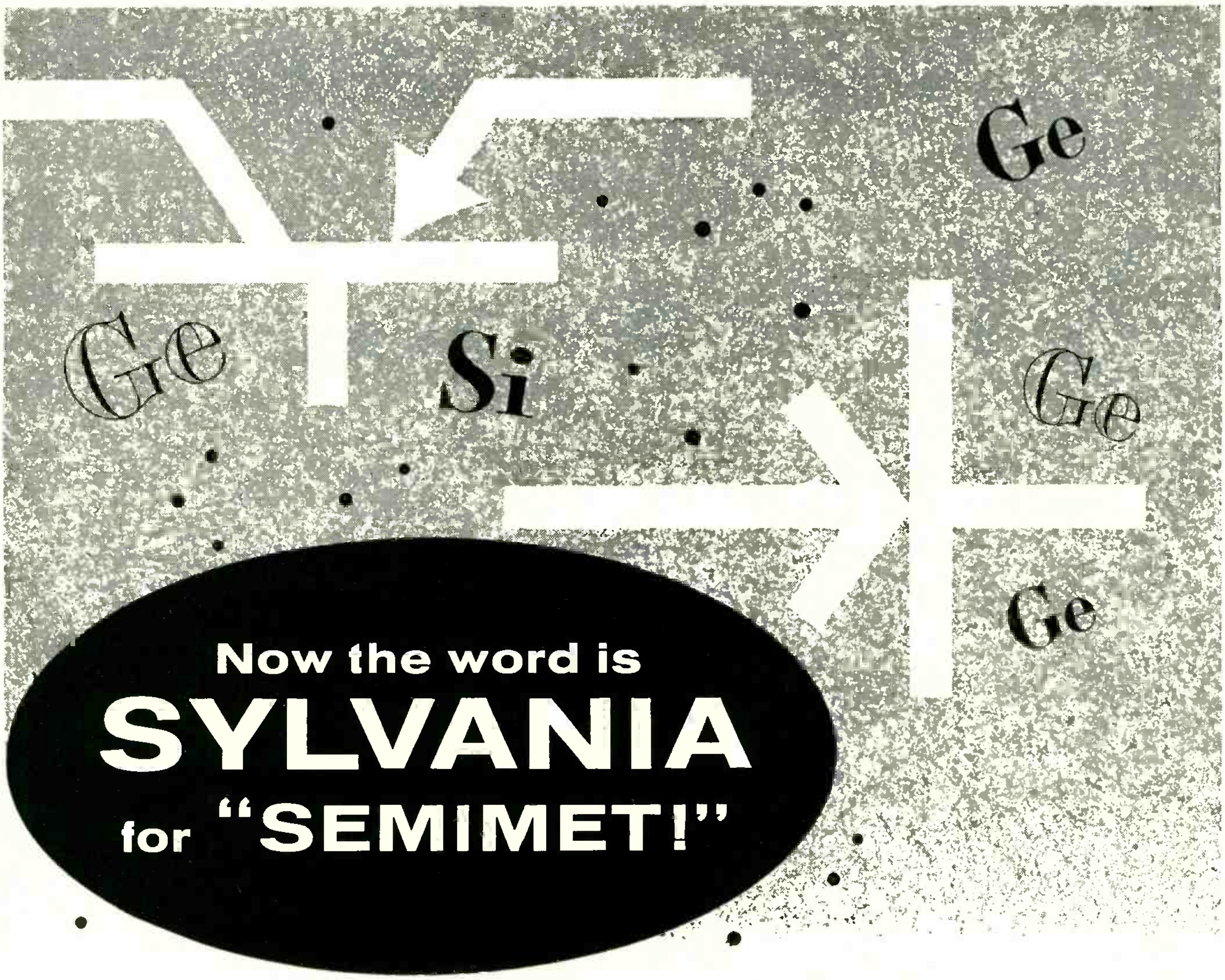

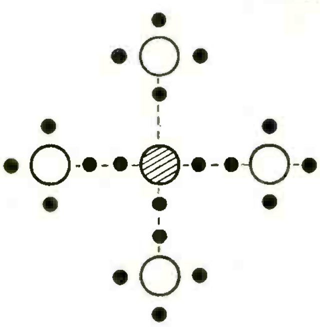

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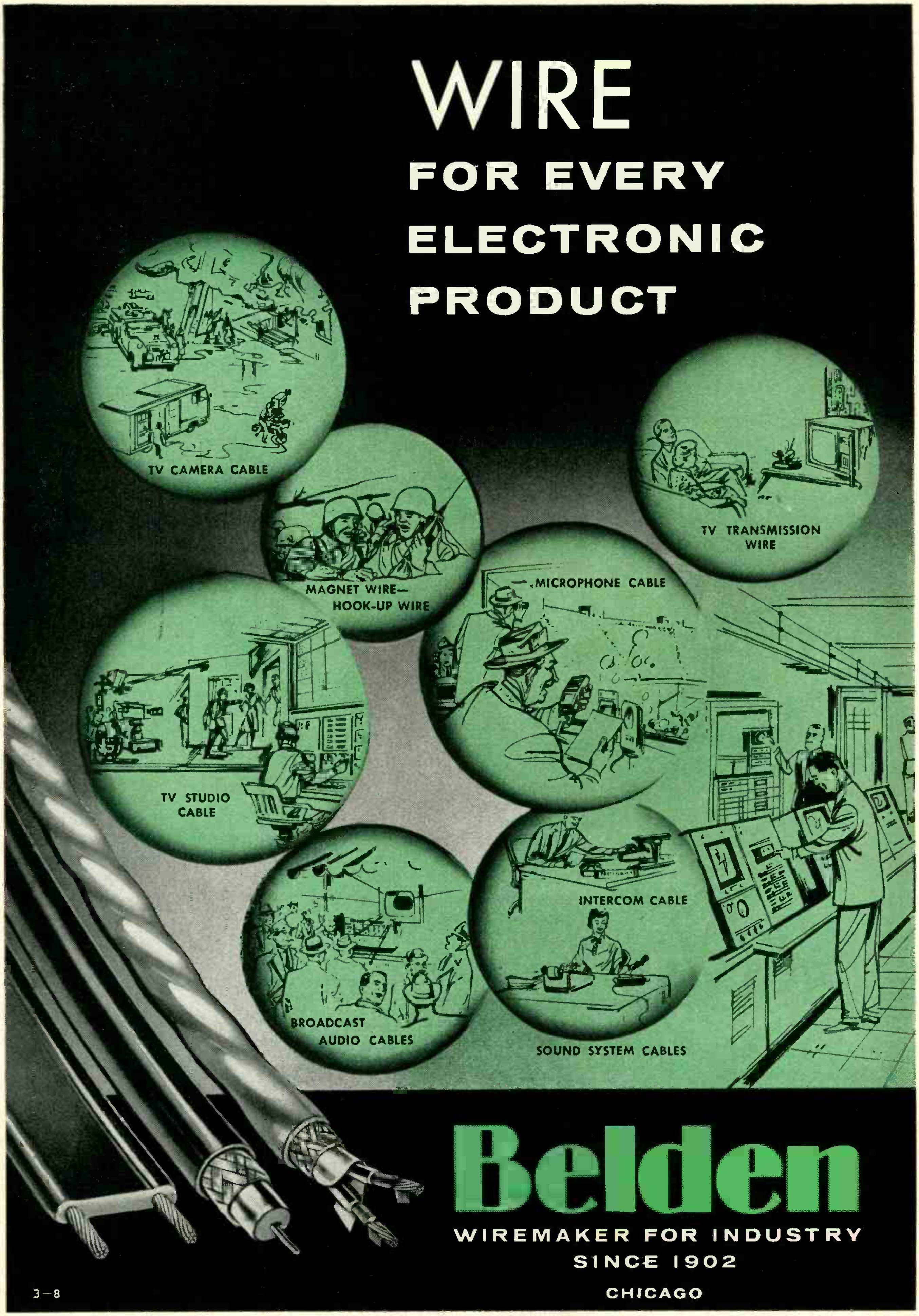
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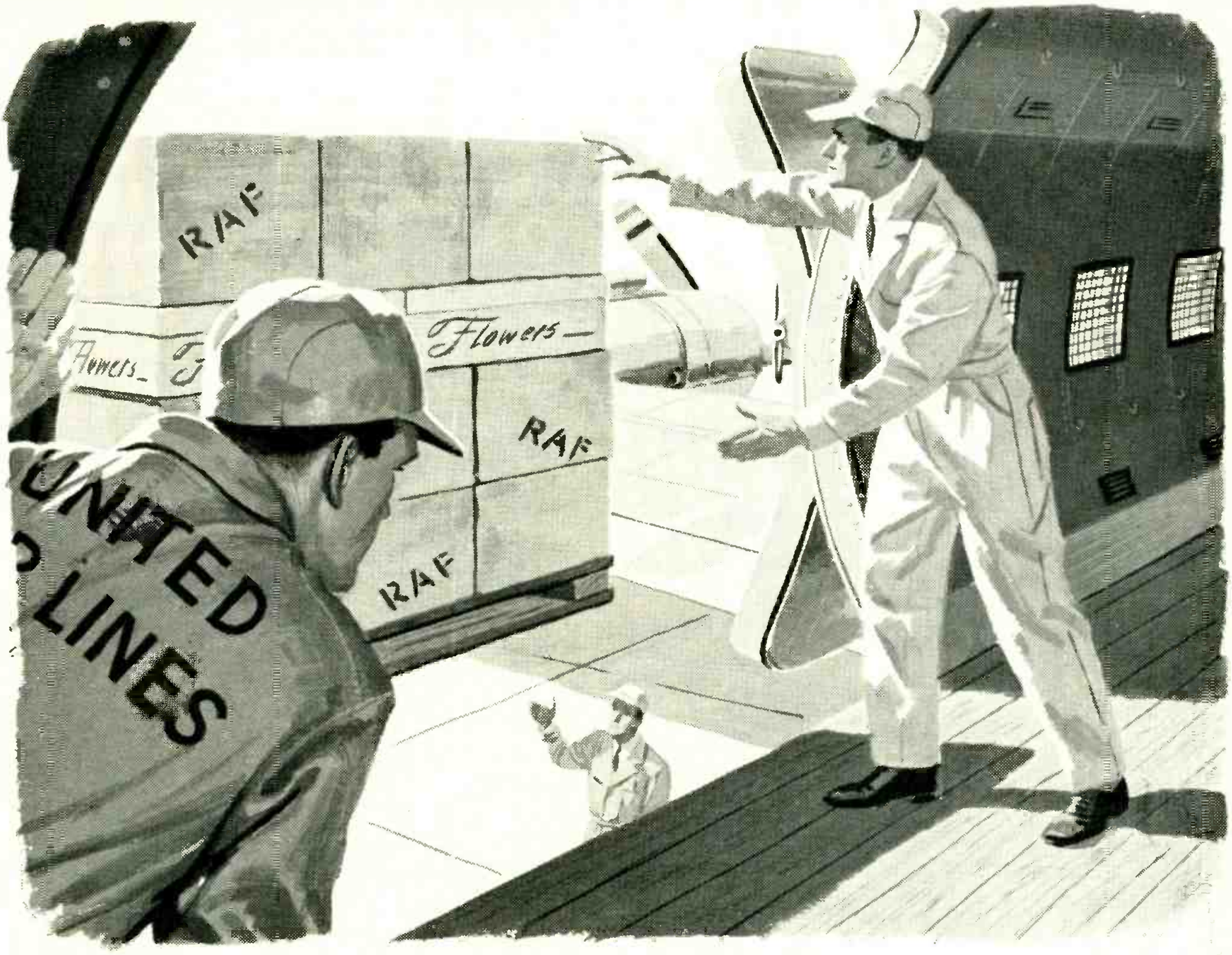

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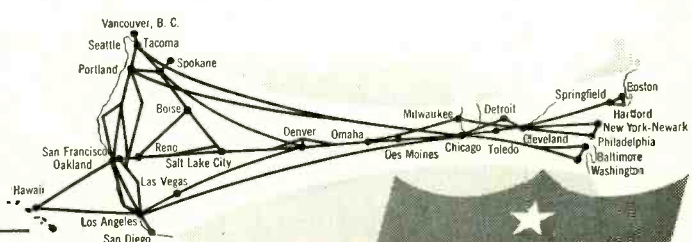

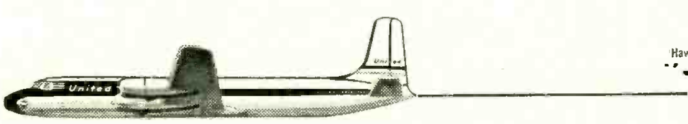

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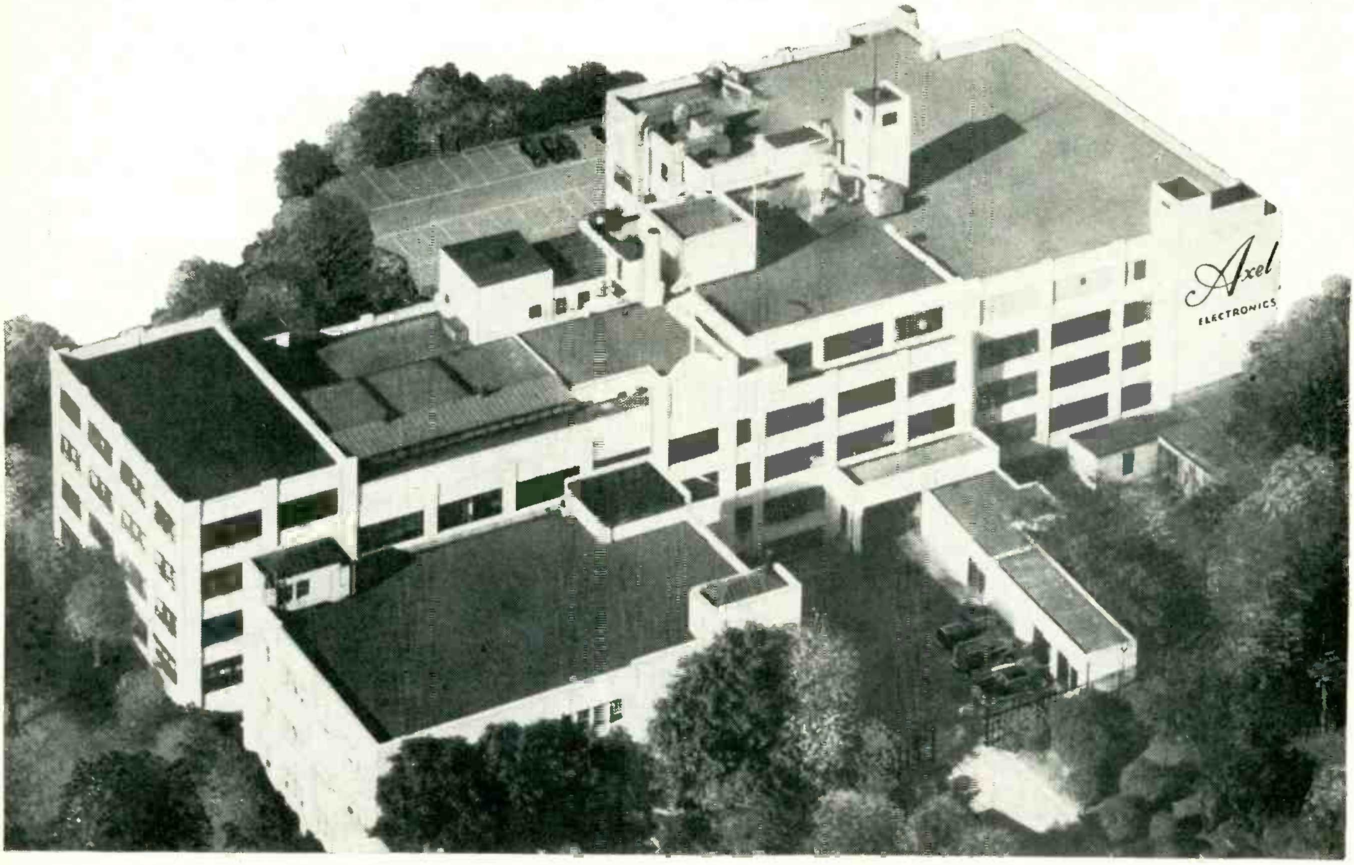

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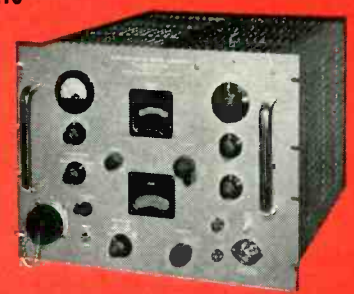


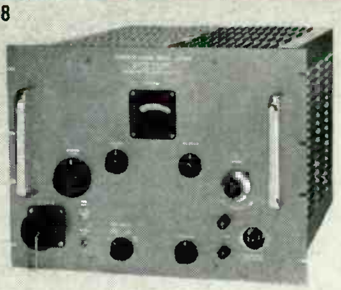
POLARAD MICROWAVE SIGNAL GENERATORS
12.4 TO 39.7 KMC

Rugged, compact, completely integrated units. Designed to save engineering manhours in the laboratory and on the production line. Operate simply with direct-reading continuously variable dials. No calibration charts.

Frequency is measured by direct-reading reaction-type wave-meters that assure extreme accuracy. VSWR is exceptional—Signal Generators 1.7 to 1; Signal Sources 1.7 to 1 when attenuated. Calibration accuracy is given special attention.

Consult Polarad on all your EHF problems.

SS-1218



POLARAD MICROWAVE SIGNAL SOURCES
12.4 TO 50.0 KMC

	SIGNAL GENERATORS		SIGNAL SOURCES	
Frequency Range	Model Number	Output Power	Model Number	Power Output (Average)
12.4 to 17.5 KMC	SG 1218*	–10 DBM	SS 1218	15 mw
18.0 to 22.0 KMC	SG 1822	–10 DBM	SS 1822	10 mw
22.0 to 25.0 KMC	SG 2225	–10 DBM	SS 2225	10 mw
24.7 to 27.5 KMC	SG 2427	–10 DBM	SS 2427	10 mw
27.27 to 30.0 KMC	SG 2730	–10 DBM	SS 2730	10 mw
29.7 to 33.52 KMC	SG 3033	–10 DBM	SS 3033	10 mw
33.52 to 36.25 KMC	SG 3336	–10 DBM	SS 3336	9 mw
35.1 to 39.7 KMC	SG 3540	–10 DBM	SS 3540	5 mw
37.1 to 42.6 KMC	* External Source Power Measurement Range +10 to +30 DBM Accuracy with Correction: ±2 DB		SS 3742	Approx. 3 mw
41.7 to 50.0 KMC			SS 4150	Approx. 3 mw

Modulation:
1. Internal
   1000 CPS Square Wave
2. External
   a. Pulse
      Pulse Width: 0.5 to 10 Microseconds
      PRF: 50 to 10,000 PPS
      Pulse Amplitude: 10 volts Pk to Pk Min.
      Polarity: Positive
   b. Sawtooth or Sinusoidal
      Frequency: 50 to 10,000 CPS
      Amplitude: 15 Volts RMS Min.

SPECIAL FEATURES OF EHF SIGNAL GENERATORS

- Unique power measurement system employs waveguide components of unusual design — allows continuous and front panel monitoring.
- Attenuation is independent of power set and frequency.
- 1000 cycles cps square wave modulation and external fm or pulse modulation provided over entire frequency range.

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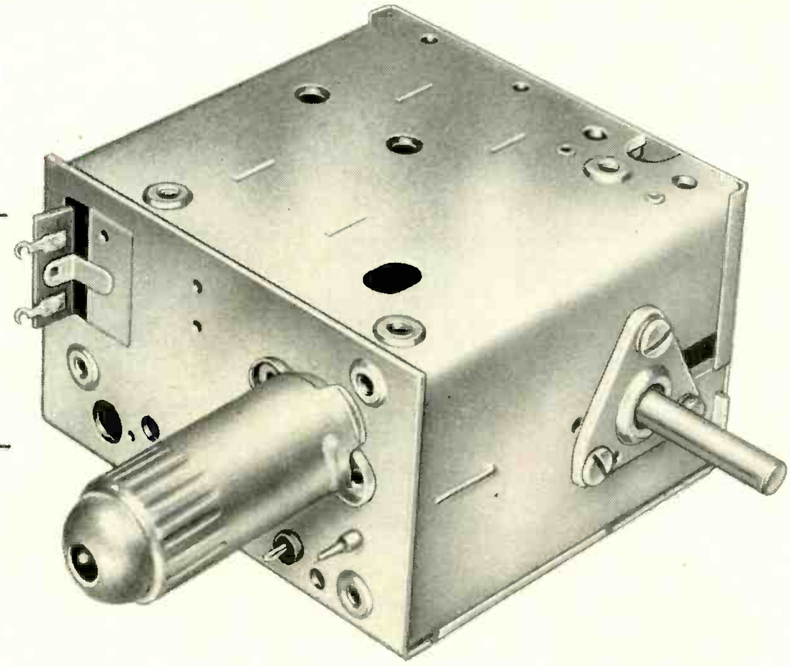


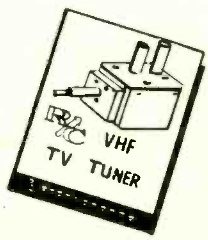
how we cut tuner costs without cutting quality corners

The hotly competitive TV market has long wanted high quality tuners at low prices. But everytime we took a production tuner and cut enough circuit and package "corners" to effect a significant price cut, we wound up with a product unworthy of our R/C trademark.

But last year we had our Engineering Department design a new series of tuners from scratch . . . requesting top performance and bottom costs. What we got was remarkable performance —better than requested—but no appreciable price differential. Until production got into the act, that is. Production designed and sold management on setting up a line of mechanized production equipment. And that equipment brought costs down to the desired level.

The result is evident in the T-90 uhf TV tuner illustrated. Double-circuit tuned, it features oscillator radiation fixes . . . meets all RETMA spurious radiation requirements. Performance is just what you would expect from Radio Condenser, *but the T-90 costs you far less than any previous R/C uhf tuner!*

If you want information on the new R/C line of low cost tuners, we'll be happy to have one of our engineers call at your convenience.



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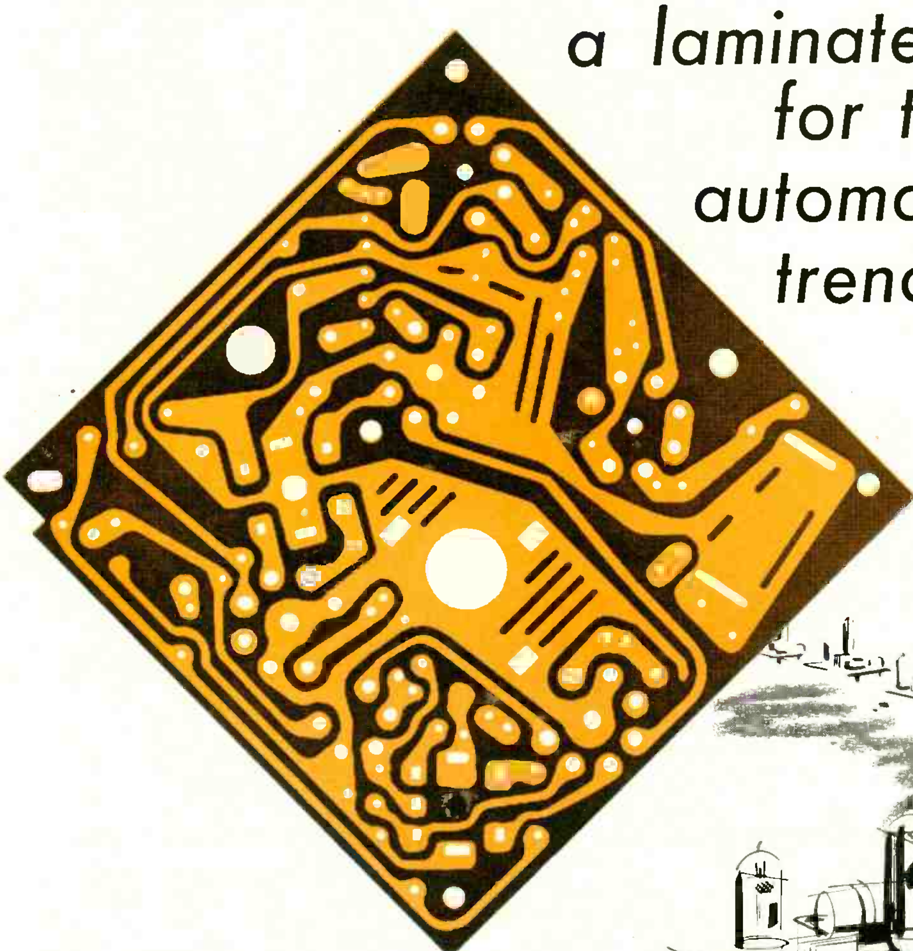
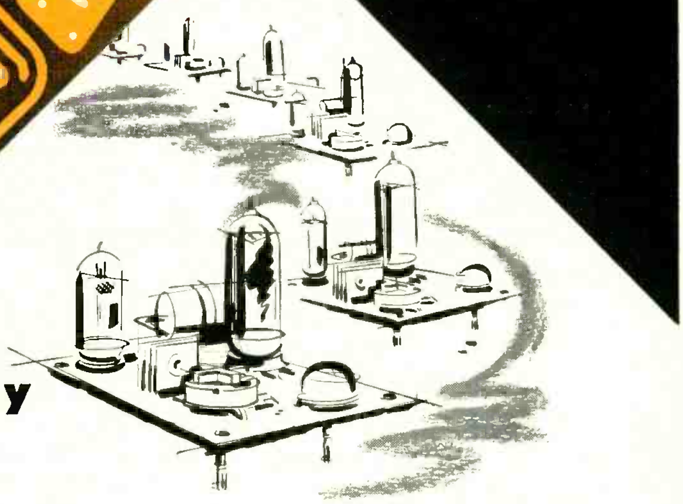
a laminate for today's automation trends...





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G-E TEXTOLITE Cold Punch 11570, a phenolic paper-base laminate, adds new concepts to mechanized printed circuitry. This high insulation resistance XXXP laminate can be punched at normal room temperatures—eliminating dimensional changes in the material, as is the case of grades that are heated prior to punching.

The cold fabricating quality of G-E TEXTOLITE 11570 makes possible precision registration of printed circuits, and affords manufacturers the opportunity to use automatic assembly equipment in mounting components.

Other outstanding features of G-E TEXTOLITE 11570 include high flexural strength, very low power factor, high heat resistance, and optimum uniformity. The translucency of TEXTOLITE 11570 permits a visual check for accuracy of circuit registration.

This new G-E TEXTOLITE Cold Punch 11570, with superior electrical and mechanical properties, now offers new opportunities to electrical and electronic manufacturers.

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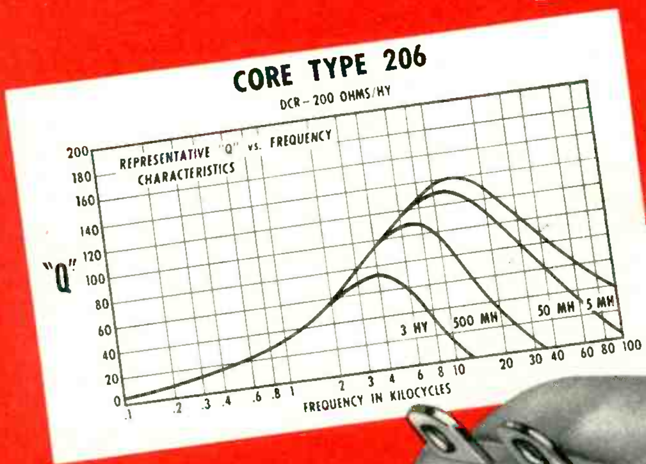

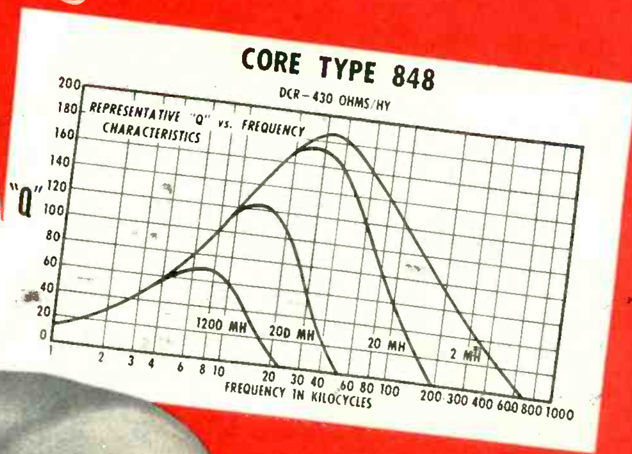

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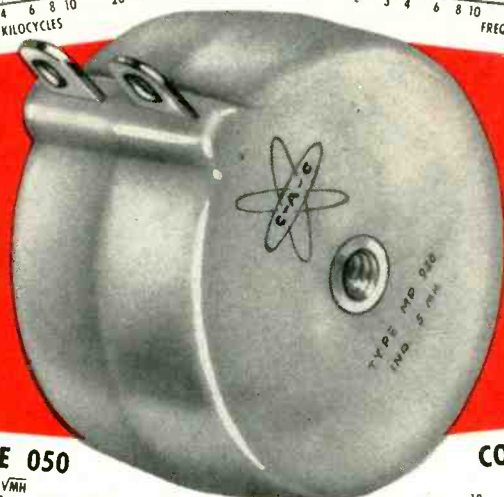

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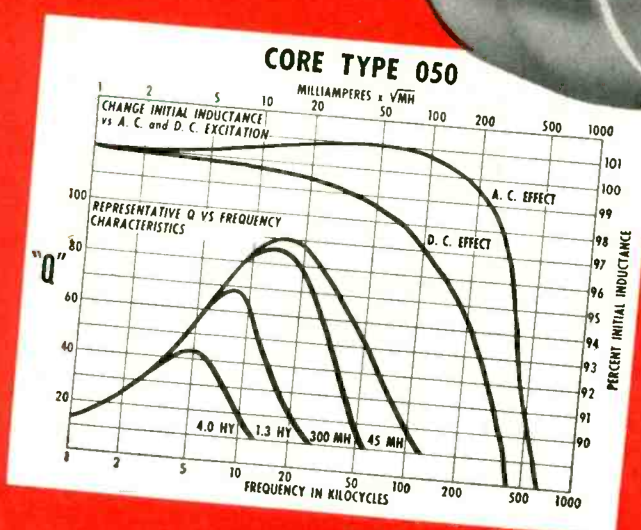

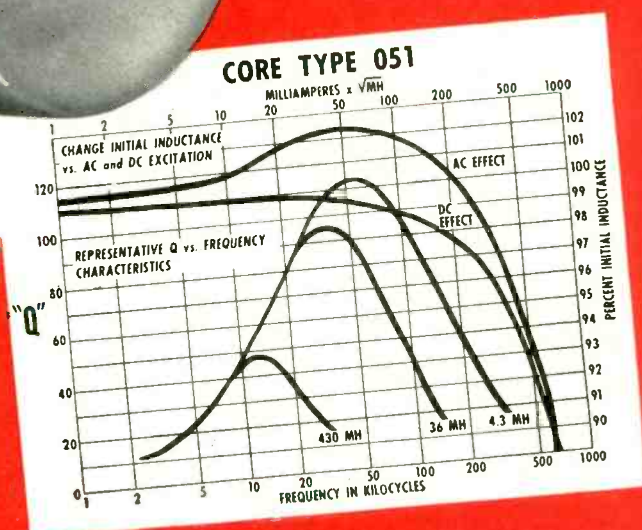

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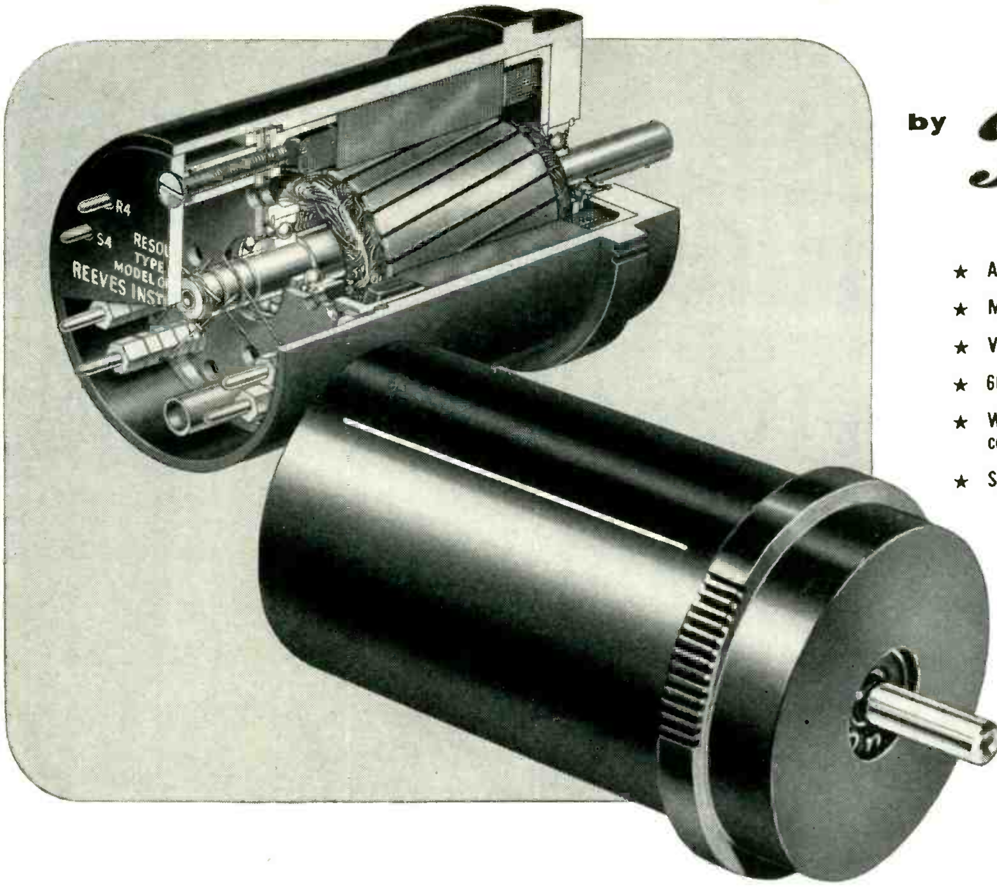

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Write for the Reeves Resolver Handbook.

REEVES PRECISION RESOLVERS AND RELATED COMPONENTS

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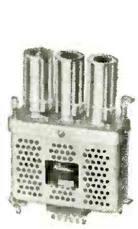
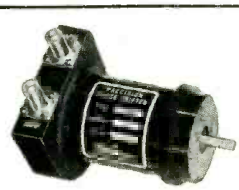


BOOSTER AMPLIFIERS



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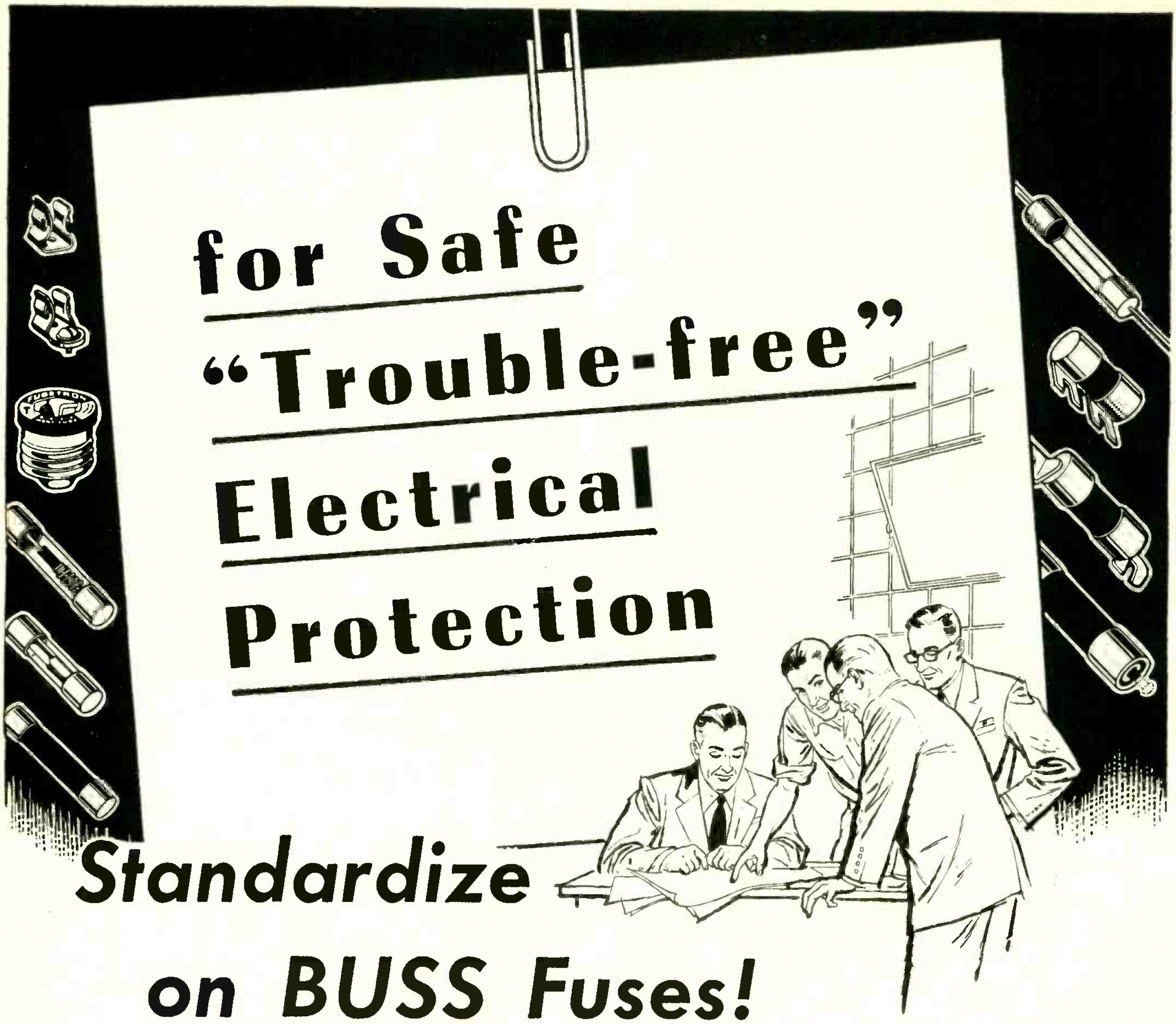

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Today, Industry, the Trade and the Public accept BUSS fuses without question. The BUSS reputation for fuses of unfailing dependability has been established over the past 41 years by millions upon millions of BUSS fuses used in homes, on farms, in industries, as well as in electronic equipment.

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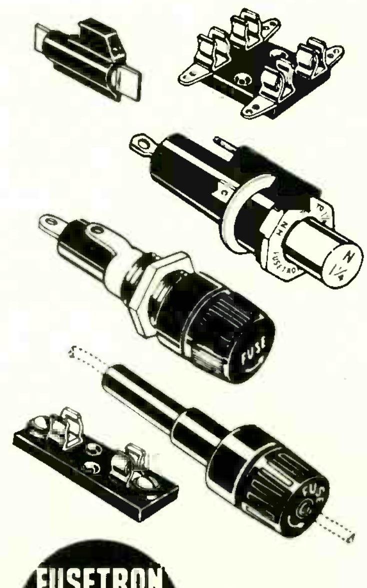
There's a complete line of BUSS fuses and fuseholders available. So be profit wise — and rely on dependable BUSS fuses to help safeguard the good name of your product or service as surely as they protect users.



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Now Fairchild is able to miniaturize potentiometers and still give you the accuracy and reliability you need.

This advance is made possible by Fairchild's continuous and extensive research on new materials such as epoxy-resin and halogenated polyethylene insulating materials, and precious metal alloy resistance wire, and by thorough evaluation of these materials in our own environmental testing facilities. These advances are maintained by our rigid quality control program on materials, processes, and manufacturing.

MINIATURIZATION

without sacrificing performance

Fairchild miniature precision potentiometers meet applicable portions of MIL-E-5272A for humidity, vibration, temperature cycling, fungus resistance and salt spray. These units, in 7/8" and 1 1/8" diameters, meet the same requirements for accuracy and reliability as most standard precision units up to 2" in diameter.

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PRECISION POTENTIOMETERS

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As the Signal Generator is the basic tool in radio research, it is not surprising that Marconi Instruments have had long and unrivalled experience in this fundamental field. Generators are available which will fulfil practically every requirement, and new types are continually being added to the already large range at present available.

F.M./A.M. SIGNAL GENERATOR
TYPE TF 1066

For particulars of other Generators please see the Complete Catalogue of Marconi Instruments

Carrier Frequency Range: *10 to 470 Mc.* • No spurious sub-multiple outputs; *r.f. oscillator generates direct at carrier frequency on all bands.* • F.M. monitored and variable *up to 100 kc deviation.* • A.M. monitored and variable *up to 80% depth.* • Output Level variable *from 0.2 microvolt to 200 millivolts.* • Precision Incremental Tuning *with frequency change indicated on a directly-calibrated meter.*

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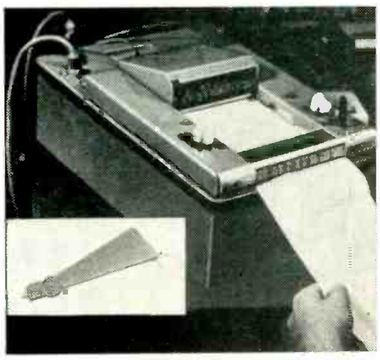
ELECTRONIC DESIGN NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Heat resistance, low friction of TEFLON® solves design problem in miniaturization of potentiometers

Du Pont ZYTEL® provides needed insulation in strong, lightweight parts

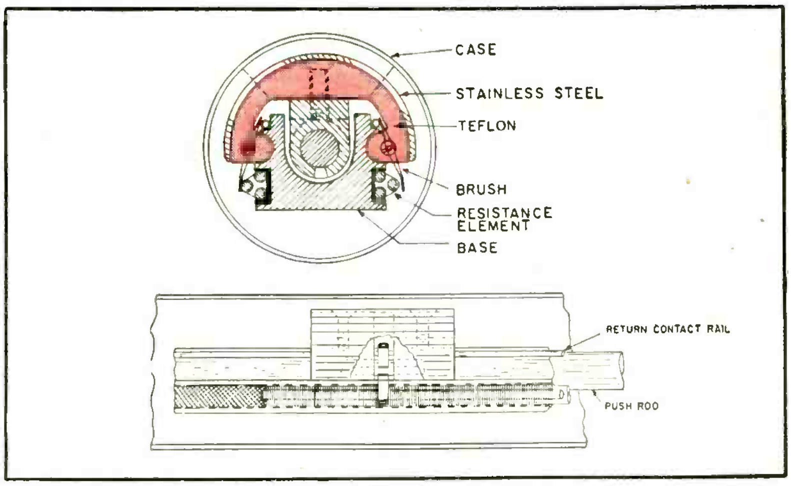


Marking electrodes, housed in Du Pont "Zytel" nylon resin, trace impulses on electrosensitive paper. "Zytel" is used because of its insulating properties and its strength in thin sections. (Recorder manufactured by Alden Electronic & Impulse Recording Equipment Co., Alden Research Center, Westboro, Mass.)

With the Alden 30-channel recorder, up to 30 machines can be monitored remotely and their records studied for optimum scheduling, and downtime. Tiny motion switches mounted on the machines and activated by machine motions transfer electrical currents to the recorder. The currents then activate electrodes that mark out lines on electrosensitive paper, providing a permanent record of operating cycle, and downtime.

One of the problems in developing the recorder was to find a material to house the marking electrodes. It had to be lightweight, strong, provide good insulating properties, and be economical to produce.

The manufacturer solved the problem with Du Pont "Zytel" nylon resin. This engineering material is strong, even when molded in thin sections. The metal inserts form an integral part of the marking electrodes because "Zytel" can be injection-molded around these inserts. With this method there are fewer parts, and assembly costs are reduced. The holders of "Zytel" can be produced in a variety of attractive colors.



Cross section of typical dual rectilinear potentiometer with insulation of "Teflon." Du Pont "Teflon" protects the core from heat and friction.

Miniaturization in guided missiles and other airborne equipment necessitates improvement in design and insulation of potentiometers. Du Pont "Teflon" tetrafluoroethylene resin fills the insulation requirements. A trunnion pin fitted into two shoes of "Teflon" holds the double-leaf brush in the new line of high-temperature potentiometers manufactured by the Pacific Scientific Company, Los Angeles, California.

The importance of "Teflon" in this application stems from its high heat resistance and low coefficient of friction. In use, this potentiometer must operate at temperatures as high as 400°F. and intermittently to 550°F. "Teflon" insulates the potentiometer and protects the core. The movement of the sleeve calls for a material with a low coefficient of friction. "Teflon" solves this problem, too.

"Teflon" offers a combination of electrical, chemical and mechanical properties that makes it well suited for use in high-frequency, high-temperature and some high-voltage applications; in applications such as this, where miniaturization and compactness of design are essential; and for uses where equipment is exposed to corrosive action.

NEED MORE INFORMATION?

CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

"Teflon" and "Zytel" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.).

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Room 222, Du Pont Building, Wilmington 98, Delaware
In Canada: Du Pont Company of Canada Limited,
P. O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ "Teflon"* tetrafluoroethylene resin and ☐ "Zytel"* nylon resin.

I am interested in evaluating these materials for______

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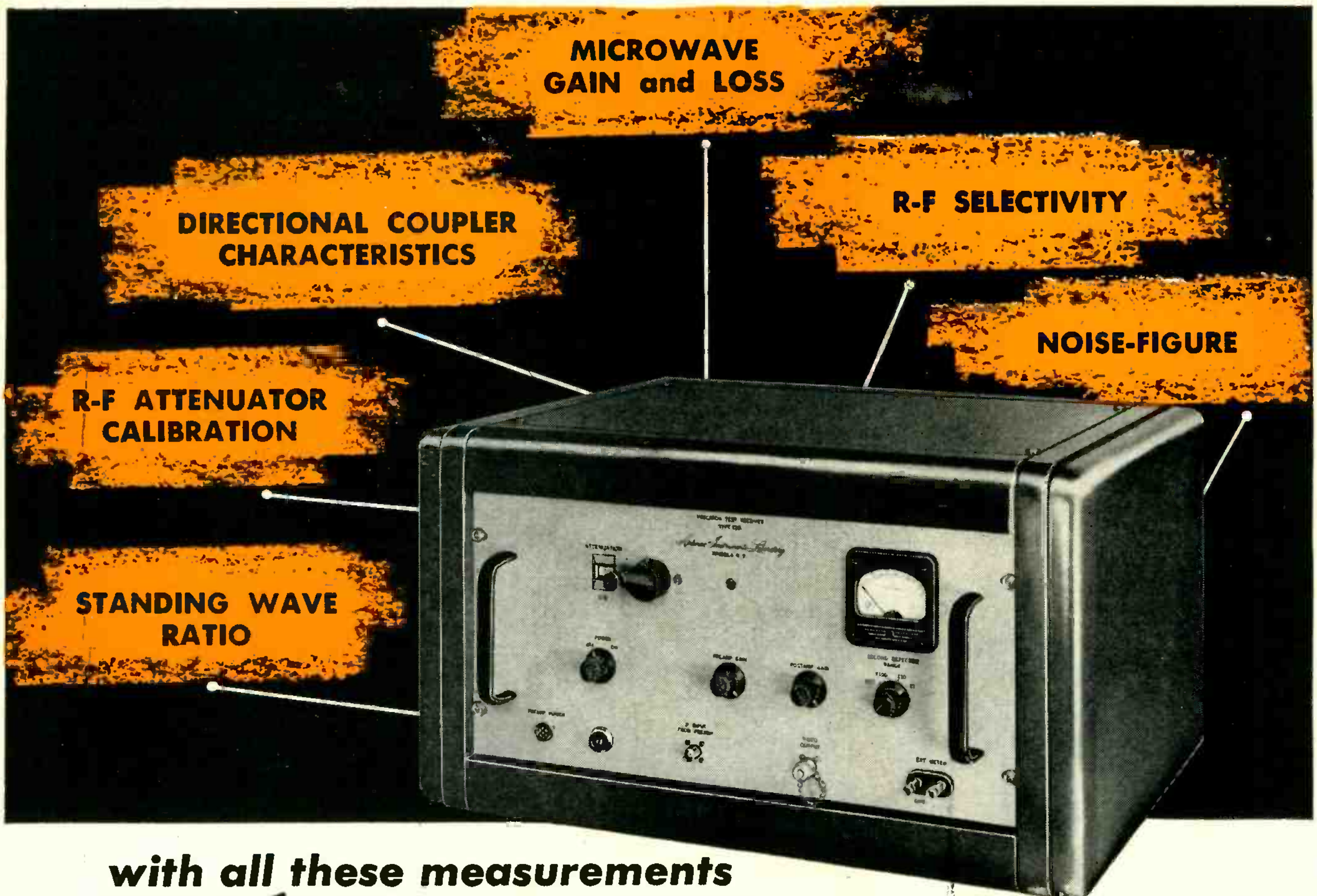

with all these measurements

AIL PRECISION TEST RECEIVER

offers complete versatility

How often have you put together a breadboard setup of a pre-amplifier, post-amplifier, attenuator, power supply, output indicator, bias control and the rest of the haywire needed to make the multitude of measurements which require an intermediate frequency receiver?

AIL's engineers did it often enough to force the design of a single package for their own use. As a result, the type 130 Receiver is an engineer's design for engineers' use.

The AIL Type 130 Precision Test Receiver is a versatile instrument combining a high-gain, low-noise-figure i-f receiver and a secondary standard of attenuation. It is designed to operate from the i-f output of a wide variety of standard microwave mixers. In combination with such mixers and a suitable local oscillator, the Receiver becomes a sensitive detector of microwave energy. It can be used wherever accurate measurements of the differences of r-f or i-f power levels are required.

The complete AIL Type 130 Precision Test Receiver is priced at $1,350.00. The standard model is available for 30MC use. Prices on models operating at other frequencies will be provided on request. F.O.B. Mineola, N. Y.

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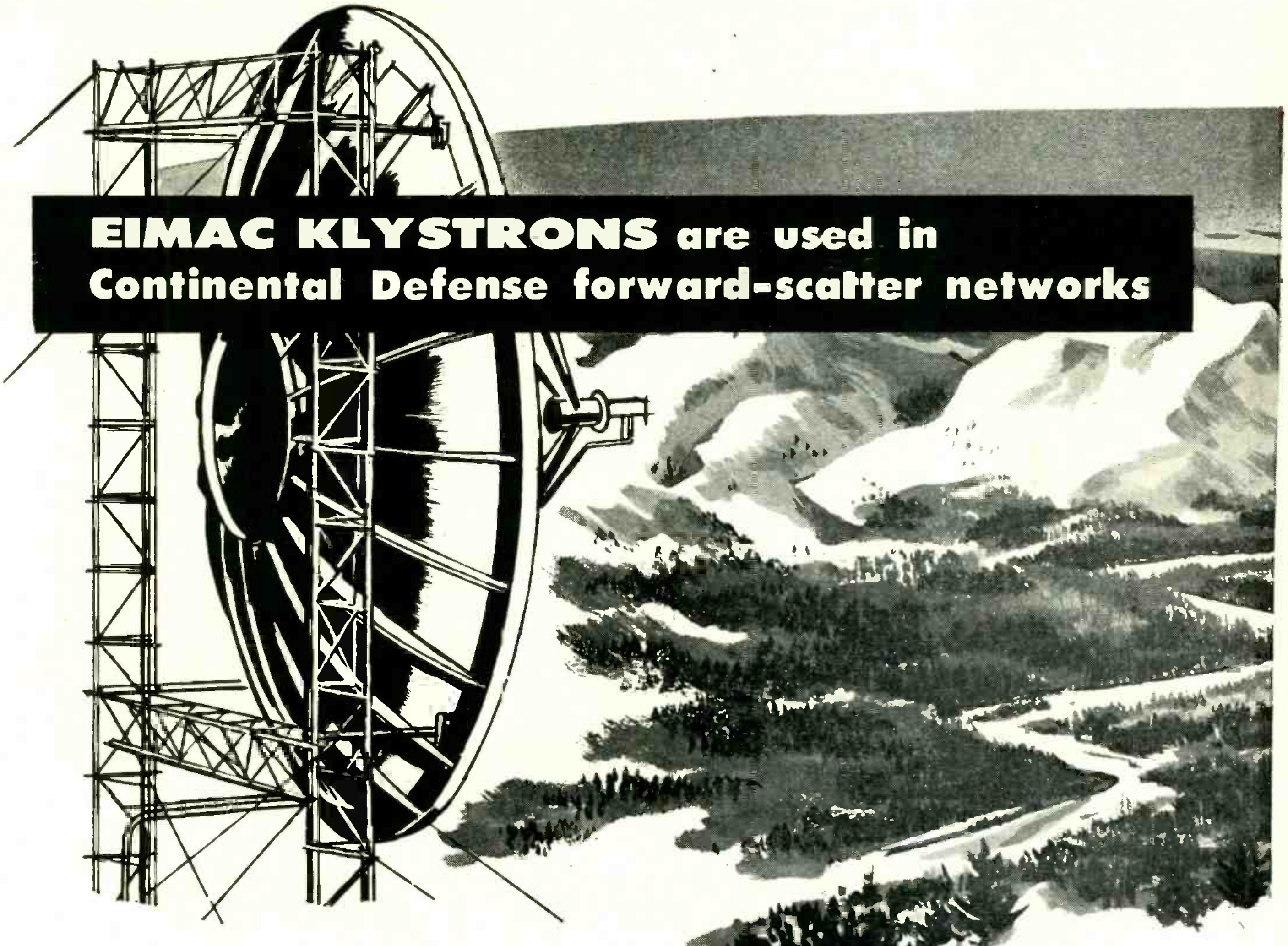
EIMAC KLYSTRONS are used in Continental Defense forward-scatter networks



Collins Radio Company's pioneering of circuits and equipment has contributed greatly to the success of the revolutionary new art of forward-scatter communications. From the beginning of this program, Eimac tubes have provided the high power necessary to make scatter propagation practical. In Collins newest high power microwave transmitters for beyond-the-horizon communications in Continental Defense networks, only Eimac klystrons are used as final amplifier tubes.

Third in a series of advertisements emphasizing the extensive application of Eimac amplifier klystrons and circuit components, negative grid tubes and rectifiers by leading manufacturers of forward-scatter UHF/microwave transmitters.

Collins two and ten kilowatt forward-scatter transmitters utilize Eimac amplifier klystrons, negative grid tubes and rectifiers.

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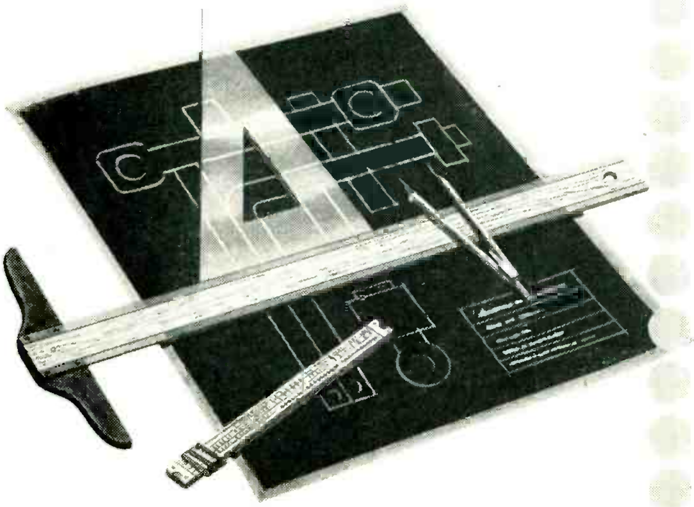

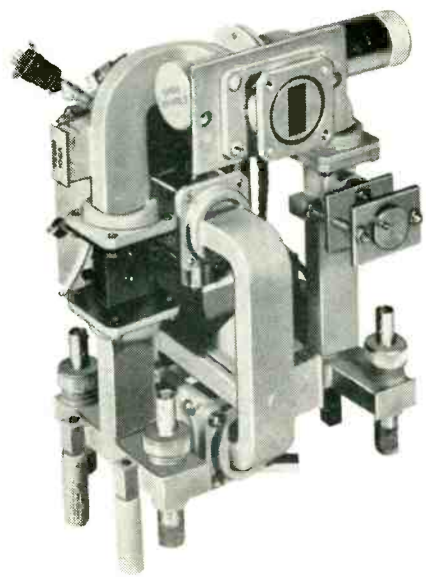

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MOLONEY ELECTRIC COMPANY

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PYRAMID technical bulletin

NO. 65

GENERAL

Pyramid subminiature, solid-impregnant Type R "Glasseal" tubular capacitors are the latest addition to the line of fixed DC paper-dielectric capacitors, hermetically sealed in metallic cans. They are being produced in response to the demand for more rugged capacitors capable of withstanding the vibrational stresses of high acceleration and frequency as well as severest

shock conditions. They meet the performance requirements for Characteristic K capacitors of U.S. Government Military Specification MIL-C-25B.

QUALITY AND RELIABILITY

As a result of continuous testing and quality control progress throughout the manufacturing process, Pyramid Capacitors meet the highest standards of quality and reliability. Production tests for voltage breakdown, capacitance, power factor, insulation resistance and seal are performed on 100% basis. Each production lot also is subjected to a group of sampling tests consisting of life, temperature and immersion cycling, vibration, and corrosion tests.

CONSTRUCTION

External Construction: Type R "Glasseal" capacitors are assembled in nonmagnetic cases and utilize the new, rugged, compression-seal type, glass-to-metal solder-seal terminals. These provide mechanically superior performance and a permanent gas-tight seal with generous air strike and creepage distance. They will not rotate or work loose under any conditions.

Internal Construction: Solid-impregnant Type R "Glasseal" capacitors are available in either the inserted-tab or extended-foil construction. Both types are noninductively wound. For normal applications, either type may be used. Inserted-tab capacitors should not be used at voltages lower than 10 volts without preview of the application by the Pyramid Engineering Department. Extended-foil capacitors may be used down to zero volts.

TEMPERATURE RANGE

"Glasseal" capacitors have a functional operating range of from −55°C to +125°C. The capacitors are thoroughly impregnated and filled with a solid impregnant of the thermosetting resin type. This prevents any movement of the section within the case and is the basis of the exceptional vibration-and-shock-test performance of these capacitors.

CAPACITANCE TOLERANCE

The standard tolerance is ±20%. Closer tolerances are available on request.

VOLTAGE BREAKDOWN TEST

Type R "Glasseal" capacitors will withstand, at 25°C, a d.c. breakdown test voltage of twice the rated operating voltage, between terminals, and between terminals and case, for a maximum period of two minutes. The test voltage on applied through a resistance sufficient to limit the current, on breakdown, to 5 milliamperes.

LIFE TEST

Type R "Glasseal" capacitors will withstand application of a d.c. voltage 1.4 times the rated working voltage for 250 hours at 125°C.

VOLTAGE DERATING AT ELEVATED TEMPERATURES

Type R capacitors are designed for a minimum continuous service-life expectance of 2,000 hours at 125°C without any reduction of the rated d.c. working voltage. For a life expectancy of one year (8,800 hours), a voltage derating of 30% at 125°C., or a limitation of the maximum operating temperature to 85°C without any voltage derating is necessary.

INSULATION RESISTANCE

Insulation resistance is measured after an electrification period of two minutes. Capacitors rated below 600 volts d.c. are tested at 100 volts d.c.; those rated at 600 volts d.c. or above are tested at 500 volts d.c. The minimum value of insulation resistance for a particular capacitor may be determined from the following table:

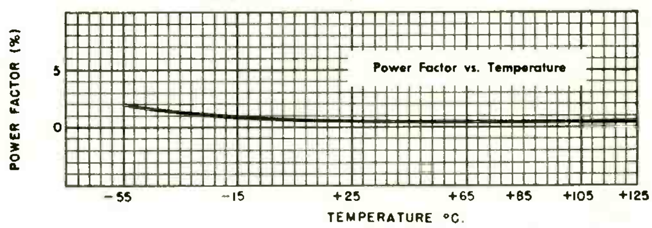
Temperature (°C)	Minimum Megohms x MF*	"Need Not Exceed" Value (Megohms)	Capacitance Range (MF)
25		12,000	.001 to .33
	4,000		.33 and over
85		1,000	.001 to .1
	100		.1 and over
125		150	.001 to .066
	10		.066 and over

*It is not practical, in the manufacture and measurement of capacitors of low capacitance value, to adhere to the Megohms x MF values given in the column under the latter heading. Consequently, the values given in the "Need Not Exceed" Value column are those values of insulation resistance which are considered satisfactory for low capacitance units. Where the Megohms x MF value governs, the minimum value of insulation resistance is determined by dividing the Megohms x MF figure by the capacitance in microfarads. For example, the minimum insulation resistance required for a 0.25 mf capacitor at 85°C is

$$\frac{100\text{ (Megohms x MF)}}{0.25\text{ (MF)}} = 400\text{ megohms.}$$

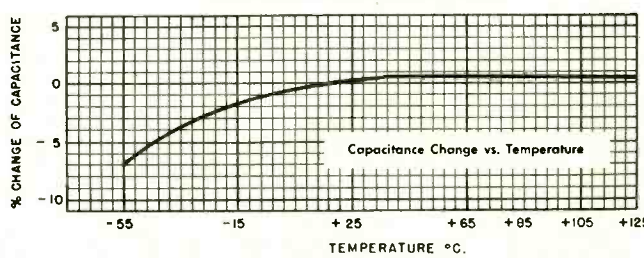
POWER FACTOR

When measured at, or referred to, a frequency of 1,000 cycles per second at 25°C., the power factor will not exceed 1%.



CAPACITANCE CHANGE AT LOW TEMPERATURES

At −55°C., the capacitance change (decrease) will not exceed 10% of the capacitance measured at 25°C.



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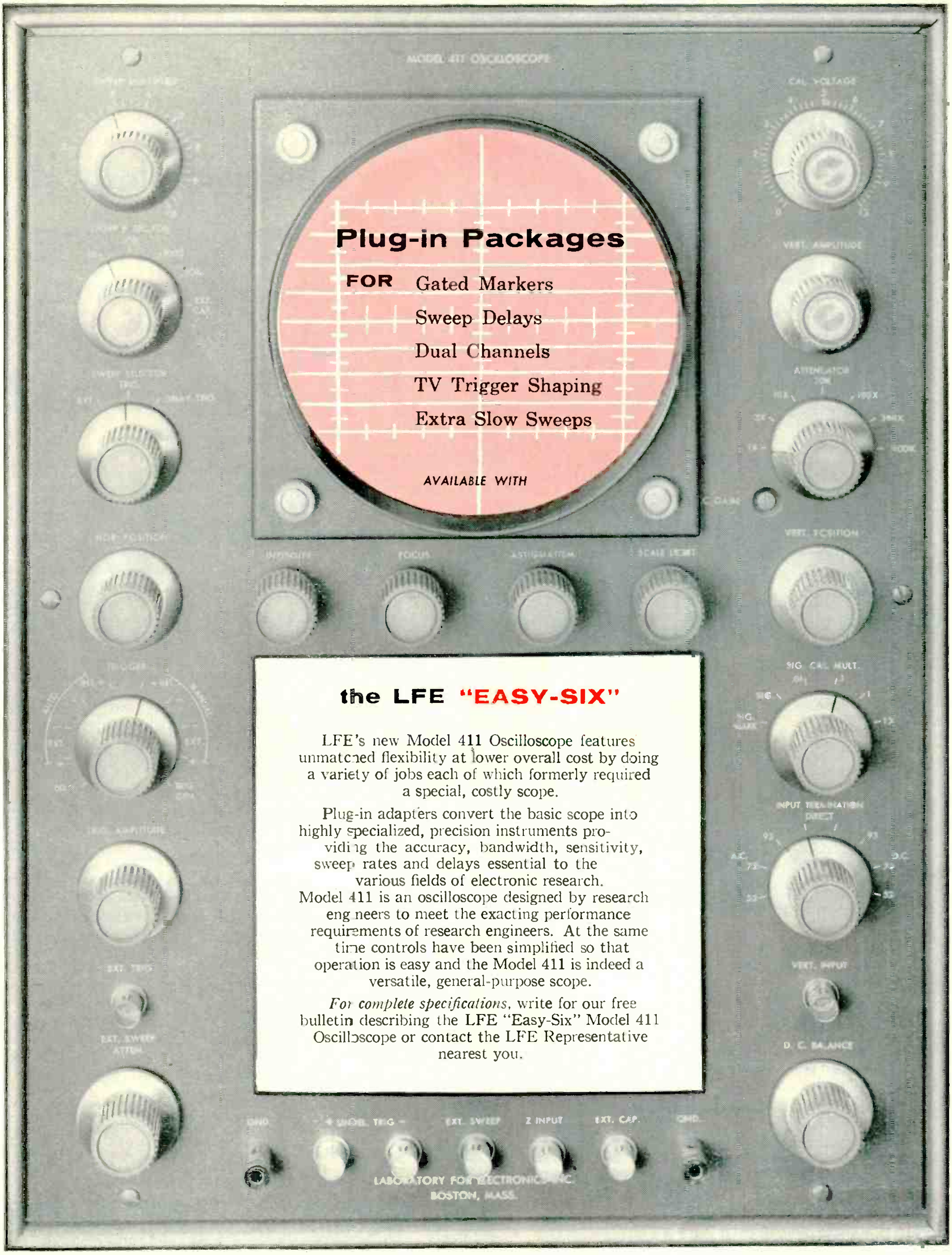

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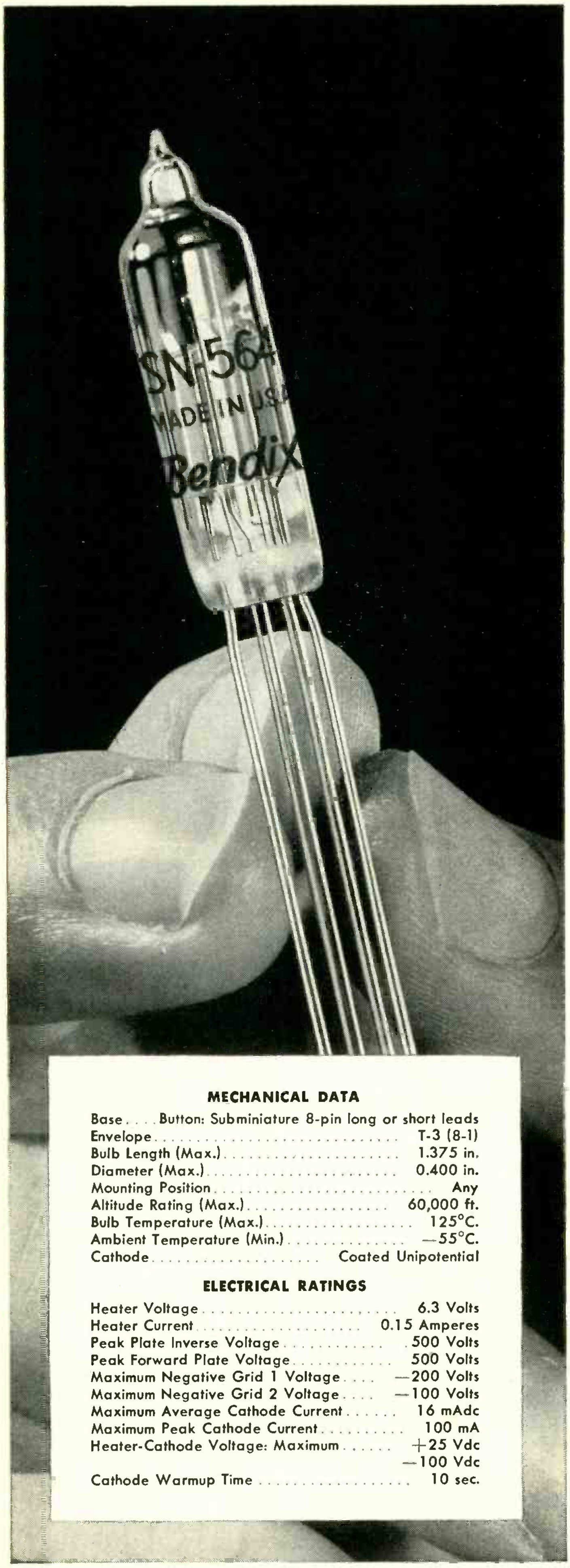

MECHANICAL DATA

Base . . . . Button: Subminiature 8-pin long or short leads	
Envelope	T-3 (8-1)
Bulb Length (Max.)	1.375 in.
Diameter (Max.)	0.400 in.
Mounting Position	Any
Altitude Rating (Max.)	60,000 ft.
Bulb Temperature (Max.)	125°C.
Ambient Temperature (Min.)	—55°C.
Cathode	Coated Unipotential

ELECTRICAL RATINGS

Heater Voltage	6.3 Volts
Heater Current	0.15 Amperes
Peak Plate Inverse Voltage	500 Volts
Peak Forward Plate Voltage	500 Volts
Maximum Negative Grid 1 Voltage	—200 Volts
Maximum Negative Grid 2 Voltage	—100 Volts
Maximum Average Cathode Current	16 mAdc
Maximum Peak Cathode Current	100 mA
Heater-Cathode Voltage: Maximum	+25 Vdc —100 Vdc
Cathode Warmup Time	10 sec.

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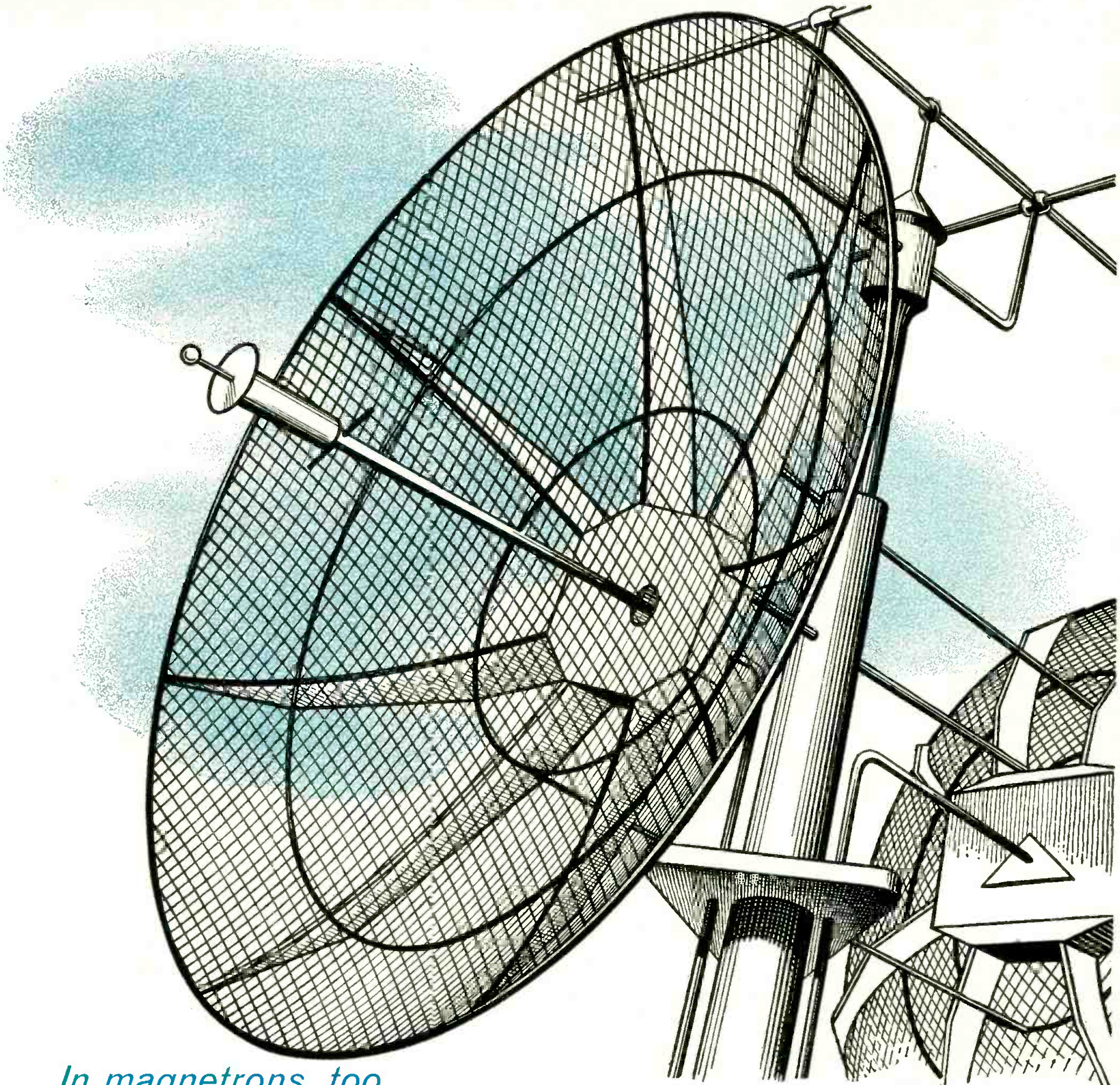


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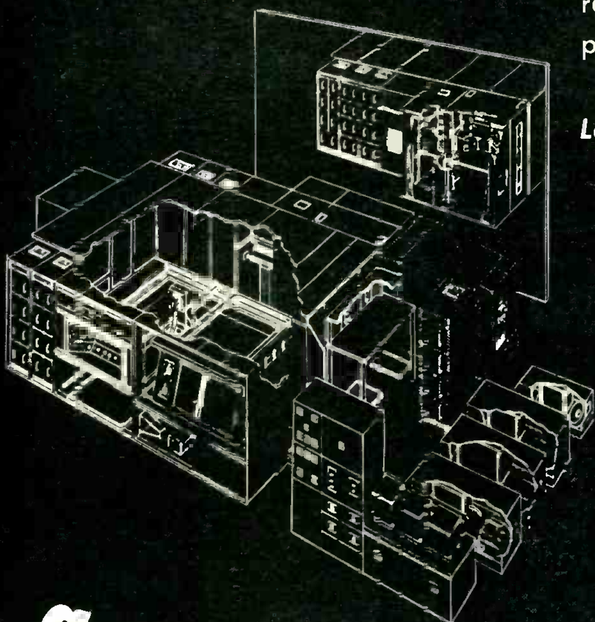

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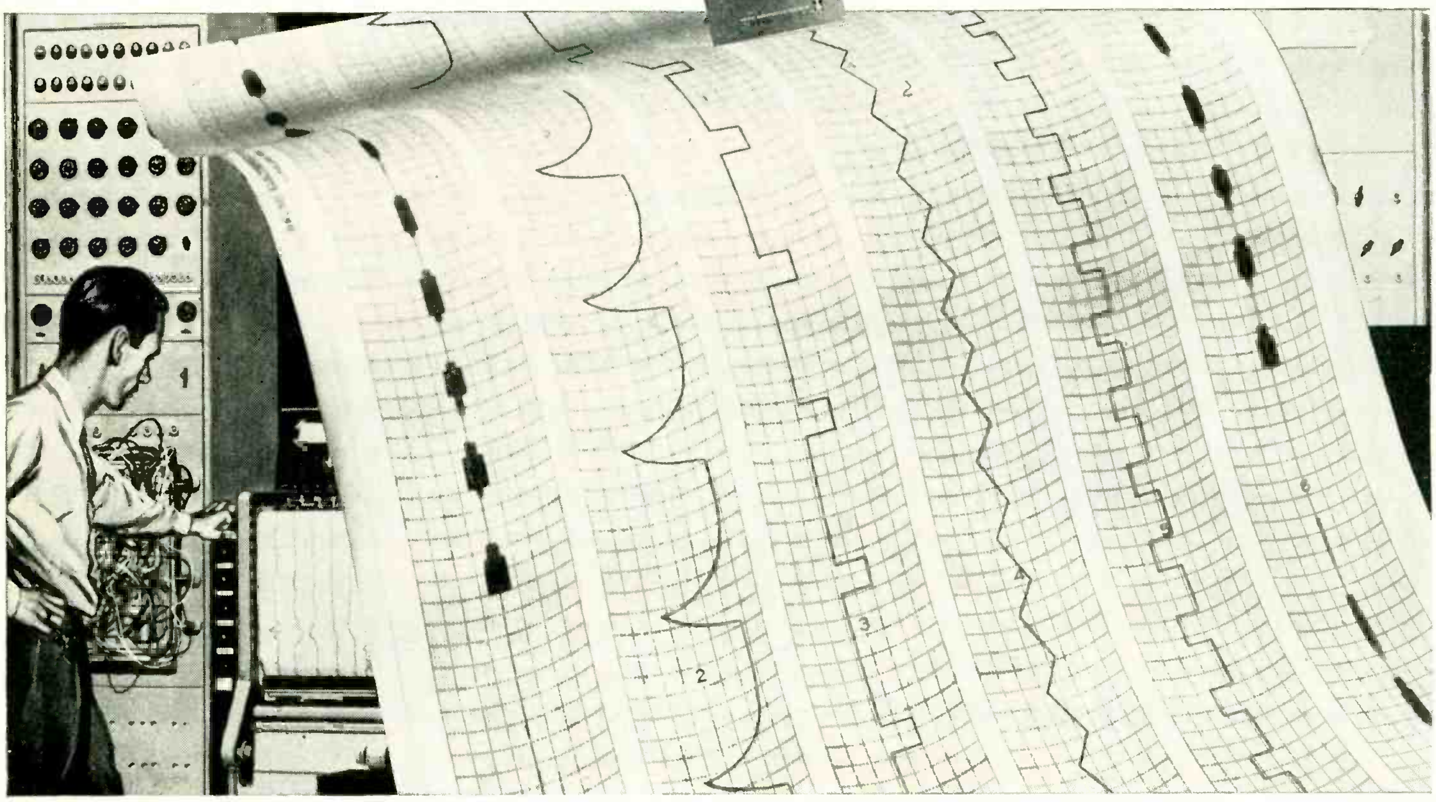

Illustration Courtesy Grumman Aircraft Engineering Corporation.

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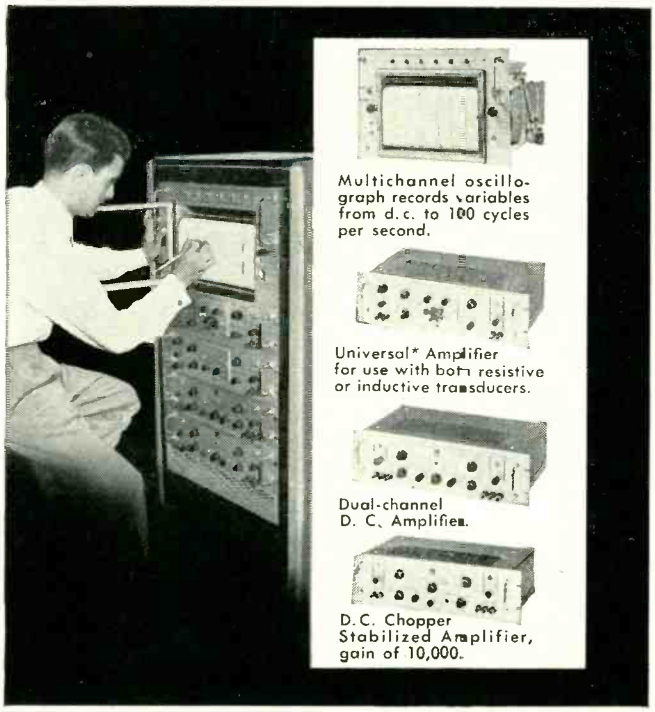

FLEXIBILITY—Four and six channel oscillographs are physically interchangeable. A four channel unit, selected to meet present requirements, can be *expanded* to a six channel unit later. All oscillographs and amplifiers mount in standard 19-inch racks or consoles. Complete selection of amplifiers.

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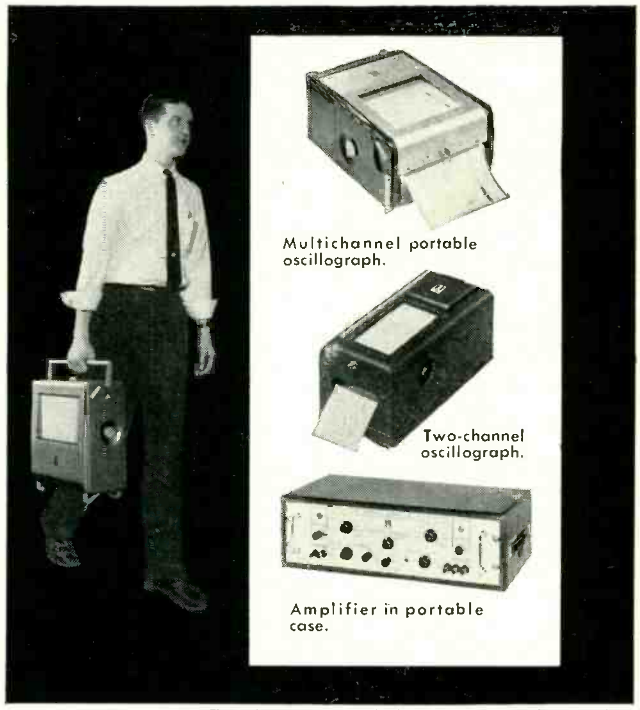
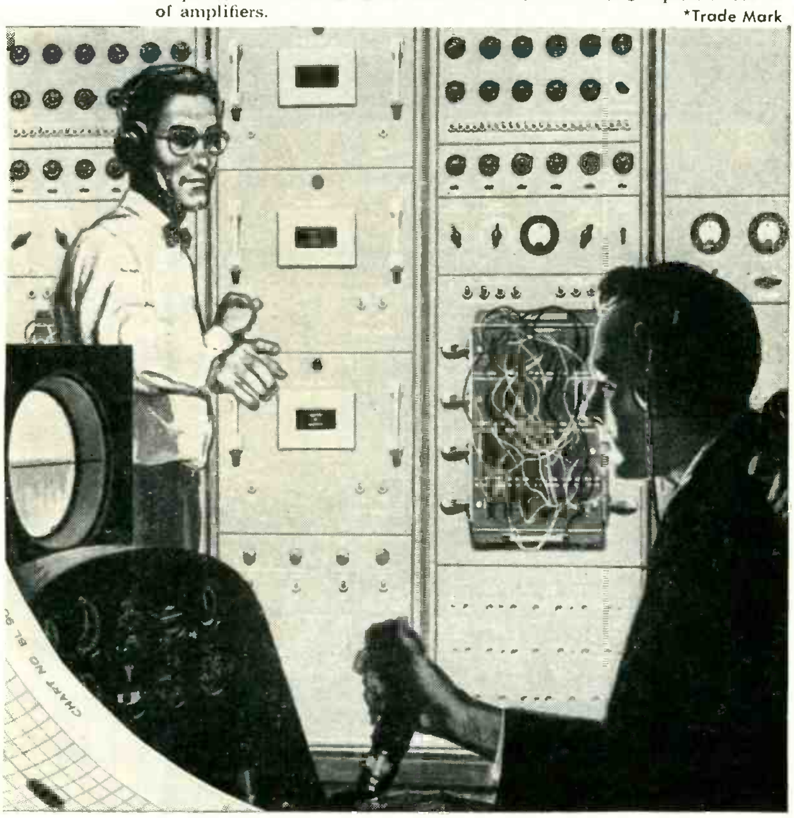
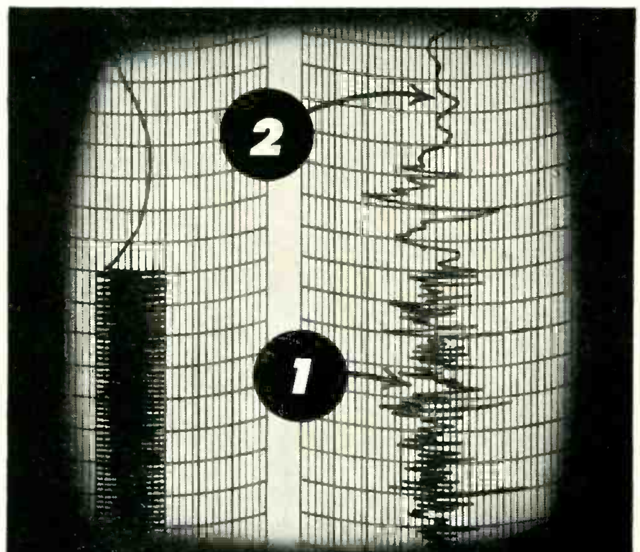


PORTABILITY—Complete systems designed for portable use simplify field testing and measurements. Units are light in weight, durable, easy to set up. Typical weights for oscillographs: 2-channel 25 lbs., 4-channel 38 lbs., 6-channel 51 lbs.





READABILITY

At (1) above typical signal is recorded at 10 mm. per second chart speed. At (2) unit is switched to 250 mm. per second speed to give optimum resolution. No interruption in recording.

All oscillographs have electrically controlled chart drive transmissions, permitting instantaneous switching and remote control. Choice of 8 or 16 chart speeds to give the best readability and economy for all signals.

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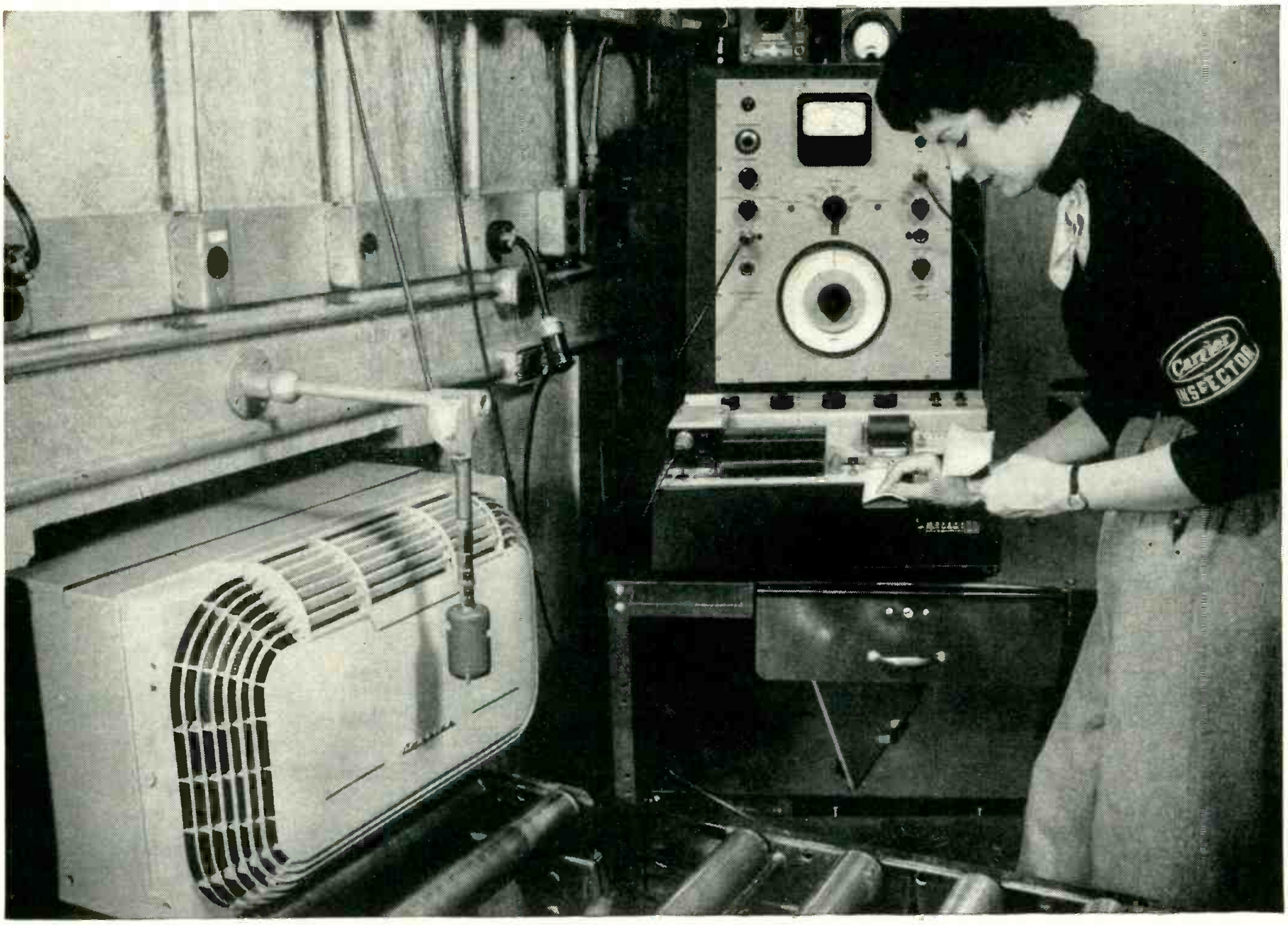

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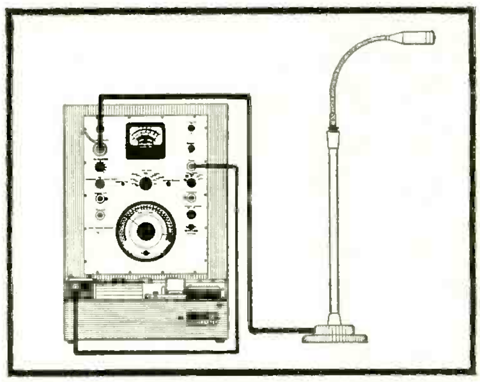
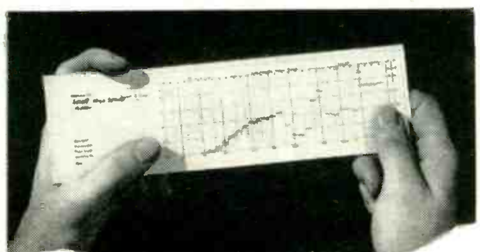


Test setup shown requires only a measurement microphone and Spectrum Recorder.



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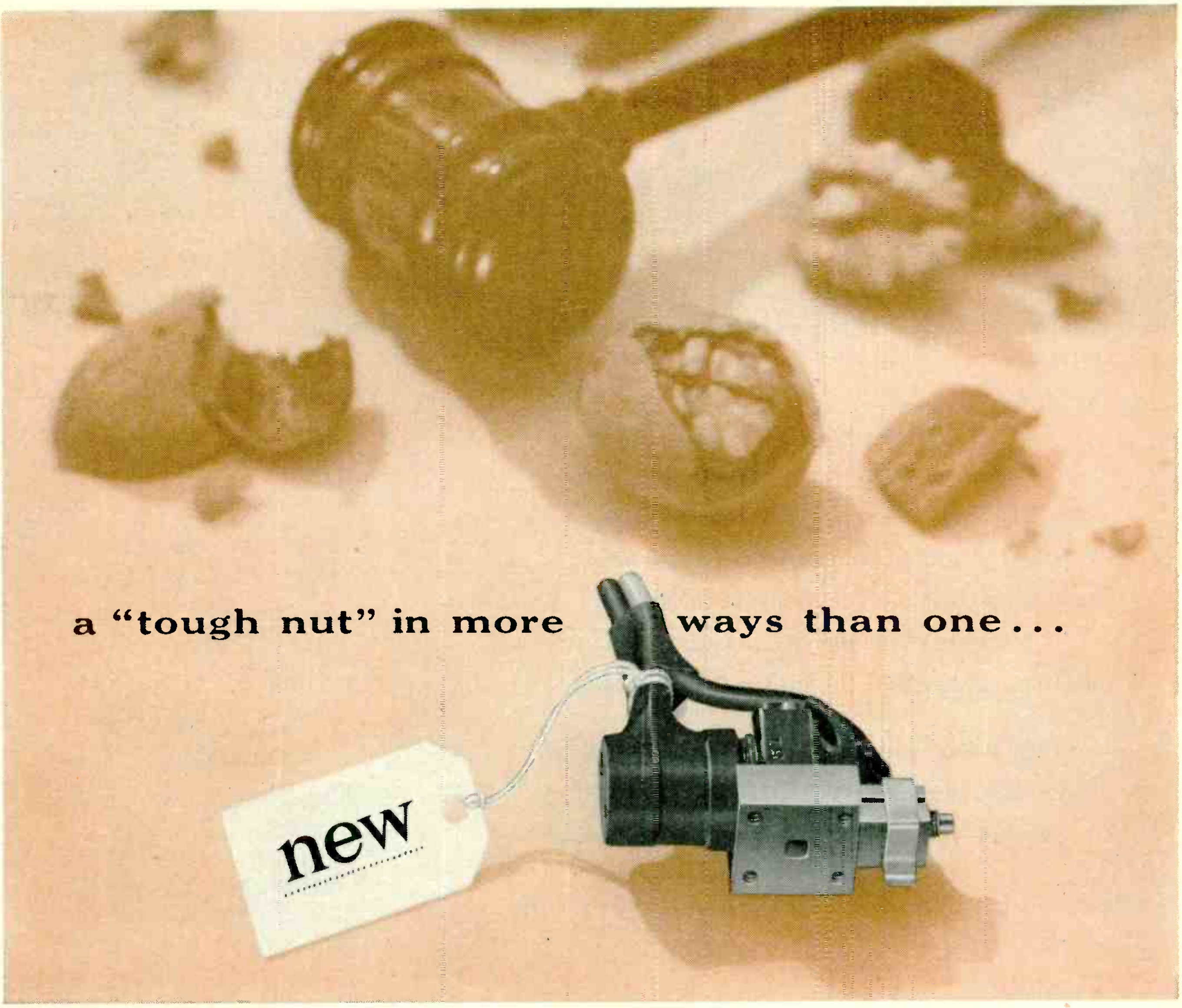

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	Frequency	Resonator Voltage	Power	Electronic Tuning Range
VA-97	34.0 - 35.6 kMc	400 V	15 mW	90 Mc
VA-94	16.0 - 17.0 kMc	300 V	40 mW	75 Mc

FOR TEST EQUIPMENT AND LABORATORY MEASUREMENT . . . Varian's V-39C and V-40C klystrons feature separate external cavities that afford an extremely wide tuning range for testing and laboratory research applications, in frequency ranges between 10.0 and 21 kMc.

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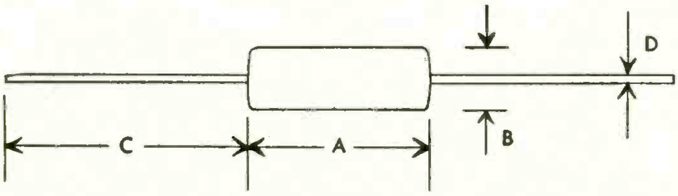
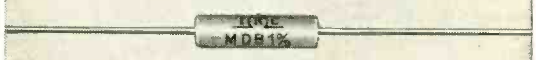


Precistor Types	IRC Size Equivalent	Dimension			
		A	B	C	D
MDA — MBA	BTS	13/32"	1/8"	1 1/2"	.025"
MDB — MBB	BW1/2	5/8"	3/16"	1 1/2"	.025"
MDC — MBC	BTA	23/32"	1/4"	1 1/2"	.032"

MOLDED DEPOSITED CARBON PRECISTORS

Type MDA — 1/8 Watt



Type MDB — 1/4 Watt

Type MDC — 1/2 Watt

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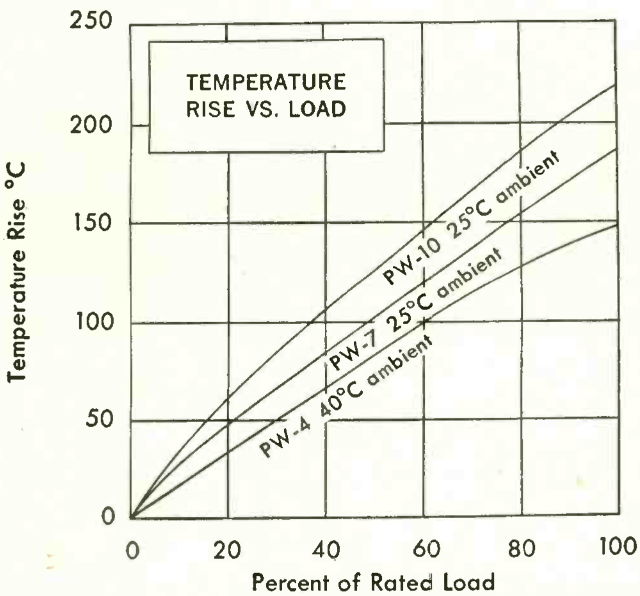

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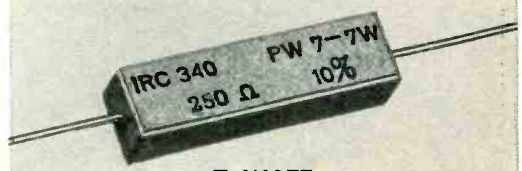
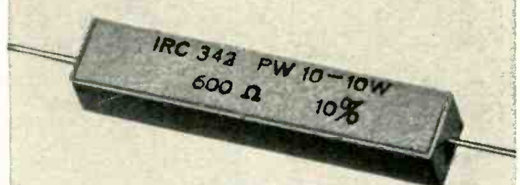


7 WATT

Types PW-7 and PW-10 allow safe operation with hot-spot temperatures up to 275°C.



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		0-2	2-3	4-15	0-2	2-3	4-15	1-2	2-3	4-15	1-2	2-3	4-15
• *SYSTEMS* *(Integration of theory, equipments and environment to create and optimize major electronic concepts.)*													
AVIATION ELECTRONICS • CONTROLS			W	W M			M		W	W M			
DIGITAL DATA HANDLING DEVICES	M C		M C	M C		C	C		C	C			
MISSILE ELECTRONICS • RADAR	M W		M W X	M W X		M W	M W		M W	M W			
INERTIAL NAVIGATION	W			W			W			W			
COMMUNICATIONS				C						C			
• *DESIGN • DEVELOPMENT*													
KINESCOPES (B & W and COLOR), OSCILLOSCOPES—Electron Optics—Instrumental Analysis—Solid States (Phosphors, High Temperature Phenomena, Photosensitive Materials and Glass to Metal Sealing)		L	L Y	L Y	L	L Y	L Y	L	L	L	L	L Y	L Y
RECEIVING TUBES—Tube Design—Test and Application Engineering—Chemical and Physical Development—Methods and Process Engineering—Advanced Development		H	H	H		H	H		H	H		H	H
SEMI-CONDUCTORS—Transistors—Semi-Conductor Devices—Materials		H	H	H	H	H	H	H	H	H	H	H	H
MICROWAVE TUBES—Tube Development and Manufacture (Traveling Wave—Backward Wave—Magnetron)	H		H	H		H	H		H	H		H	H
GAS, POWER AND PHOTO TUBES—Photosensitive Devices—Glass to Metal Sealing—UHF and VHF—Power		L	L	L	L	L	L	L	L	L	L	L	
AVIATION ELECTRONICS—Radar—Computers—Servo Mechanisms—Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Automation—Transistorization	W C	W C X	W C X	W C X	W C	W C X	W C X	W C X	W C X	W C X			
COMPUTERS—Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms—Programming		C	C X	M C X	C	C X	M C X	C	C	M C			
RADAR—Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control—Information Handling—Displays	M C	M C X	M C X	M C X	M C X	M C X	M C X	M C X	M C X	M C X			
COMMUNICATIONS—Specialized Military Systems—Microwave—Aviation—Audio—Propagation Studies		C	C	C		C	C	C	C	C			
MISSILE ELECTRONICS—Systems Planning and Design—Radar—Fire Control—Shock Problems—Servo Mechanisms	M	M X	M X	M X	M	M	M X	M	M X	M X			
COMPONENTS—Transformers—Coils—TV Deflection Yokes (Color or Monochrome)—Resistors—Ferrites (Material and Parts)		C	Z C	Z C	C	Z C	Z C	C	C	C		Z C	Z C
• *SYSTEMS APPLICATION* *(Evaluation and Planning—Design and Development—Modification—Specification)*													
MISSILE TEST INSTRUMENTATION (Data Acquisition and Processing)—Radar—Telemetry—Timing—Communications—Optics—Computers	F	F S.	F S	F S	F S	F S	F S	F S	F S	F S			
RADAR—Airborne—Surface—Shipboard—Sonar—Fire Control	F	F S'	F S	F S	F S	F S	F S	F S	F S	F S			
COMMUNICATIONS—Radio—HF—VHF—UHF—Microwave—Telephone—Teletype—Telegraph Terminal Equipment—Wave Propagation	F	F S I	F S I	F S I	F S	F S	F S	F S	F S	F S			
• *MACHINE DESIGN* Mechanical and Electrical—Automatic or Semi-Automatic Machines		L	L		L	L H Y	C H Y		L	L			

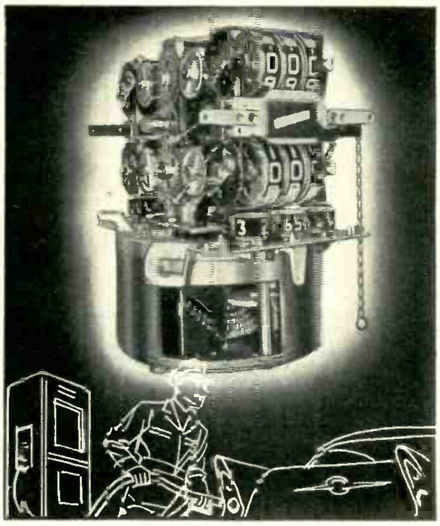
Locations: **C**—Camden, N.J. **F**—Cocoa Beach, Fla. **H**—Harrison, N.J. **I**—International Div. **L**—Lancaster, Pa. **M**—Moorestown, N.J. **S**—RCA Service Co. (Cherry Hill, N.J.; Alexandria, Va.; Tucson, Ariz.; San Diego, Sacramento, San Francisco, Calif.; Foreign Assignments). **W**—Waltham, Mass. **X**—Los Angeles, Calif. **Y**—Marion, Ind. **Z**—Findlay, Ohio

Please send resume of education and experience, with location preferred, to:

Mr. John R. Weld, Employment Manager
Dept. A-15B, Radio Corporation of America
30 Rockefeller Plaza, New York 20, N.Y.

RCA ®

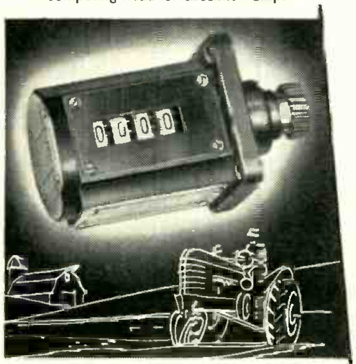
RADIO CORPORATION of AMERICA



Computing Head for Gasoline Pumps

"Master Meter Duplicator" prints receipts for fuel oil delivered from trucks

"Vary-Tally" Multi-Unit Reset Manual Counter

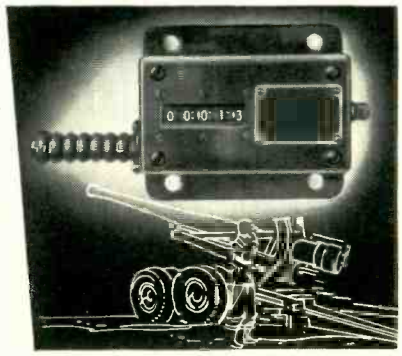


Rev-Counter for all types of engines

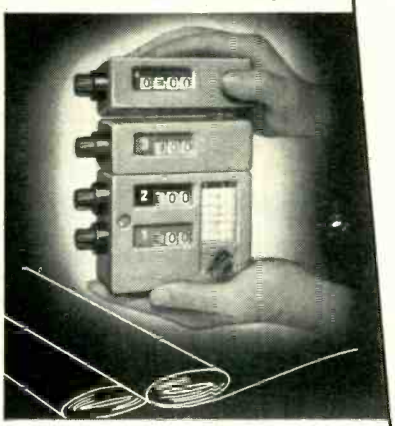
Everyone Can Count on VEEDER ROOT

Everywhere you look in everyday life, you see a familiar face . . . the face of a Veeder-Root Counter or Computer. From gasoline pumps to fuel oil trucks to textile mills . . . in the home, on the farm, in business and commerce, in modern automated industry . . . Veeder-Root standard and special devices are keeping everything under *Count*rol . . . manually, mechanically, electrically. And the mathematical probabilities are mighty high that *you* can count on Veeder-Root, too . . . to your advantage and profit. Why not let us figure out how, *right now?*

VEEDER-ROOT INC. • HARTFORD 2, CONN.

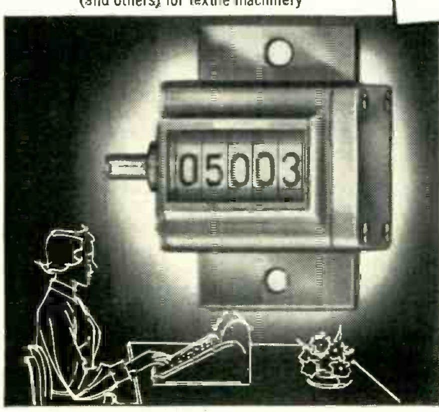


Recoil Counter for new 280 mm atomic cannon

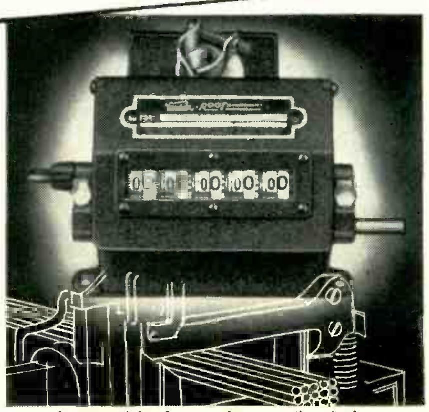


2-3-4 Convertible Counters (and others) for textile machinery

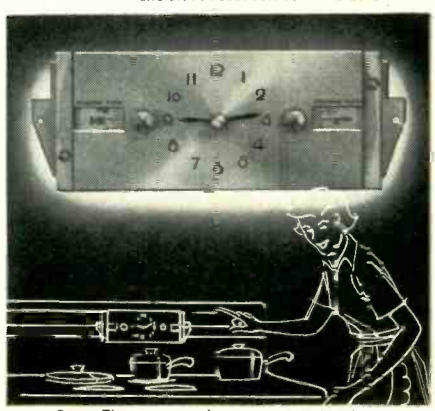
Fuel-Remaining Counter for aircraft . . . subtracts as fuel is used



Small Square-Case Counters for office and other machines



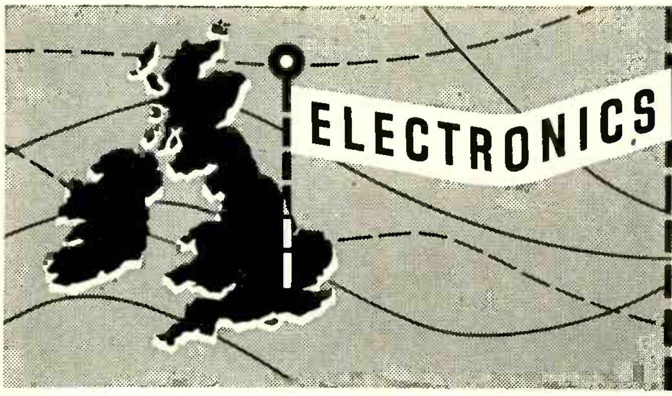
Predetermining Counters for preventing short and over-runs on production machines



Range Timer . . . easy to read . . . easy to set

STOCKS OF STANDARD COUNTERS AVAILABLE AT—Greenville, S. C. • Chicago 6, Ill. • New York 19, N. Y. • Los Angeles • San Francisco
Montreal 2, Canada • Offices and Agents in Other Principal Cities

Want more information? Use post card on last page.



ELECTRONICS *in Britain*

The British Electronics Industry is making giant strides with new developments in a variety of fields. Mullard tubes are an important contribution to this progress.

EF86

Another Mullard contribution to high fidelity

Principal Ratings

Heater	6.3V, 0.2A
Max. plate dissipation	1W
Max. screen dissipation	0.2W
Max. cathode current	6mA

Characteristics

Plate voltage	250V
Screen voltage	140V
Grid voltage	—2V
Plate current	3mA
Screen current	0.6mA
Transconductance	1800 μmhos

Base

Small button noval 9-pin

The Mullard EF86 audio frequency pentode is one of the most widely used high fidelity tubes in Britain today. It has been adopted by the leading British manufacturers whose sound reproducing equipment is enjoying increasing popularity in the United States and Canada.

The marked success of this tube stems from its high gain, low noise and low microphony characteristics.

By careful internal screening, and by the use of a bifilar heater, hum level has been reduced to less than 1.5μV. Over a bandwidth of 25 to 1,000c/s equivalent noise input approximates 2 μV.

When operated below 1,000c/s, internal resonances of the EF86 are virtually eliminated. Even at higher frequencies chassis and tube socket damping are usually sufficient to make vibration effects negligible.

Supplies of the EF86 are now available for replacement purposes from the companies mentioned here.

Supplies available from:—

In the U.S.A. International Electronics Corporation,
Dept. E2, 81 Spring Street, N.Y.12,
New York, U.S.A.

In Canada Rogers Majestic Electronics Limited,
Dept. IF, 11-19 Brentcliffe Road,
Toronto 17, Ontario, Canada.

Mullard ELECTRONIC TUBES

used throughout the world

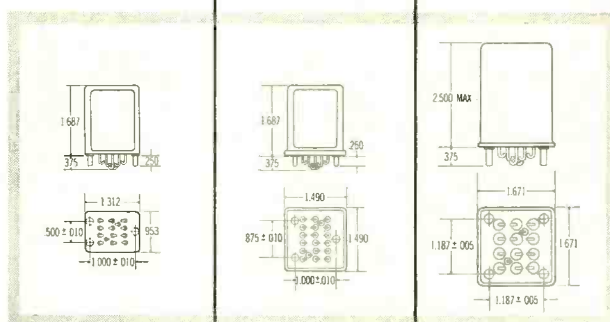
MULLARD OVERSEAS LTD., CENTURY HOUSE, SHAFTESBURY AVE., LONDON, ENGLAND

Mullard is the Trade Mark of Mullard Ltd. and is registered in most of the principal countries of the world.

MEV 34

Want more information? Use post card on last page.

"System-designed" Leach relays serve all three



Yes, the missile age is the toughest challenge yet for electronic components . . . and supersonic inhabited aircraft aren't far behind in their demands for reliability. Just meeting specifications is no longer enough. In this newest family of electronic-aircraft-missile relays, LEACH does more, offers reliability *beyond* specs . . . dependability based on design and manufacturing experience second to none.

These relays were *system designed* . . . Leach Engineers started with the framework of today's *system* demands, they built a family of relays not merely to satisfy specifications but *to do a job*. Here are some of the features that help insure *system reliability* in your electronic, aircraft and missile work . . .

HERMETIC SEALING — *every relay checked by mass spectrometer*

OPTIONAL LEADS — *solder terminals, potted leads or plug-in bases*

SQUARE CANS — *20% more relays in the space required by round cans*

SHOCK RESISTANCE — *vibration and shock properties exceed MIL specs*

HIGH-TEMPERATURE — *dependability assured at 120°C ambient*

	9220	9226	9230
Contact arrangement	4PDT	6PDT	4PDT
Operating voltage	18-30 VDC	18-30 VDC	18-30 VDC
Contact rating at 28 VDC Resistive Inductive	 5 amp 1.5 amp	 5 amp 1.5 amp	 10 amp 7 amp
Coil resistance	250 ohms	200 ohms	150 ohms
Duty	Continuous	Continuous	Continuous
Weight	.25 lb.	.25 lb.	.5 lb.

COMPLETE SPECIFICATIONS on these three new relays will be sent on request. *Write for them today.*

LEACH CORPORATION | LEACH RELAY DIVISION

5915 AVALON BOULEVARD, LOS ANGELES 3, CALIF.

DISTRICT OFFICES AND REPRESENTATIVES IN PRINCIPAL CITIES OF U. S. AND CANADA

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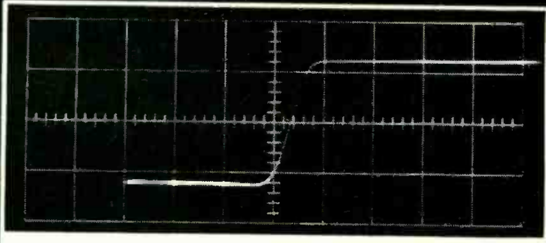
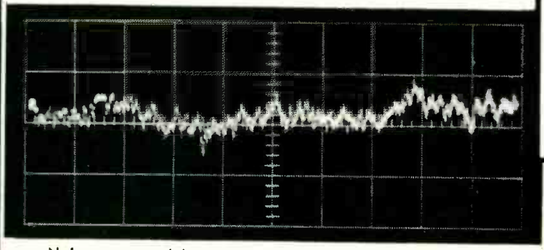


Leading edge of pulse displayed on 0.02 μsec/cm sweep shows clean response of the Type 541 with the Type 53/54K Plug-In Unit.



Noise generated by a 1-megohm carbon-film resistor with 45 v dc applied, displayed on 2 msec/cm sweep of the Type 541 with the Type 53/54E Plug-In Unit at 50 μv/cm sensitivity.

DC-to-30MC Oscilloscope *retains* GENERAL-PURPOSE *utility*

No longer do you require a highly specialized oscilloscope for your high-speed pulse applications. These applications are now capably handled with an oscilloscope that has general-purpose qualifications, too . . . the Tektronix Type 541.

The Type 541, although priced lower than specialized instruments, combines an extremely wide sweep range and the inherent characteristics of the high-speed oscilloscope with a flexibility possible only through interchangeable plug-in preamplifiers. You can apply the Type 541 to all ordinary and many unusual tasks with complete confidence. In the many areas covered by this versatile instrument your time and amplitude measurements will be accurate, your waveform displays will be true.

NEED SWEEP DELAY? *The Tektronix Type 545 offers flexible sweep delay in addition to all the characteristics of the Type 541. Delay is accurately calibrated from 1 μsec to 0.1 sec — can be operated in the conventional manner, or triggered for jitter-free display.*

Vertical-amplifier characteristics. With the Type 53/54K Plug-in Preamplifier, frequency response is dc to 30 mc, risetime is 12 millimicroseconds. Sensitivity is 0.05 v/cm to 20 v/cm in 9 calibrated steps. Input capacitance is 20 $\mu\mu$f direct, 8 $\mu\mu$f with 10x probe.

Triggering facilities. Amplitude-level selection, automatic triggering, and high-frequency sync in addition to all standard triggering modes.

Sweep characteristics. Linear sweeps from 0.02 μsec to 12 sec/cm (600,000,000-to-1 ratio), with 24 calibrated steps from 0.1 μsec/cm to 5 sec/cm. 5x magnifier is accurate on all ranges.

Display characteristics. Full 4-cm by 10-cm linear display, 10-kv accelerating potential, writing rate of 250 cm/μsec.

Versatility. Available plug-in units provide for low-level dc differential and micro-sensitive applications in addition to fast-rise applications. Plug-in units covering many other applications are ready for production.

Type 541 — $1145

Type 545 — $1450

plus price of desired plug-in units

Type 53/54K Fast-Rise Plug-in Unit. . **$125**

Prices f.o.b. Portland (Beaverton), Oregon

ENGINEERS —

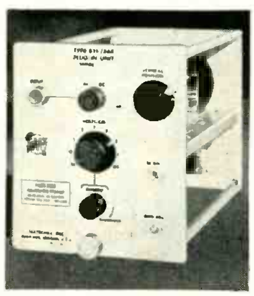
interested in furthering the advancement of the oscilloscope? We have openings for men with creative design ability. Please write to Don Kepler in Portland, or contact him at booths 129 and 131 during the I.R.E. show.

See these and many other oscilloscopes at the Tektronix exhibit, booths 129 and 131, March IRE show.

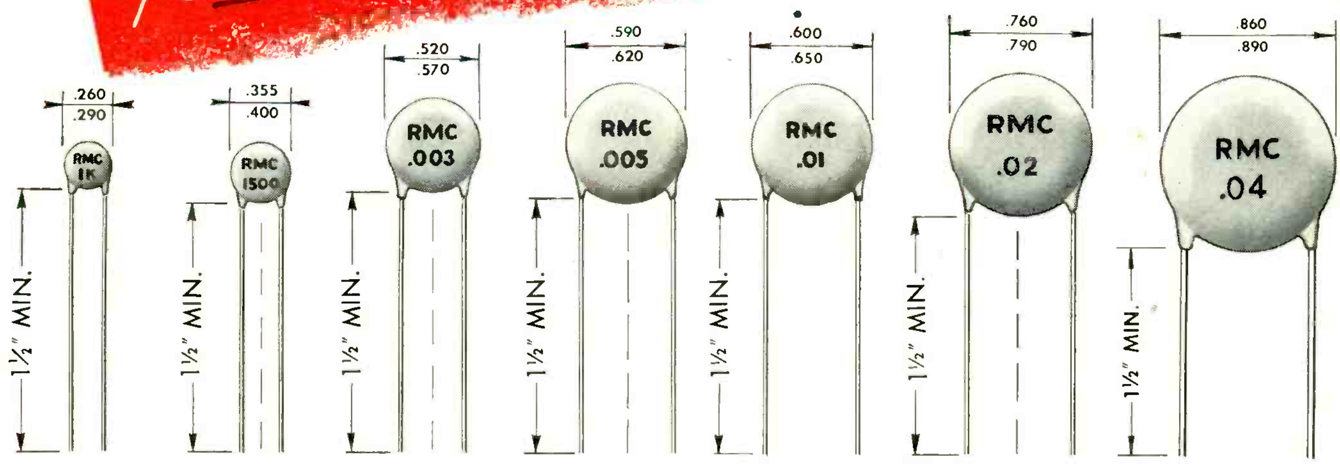
Tektronix, Inc.

P. O. Box 831, Portland 7, Oregon

CYpress 2-2611 **Cable: TEKTRONIX**



Efficiency Economy Guaranteed in RMC type B DISCAPS



.00015 .00047 .00068 .0008 .001	.0015 .002 2x.001	.003 .004* .005* 2x.0015 2x.002*	.0047 .005 2x.002 .01* ±20% .02* +80%−20%	.01* .02*	.01 .02 2x.004	.02* +80%−20% .04* +80%−20%

*Rated 600 V.D.C.W. Flash test 1200 V.D.C

SPECIFICATIONS

Guaranteed Minimum Value

POWER FACTOR: 1.5% Max. @ 1KC (initial)

POWER FACTOR: 2.5% Max. @ 1 KC (after humidity)

WORKING VOLTAGE: 1000 V.D.C.

TEST VOLTAGE (FLASH): 2000 V.D.C.

LEADS: No. 22 tinned copper (.026 dia.)

INSULATION: Durez phenolic—vacuum waxed

INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms

AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms

RMC Type B DISCAPS are designed for all by-pass or filtering applications and meet or exceed the RTMA REC-107-A specifications for Z5U ceramic capacitors. The efficiency of Type B DISCAPS in all types of electrical and electronic equipment has been proven over the years. New lower prices guarantee initial economy while additional economies are effected in faster production line handling.

Type B DISCAPS are rated at 1000 V.D.C.W. and are available in capacities between 150 MMF and 40,000 MMF.

It will pay you to investigate the advantages offered by RMC DISCAPS. Write today for expert engineering help on your capacitor problems.

DISCAP CERAMIC CAPACITORS

RMC

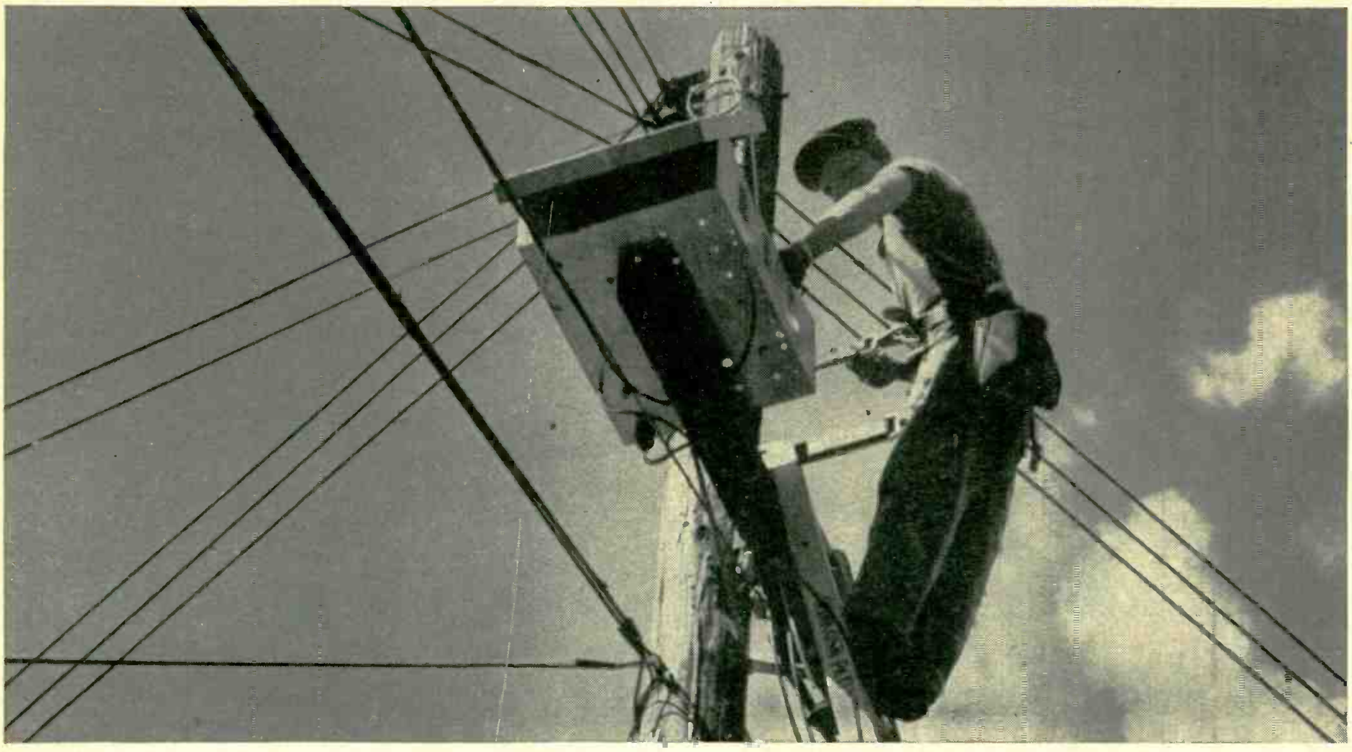
RADIO MATERIALS CORPORATION

GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

Two RMC Plants Devoted Exclusively to Ceramic Capacitors

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Want more information? Use post card on last page.



The key to high quality reception for Dubuque TV viewers is provided by Jerrold's high-gain, low-distortion signal amplifying equipment. "Right down the line" — at the antenna site, at the distribution hubs, and at the pole line feeders (above) — these amplifiers depend on built-in and accessory Sola Constant Voltage Transformers.

From Head End to Pole Line Feeders, Sola Constant Voltage Transformers Regulate Dubuque Jerrold TV System

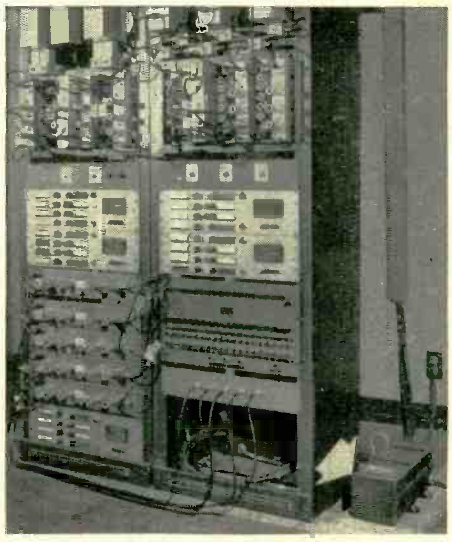
The Jerrold community television system from Dubuque, Iowa, is an excellent example of system-wide use of *regulated* supply voltage to insure top performance and low maintenance costs.

To provide Dubuque viewers with the highest quality picture possible, the system uses high-gain receiving antennas, mounted on a 420' tower. Jerrold high-gain amplifiers then forward signals through 12 miles of coaxial cable, branching into an amplified distribution network of 130 miles of coaxial cable embracing the whole of the city.

Peak performance of amplifiers and other electronic system components requires maximum stabilization of supply voltages throughout the system. For this reason Sola Constant Voltage Transformers are an integral part of line amplifier power supplies, and are used as accessories with other equipment.

Sola standard static-magnetic regulators provide automatic, instantaneous output voltage unaffected by changes in input voltage. Their regulation is within $\pm 1\%$ regardless of primary voltage swings of 30%. They have no moving parts, no tubes, require no manual adjustments and are self-protecting against short circuit.

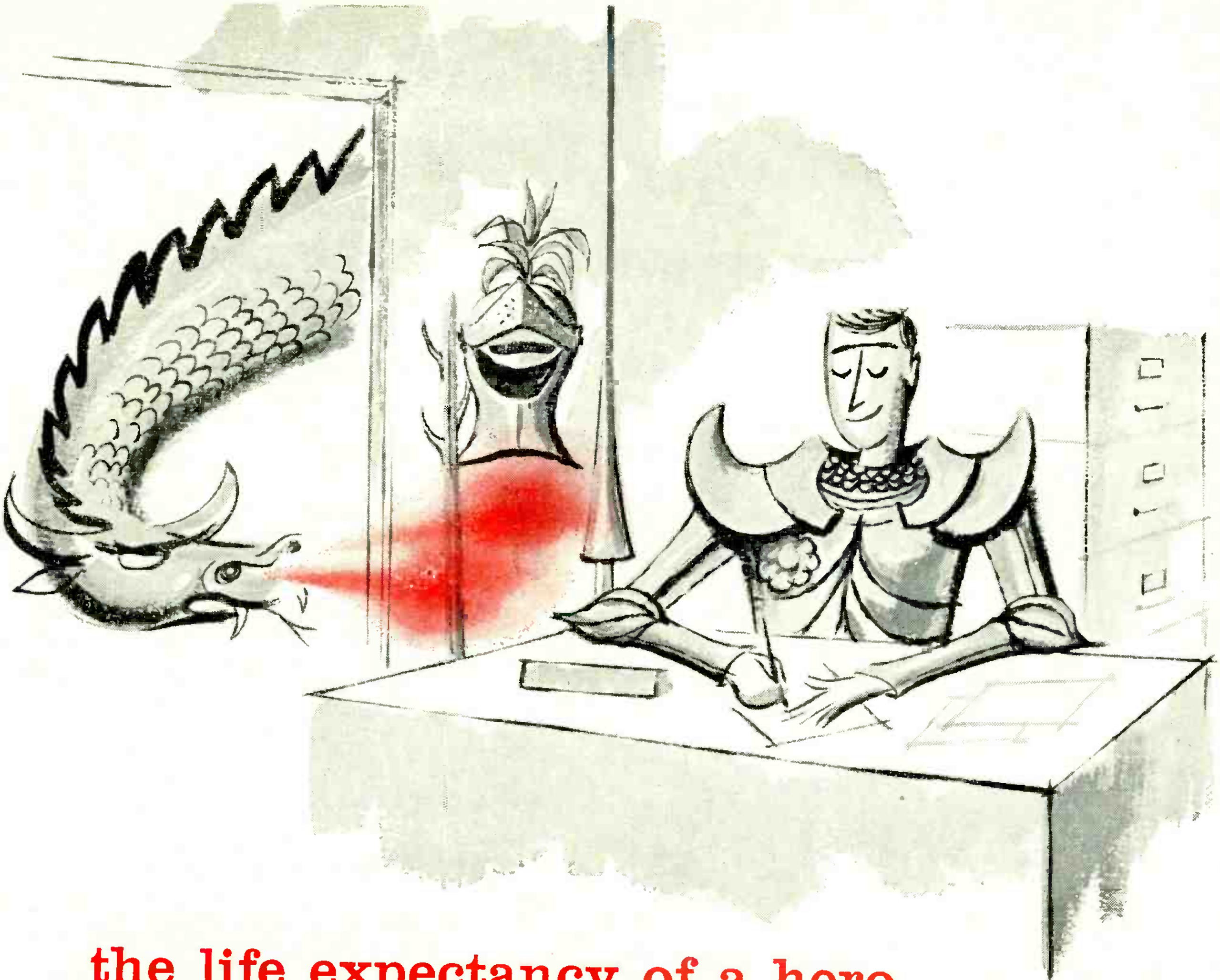
If you require a maintenance-free source of stabilized voltage, Sola Constant Voltage Transformers may be your answer. Call a Sales engineer, or write for Circular 7B CV-170D.



Stabilized voltage for Dubuque Jerrold system head end equipment, such as preamplifiers and converters shown here, is provided by the stock 500va Sola Constant Voltage Transformer (arrow) installed as an accessory.

SOLA *Constant Voltage* **TRANSFORMERS**

CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • **LIGHTING TRANSFORMERS** for All Types of Fluorescent and Mercury Vapor Lamps. • **SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414** • *NEW YORK 35: 103 E. 125th St., TRafalgar 6-6464 • PHILADELPHIA: Commercial Trust Bldg., RIttenhouse 6-4988 • BOSTON: 272 Centre Street, Newton 58, Mass., BIgelow 4-3354 • CLEVELAND 15: 1836 Euclid Ave., PRospect 1-6400 • KANSAS CITY 2, MO.: 406 W. 34th St., JEfferson 4382 • LOS ANGELES 23: 3138 E. Olympic Blvd., ANgelus 9-9431 • TORONTO 9, ONTARIO: 617 Runnymede Rd., RO 7-1654 • Representatives in Other Principal Cities*



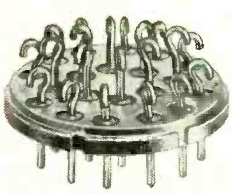
the life expectancy of a hero

. . . is directly proportional to the reliability of the products he purchases

To you, heroes of purchasing and engineering departments, HERMETIC offers the most reliable hermetic seals manufactured . . . the most diverse line to meet your every requirement.

There are three good reasons why heroes always remain heroes when they specify HERMETIC as their one source of supply:

1. *The most technologically advanced production techniques are employed in every manufacturing step.*
2. *Vigorous testing procedures assure the dependability of* HERMETIC'S *complete line under the most critical operating conditions.*
3. HERMETIC *offers long experience in the design, development and manufacture of standard, as well as specially designed seals for economical solutions to procurement problems.*



Heroes: write for a complete set of catalogs and engineering assistance.

Hermetic Seal Products Company

31 South 6th Street, Newark 7, New Jersey

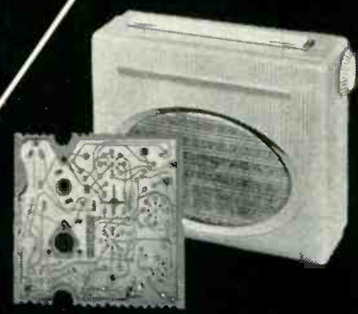
California Associate: Glass-Solder Engineering, Pasadena

SEALED IN HERMETIC HEADERS

FIRST AND FOREMOST IN MINIATURIZATION

Want more information? Use post card on last page.

This is now a **Packaged** *Electronic Circuit*



Don't confuse with this...called a printed circuit

It pays to know the difference!

- A Centralab Packaged Electronic Circuit (P.E.C.*) is a *complete circuit,* which can include capacitance, resistance, and inductance . . . in addition to wiring.
- *Circuit performance* can be guaranteed with Centralab P.E.C.'s, because they are manufactured and tested on a performance basis.
- A Centralab Packaged Electronic Circuit offers (a) Operating life many times that of conventional components; (b) Reduction in size, weight, and assembly cost; (c) Saving in soldering time; (d) Elimination of wiring errors.
- Over 160 standard P.E.C. designs are available for your immediate use. For your special requirements, ask for custom design.
- 60 million Centralab P.E.C.'s are in use in the electronics industry.

For complete basic data, write for Technical Bulletin 42-227.

*Trademark

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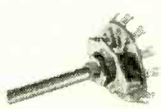
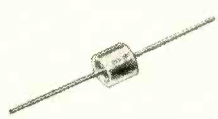
914B E. Keefe Avenue, Milwaukee 1, Wisconsin In Canada: 804 Mt. Pleasant Road, Toronto, Ontario

VARIABLE RESISTORS

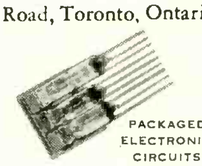


SWITCHES



CERAMIC CAPACITORS

ENGINEERED CERAMICS



PACKAGED ELECTRONIC CIRCUITS

SINCE 1922, INDUSTRY'S NO. 1 SOURCE OF STANDARD AND SPECIAL COMPONENTS

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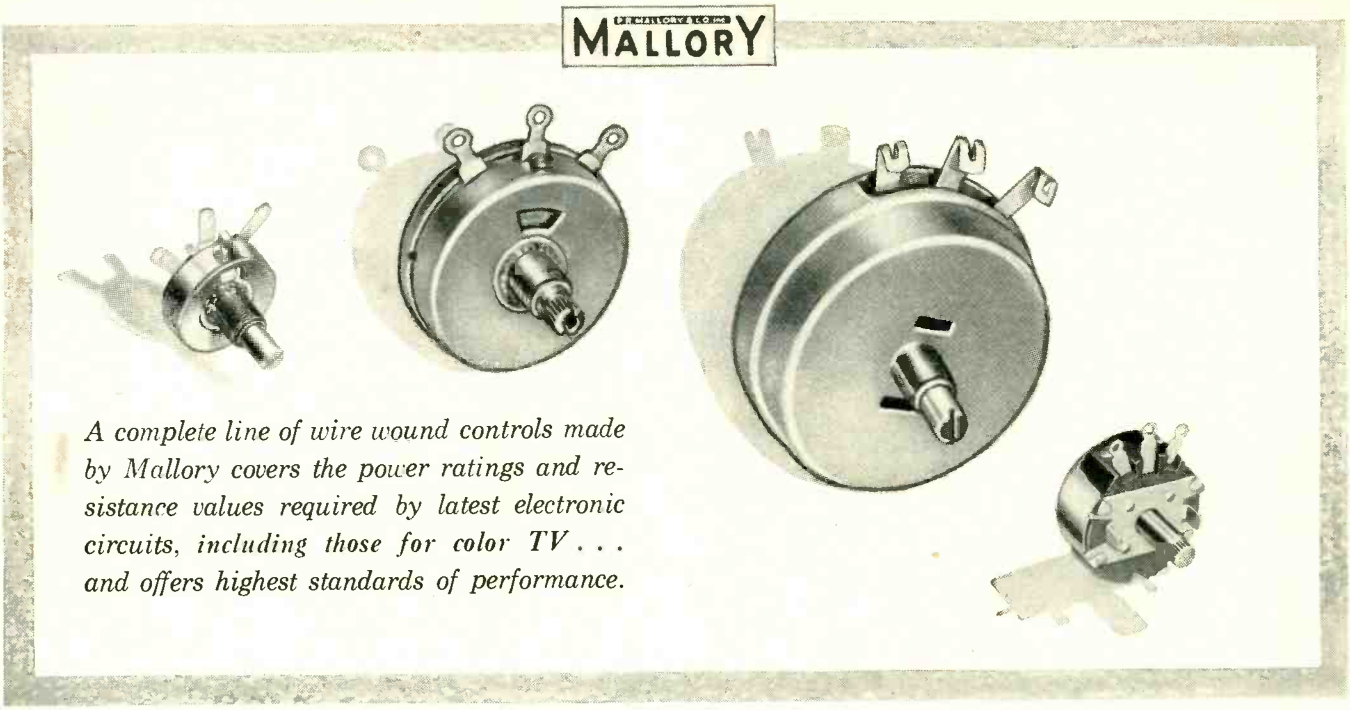


Wire wound controls with the ratings, resistances and reliability you want

Mallory
Wire Wound Resistors
for heavy duty service

A comprehensive line of vitreous enamel power resistors made by Mallory meets the requirements of many electrical and electronic circuits where high power dissipation is needed . . . in voltage dividers, bleeders, load or shunt resistors.

Mallory resistors are space-wound on high quality steatite cores, using large gage wire with matched temperature coefficients of all parts. They are designed for maximum heat dissipating area, to assure cool operation. A special non-porous, non-alkaline vitreous enamel coating gives effective protection of the winding.

Fixed and adjustable types are available in ratings from 5 to 200 watts. Write for data.

When your new circuit designs call for controls with higher power dissipation, plan to use the dependable, trouble-free performance that you can get with Mallory wire wound controls. These are true precision products, made to exacting standards to guarantee complete uniformity and adherence to specifications on every control you receive.

The Mallory line of wire wound controls includes a broad range of designs, wattage ratings and resistance values. All ratings are conservative . . . no need to over-design to allow for extra safety. You can choose from models with insulated or grounded rotors . . . all fitted with standard 3/8″ mounting bushing and short screwdriver-slotted shaft. The following types are available:

Model	Watts	Resistance range—ohms	Rotor connection
R	2	1- 20,000	insulated
C	2	½- 15,000	grounded
M	4	½-100,000	insulated
E	7	3-150,000	grounded

For complete information, write to Mallory today for Technical Bulletin. A Mallory control specialist will be glad to lend personal assistance on your commercial or military applications.

Expect more . . . get more from

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Serving Industry with These Products:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.

CROSS TALK

► **LAG** . . . When a circuit diagram is found packed with a piece of apparatus it is logical, we submit, to assume that said apparatus is wired as per accompanying circuit. Surprisingly enough, such is frequently not the case.

It seems that manufacturers often make changes in wiring and component parts without transferring these changes to new circuit diagrams. The soldering iron is, as it were, quicker than the drafting pen.

In such cases we'll take our apparatus sans circuit diagram. There is no future whatever in looking over a diagram that shows what the apparatus ain't.

► **AVIATION ELECTRONICS** . . . We are indebted to N. E. Edlefsen of North American for this frankly exaggerated word picture of what an airplane looks like to some electronics engineers:

"Large airframe with huge engines and propulsion system; fuel tanks and flight personnel (unacquainted with electronics) everywhere; a tiny primary power supply fully loaded by airframe demands, ±50 percent variations in supply voltage and frequency; an air conditioning system with barely enough capacity to keep all the people alive; a perfectly smooth exterior contour (no radomes) except for unexplainable aerodynamic gargoyles; randomly scattered inaccessible spaces of a few cubic inches each for the electronic equipment—with no provision for connecting cables or cooling ducts.

"The plane starts with a high-g jerk; it flies with high-g vibration at all audio frequencies; temperatures oscillate between −65 F and +140 F through frequent dew point conditions; it encounters high-g accelerations during flight; it lands with a high-g jolt; and, after landing, a large crew of airframe maintenance men do excellent footwork all over the electronic equipment while they service the airframe and fight off the poor electronic maintenance man (who really knows nothing about the equipment anyway)."

► **BUSY BOOKWORMS** . . . Electronics and electrical engineers probably read more technical books than any other comparable group, with chemical engineers a close second. This, at any rate, is the impression we gather in our travels, and the boys downstairs in the McGraw-Hill Book Company think it could be.

There is a good reason why electronics engineers are such avid readers. They have to be. The art is moving so rapidly, in so many directions, no one can afford to start any new project from scratch without referring to the literature. Some of the answers are almost certain to be found in a book or in a magazine.

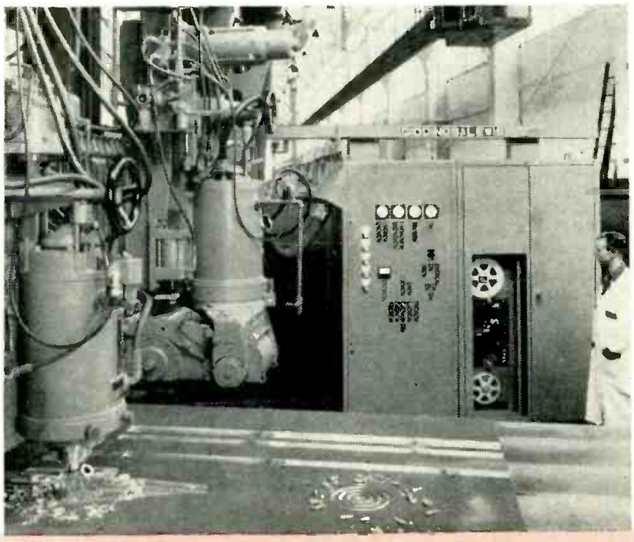
LOOKING AHEAD . . .

Latest military planning places even greater emphasis upon guided missiles, increasing electronics' share of government dollar

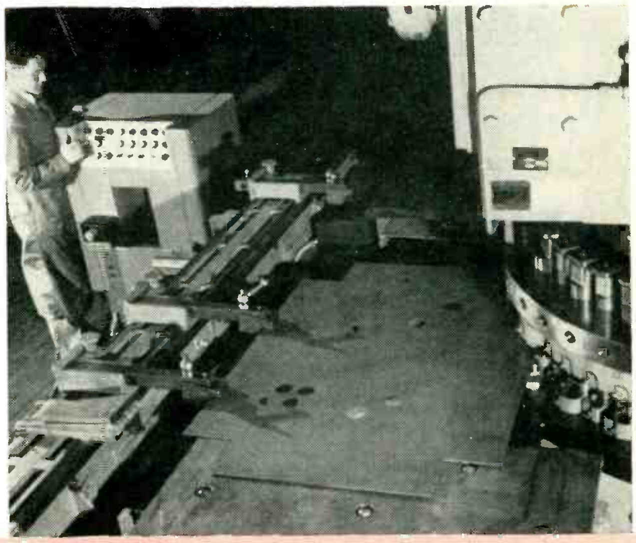
Cheap and plentiful radioactive materials will greatly alter character of x-ray business in next few years, eliminating need for high voltage in many cases

Automobile turbine engine development may reduce need for electronic ignition systems but parts designed for this purpose should have other industrial applications

Demand for further standardization of component parts continues to build up as result of growing trend toward more automatic equipment assembly



MILLING BY TAPE



PUNCHING BY CARD

Electronic Controls for

SUMMARY — Increased interest in automatic production has spurred the growth of electronics in the machine tool field. Applications range from complete control of complex milling operations by tape to systems for following operator's orders in proper sequence

By DAVID A. FINDLAY
Assistant Editor
ELECTRONICS

ELECTRONIC equipment is being used to control many machining operations. These are mainly systems for moving the tool or work table in one, two or three dimensions to cut the desired shape. The simplest form of control is in the single-dimensional machine where a plugboard is used to set spindle speeds and feed rates. In lathe operations where a symmetrical piece is being turned tracer or magnetic-tape control can be used to change the position of the cutter.

Punch press and drilling machine controls position the work table under the drill. Position information in rectangular coordinates is recorded on punched tape, cards or magnetic tape. A servo system is used to position the table.

Milling machines, used to cut complex forms, require programming information to raise or lower the cutting tool as well as to move the table in two directions. Rectangular coordinate data can be processed in a computer to provide a step or continuous tool motion, with the computer calculating the tool path between points according to equations inserted by the programmer. Tracer-controlled millers use deflection of a stylus on a three-dimensional model to provide control information to the cutting head.

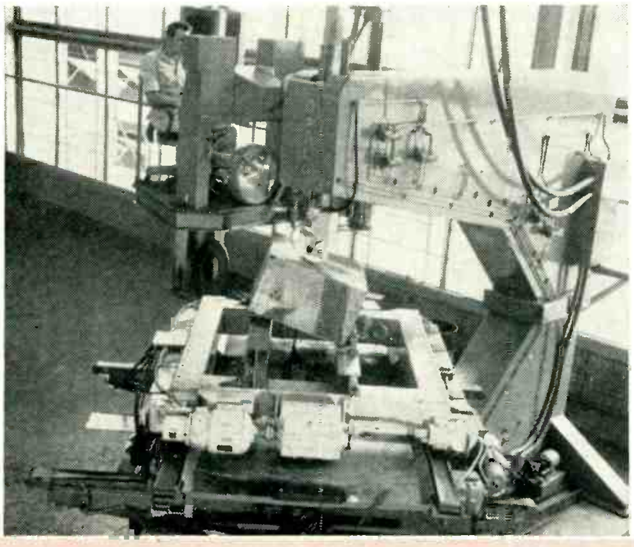
Program-Controlled Machines

In milling machines, for aircraft wing members or three-dimensional cams for fuel control, the complete cutting operation is under control of signals recorded on punched or magnetic tape.

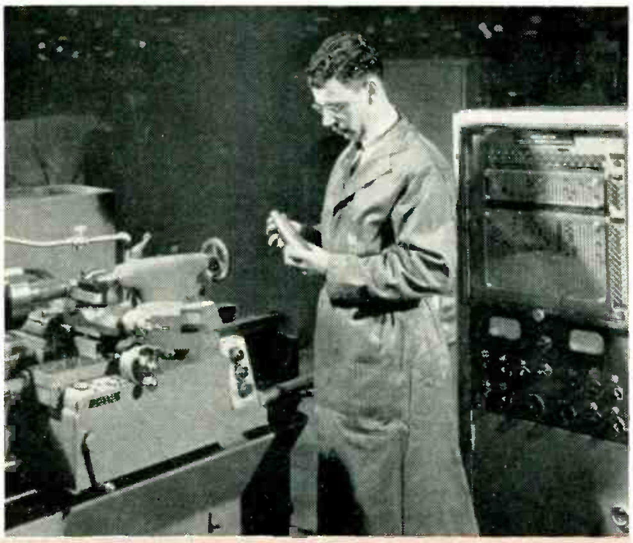
In the Bendix cam milling machine, shown in Fig. 1, the problem of programming a three-dimensional contour of jet-engine fuel-control cams is reduced to a two dimensional one by fixed gearing between the work spindle and the longitudinal carriage. In this method, the information required by the machine control is the difference in radius in relation to the angular interval.

The basic increment in tool position is 0.0002 in. and radius difference is punched on eight-hole paper tape in terms of these increments. An increase in radius of 0.03 in. corresponds to ± 150 increments. Two hole positions are used to indicate angular intervals and may be 5, 10, 20 or 80 degrees. The larger intervals are used on sections where the countour is mild.

Data from the tape, giving the



SAWING BY WHEEL



TURNING BY PLUGBOARD

Machine Tools

change of cutter position for each angular interval, is fed to an interpolating unit together with pulses fed back from the spindle and indicating its angular position. The pulse generator is connected to the spindle drive motor and produces 50 pulses per degree of rotation.

The interpolator consists of a binary multiplier and two flip-flop storage registers. While cutting is being done under control of the first storage register information for the next interval is being read into the second register.

The multiplier is controlled by the difference information in the storage register. A binary counter accepts pulses from the spindle-drive pulse generator and generates a command pulse to the cross-slide servo in accordance with the angular interval indicated on the tape.

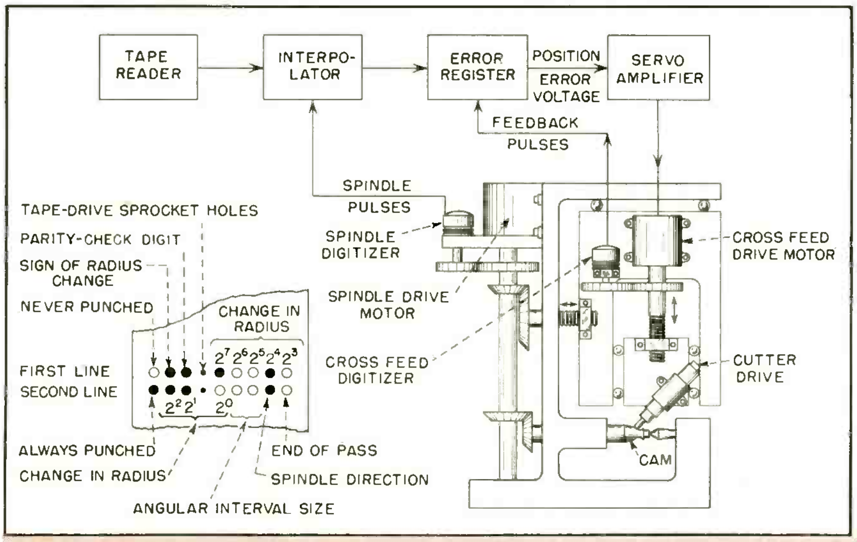


FIG. 1—Milling machine for three-dimensional fuel control cams. Tape section at left shows distribution of punched information

The cross-feed position is sensed by a reversable binary counter which accepts command pulses in one sense and feedback pulses from the cross-feed digitizer in the other sense. The feedback information to the interpolator is the difference between number of command pulses received and number of feedback pulses from the digitizer. This difference count is converted to a proportional voltage by a resistor-rectifier decoding matrix and used as an error voltage by the servo amplifier.

As shown in one of the photographs appearing here, the tape is held on a large reel with the tape reader placed in the center. One complete circulation of the tape through the reader corresponds to a complete cutting pass along the axis of the cam.

For larger-scale milling operations, a three-axis milling machine for aircraft spars is now being constructed. It will employ the same basic techniques as developed for the cam-milling machine. The method of data handling is similar to that developed by MIT and now being used by Giddings and Lewis in their numerically-controlled miller.

In the spar milling machine made by Giddings & Lewis, data from blueprints are punched into paper tape as control signals for five machine axes and 22 auxiliary machine functions. The digital data is converted into a phase-modulated continuous function with the computer interpolating the curves and linear motions required to connect the discrete point information on the punched tape. The phase-modulated signals recorded on magnetic tape are used to control tool and table motion through an amplidyne servo.

A system now under development by Electronic Control Systems-Stromberg-Carlson is shown in Fig. 2. In the planning section, coordinate data is entered from a ten-key adding machine. This data is fed to a storage register along with cutting-speed information and equations for curve type selected on the control panel. The special-purpose computer calculates the tool path along first and second degree contours rather than as chord approximations. Output from the computer consists of a series of pulses recorded on three separate channels of a tape recorder. For straight-line sections, the pulse trains on each channel have constant spacing.

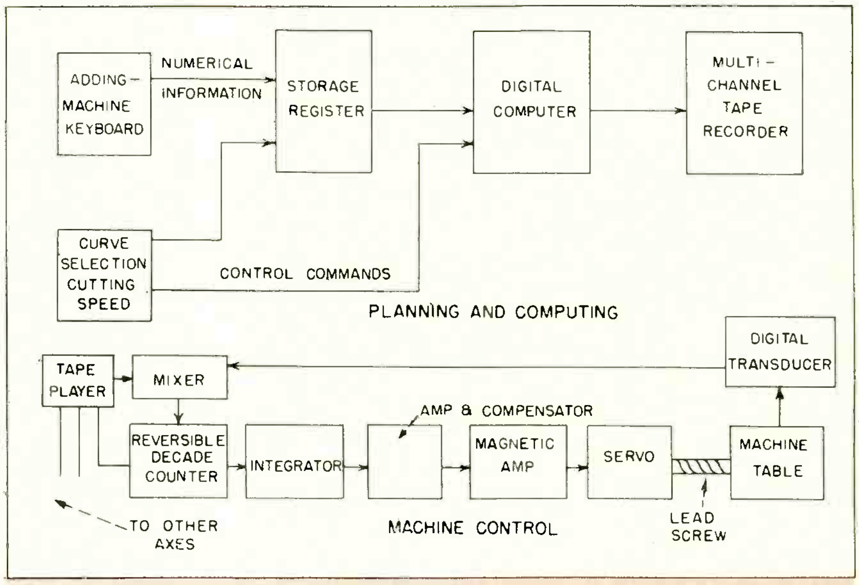


FIG. 2—Computing and control sections of ECS path-control system. Special purpose computer supplies interpolation to calculate continuous curves

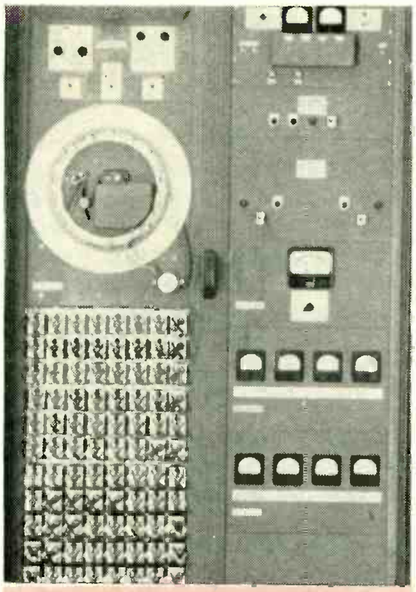
In the machine-control section, the pulse output from the tape player is mixed with information fed back from a digital transducer on the machine table. The sum-or-difference signal is then fed through an integrating circuit to provide a varying d-c voltage to the magnetic-amplifier controlled servo.

In a similar system developed by Ferranti Ltd., digital feedback information is obtained through a phototube-grating arrangement shown in Fig. 3. A length of grating ruled with 5,000 lines per inch is mounted on the machine table. A second shorter section is fixed to a stationary part of the machine so that movement of the table will cause the long section to traverse the other with their surfaces almost in contact. The fringe pattern produced by this motion is used to modulate a light beam. Two phototubes are situated so that the modulated light will reach them in different phase relation. Using this system the number of cycles will give the distance moved, frequency will give velocity and phase relationship will provide direction.

A programming system for recording pulsed control information on recorded tape is shown in Fig. 4. In this control, developed by the Automation Corp. of America, each axis of the machine is driven by

Table I—Systems for Programmed Machining

Manufacturer	Data Storage	Modulation	Notes
Automation Corp. of America	35-mm magnetic tape	f-m	Machine drive through mechanical differential and synchronous motors
Bendix Aviation Corp.	punched plastic tape	pulse	Special purpose machine for milling fuel control cams
Bendix Aviation Corp.	magnetic tape	phase	Under development for Martin Aviation Corp.
ECS-Stromberg Carlson	magnetic tape	pulse	Tool path computed as continuous curve rather than chord approximation
Farrand Controls Corp.	punched tape	pulse	
Ferranti, Ltd.	magnetic tape	pulse	Tool path computed as continuous curve rather than chord approximation
General Electric Co.	magnetic tape	phase	Program tape recorded from operation by hand or tracer
Giddings & Lewis	magnetic tape	phase	Based on design developed at MIT
Monarch Lathe Co.	plugboard		Programs up to five operations and spindle speeds on lathe
Oerlikon Tool & Arms Co.	Translator for converting from punched tape to phase modulated magnetic tape for GE tape control		



Control panel of Bendix cam milling machine. Tape reel is at left

two synchronous motors through a mechanical differential. One motor is driven by a reference signal recorded on the 35-mm magnetic tape and the other is driven from a second tape channel at a speed determined by the programmer. When both motors receive signals of the same frequency, their speeds are equal and the output from the mechanical differential is zero. Varying the frequency of the signal to one motor above or below the reference frequency will produce an output to the table at a speed and direction determined by amount and direction of the variation.

In the programming unit, tape speed is synchronized with the recorded data by a basic timing pulse obtained from a phototube-disk arrangement on the tape sprocket drive. With the X, Y and Z-rate counters set at frequencies to give the desired rate, speed and direction of movement, a pulse from the phototube starts these and the reference counter and their outputs are recorded on the tape. The reference counter also supplies distance information to a counter controlling the brake and sprocket drive motor. When the required distance has been moved, as set up on the distance counter, tape motion is stopped and the machine is ready for the next motion.

A plugboard selector is used on the Monarch Lathe Co. programmer to preset turning operations. Five separate work cycles can be programmed for spindle speed, cutting tool travel and feed rate. An analog-to-digital converter pulses the control unit at the end of each work cycle to switch to the next operation.

Systems developed by Airborne Instrument Laboratory and Pratt & Whitney gage the output of the machine to control cutter position. Three consecutive pieces must be oversize before the tool is reset.

The General Electric tape control system is shown in Fig. 5. In preparing a tape, the workpiece is turned out by hand and outputs from synchros attached to the lathe controls are recorded on tape as phase-displaced 200-cps square-wave signals. On playback, the phase displaced signal is discriminated and drives an amplidyne motor control to position the tool.

A programmer developed by Oerlikon Tool and Arms Corp., will program magnetic tape for the GE control unit from punched paper tape. Rectangular coordinate data punched into the tape is translated into phase-displaced 200-cps square waves. This information is recorded on magnetic tape as a continuous signal proportional to time.

Tracer Controlled Machines

In tracer-controlled milling machines the device for following the model contours can be a resolver potentiometer, variable-reluctance transformer or similar device for converting stylus displacement into a voltage change. In the Pratt & Whitney Velvetrace, a noncontacting follower uses a changing spark-gap potential between the stylus and metal model to control the raising and lowering of the cutter and cross-feed speed of the table.

The Raytheon two-motion duplicator, shown schematically in Fig. 6, has been applied to machines for working large round parts to maintain a constant tangential cutter velocity with changes in shape of the part. A variable-reluctance follower has two sets of sensing elements aligned with the machine axes being controlled. This provides a direct measure of the pressure vector along each axis. The output of the transformer, with deflection of the stylus, will be two in-phase signals one each for the X and Y axis. These signals are fed to an amplifier and phase-shifting circuit where the signals are displaced 45 deg so that they will be 90-deg out of phase at the input to the vector adder. Here the signals are added vectorially, producing a signal vector representative of the deflection vector at the stylus with its magnitude indicating the magnitude of stylus deflection and its phase representing the direction.

To keep the stylus in contact with the model regardless of contour, a modulator vector must be added perpendicular to the signal vector in a direction depending on whether the stylus deflection is greater or less than normal.

The modulator section is a balanced circuit consisting of two 6L7's. The screen grids are held a reference potential, with the stylus signals applied to the control grids through a four-phase detector. As the slope of the template changes the output of the phase detector will

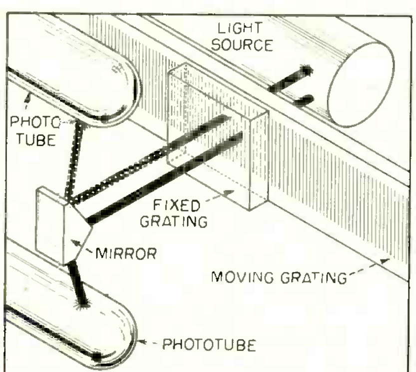


FIG. 3—Phototube-grating arrangement to obtain digital motion data from table

Inserting magnetic locating device in Pratt & Whitney rotary table

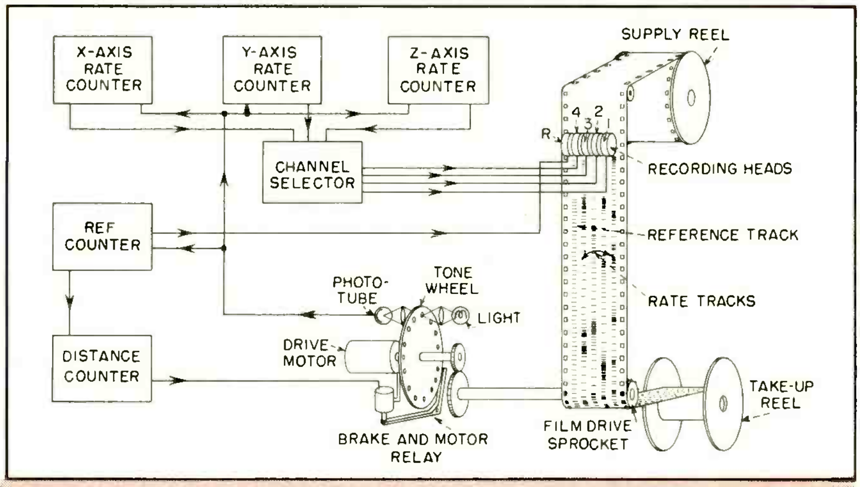


FIG. 4—Counter programming system obtains synchronizing signal from tape drive so that reference and rate tracks will be independent of tape speed

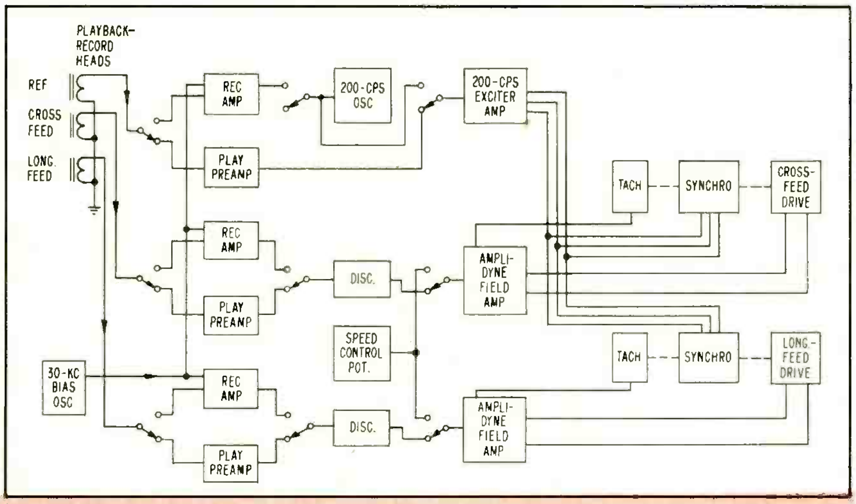


FIG. 5—Tape recorded from machine motions by synchros can be played back into lathe to duplicate parts

Table II—Programmed Positioning Systems

Manufacturer	Data Storage	Notes
Arter Grinding Machine Co.	punched tape	
Farrand Controls Corp.	keyboard input mechanical drum storage	
General Electric Co.	punched cards	Synchros positioned by pins from digital data
Laboratory for Electronics	punched tape	Positioning system for printed circuit boards (under development)
Pratt & Whitney	cards, tape or keyboard	Resolver-null balance using magnetic pickup
Radio Corp. of America	punched tape	Positioning system for printed circuit boards
Stromberg-Carlson	punched tape or cards	

change, producing a modulator output. The modulator output will have a phase relationship of zero or 180 deg to the signal vector with an amplitude dependent on the change of slope of the contour. This vector is added to the signal vector in the second vector adder and is then resolved into components 90 deg apart for discrimination. The phase-sensitive discriminators produce d-c outputs proportional to the cosine of the phase angle of the signals and the reference potential at their plates. These signals drive amplidyne systems controlling the X and Y axes motors.

Table Positioning Systems

Continuous changing of table positioning under direct control of the operator is used in the DoAll band-saw used for cutting extrusion dies for aluminum. A block diagram of the system is given in Fig. 7 and the circuit is shown in Fig. 8.

Three separate feed motions are required to machine a curved surface using a band-saw with a single cutting edge. It must be possible both to rotate the work and to move it linearally in rectangularly coordinated directions. In the DoAll band-saw, two tables providing linear motions in rectangular coordinates are mounted on a rotary table with the saw blade located in the center of the rotary table.

Sawing a straight line requires movement of only the linear feeds while cutting a curved surface required simultaneous operation of all three feeds. The rotary table maintains the tangent relationship to the saw blade while the feed into the blade is obtained from linear motions. Since the linear tables are mounted on the rotary tables, movement of the rotary table changes the direction of feed. During any rotary motion of the supporting table the motions of the individual linear-feed drives must constantly change in order to maintain feed at a constant direction and rate with relation to the saw blade.

The three feed drives are simultaneously controlled from a single wheel by a combination of a positioning-control system for the rotary table and a resolver speed-control for the linear motions.

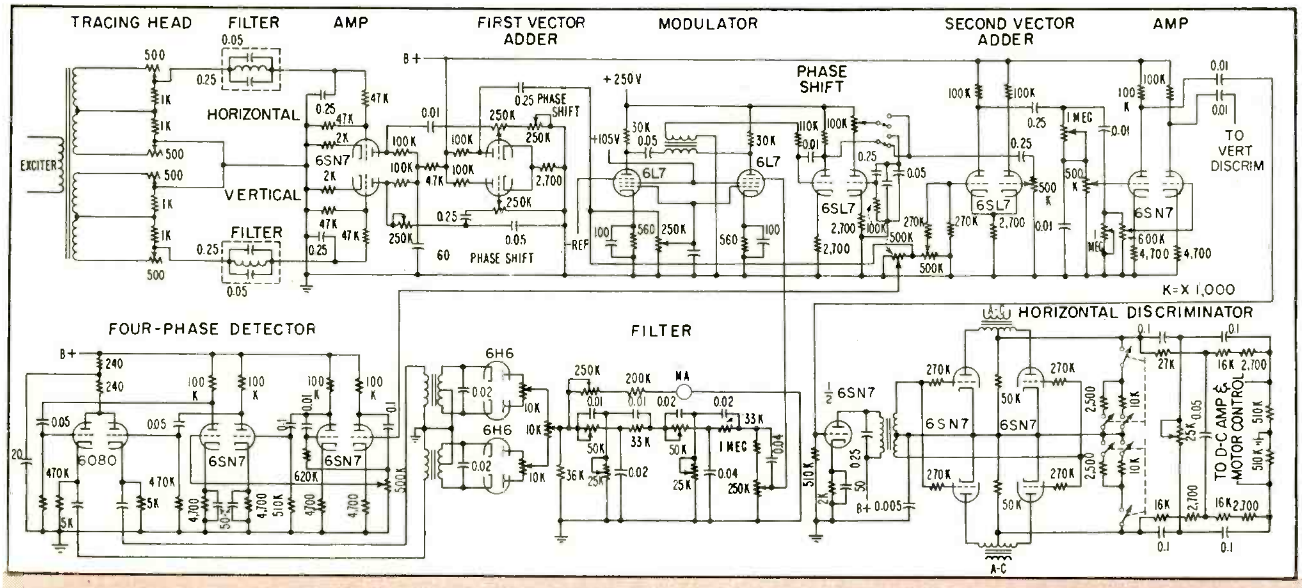


FIG. 6—Tracer control for machining circular parts holds tangential velocity of cutting tool constant with changing contour

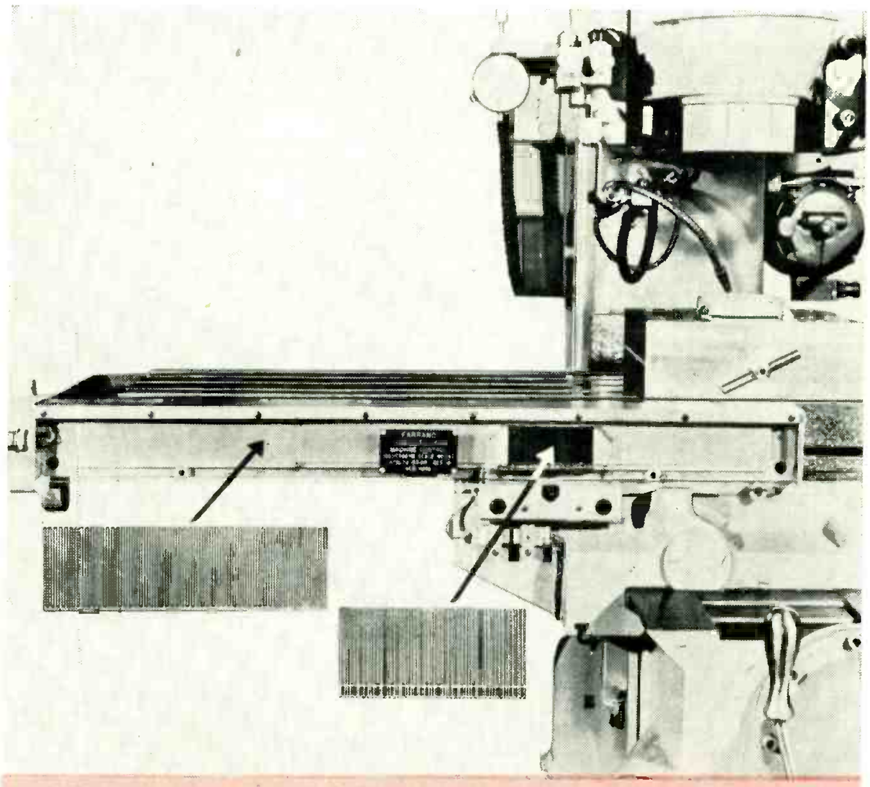
When rotated, the main control wheel actuates a transmitter synchro which controls the movement of the rotary table. When the steering wheel is moved longitudinally it actuates a speed-control potentiometer and establishes the magnitude and direction of feed. A resolver potentiometer actuated by the rotary table divides the feed-speed signal into two components for independent control of each of the linear-feed drives as shown in Fig. 7. Control winding on the resolver produces signals which have a sine and cosine relationship varying with the angular position of the resolver and rotary table.

When work is being fed into the saw in a direction parallel to the X-axis drive, the full control signal is fed through the resolver to the amplidyne driving that axis. Rotating the work table will change the position of the resolver potentiometer slider, decreasing the drive signal to the X axis and increasing the signal to the Y-axis drive. Turning the table a full 90 deg, so that feed is parallel to the Y axis, positions the resolver so that the full signal is transmitted to the Y-axis control.

Discrete positioning of a workpiece under a drill or punch requires control of table motion in two coordinates. In the General Electric punch-card positioner, conversion from decimal to analog is performed by feeding the units, tens, hundreds and thousands column data into separate synchros geared in a ten-to-one ratio. Pins representing values from zero to nine are spaced evenly around each synchro. The pin actuated by the card reader is moved into position to stop the synchro at the proper point in its revolution.

The operating cycle is initiated by the card entering the reader. The synchros are rotated approximately one revolution away from their zero position and then start to return until they are stopped by a pin selected by the card reader.

Because of the gearing between synchros, the position of the units synchro will modify that of the tens, which will in turn modify the



Inductive-strip pickup on Farrand machine control provides resolver output of table position for feedback information

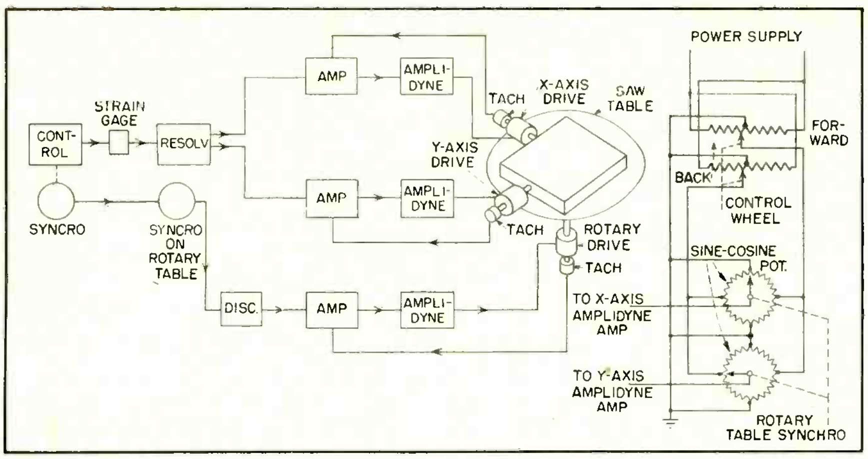


FIG. 7—Control system for band-saw table uses resolver potentiometers to change axis drive speeds with rotation

position of the hundreds. A position synchro matched to each command synchro is driven from the machine table and provides difference information between the desired table position and the present position.

The difference signal from the four synchros is mixed and amplified. A discriminator gives an output to motor-control circuits of a magnitude and polarity dependent on the phase and amount of error.

In the Reeves Instrument Co. positioning system, voltages corresponding to distances along the table travel are set up on a group of potentiometers. Resolver potentiometers driven by the table are used to balance this voltage.

In the Pratt & Whitney system used on a table and on a rotary table for angular positioning, a bar of magnetic material is used as a sensing unit for table position, as shown in one of the photographs. A pickup head senses accurately placed projections on the bar. On the rotary table, the bar projections are placed by hand. A snap-action switch contacts the positioning block as it approaches the sensing head, slowing the drive speed.

A table positioning system developed by Farrand Controls, Inc. is pictured. A keyboard and mechanical memory drum is used to program decimal values of X and Y coordinates for up to 15 drilling locations. A linear strip along the bed of the machine has continuous hairpin wiring along its length. A noncontacting inductively coupled slider mounted on the worktable has 32 pairs of poles on its surface. When energized with single-phase a-c, a sine wave output, similar to that of a resolver driven by a rack-and-pinion arrangement, is obtained.

A keyboard is used to insert positioning information. Keys for course values (down to 0.01) are connected to the carrage drive motor through a servo amplifier with error feedback from a geared potentiometer. Positioning to less than 0.01 in. is accomplished through the inductive slider. Transfer from course to fine is made by a relay when the error signal reaches a predetermined value.

An automatic sizing control circuit applied to a Micromatic Hone Corp. cylinder hone is shown in Fig. 9. An expanding cutting tool rotates inside the cylinder to remove excess material. When the workpiece comes to the required size, a gage ring closes the sizing switch, removing negative bias from the trigger tube. The trigger tube conducts, closing a relay in the plate circuit that stops the cutter feed. Another contact on the relay grounds the cathode of the timer tube. This tube does not fire immediately because of the negative charge on the 1-μf grid capacitor. During the time that it takes the capacitor to lose its charge, the cutter is rotating without feeding into the work. This run-out period gives the final finish to the honed surface. When the capacitor has discharged its bias the timer tube conducts, closing its plate relay to collapse the cutting tool and energize the solenoid to lift it from the work.

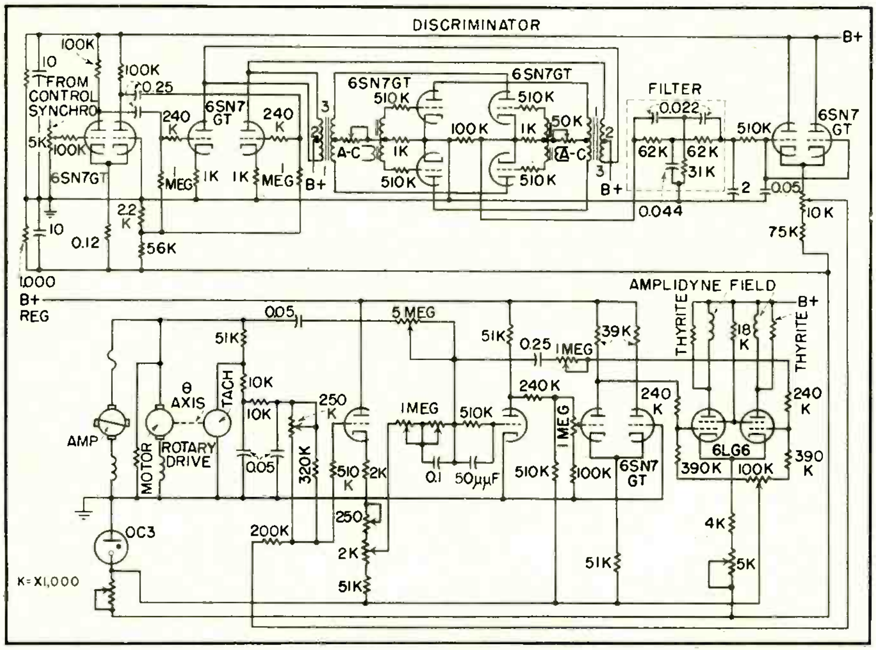


FIG. 8—Rotary table control circuit for DoAll band saw. Amplidyne sections for X and Y axes are same as shown for rotary table

Solid-State Control Equipment

The circuit of a basic decision element made by Minnesota Electronics Corp. is shown in Fig. 10A. These units can be used to form *and*, *or*, or *flip-flop* circuit in logical machine-tool control systems. A unidirectional four-phase clock supplies pulses to set and reverse the state of the cores. The input wind-

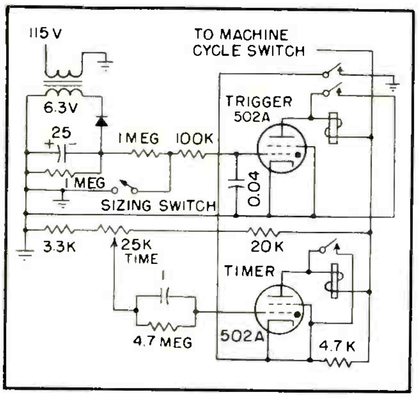


FIG. 9—Control and timing circuit for precision cylinder hone

Table III—Tracer Control Systems

Manufacturer	Transducer	Notes
General Electric Co.	potentiometer balance	
Moog Valve Co.	potentiometer balance	Error signal controls four-way hydraulic valve to position cutter
Raytheon Mfg. Co. (two motion)	differential transformer	Maintains constant tangential velocity on miller for circular parts
Raytheon Mfg. Co. (single and dual motion)	differential transformer	Single and dual motion control use similar circuits

ing and upper output winding are similarly sensed, so that if a pulse energizes the input winding the next clock pulse will find a low impedance in the upper winding and will produce an output pulse. The lower output winding, being oppositely sensed, will offer a high-impedance to the clock pulse. Thus, the element provides output on the upper element for an input pulse and an output on the lower winding for no input pulse.

An *and* circuit is formed by applying inputs to either end of the input winding. With two inputs through mixing diodes of pulses large enough to saturate the core an *or* circuit is produced. Two decision units combined as shown in Fig. 10B, form a flip flop. With no input on the set line, the lower winding produces a series of pulses to the input of the second element, saturating the core so that it will not pass a pulse on the lower winding. Inserting a pulse to the input will stop a pulse to the second element, permitting it to supply a pulse to the input, thus maintaining that state. A reset pulse inserted at the time of the zero output from the first element will set the flip-flop to its original state.

An application of solid state logical elements to machine control is shown in the punch press circuit of Fig. 10C. In this Westinghouse Cypac system the operator presses two run buttons to actuate an air clutch connecting the punch head to the drive power. When the buttons are pushed the input to the first *not* circuit is removed. This provides an output through the lower contacts of the run button to the *on* input of the flip-flop and through limit switch S_2, giving a second input to the *and* circuit. With both inputs present, the *and* circuit provides an output to actuate the air clutch solenoid. As the punch moves down, limit switch S_2 opens and S_1 closes. The operator can then release the run buttons without stopping the cycle. If the operator does not release the run buttons until after limit switch S_3 closes, the machine will stop. If he does release them and depresses them after limits switch S_3 has opened, the machine will continue into the next cycle.

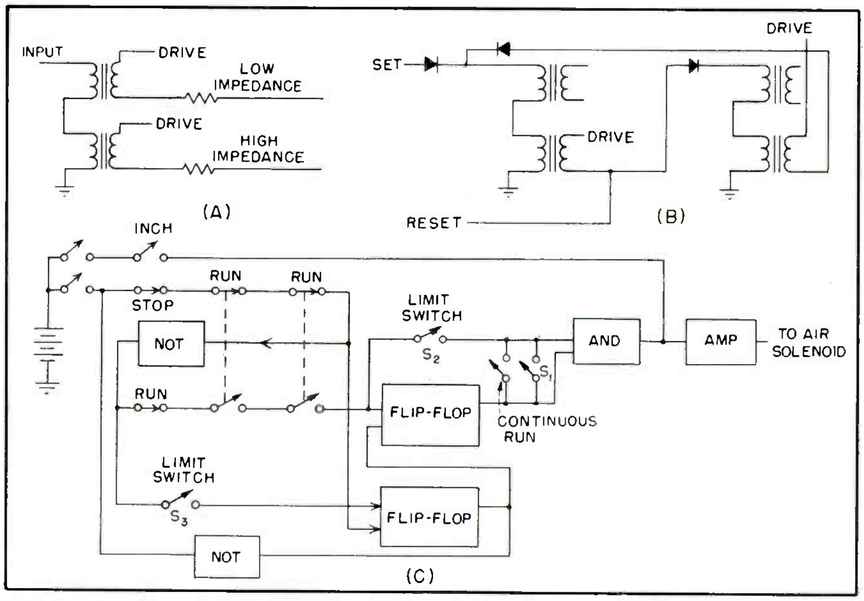


FIG. 10—Decision element (A) provides or, *and;* or *not* circuit. Combined as a (B) a flip-flop is formed. Control (C) was designed by Westinghouse for punch press

Tilting the cutting head of a miller in response to information from a cam is an application using magnetic amplifiers. In this, system designed by Magnetic Amplifiers Inc., the input synchro is positioned by a cam arrangement which sets the prescribed tilt according to the position of the machine table.

A synchro control transformer coupled to the tilt drive senses the degree of tilt and has an output proportional to the difference between the desired angle and the actual angle. A phase-sensitive demodulator produces a d-c output proportional to the a-c error signal from the synchro. The demodulator output is fed to a high gain magnetic amplifier which produces two output signals to the tilt-head hydraulic valve control. The two outputs of the magnetic amplifier are equal with a zero input signal. Input to the magnetic amplifier from the phase-sensitive demodulator unbalances the valve control to change the flow of hydraulic fluid to the tilt-actuating piston.

Broadband Antenna for

SUMMARY —— Unity-gain antenna and balun cover range from 88 to 400 mc without adjustment for frequency. Biconical construction and balun design can be modified to cover any 4.5-to-1 frequency range

MANY UHF AND VHF radio interference and field-intensity meters use a standard resonant dipole antenna as a pickup device. This dipole requires several adjustments for every frequency measured. In addition, a balun shorting stub must also be measured and adjusted to its proper length. These adjustments make radiation measurements over a wide frequency range cumbersome and time-consuming.

A broadband antenna and balun requiring no adjustment over a range from 88 to 400 mc has been developed for use with meters having a 50-ohm coaxial input. The design of the antenna has been calculated in general terms so that antennas may be constructed for any 4.5-to-1 frequency coverage in the uhf and vhf spectrum.

Voltage gain of the broadband antenna should ideally be the same as a resonant dipole to enable direct substitution. The resistance of the antenna should be fairly constant and the reactance comparatively small over the entire frequency range. The orientation of the field intensity patterns should be constant with frequency over the entire range.

The biconical type of antenna was selected after a study of different types of broadband antennas. There are two determining physical parameters for a cone. They are the length L and the flare angle α as illustrated by the longitudinal conical sections in Fig. 1.

A cone with a flare angle of 70 deg will give a voltage gain approximately the same as a resonant dipole antenna over a wider frequency range than any other flare angle.[1] Therefore, the flare angle of the cone was fixed at 70 deg.

Maximum length of the cone was determined by the breakup of the horizontal field-intensity pattern when the length of the cone is greater than $\frac{3}{4}$ wavelength. As cone length is increased the side lobes become larger until at $\frac{3}{4}$ wavelength they are only slightly less than the main lobe. This fixes maximum cone length at $\frac{3}{4}$ wavelength.

Minimum length of the cone was determined by the sharp decrease in resistance and increase in reactance when the cone is small compared to the wavelength. Figure 2 is derived from experimental data[1] and shows variation of resistance and reactance as length of cone varies with respect to wavelength.

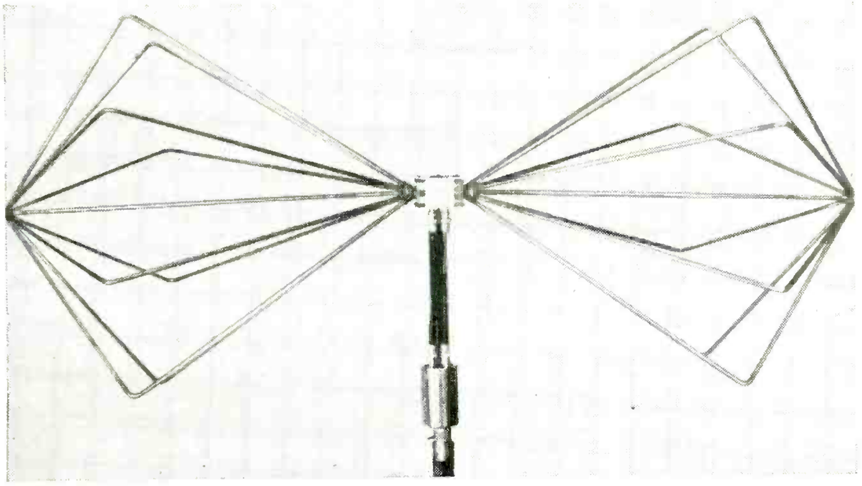
Impedance Matching

A large change in resistance or reactance with frequency makes impedance matching of the antenna difficult. For this reason the minimum length of the cone was fixed at $\frac{1}{6}$ wavelength. Ratio of minimum to maximum length is 4.5-to-1, which is the maximum frequency range. Within these limits the resistance varies from 80 to 180 ohms. Reactance over most of this frequency range is relatively small.

This physical size of the cone may be reduced somewhat by closing the end. Figure 1 shows a comparison of open-ended and closed-end cones of the same flare angle, α, and the same electrical length, L.

Solid cones at vhf are generally impractical because of their size. Since solid antenna forms may be simulated by rods or wires that closely follow the shape of the form this type of construction was used.[2]

Each cone is attached to a small copper stud mounted in the junc-



Biconical antenna design provides unity gain over a 4.5-to-1 frequency range. Closed-end construction gives same electrical length as a flare but is sturdier and more compact

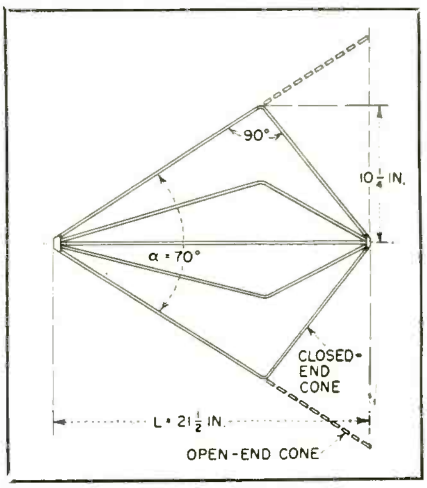


FIG. 1—Dimensions of single cone for unity gain antenna.

Field-Intensity Meters

By EDWARD N. SINGER and HERSCHEL R. CALER

Radio Propagation and Standards Section
U. S. Naval Material Laboratory
New York Naval Shipyard
Brooklyn, N. Y.

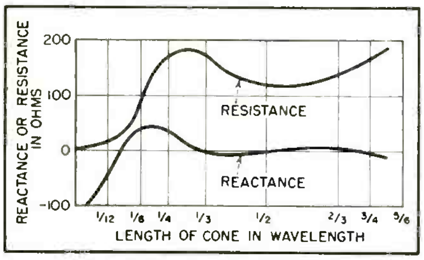


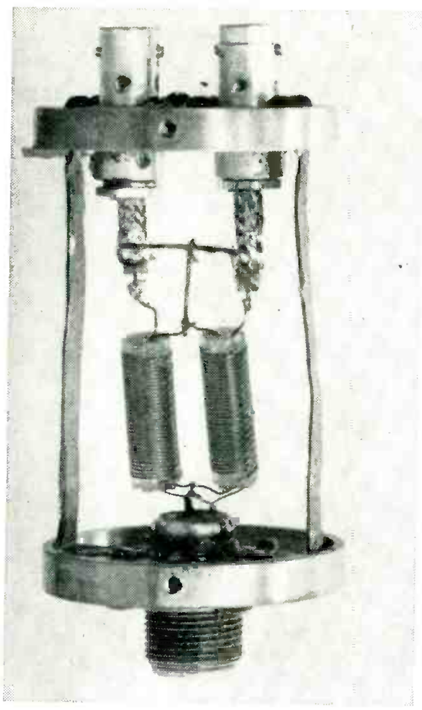
FIG. 2—Antenna resistance and reactance as a function of wavelength

tion box. This stud adds ¾ inch to the length of each cone bringing the total length to 22¼ inches which is approximately ⅙ wavelength at the lowest frequency, 88 mc.

Balun Design

Figure 2 shows that the antenna resistance varies from approximately 80 to 180 ohms for the design chosen.

The balun is a modified version of the elevator type.[3] It matches a 50-ohm coaxial impedance to a 200-ohm shielded balanced output over a 4.5-to-1 frequency range. Figure 3A shows a simplified form of this balun.



Internal construction of broadband balun with bifilar coils at center

Two 100-ohm transmission lines are connected at the lower end in parallel to form a 50-ohm coaxial connection and are connected at the upper end in series to make a balanced 200-ohm output. The two 100-ohm coaxial lines form a shielded output.

It is necessary in the elevator type of balun to have the two-wire transmission lines bifilar wound in the form of coils. The number of turns used should make each two-wire transmission line approximately a quarter-wavelength long at the lowest frequency used. The exact number of turns may be determined empirically.

Seventeen and a half bifilar turns were used on each form. The ridges of the scalloped coil form act as dielectric spacers.

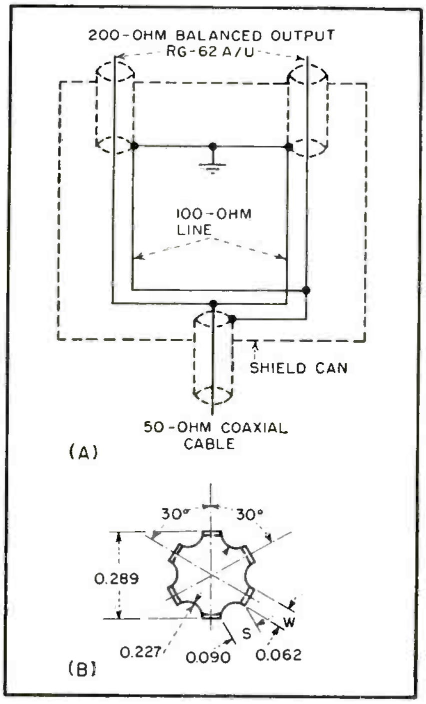


FIG. 3—Circuit of balun (A) and cross-section of balun coil form (B)

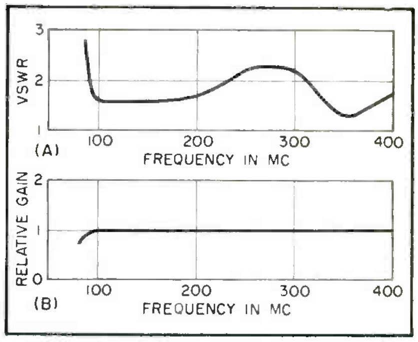


FIG. 4—Plot of vswr (A) and relative gain (B) for biconical antena and balun assembly

The impedance of a two-wire transmission line wound on a scalloped form is

$$Z = \left(120 \cosh^{-1} \frac{D}{d}\right) \Bigg/ \left[1 + \left(\frac{E-1}{S}\right) W\right]^{1/2}$$

where D is distance between centers of wire, d is diameter of wire, E is dielectric constant of spacer, W is thickness of spacer and S is distance between spacers.

A value of 25 mils was chosen for D as a convenient practical value. For the desired impedance of 100 ohms and with the parameters of the coil form in Fig. 3B the value of d was calculated to be 14 mils. This corresponds to No. 27 wire, B & S gage.

The vswr of the antenna-balun with a 50-ohm cable was measured by a slotted line from 88 to 400 mc. The results are as shown in Fig. 4A. Highest vswr measured 2.8 at 88 megacycles. The lowest vswr measured was 1.28. The relative voltage gain of the biconical antenna is shown in Fig. 4B.

The authors thank George C. Neuschaefer and Robert Fairweather for their helpful suggestions and encouragement.

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Character Recognition

SUMMARY —— Photoelectric scanner analyzes printed numerals and provides electrical output usable in computers and other business machines. Reader recognizes 400 characters per second. Operation is independent of type style or size of number above minimum width

Numerals printed by character reader

By M. H. GLAUBERMAN

Senior Engineer
Laboratory for Electronics, Inc.
Boston, Massachusetts

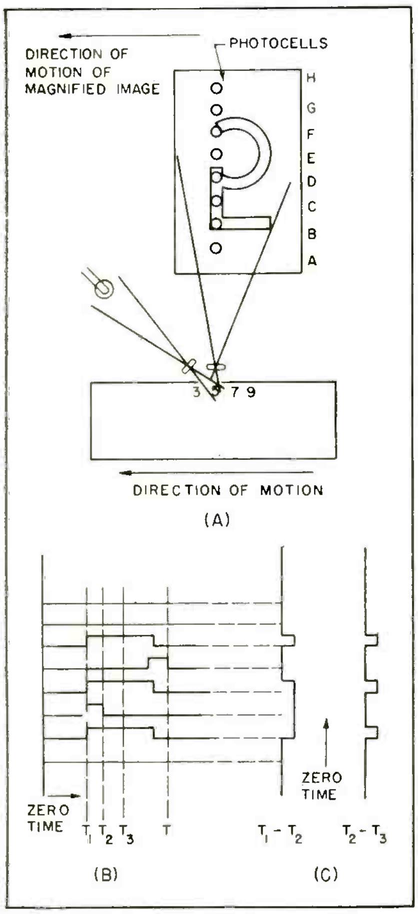

FIG. 1—Optical system of photoelectric scanner

THIS READER recognizes Arabic numerals as printed matter passes through it.

Paper is not restricted as to color, thickness, opacity, roughness or quality. Ink need have no special qualities. The depth of the impression on the paper is of no significance, and at no time does the reader come into contact with the paper.

The character reader cannot read all type styles, but is not dependent on any one style. Minimum type width is approximately $\frac{5}{64}$ in. for the widest digit. There is no restriction on maximum type width. The reader is not dependent on the height of the type providing the size is not larger than the aperture of the reading station. A common type height is about $\frac{1}{8}$ inch. Most print imperfections will not impair recognition.

With checks moving into the reader at 16 per second, it recognizes 400 characters per second. The reader is able to read 1,600 characters per second, however, and could be made to operate at twice this speed.

The reader is designed to operate serially and sorts by successive passes.

Photoelectric Scanner

The scanner consists of a column of photocells whose outputs are modulated by the black portions of characters. The photocells are sequentially gated into a common buffer. Figure 1A shows how a magnified image of a number is projected on the photocells. Figure 2 shows the scanner circuits.

Figure 1B shows the photocell outputs. The effect of sequentially gating the outputs into a common buffer is shown in Fig. 1C.

Table I—Pulse-Code Combination

Total Pulses Per Scan	Long-Black Pulses Per Scan	Coded Combination
1	0	10
1	1	11
2	0	20
2	1	21 } 21′
2	2	22
3	0	30 } 30′
3	1	31

Note that the first digit of the coded combination represents the total number of black pulses per scan and the second digit represents the number of long black pulses per scan

for Business Machines

There are photocells above and below those required to cover the number to accommodate changes in the vertical registry. See Fig. 3. Each photocell is an input to a gate whose other input is connected to a tap of a multiple-tapped delay line. The outputs of the gates are combined in the common buffer *B*.

Each photocell is individually connected to network *B* by sending a pulse down the multiple-tapped delay line. A pulse sent down the delay line corresponds to a scan. No attempt is made to synchronize the start of a scan with the entry of a character under the column of photocells.

The uncertainty of the start of the scan with respect to the edge of the character to be scanned is called horizontal registry. The character reader overcomes this registry problem by utilizing the first scan not to recognize the character but to tell the recognition circuit to look for recognition on the second scan.

Pulse Generator

The waveforms at the output of combining network *B* appear as in Fig. 1C. The total pulse generator produces one pulse for each black region of the number and serves as a noise filter in that an input pulse must exceed a certain width for an output pulse to be generated.

The long-black pulse generator (see Fig. 4) is also a pulse-width detector. In this case a pulse must exceed a predetermined length for a long-black pulse to be generated. For example, a pulse must equal or exceed the length shown in Fig. 1C.

The output of the total pulse generator and of the long-black pulse generator, along with the system trigger, are next sent to the encoder unit. Three pulses, each appearing once during every scan period, are derived from the tapped delay line and also sent to the encoder. These pulses, in the order of their time sequence, are the comparison pulse, the read-out pulse and the reset pulse.

Six instructions constitute the program of the character reader.

(1) Count the total number of black pulses per scan.

(2) Count the number of long-black pulses per scan.

(3) Combine the results into discrete combinations as shown in Table I.

(4) If adjacent scans are not identical, put the most recent scan into shift-register storage and shift the register.

(5) If adjacent scans are identical, put nothing into storage and do not shift the register.

(6) When there is no character under the reading station, advance the register but put nothing into storage.

A block diagram of the encoding unit shown in Fig. 5. The system trigger P_{st} operates an electronic switch which routes the total pulses P_t alternately into total-pulse counter *A* and total pulse counter *B* through gates G_a. The electronic switch also routes the long-black pulses P_{lb} into long-black counter *A* and long-black counter *B*, alternately, through gates G_b.

Scan Comparison

Alternately switching input information P_t and P_{lb} into pairs of

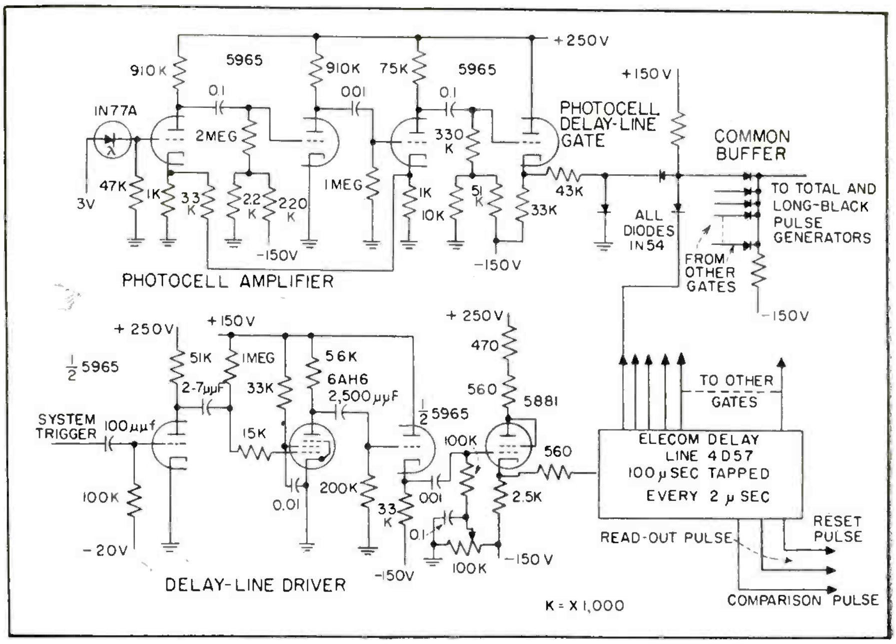

FIG. 2—Input section showing photodiode and delay line

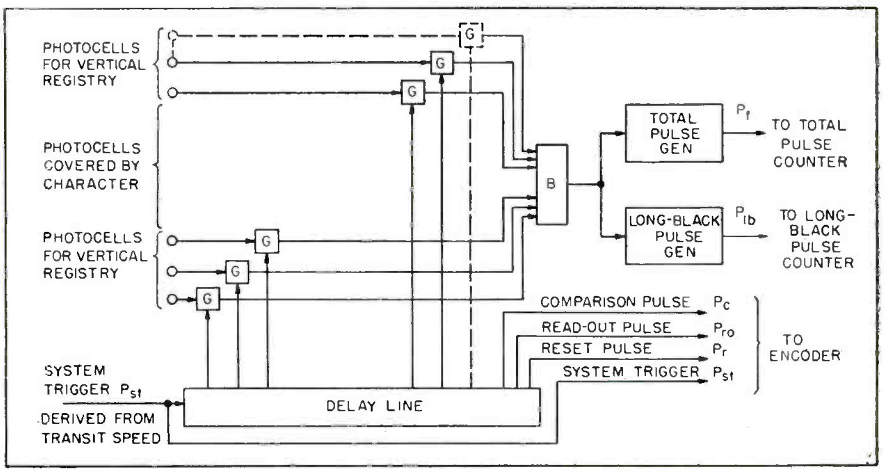

FIG. 3—Scanning station of character reader

Table II—Shift Register Storage (Numeral Three)

1 Scan	2 Total	3 Long	4 Code	5 Identity	6 Read-in	7 Shift	8 Interrogate	9 1st read-in in core row	10 2nd read-in in core row	11 3rd read-in in core row	12 4th read-in in core row
1	1	0	10	no	yes	yes	no	1	—	—	—
2	2	0	20	no	yes	yes	no	2	1	—	—
3	2	0	20	yes	no	no	no	2	1	—	—
4	2	0	20	yes	no	no	no	2	1	—	—
5	2	0	20	yes	no	no	no	2	1	—	—
6	3	0	30[1]	no	yes	yes	no	3	2	1	—
7	3	0	30[1]	yes	no	no	no	3	2	1	—
8	1	1	11	no	yes	yes	no	4	3	2	1
9	0	0	—	no	—	yes	no	5	4	3	2
10	0	0	—	no	—	yes	—	6	5	4	3
11	0	0	—	no	—	yes	next shift pulse	7	6	5	4
12	0	0	—	no	—	yes	yes	x	7	6	5

identical counters provides for comparing adjacent scans for identity. The counters hold the input information until they are reset by reset pulse P_r, which is electronically switched through gates G_c once each scan alternately to reset both B counters and both A counters.

The comparison is accomplished in gates G_d once each scan after the counters have received their input information and at a time determined by the comparison pulse P_c. One of the six comparison gates will respond only when the input data P_t and P_{lb} have remained constant from one scan to the next.

Scan-to-scan identity in the long-black counter allows the comparison pulse to appear at the output of buffer B_{dl}. Scan-to-scan identity in the total-pulse counter allows the comparison pulse to appear in the output of buffer stage B_{dt}. A pulse appears at the output of both of the buffer stages only when scan-to-scan identity is indicated by both the total-pulse and the long-black counters. This is the necessary condition to pass the signal through gate G_6 to the identity-gate generator.

After the A and B counters have been compared for identity they are read out by read-out pulse P_{ro}. If there has been no identity the read-out pulse appears at the output of gate G_h. The electronic switch then allows the read-out pulse to appear alternately at the input of the G_g gates. It enables the outputs of either the A or the B counters to appear at the outputs of the appropriate G_f gates.

The B_j buffers then show the accumulated count per scan independently of whether the counts appear in the A counters or the B counters. The first scan of the character is detected in buffer B_k and used to generate an inhibiting signal whose duration is 1½ scan periods. This inhibiting signal, applied to gate G_e prevents the recognition of an identity on the first two scans of the character. Subsequent scans of the character are prevented from generating additional inhibiting gates by the 1½-character-period gate generator applied to gate G_i to disable it for the duration of the number.

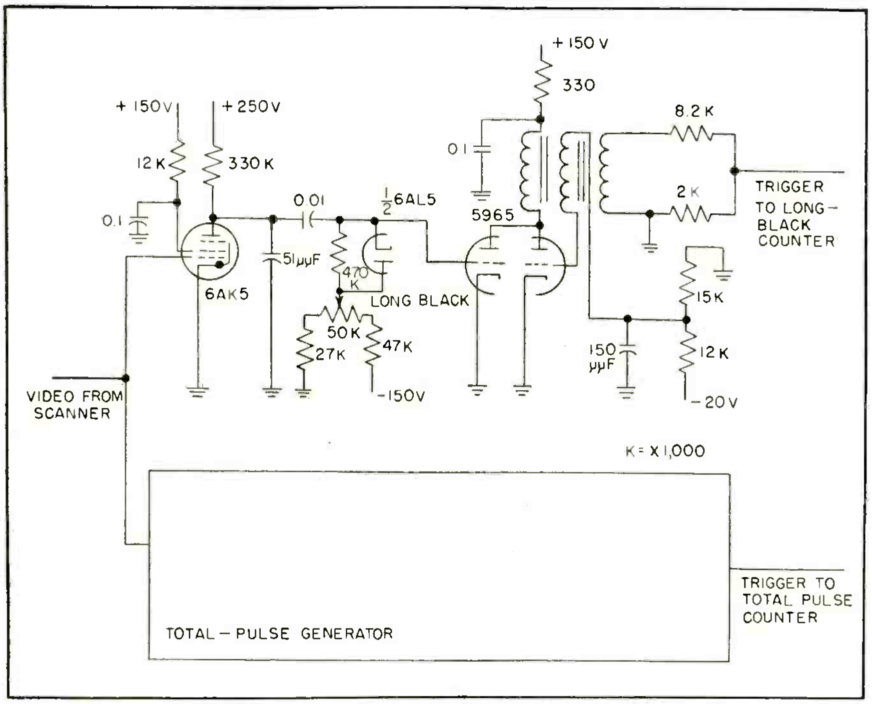

FIG. 4—Long-black pulse generator is pulse-width detector

Coding

The coded combination (Table I) of total-pulse and long-black counters is formed by the G_m gates. Only one or none of these five combinations can appear during one scan. The prime combinations are obtained in the B_m buffers.

The instruction to put into storage is accomplished implicitly whenever a signal appears on one of the five code-combination lines. The storage register is shifted or advanced by the system trigger P_{st} when the trigger is enabled to appear at the output of gate G_n. System trigger P_{st} appears and the register is enabled to advance when a permissive signal appears on either one of the two inputs to the B_n buffer. One input is connected to the identity-gate generator and allows the register to shift unless there is an identity.

Between characters, the outputs of both the total-pulse counter and the long-black counter are zero. This combination of 00 is not sensed for identity in the G_d gates; therefore no identity signal can be generated. Also, since the code combination 00 has not been explicity formed in the G_m gates, there is nothing to put into storage.

Readiness for interrogation is detected in buffer B_o which is connected to the seventh and last stage of storage. The first signal at the output of B_o passes through gate G_o and generates a gate whose duration is $1\frac{1}{2}$ scan periods. This gate connected to B_n enables the register to advance on the next system trigger.

Subsequent signals at the output of B_o during the character storage time are prevented from passing through gate G_o by the $1\frac{1}{2}$-character-period gate generator, the latter being energized by the system trigger that occurs after the first output signal at B_o. This particular system trigger is broadened in the matrix interrogation-pulse generator and is then used in the diode matrix.

Shift Register Storage

Each block in Fig. 6A represents one magnetic core. There are thirty-five cores arranged in five columns of seven each. Each of the five columns is used to store one of the five discrete code combinations.

Information is always read into row 1 and remains in row 1 until a shift signal is applied whereupon the content of row 1 is advanced to row 2.

Access to the information in the cores is available only during the shift-pulse time. As indicated in Fig. 6A, a single shift signal suffices to advance all thirty-five cores.

Figure 6B shows the scanned character THREE. The total number of pulses T in scan one is one. There are no long pulses L (code 10). For scan two: $T = 2, L = 0$ for code 20. Scans three, four and five also yield code 20. In scans six and seven, $T = 3$, $L = 0$ for code 30. Scan eight contains only one long pulse

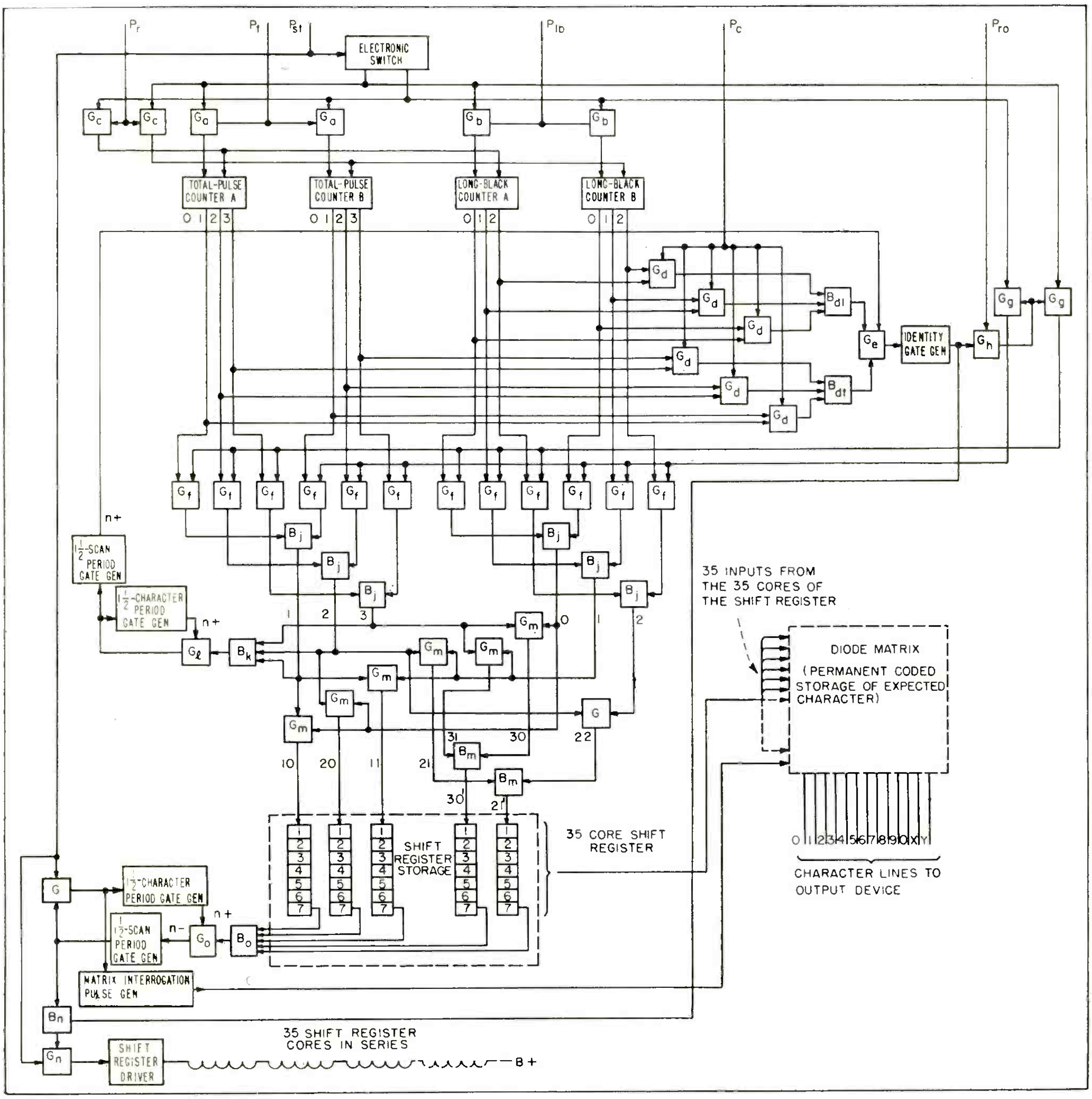

FIG. 5—Encoding unit which carries out the instructions comprising the program of the character reader

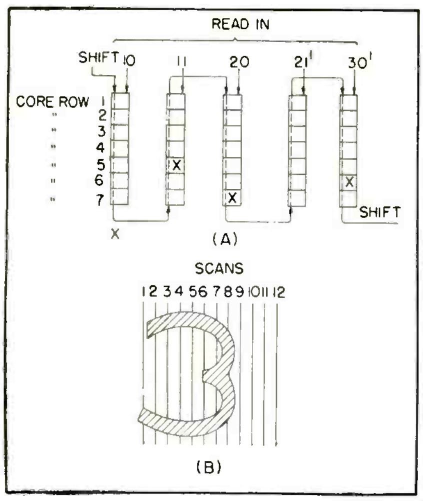

FIG. 6—Shift register storage with blocks representing magnetic cores (A) and the character THREE to be scanned (B)

which is indicated by code 11.

During scans nine through twelve there is nothing under the reading station; $T = 0$, $L = 0$ and no code exists for this combination. The contents of this paragraph are tabulated in columns 1 through 4 of the chart in Table II. The remainder of the columns show how the coded data gets into storage and is advanced to a known position.

Column 5 shows whether or not the code combinations of adjacent scans are identical. Although scans 9 through 12 are similar to the naked eye, the encoder does not indicate identity because it does not explicitly sense for the 00 combination. This is the significance of the 4 dash marks at the bottom of column 4.

Column 6 indicates that information is read into the shift register only on scans 1, 2, 6 and 8. Referring to column 4, information is read into the core columns that store 10, 20, 30′ and 11 in that time sequence. Column 7 shows that the register is advanced whenever there is no scan-to-scan identity (column 5).

Column 9 shows how the first bit of information (code 10) read into the register progresses from the first to the seventh row of cores and then out of the cores. Columns 10, 11 and 12 show that the subsequent read-ins (codes 20, 30 and 11) will occupy core rows 6, 5 and 4 respectively at the time the first read-in is at core-row 7.

When the first read-in has been shifted out of the cores, codes 20, 30 and 11 occupy rows 7, 6 and 5. The blocks in Fig. 6A indicate the positions in storage of the four code combinations that result from scanning the figure THREE. This is in accordance with the basic instructions built into the character reader at the time the interrogation pulse appears to check which character has passed under the reading station. The signal derived from the first scan shifting out of the register signifies to the reader that the scanned character has now been read into a known position in storage. The register must be interrogated for recognition on the next system trigger.

Diode Matrix

The diode matrix indicated on the encoder block diagram of Fig. 5 is shown in detail in Fig. 7. It consists of five groups of vertical lines, seven lines per group, which can be interlaced as many times as there are characters to be recognized. Each of the seven vertical lines per group is connected to one horizontal row of the shift-register cores.

The expected character configuration in a known position in the register is stored by connecting horizontal and vertical lines through gates and buffers. Take, for example, the number THREE whose code is 10, 20, 30, 11. When the 10 is shifted out of the seventh row of cores the machine is instructed to interrogate the matrix at the time the next shift pulse occurs.

At this new time the 20 will be in core-row 7, the 30 in row 6 and the 11 in row 5. Referring to horizontal line A in Fig. 7, gate G_a is formed from the first wire of the 20 register, the second wire of the 30 register and the third wire of the 11 register. The references to wires are respectively synonymous to first, second and third coded scans. The final connection to gate G_a is the interrogation pulse.

The output of gate G_a is called the THREE wire and its significance is that whenever the reader recognizes the number THREE a pulse appears on this and only this line. The pulse then operates terminal equipment such as a sorter, printer or accumulator.

Horizontal group B represents a more general case where a number can be represented by two sequences of coded scans. Recognition of the character yields a pulse at the output of either one of the two gates and the buffer combines the two possible output lines to a single line.

The remaining horizontal wires are shown to indicate that the reader will recognize the remaining nine decimal digits.

The author thanks M. Hale, S. Butcher, R. Preece and other members of the Laboratory for Electronics for their contributions to this work. This development was sponsored by the Chase Manhattan Bank.

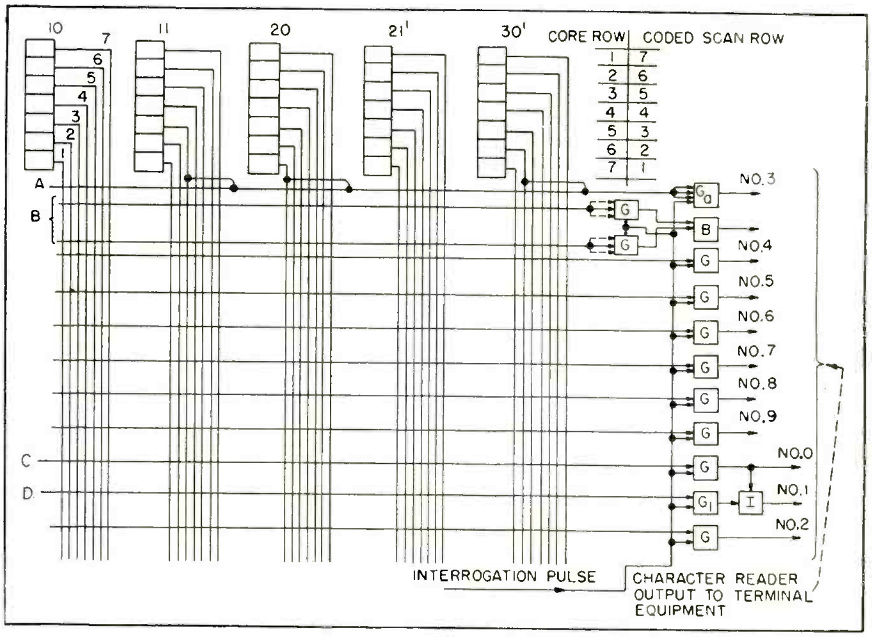

FIG. 7—Diode matrix gives permanent coded storage of expected character

Fabricating diffusion transistors: left, adjusting temperature of vacuum oven in which solid-state diffusion occurs; center, evaporating metal contacts to transistor prior to attaching wire leads. Silicon double-diffusion transistor is shown at right

Diffusion Transistors Raise Frequency Limits

By JOHN M. CARROLL

Associate Editor, ELECTRONICS

SUMMARY — Extremely thin base regions produced by solid-state diffusion of impurities provide high-frequency operation without sacrificing power-handling ability. Silicon operates up to 120 mc with 500-mw collector dissipation. Germanium works up to 600 mc and dissipates 150 mw

THICKNESS of the base region may seriously restrict a transistor's upper frequency limit. High-frequency operation can be obtained in a grown-junction tetrode, but at the expense of power-handling capability. Transistors made by a diffusion technique can achieve both high-frequency operation and power-handling ability.

In the solid-state diffusion process, impurity atoms in the vapor phase diffuse into the body of a solid semiconductor crystal. This takes place in a controlled atmosphere at about 750 C for germanium and a higher temperature (about 1,100 C) for silicon.

Two processes for making transistors by diffusion are currently used. In the diffused-base method, the mother crystal forms the collector layer onto which the base layer is diffused. The emitter is alloyed to the base layer. Base diffusion is used to make germanium units.

In the double-diffusion process, both base and emitter layers are diffused onto the mother crystal. This process has manufacturing advantages for making silicon units. However, silicon transistors are also made by base diffusion.

Bell Telephone Laboratories is in pilot-plant production of germanium units at Murray Hill, New Jersey. Silicon units are approaching this stage. Quantity production of both types for government applications is planned for this year at the Western Electric plant in Laureldale, Pa.

Frequency and Power

Diffusion transitors with base regions 0.04 mil thick have been made by Bell from germanium. Germanium transistors have alpha-cutoff frequencies from 400 to 600 mc with permissible collector power

Table I—Bell Labs Comparison of Diffusion Transistors and Other High-Frequency Germanium Transistors

Transistor Type	Alpha-Cutoff Frequency in mc	Max Collector Dissipation in mw
Grown junction triode	60	10–50
Alloy junction triode	10	50
Point contact	50	50–150
Grown junction tetrode	50–200	50
Surface barrier	70–100	5–10
Diffused silicon	100–120	100–500
Diffused germanium	400–600	150

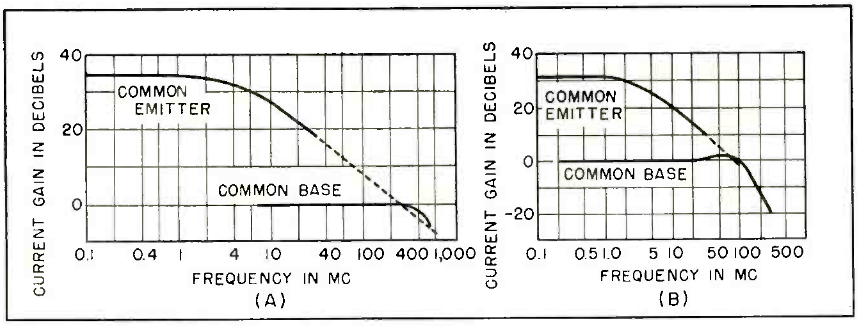

FIG. 1—Common-emitter and common-base current gain as a function of frequency for germanium (A) and silicon (B) diffused junction transistors

dissipations of 150 milliwatts. Silicon units have been made with base layers 0.15 mil thick. They have alpha-cutoff frequencies from 100 to 120 mc. Since silicon transistors can withstand higher junction temperatures, they have permissable collector dissipations up to 500 mw.

The thicknesses achieved by diffusion contrast with the 0.3-mil base region of better grown or fused-junction transistors manufactured to date.

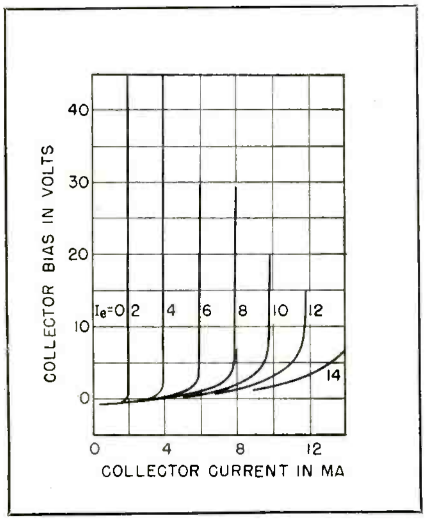

FIG. 2—Static collector characteristics for a double-diffused silicon transistor; collector cutoff current is extremely small

A 200-mc experimental oscillator using a diffused-base germanium transistor delivered 69 mw with an efficiency of 36 percent. A two-stage video amplifier gave a 40-db current gain to flat ±0.5-db from audio +0 20 mc.

Diffusion transistors of the *pnip* and *npin* types may further extend frequency and power-handling ability. In these structures a layer of intrinsic germanium or silicon is interposed between base and collector regions. It permits high-frequency operation by reducing collector junction capacitance, without limiting power-handling ability.

Electrical Characteristics

Table I contrasts alpha-cutoff frequencies and collector dissipations for diffused silicon and germanium transistors with other transistor structures. Table II lists operating characteristics of diffused silicon and germanium units. Note low values of collector capacitance, high values of short-circuit common-base current gain (alpha) and low collector-cutoff currents. High-speed switching characteristics are extremely good, especially for germanium units.

Figure 1A shows alpha and the short-circuit common-emitter current gain (beta) in decibels plotted against frequency for a typical diffused-base germanium unit. Figure 1B shows the same characteristics plotted for a double-diffused silicon unit. The increase in alpha above unity at 50 mc is caused by reactance gain error in the common-base measurement.

Static collector characteristics for a double-diffused silicon transistor are shown in Fig. 2. At zero emitter current, collector current is too small to be shown. Although collector current does not truly saturate, collector junction resistance is high. Resistances of several hundred megohms at a reverse bias of 10 v are common.

In the lumped-constant high-frequency equivalent circuit of the diffused transistors two additional series resistances need be considered. Resistance r_e' in the emitter circuit represents resistance of the emitter point contact. Resistance r_c' is the ohmic resistance between collector terminal and effective collector junction. These resistances exist in all grown-junction transistors but become significant only at high frequencies.

Diffused-Base Transistor

Description of the fabrication of a diffused-base *pnp* germanium transistor illustrates manufacturing techniques. Bars were cut from monocrystalline *p*-type germanium of about 0.8 ohm-cm resistivity, then lapped and polished. After a slight etch, the bars were washed with deionized water and placed in the diffusion oven. Arsenic-doped germanium was used as the source of *n*-type impurity.

After diffusion, which creates the *n*-type base region, the bar was masked and a film of aluminum 1,000 A thick and 1-by-2 mils in area was evaporated onto it. The bar was heated to alloy the aluminum, thus forming the emitter region.

The bar was again masked and a film of gold-antimony 3,000-4,000 A thick and 1-by-2 mils in area evaporated onto the base region. The bar was heated to the gold-germanium eutectic temperature to form an ohmic base contact. The base contact was parallel to the emitter and 0.5 to 1 mil away from it.

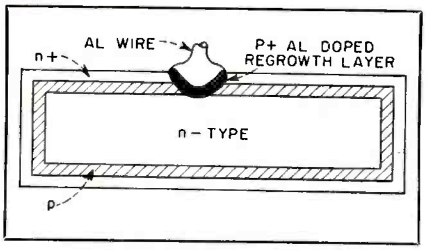

FIG. 3—How base connection is made to double-diffused silicon unit by alloying through emitter region

Strip-type emitter and base contacts are especially useful in high-frequency transistors. For other units, the emitter may take the form of a dot of aluminum centered in a ring of evaporated and alloyed gold-antimony which makes ohmic contact to the base region.

A platinum tab with indium was then soldered to the back of the unit. Enough indium was used to alloy through the surface *n*-region. The emitter and base regions were both masked with a 6 to 8-mil diameter dot of wax and a collector area formed by etching. The unit was washed in solvent to remove the wax and mounted in a header. Contact to the emitter and base regions was made by an electrolytically pointed 1-mil phosphor-bronze wire.

Double-Diffusion

The diffusion coefficient of a Group III acceptor such as aluminum is 10 to 100 times that of a Group V donor such as antimony. Thus by simultaneous diffusion of selected donor and acceptor impurities into *n*-type silicon, an *npn* structure will result. The first *n*-layer forms because the surface concentration of the donor is greater than that of the acceptor. The *p*-region forms because the donor diffuses faster than the acceptor and gets ahead of it. The final *n*-region is the background doping of the *n*-type silicon bar. However, in some cases one of the impurities must be started ahead of the other in a prior diffusion.

After diffusion, the silicon bar is completely covered with diffused *n* and *p*-layers. Base contact is made by alloying directly through the *n*-type emitter region.

If the surface concentration of the donor diffusant is not too great, it is possible to alloy an aluminum wire directly through the outer *n*-region. The contact to the aluminum is rectifying in the emitter region and ohmic in the base region. The *n*-layers produced by diffusing elemental antimony are below critical concentration and here direct aluminum alloying is feasible. This technique is illustrated in Fig. 3.

Experimental double-diffused silicon transistors were prepared from 3 ohm-cm silicon using antimony and aluminum as diffusants. The base contact was produced by masking the bar and evaporating a line of aluminum 100,000 A thick and 2 by 6 mils in area onto the surface. The line was then alloyed through the emitter region.

Contact to the emitter is achieved by alloying a gold-antimony film to the outer surface of the bar. Since this alloy will produce an *n*-type regrowth later, it is necessary only to be sure that the film does not alloy through the base region and short the emitter to the collector. This may be achieved by evaporating the film on. However, in the unit described, a gold-antimony plated tungsten point was brought into pressure contact with the emitter layer and alloyed to it by passing a controlled electrical pulse from emitter to collector.

Ohmic contact to the collector is achieved by alloying the silicon bar to a Kovar tab plated with gold-antimony. An area 6 mils in diameter was masked about the base region and the bar etched to remove unwanted layers. The unit was mounted in a header. Collector contact was made by soldering to the tab. A tungsten-point pressure contact was made to the aluminum of the base region.

Silicon Diodes

Diffusion has also been used in making diodes. Diffused silicon junction diodes have maximum current densities up to 2,000 amperes per sq cm. This makes the diffusion process ideal for making power rectifiers. The diffusion process was first used in this connection.

The units are expected to have an almost unlimited life span and will be capable of operating continuously at temperatures up to 400 F. Their efficiency is more than 98 percent of the theoretical limit.

Two of the new rectifiers, which are about the size of peas, linked together and mounted on a cooling fin, will furnish more than 20 amperes d-c at 100 v with 20 w lost as heat. They provide 5,000 times more current than conventional rectifiers of the same size.

The author is indebted to many members of the technical staff of Bell Telephone Laboratories who have made information available to him.

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Table II—Diffused Junction Transistor Typical Operating Parameters

Parameter	Double-Diffused Silicon	Diffused-Base Germanium
Alpha-cutoff frequency (f_{aco})	100–120	400–600 mc
Collector capacitance (C_c)	0.5 $\mu\mu$f	0.5 $\mu\mu$f
Max collector dissipation	500 mw	150 mw
Max ambient temperature	150 C	75 C
Collector voltage (V_c)	10–30 v	10 v
Emitter current (I_e)	1–15 ma	10 ma
Collector cutoff current (I_{co})	0.005 μa	1–2 μa
Alpha	0.95–0.98	0.95–0.98
Equivalent-circuit collector resistance (r_c)	>100 meg	2 meg
Equivalent-circuit collector series resistance (r_c')	~150 ohms	~80 ohms
Equivalent-circuit base resistance (r_b)	15–100 ohms	15–100 ohms
Equivalent-circuit emitter resistance (r_e)	15 ohms at 3 ma	3 ohms at 10 ma
Common-emitter current gain in decibels at 50 mc	7 db	16–20 db

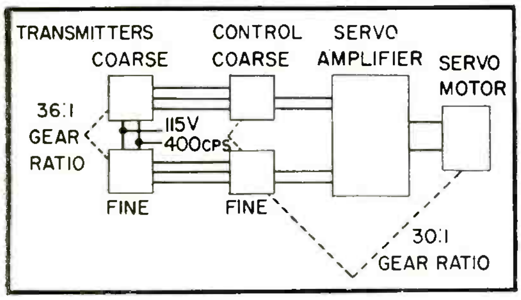
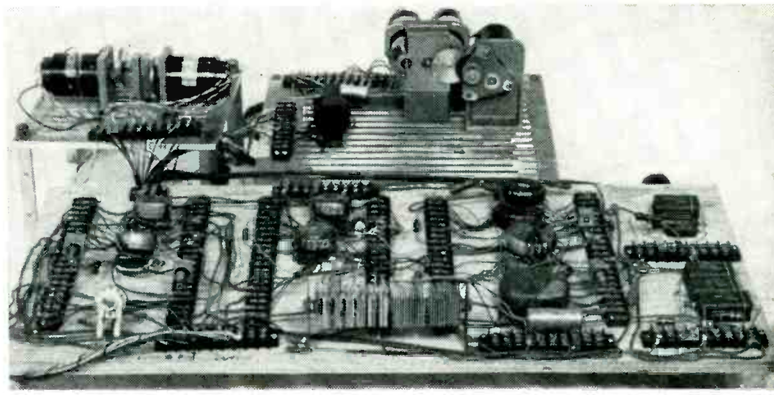


FIG. 1—Functional block diagram of servo system. Fine and coarse control transformers are of the 1-volt/degree type with 36-to-1 gear ratio. The two-phase servomotor rotates at 7,200 rpm. Gear ratio to fine control transformer is 30 to 1



Breadboard model of the magnetic-amplifier servo system to be described

Magnetic-Amplifier

FREQUENTLY, in a servo system, the same requirements which can be met by an electron-tube amplifier with high input impedance and high voltage gain can also be met by a magnetic amplifier with lower input impedance and lower voltage gain. A standard electron-tube amplifier driving a high-impedance two-phase a-c servo motor in a two-speed servo system was therefore replaced by a three-stage half-wave magnetic amplifier using a full-wave slave output stage and proper synchronizing networks.

The present system consists of a fine and coarse control transformer of the 1-volt/degree type, with a gear ratio of 36-to-1 between coarse and fine shafts. The two-phase a-c servo motor is a Transicoil high-impedance 7,200 rpm motor. The gear ratio between the fine control transformer and motor is approximately 30-to-1.

The servo amplifier consists of three voltage-amplifier stages driving two 6V6's in push-pull capable of supplying 10 watts to the control phase of the motor. A functional block diagram is shown in Fig. 1.

The design of a magnetic amplifier was undertaken with the following requirements set up as a guide: bandwidth—10 to 15 cps, velocity constant — 1,000/second, resonant rise—3 db, and overall accuracy—less than ½ degree.

The magnetic amplifier should be completely replacable with the existing electron-tube amplifier. Thus, the magnetic amplifier had to be designed to drive a high-impedance motor, whereas a low-impedance motor would be more suitable.

Magnetic Amplifier

The magnetic amplifier consists of two conventional half-wave bridge-type stages driving a full-wave slave-type output stage. A schematic of the amplifier is shown in Fig. 2. The output of the amplifier is fed into autotransformer T_1 to match the motor impedance. When using a low-impedance motor, the autotransformer may be eliminated.

The first stage consists of two Orthonol cores with appropriate power windings N_1, N_2, N_3, N_4 and selenium rectifiers D_3 and D_4 doubler connected. Three control windings, N_5, N_7, N_9 and N_6, N_8, N_{10} are placed on each core, one for signal input and one each for lead-and-lag compensation. The output is fed directly into the control windings of the second stage which is approximately the same type stage as the first minus the extra control windings.

Resistors R_{13}, R_{14}, R_{15} and R_{16} are all used to set the quiescent firing

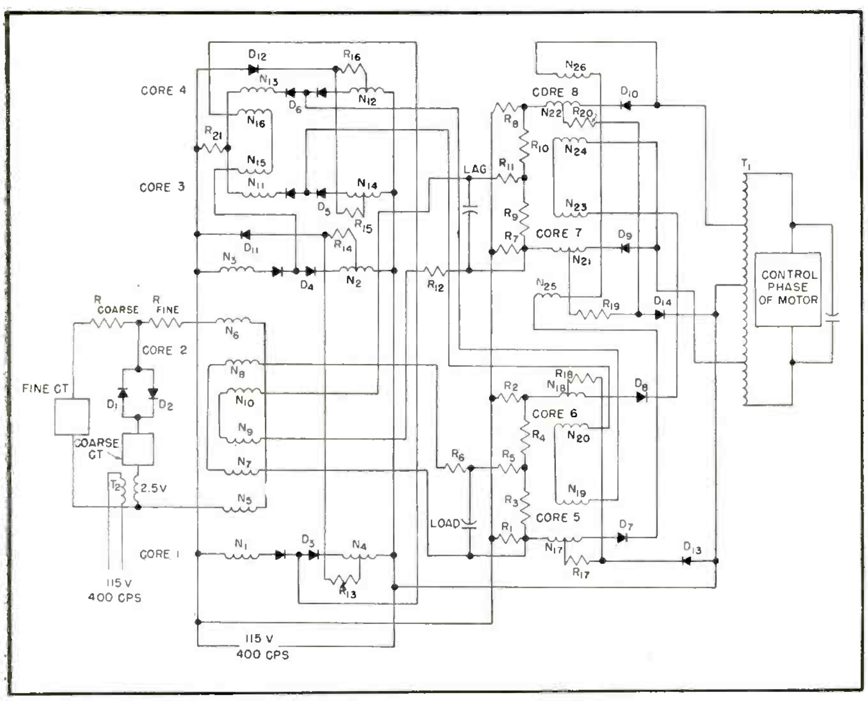


FIG. 2—In-phase control of the fine and coarse control transformer voltages of this magnetic amplifier is achieved by mechanical rotation of the outside frames

SUMMARY —— Half-wave magnetic amplifier with full-wave slave output replaces electron-tube amplifier in two-speed servo system. Design data on the amplifier and compensating networks are given as well as tabular design information on a number of systems

By JOSEPH JOHN SUOZZI
U. S. Naval Ordnance Laboratory
White Oak, Silver Spring, Maryland

Two-Speed Servo System

angles of the cores in the two stages. The output of the second stage is fed into a set of control windings on the main cores of the output stage. The output stage consists of four cores connected as shown in the schematic. When cores 5 and 6 are supplying output, they reset cores 7 and 8 by windings N_{23}, N_{24}, N_{25} and N_{26}. Hence, when cores 5 and 6 are resetting, cores 7 and 8 supply output in the opposite direction.

Proper choice of windings N_{23}, N_{24}, N_{25} and N_{26} will give symmetrical output across the transformer. Full-wave output can then be realized across the load while maintaining the simplicity of half-wave circuitry. The power output into the motor was greater than 10 watts. The gain of the amplifier is shown in Fig. 3.

Crossover Network

A two-speed synchro increases the static accuracy of a synchro system. The voltages from the coarse and fine-control transformers should be in the same phase at low signal levels.

This condition can be attained by mechanically rotating the outside frames of the control transformers. The coarse signal is a measure of the actuating signal for

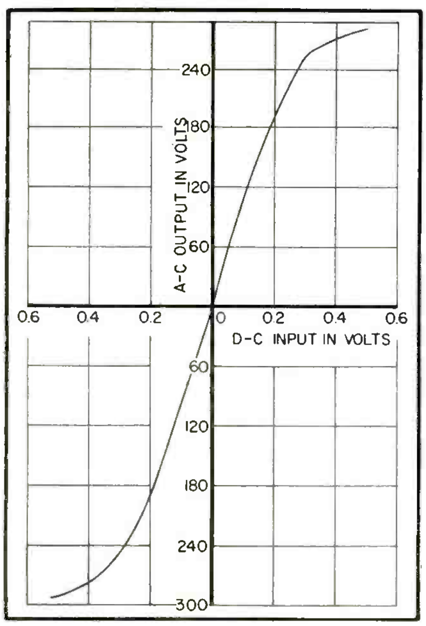


FIG. 3—Gain characteristic of the magnetic amplifier shown in Fig. 2

Table I—Component Values in Magnetic Amplifier Shown in Fig. 2

Core data: first and second stages
Cores 1, 2, 3 and 4 — Orthonol, 0.002-in. tape, 3/4 × 1 × 3/8 in.
Winding data

Core 1	Core 2	Core 3	Core 4	Turns	Wire Size
N_1	N_3	N_{11}	N_{13}	1,250	No. 34
N_2	N_4	N_{12}	N_{14}	1,250 Tapped at 650	No. 34
N_5	N_6			600	No. 37
N_7	N_8			300	No. 37
N_9	N_{10}			1,000	No. 37
		N_{15}	N_{16}	100	No. 34

Output stage
Cores 5, 6, 7 and 8 — Orthonol, 0.002-in. tape, 1 × 1 1/4 × 1/4 in.
Winding data

Core 5	Core 6	Core 7	Core 8	Turns	Wire Size
N_{17}	N_{18}	N_{21}	N_{22}	4,000 Tapped at 500	No. 32
N_{19}	N_{20}	N_{23}	N_{24}	7	No. 32
		N_{26}	N_{25}	7	No. 32

Rectifier data
D_3, D_4, D_5, D_6 — 6 plates, selenium, 1 in. square, doubler-connected
D_7, D_8, D_9, D_{10} — 6 plates, selenium, 1 in. square
D_1, D_2, D_{11}, D_{12}, D_{13}, D_{14} — 6 plates, selenium, 1/2 in. square
Resistor data
R_{13}, R_{14}, R_{17}, R_{18}, R_{19}, R_{20} — 56,000 ohms, 1/2 watt
R_{15}, R_{16} — 100,000 ohms, 1/2 watt
R_{21} — 150 ohms, 5 watt
$\left.\begin{array}{l} R_1 \text{ through } R_{12}, \\ R_{fine} \text{ and } R_{coarse} \end{array}\right\}$ — vary depending on amount of compensation
Capacitor data
C_3 — 0.1 μf, 400 v, paper
C_1 and C_2 — vary depending on amount of compensation
Transformer data
T_1 — Westinghouse, Hypersil cut core, No. 6H
Windings 1,200 turns No. 30 wire
Tap at 400 turns
600 turns
800 turns
T_2 — 115/2.5-v transformer for stickoff voltage

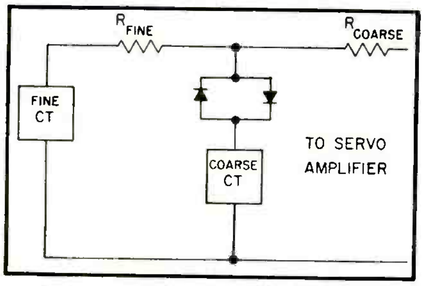


FIG. 4—Limiter-type synchronizing network used to switch in the fine control transformer at low signal levels

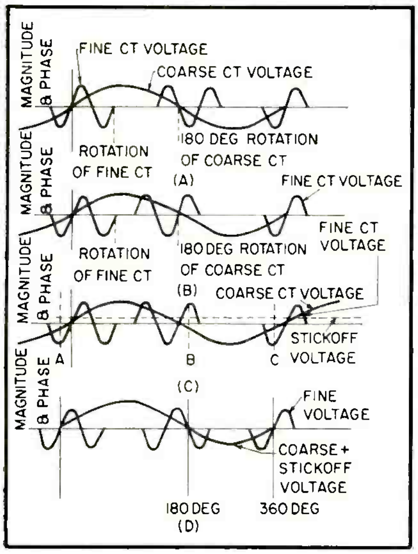


FIG. 5—System voltage versus magnitude and phase when an odd gear ratio is used between the fine and coarse control transformers (A), an even gear ratio (B), even gear ratio after addition of stickoff voltage before rezeroing (C) and after rezeroing (D)

any position of the controlled shaft while the fine signal is a measure only of the actuating signal for one revolution of its shaft. Consequently, a method of switching in the fine control transformer at low signal levels is essential for proper operation of the system.

Since the coarse signal is a true measure of the correct position of the controlled shaft, it should initiate the switching process at the correct time to avoid false nulls. Theoretically, a coarse voltage corresponding to one revolution of the fine control transformer is the greatest voltage at which the switching should occur. For practical reasons, the voltage chosen is usually one which corresponds to ¼ revolution of the fine shaft. In a 36-to-1 system, this voltage is (1) (360)/(36) (4) = 2.5 volts. The synchronizing circuit, Fig. 4, was used in the magnetic amplifier. In this case, both fine and coarse voltages are applied to the amplifier with large actuating signals, while only the fine voltage appears at low signal levels.

When an odd gear ratio is used between fine and coarse control transformers, the system can null at only one position provided the synchronizing network is properly adjusted. Figure 5A shows the conditions which would exist if an odd gear ratio were used between coarse and fine control transformers. At the 180-deg rotation point of the coarse control transformer, the fine control transformer is also at its 180-deg rotation point. Therefore, there can be no false null.

In many applications a 36-to-1 gear ratio is desirable for ease in reading shaft angles on two dials. When this ratio is used, the conditions of Fig. 5B would exist. The servo system can null at the 0-deg and 180-deg rotation point of the coarse control transformer since the fine control is at 0 deg in both cases. To eliminate this false null at 180-deg, a stickoff voltage is added in series with the coarse control transformer.

Figure 5C shows the magnitudes and phases of the voltages from coarse and fine control transformers together with the stickoff voltage which is a constant-amplitude, constant-phase, 400-cycle voltage. Since the stickoff voltage is always of the same phase, it will add to the coarse voltage for ½ revolution and subtract from it for the next ½ revolution. By proper choice of the magnitude of the stickoff voltage, the coarse plus stickoff voltage will have nulls at *A*, *B* and *C* which would correspond to ¼-revolution points on the fine control transformer. By rotating the frame of the coarse control transformer, the conditions of Figure 5D can be achieved. At 180-deg rotation of the coarse control, the conditions are the same as with an odd gear ratio and no false null is possible.

The magnitude of the stickoff voltage can be found by determining the voltage of the coarse control transformer which corresponds to a ¼ revolution of the fine control

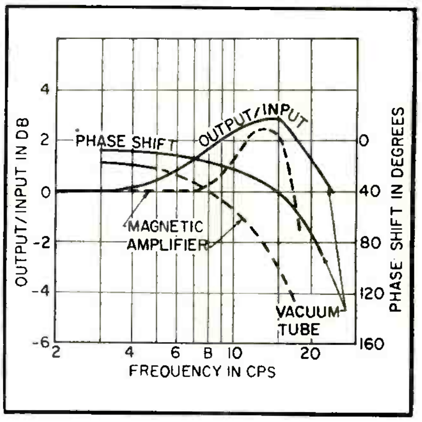


FIG. 6—Phase and magnitude curves for electron-tube and magnetic-amplifier servo systems

Table II—Magnetic Amplifier Servo System of Fig. 6

Bandwith	= 15 cps
Resonant rise	= 2.28 db
Velocity constant	= 1,800/second
Static accuracy	= ± 2 deg (fine control transformer)
R_{fine} = 10,000 ohms	
R_{coarse} = 10,000 ohms	
Lead network	Lag network
$R_1 = R_2 = 60$ ohms	$R_7 = R_8 = 60$ ohms
R_3 = Open	$R_9 = 30{,}000$ ohms
$R_4 = 0$	$R_{10} = 10{,}000$ ohms
$R_5 = 3{,}700$ ohms	$R_{11} = 39{,}000$ ohms
$R_6 = 7{,}000$ ohms	$R_{12} = 55{,}000$ ohms
$C_1 = 10 \mu f$	$C_2 = 20 \mu f$

Table III—Magnetic Amplifier System of Fig. 7A

Bandwidth	= 15 cps
Resonant rise	= 3.8 db
Velocity constant	= ∞
Static accuracy	= ±0.2 deg (fine control transformer)
R_{fine} = 10,000 ohms	
R_{coarse} = 10,000 ohms	
Lead network	Lag network
$R_1 = R_2 = 60$ ohms	$R_7 = R_8 = 60$ ohms
R_3 = Open	$R_9 = 25{,}000$ ohms
$R_4 = 0$	$R_{10} = 0$
$R_5 = 3{,}400$ ohms	$R_{11} = 29{,}000$ ohms
$R_6 = 8{,}000$ ohms	$R_{12} = 55{,}000$ ohms
$C_1 = 4 \mu f$	$C_2 = 20 \mu f$

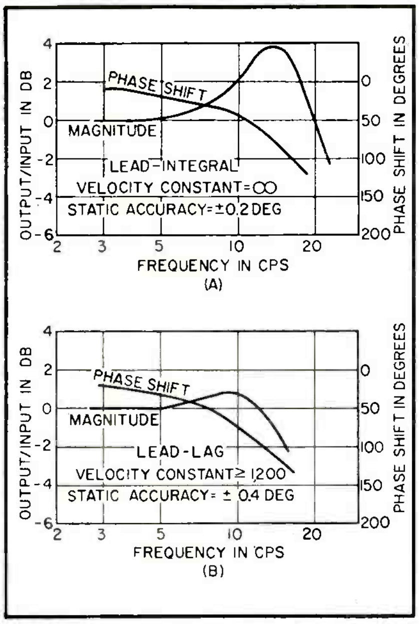


FIG. 7—Phase shift and input-output ratio in db plotted against frequency

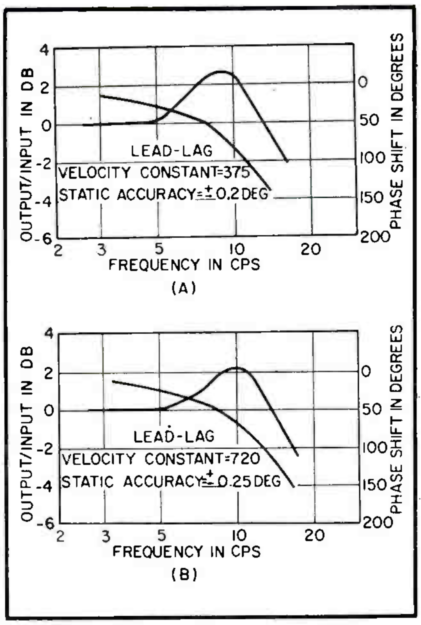


FIG. 8—Frequency versus phase shift and input-output ratio in db

Table VI—Magnetic Amplifier System of Fig. 8B

Bandwidth	= 12 cps
Resonant rise	= 2.28 db
Velocity constant	= 720/second
Static accuracy	= ±0.25 deg (fine control transformer)
R_{fine}	= 10,000 ohms
R_{coarse}	= 10,000 ohms

Lead network	Lag network
$R_1 = R_2 = 60$ ohms	$R_7 = R_8 = 60$ ohms
R_3 = Open	$R_9 = R_{10} = 30,000$ ohms
$R_4 = 0$	$R_{11} = 39,000$ ohms
$R_5 = 4,000$ ohms	$R_{12} = 55,000$ ohms
$R_6 = 7,000$ ohms	$C_2 = 10\ \mu f$
$C_1 = 10\ \mu f$	

transformer. Utilizing 1 volt/degree synchros and a 36-to-1 gear ratio, the stickoff voltage should be (1) (360)/(4) (36) = 2.5 deg or 2.5 volts. This voltage was supplied from a 2.5-volt transformer as shown in Fig. 2.

Servo Compensation

Half-wave magnetic-amplifier servo systems can easily be compensated for the proper servo characteristics by the use of simple R-C networks. Both lead and lag circuits were used in this system. The necessary lead function for extension of the system-break frequency is provided by the magnetic amplifier utilizing negative integral feedback around it. The corner-frequency extension is a function of the d-c gain of the amplifier.

Since the output of the slave stage is a-c, this type of compensation cannot be achieved by taking a portion of the output and feeding it back directly. However, since the output stage is essentially two half-wave stages, compensation can be achieved by inserting resistors in the bridge and taking the d-c voltage which appears across R_1 and R_2 and feeding it back through the R-C network. This can be done on the slave portion of the output stage also. Proper adjustment of the values of resistance and capacitance will give different servo characteristics.

The lag network can be made to integrate by proper choice of the resistance and capacitance values.

Table IV—Magnetic Amplifier System of Fig. 7B

Bandwidth	= 12 cps
Resonant rise	= 0.8 db
Velocity constant	= 1,200/second
Static accuracy	= ±0.4 deg (fine control transformer)
R_{fine}	= 10,000 ohms
R_{coarse}	= 10,000 ohms

Lead network	Lag network
$R_1 = R_2 = 60$ ohms	$R_7 = R_8 = 60$ ohms
R_3 = Open	$R_9 = 30,000$ ohms
$R_4 = 0$	$R_{10} = 0$
$R_5 = 5,000$ ohms	$R_{11} = 39,000$ ohms
$R_6 = 4,000$ ohms	$R_{12} = 55,000$ ohms
$C_1 = 10\mu f$	$C_2 = 20\mu f$

Table V—Magnetic Amplifier Servo System of Fig. 8A

Bandwidth	= 10 cps
Resonant rise	= 2.6 db
Velocity constant	= 375/second
Static accuracy	= ±0.2 deg (fine control transformer)
R_{fine}	= 10,000 ohms
R_{coarse}	= 10,000 ohms

Lead network	Lag network
$R_1 = R_2 = 60$ ohms	$R_7 = R_8 = 60$ ohms
R_3 = Open	$R_9 = 20,000$ ohms
$R_4 = 0$	$R_{10} = 0$
$R_5 = 5,000$ ohms	$R_{11} = 10,000$ ohms
$R_6 = 5,000$ ohms	$R_{12} = 22,000$ ohms
$C_1 = 10\mu f$	$C_2 = 20\mu f$

System Performance

Phase shift and magnitude curves for the electron-tube and magnetic amplifier are shown in Fig. 6.

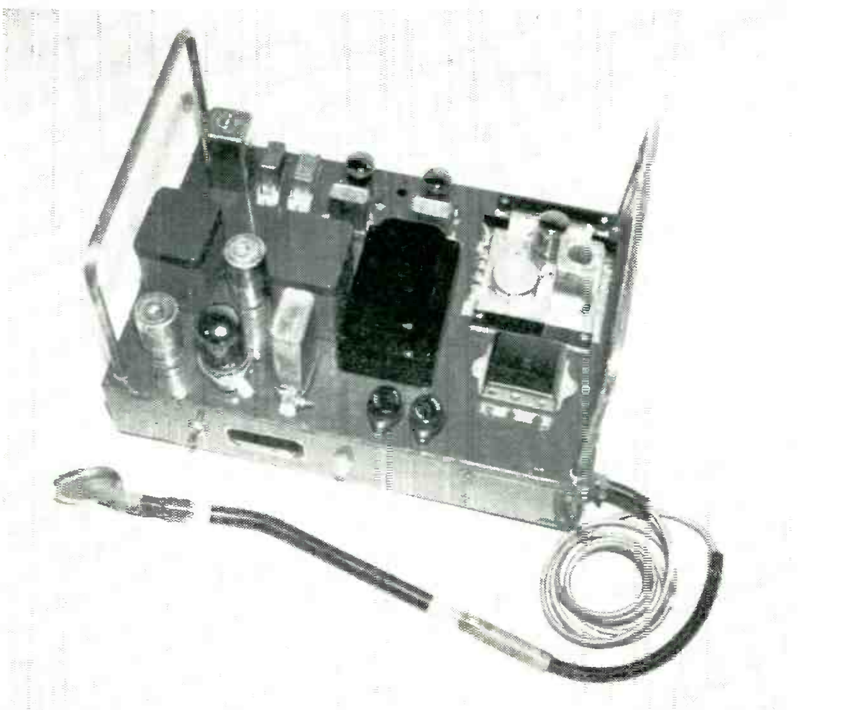
Bandwidth and resonant-rise measurements were made with a signal level of 0.2 volt to the amplifiers. Velocity-constant measurements were made by reading error at the fine control transformer while driving the control transformer at a constant speed of approximately 360 deg/sec. Additional data and component values on this and other magnetic-amplifier systems are given in Fig. 7 and 8 and in the tables.

To illustrate the versatility of the half-wave bridge-type magnetic amplifier, a number of systems utilizing the same magnetic amplifier but different compensating networks were tested. Magnitude and phase-shift curves are plotted for each system.

The Front Cover

Checking shoe insoles for projecting tacks is speeded by r-f detector using oscillator loading to signal presence of metal

Tack Detector for



PERMANENT metal fastenings and metal supports are used in the manufacture of several types of shoes. In addition, temporary tacking is used to position insoles and uppers.

Inspection of the finished shoe is necessary to insure that temporary fastenings have been removed and that all permanent tacking remains in the body of the shoe and does not protrude through the insole. Heel nails should be clinched over below the heel line, and not extend above the heel seat.

Hand-searching inside the shoe forepart and heel seat requires about one second per shoe and this rapid work carries with it the danger of painful finger cuts.

The tack detector described here is the result of several years of de-

Chassis of tack detector with long probe used for searching forepart of shoe

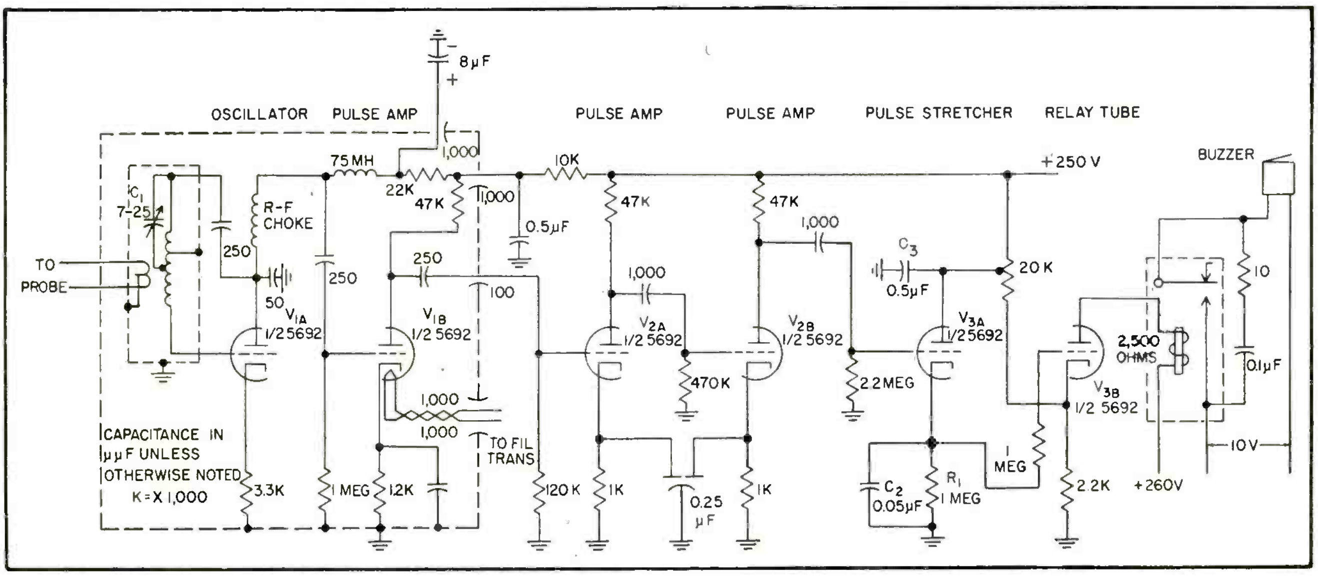


FIG. 1—Plate-current pulse caused by loading of tack-detector oscillator is amplified and stretched to trigger alarm

SUMMARY —— Loading of oscillator probe by contact with metal tack triggers alarm in production checker for shoes. Operator can inspect 440 dozen pair per day, detecting tacks projecting only a few thousandths of an inch above insole

Shoe Production

velopment work. It is a bench-type device consisting of a completely enclosed electronic unit and a probe attached to the unit by a flexible cord.

For general design requirements the unit must be rugged, have long component life and be uniformly sensitive over long periods of time. The device must be free from factory electrical disturbances causing pretriggering or false signalling. It also must be free from r-f radiation.

In use, the probe is inserted in the shoe by hand and passed over the surface of the insole. When contact is made with a fixed or free metallic substance, as small as $\frac{1}{16}$ of an inch long, an audible signal is emitted from a buzzer within the unit. Unwanted metal is then removed by hand. The tack detector can be equipped with various size

By ROBERT W. BRADLEY

Senior Electronic Engineer
Research Division
United Shoe Machinery Corp.
Beverly, Massachusetts

probes for men's, women's or children's shoes.

Theoretically the device must signal the presence of a tack protruding a few thousandths of an inch above the insole surface, yet it must not signal a tack just below the surface. It is also desirable to locate staples in the forepart lining as high as $\frac{3}{16}$-inch above the insole.

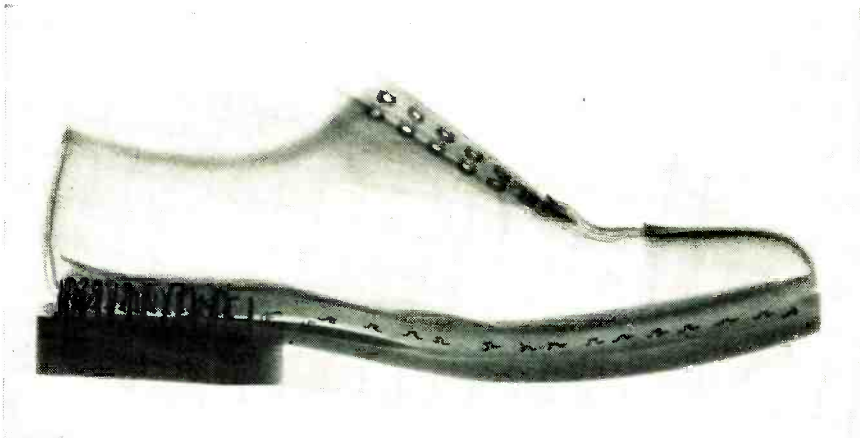
Because of these severe requirements, usual concepts of metal detection principles did not apply to this problem.

Theory

Operation is based on the audio and ultrasonic noise created when a piece of metal is touched to a radio-frequency resonant circuit. If a piece of metal, such as a tack, touches a high-frequency oscillator grid connection, an intermittent contact is made, loading the oscillator and causing an abrupt plate-current change. This transient in plate current contains audio-frequency components which may be amplified and stretched to control a buzzer.

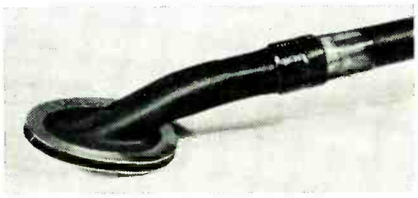
A resonant circuit probe head is link-coupled through a low-impedance transmission line to the oscillator coil in the main unit. Audio-frequency signals are taken from the oscillator plate circuit. Seventy db of audio amplification is sufficient to drive the pulse stretcher which in turn operates a sensitive 2,500-ohm relay controlling a buzzer.

Overall tack detection sensitivity is adjusted by tuning the oscillator to a frequency near the natural fre-



X-ray photograph showing permanent tacks and staples in finished shoe

Tack detector with probe is a compact bench-type unit for production checking



Probe heads are interchangeable and shaped to fit various types of shoes

quency of the probe head. The sensitivity may be increased to the point where free pieces of metal so small they can hardly be seen with the naked eye will signal a response. In practice, the sensitivity is set for buzzer response from touching a $\frac{3}{32}$-inch long by 0.020-inch diameter free metal piece resting on a polystyrene board.

Probe

The probing element must be light and easily wielded yet be capable of severe usage. Use of high radio frequencies requires a strong, flexible low-loss probe-head rubber.

The probe is composed of a resonant head system attached to a Plexiglas and rubber handle. Flat oval stainless-steel rings serve as tack-searching plates and as the resonant-circuit capacitor. Each ring is flexibly connected through the probe-head rubber to opposite ends of an inductor wound on the coil handle. A one-turn pickup loop around this inductor is connected to terminals at the cord end of the handle. No shielding of the probe head or of wires in the probe handle was found necessary. Low-loss material having a natural-rubber base with proper mechanical properties was developed for the probe head, giving tan $\delta = 0.00147$ and dielectric constant $\epsilon = 4.2$ in the 30 mc region.

The natural resonant frequency of the entire probe, with 10 feet of transmission line link-coupled to the main-unit oscillator coil, is 31.75 mc. Manufacturing variation of this response frequency is from 31 to 32.5 mc.

Final choice of the probe-cord transmission wire was the result of experiment. Heavy and light tinsel wires were found to cause too much attenuation. Flexible motor cables were heavy and subject to quick breakage at terminals. The cord finally decided upon is a No. 18, 41-strand, 2-conductor cable. Excess cable length is stored in a housing at the front of the main unit.

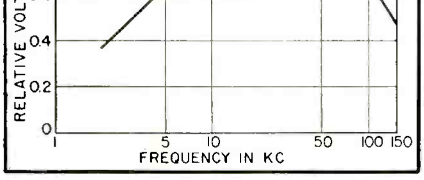


FIG. 2—Response curve for tack-detector amplifier is peaked at 20 kc

Circuit

Oscillator frequency is varied from 26 to 33.5 mc with capacitor C_1 in Fig. 1. The one-turn coupling loop is space ¼ inch from the tank coil. Such loose coupling was found necessary to prevent false triggering from probe mechanical shock and to eliminate frequency pulling of the oscillator frequency by the probe head resonant system.

The amplifier low-frequency response is reduced to avoid false signalling from power-supply hum and mechanical shock of the probe. The amplifier is operated at full gain and, as shown in Fig. 2, peaks at 20 kc.

The pulse stretcher and relay-tube system require a peak input signal of 13 volts to actuate the relay. Positive input voltage on the grid of the pulse stretcher charges the 0.05-μf cathode capacitor C_2 from C_3 through triode V_{3A}. The voltage across C_2 discharges slowly through 1-megohm resistor R_1 maintaining the relay tube conductive for a sufficient period to insure reliable operation of the sensitive relay and the buzzer.

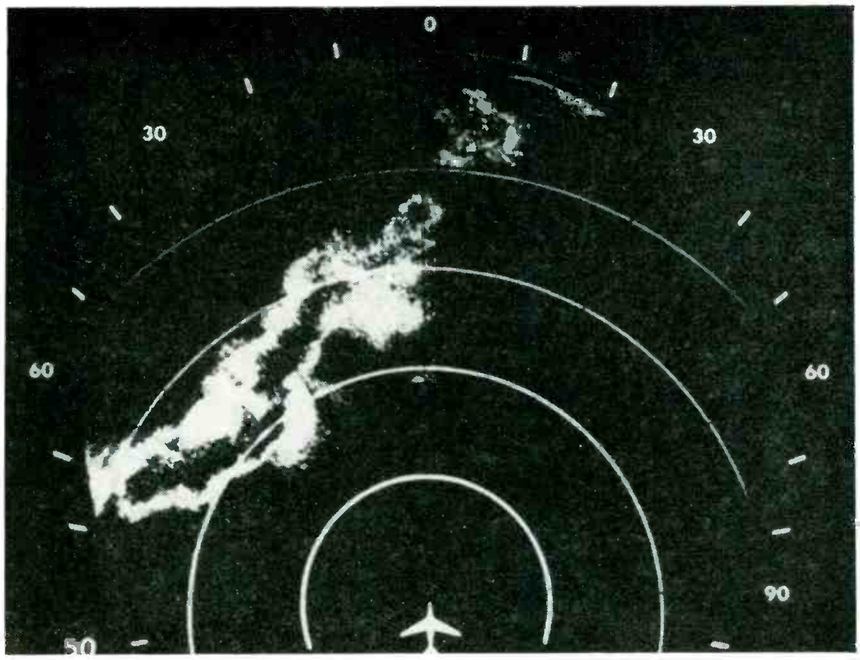
Radiation

Radiation field strength measurements were made to certify the unit for compliance with the requirements of the FCC. A 50-$\mu\mu$f capacitor with short leads from the oscillator plate to the ground and a 7.0 millihenry r-f choke placed in series with the oscillator plate eliminated parasitic oscillations so that there was no measurable radiation in the tv bands. Fundamental frequency radiation is negligible.

The tack detector will not pretrigger from unwanted signals such as those generated by an electric drill or a high-frequency sparker one foot away from the probe or probe cord.

Successful field use shows that production, quality and design requirements were met. Packing room inspection by one operator averages 440 dozen pair of shoes per day.

Radar ppi shows storm cells within clouds when isoecho contour circuit is connected



By F. W. RUPPERT and J. M. SMITH

*Bendix Radio Communications Div.
Bendix Aviation Corp.
Baltimore, Md.*

Airborne Weather Radar Uses Isoecho Circuit

SUMMARY —— Dynamic range of a cathode-ray oscilloscope screen is insufficient to display desired intensity of radar reflection from storm areas. A novel circuit changes direction of intensity after a preset level, creating on the screen a dark spot surrounded by illumination

FACILITIES for storm detection, ground mapping and terrain avoidance are combined in a lightweight, airborne radar equipment designed particularly for commercial and executive aircraft.

Five units, including the synchronizer-amplifier-power supply illustrated, weigh less than 130 pounds. Of prime importance in space conservation is the duplexer-mixer assembly, which includes local oscillator, two atr tubes, a t-r tube and three crystal holders.

Besides employing new-style contact atr tubes, the unit contains a folded hybrid and balanced mixer. An integral crossguide directional coupler is a part of the assembly and is terminated in a test jack. A flexible, tapered transition twist section to the magnetron gives mechanical flexibility and isolates the duplexer and mixer sections from the magnetron.

The flexible twist section, comprising a tapered transition from large guide to small guide employs a split-clamp type of mounting for the magnetron and a miniaturized contact flange to mate with the duplexer.

Physical placement of the radar circuits plays an important role in reducing size, weight and power requirements. An example of economy is the handling of indicator sweep driver tubes.

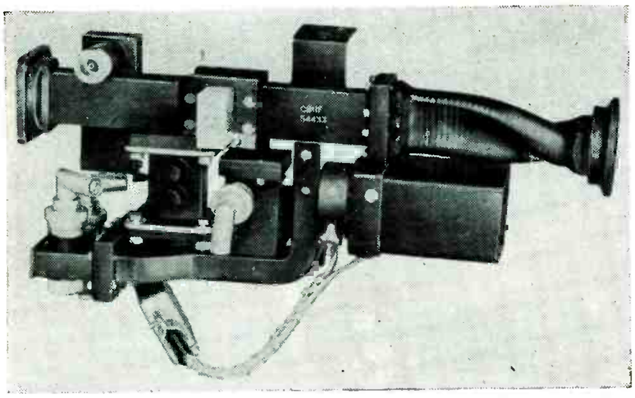
Circuit Simplification

On a radar previously used in standard military aircraft installations, two 6L6 tubes, located on a synchronizer chassis removed by 30 feet from the indicator, were required to drive sweeps. These tubes have been replaced and identical driving requirements fulfilled by one miniature tube located in the ppi package a few inches from the c-r tube and its associated sweep circuits.

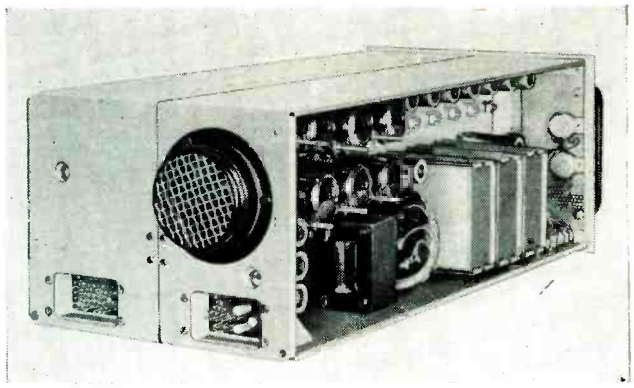
Encapsulation was used for nearly all transformers in the system. This treatment provides a unit sealed against moisture. It is likewise electrically insulated and thoroughly impregnated against moisture while adding only a fraction of an inch to the overall size.

As contrasted with oil-filled can types, drastic size reductions have been possible. This is especially true for high-voltage transformers in which the oil-filled type of construction requires large insulating terminals because of the metal enclosure.

A triple savings was effected in size, weight and power consumption by using selenium instead of vacuum-tube rectifiers in the plate



Duplexer-mixer assembly is the entire internal waveguide system used. Local oscillator housing at lower right



Synchronizer, amplifier, power supply unit removed from case shows packaging of components viewing left side and rear

supplies. These savings were realized from elimination of rectifier heater power and from resultant decrease in the amount of heat generated. Reduction in cooling requirements allowed greater component density on the chassis.

By means of unique design, the antenna provides maximum vertical beam deflection with minimum vertical reflector tilt. This is accomplished by means of a fixed radiator with a tilting reflector to multiply the deflection of the radiated beam through the mirror action of the reflector.

One function of this equipment is to furnish weather information by means of radar echo displays, thereby enabling the pilot of an aircraft to avoid the turbulence associated with thunderstorms. The display further acts as a pathfinder to guide the pilot through soft spots in a storm without serious reduction in speed and with much greater safety and passenger comfort.

Isoecho Contour

When examining a rain or storm area, the intensity of the return signal will vary depending upon the concentration of moisture reflecting the beam. Although the intensity of the return signal may vary, the normal ppi presentation of moisture-bearing cloud formations may appear almost uniform.

This condition results from inability of the phosphorescent material in the cathode-ray tube to distinguish more than a limited range of light intensities. The isoecho contour circuit in the receiver eliminates this condition. When energized, this circuit alters the normal radar presentation to display high rainfall rates as black holes in the signal return.

Action of the contour circuit is relatively simple and functions by erasing radar return signals greater than a preselected level, thus making the detection of the more intense rain areas possible. The areas of greatest turbulence within thunderstorm clouds are associated with the areas of greatest rainfall rate gradient and it is essential to distinguish these areas from those of relatively little turbulence.

The display resulting from contour-circuit action on the return signal shows areas of high rainfall rate as black holes surrounded by light areas (relatively light rainfall) making the visual evaluation of varying degrees of light intensity in the display unnecessary.

The photograph shows a ppi display of a thunderstorm area. Sweep range is 50 miles with range marks spaced at 10-mile intervals. The outer edge of the white area of the rain-return signal defines the minimum rainfall rate at which echoes are visible on the radar (near zero rain). The outer edges of the black holes in the rain-return centers outline the areas within which the rainfall rate is greater than this by a preset amount, usually 12 to 16 db.

Where the rate of rainfall changes rapidly, maximum turbulence is normally found. Therefore, where the white line between the no-rain area and the heavy-rain area is thinnest, there is greatest turbulence.

Figure 1 shows the video amplifier and contour circuits included in the receiver. When contour relay K_1 is open, contour tube V_{3A} is biased so far beyond cutoff that it is effectively out of the circuit and no contour action results. The

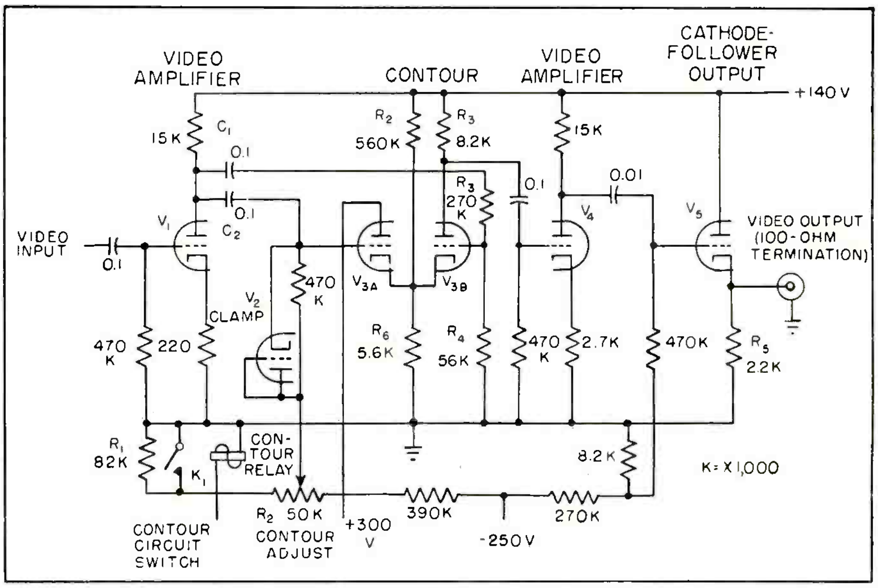


FIG. 1—Contour circuit reverses intensity of illumination on radar display above preset level of video signal

circuit acts as a video amplifier.

When the contour relay is closed, divider resistor R_1 is shorted out and contour tube V_{3A} is biased to some degree below cutoff; the degree of bias is determined by the setting of contour potentiometer R_2. Contour tube V_{3B} is normally slightly conducting.

Video Amplifier

In operation, detected signals are applied to the control grid of video amplifier tube V_1 in the form of negative-going video pulses as shown in Fig. 2A. The pulses are amplified, inverted and coupled through capacitors C_1 and C_2 to both control grids of V_3. Positive-going pulses applied to V_{3B} will be attenuated by the voltage dividing resistors R_3 and R_4 and their amplitude will be approximately one-fifth that of the positive-going pulses applied to V_{3A}.

Positive pulses at the grid of V_{3B} immediately result in negative pulses at its plate, but the positive pulses at the grid of V_{3A} will have to overcome the applied bias before V_{3A} will conduct. Therefore, all signals below a level predetermined by the setting of contour potentiometer R_2 will be blocked at V_{3A} but will see V_{3B} as a video amplifier and will appear as amplified, positive-going video pulses across cathode resistor R_5 of the cathode-follower output tube V_5. All such pulses will appear as bright displays on the face of the cathode-ray indicator tube in the ppi, indicating moisture-bearing cloud formations lacking storm cells of dangerous magnitude.

Stronger Signal

When the radar beam encounters rain of sufficient density to increase the return signal amplitude by approximately 12 to 16 db (depending upon the setting of R_2) above the mds (minimum discernible signal) level, the signal at the grid of V_{3A} will come above cutoff and the tube will begin to conduct. When V_{3A} conducts, more current flows through cathode resistor R_6, increasing the voltage drop across it and increasing the bias on V_{3B} proportionately.

As the signal on the grid of V_{3A} increases above cutoff the tube conducts more heavily biasing V_{3B} at a level sufficient to override the attenuated signal on its own grid. When this happens the signal is effectively erased, since no display results when the output of V_{3B} equals or is more positive than when the tube is conducting normally.

Illustrations in Fig. 2 (H-J) are scope photographs of the video output pulses appearing across cathode resistor R_5 of cathode-follower video-output tube V_6.

The pulse in (H) results from a return signal of amplitude below the threshold level of V_{3A} and is not affected by contour action. The level of such a signal may be up to approximately 10 db above mds level. An mds would be returned from a cloud area of near-zero-rain. Such a pulse will appear as a bright spot on the ppi.

The pulse at (I) is from a return signal of amplitude just above the threshold level of V_{3A}, with contour circuit operating. At this input signal level, approximately 13 db above mds, V_{3A} just starts to conduct and the effect can be seen as a partial erasure of the signal.

Bias Reduction

Pulse (J) comes from a return signal of amplitude greater than necessary to overcome completely the bias on V_{3A}. The level of such a signal may be approximately 12 db to 16 db or more above the mds level, depending on the setting of contour potentiometer R_2. Such a signal would be returned from a heavy rain area. In this case part of the resulting video output at V_5 cathode is negative, which has the effect of a blacker-than-black signal, since only a positive pulse output will produce a bright display on the ppi.

Clamp tube V_2, operating as a diode, prevents changes in contour action, or level, with changes in signal duty cycle. Contour potentiometer R_2 simultaneously adjusts clamping level of V_2 and bias on V_{3A}.

Tube V_4 is ideally biased as a video amplifier with a restricted dynamic range, while cathode-follower output tube V_5 is biased very near cutoff. Three advantages are gained by holding the bias of V_6 near cutoff. A conservation of power is realized, the demand on the contour circuit is reduced and negative overshoot of the output pulse is held to a minimum.

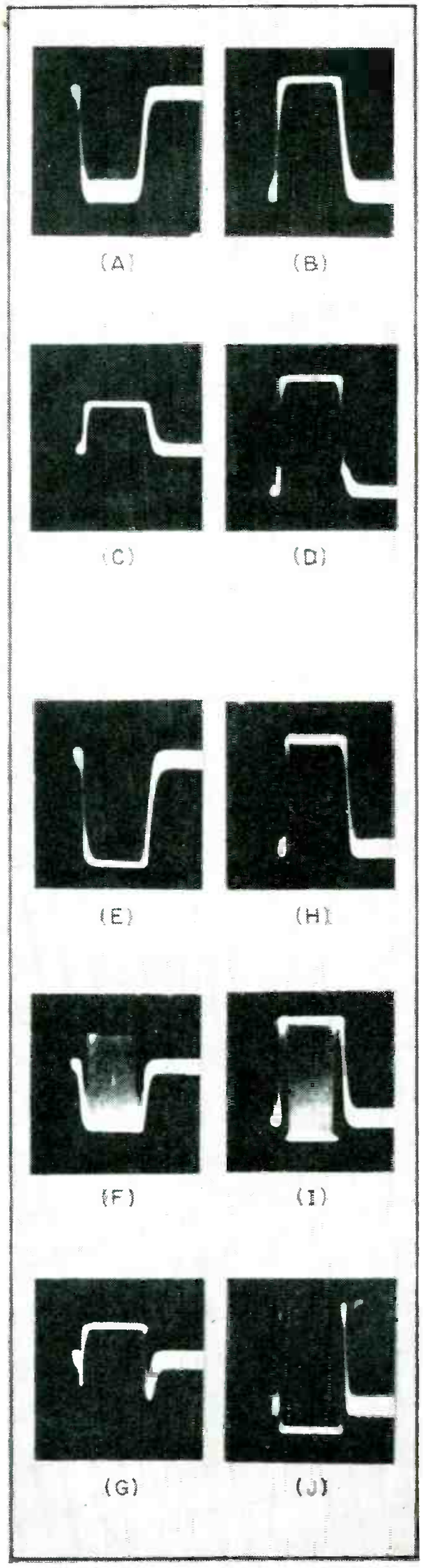


FIG. 2—Input pulse to V_1 (A) and output (B). Pulse at cathode of V_3 with contour off (C) and on (D). Pulse at plate of V_{3B} with contour off (E) and on, but partial erase (F) and full erase (G). Video output at V_5 with light (H) medium (I) and heavy (J) rain return

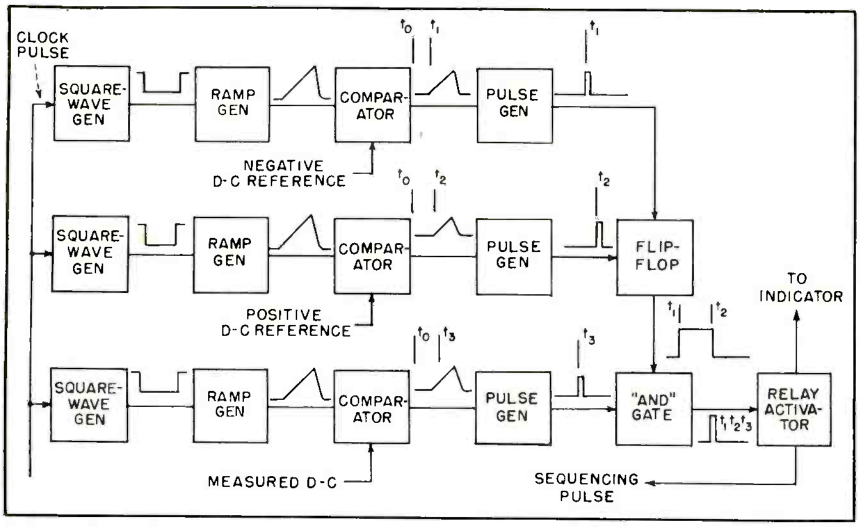
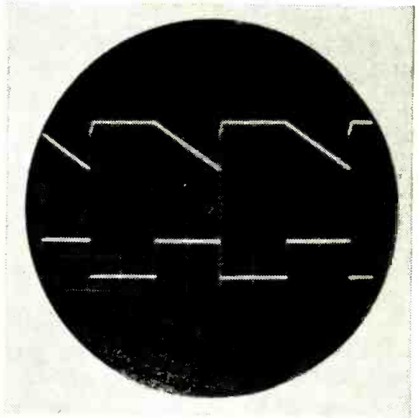


FIG. 1—Block diagram of complete automatic test-actuating system for production lines



Dual-beam oscilloscope presentation showing square-wave input to ramp generator and resultant sawtooth output produced during negative pulse time.

Automatic Measurement

By A. J. STRASSMAN

Ground System Department
Hughes Weapon Systems Development Laboratories
Hughes Aircraft Co., Culver City, Calif.

WHEN TESTING electronic equipment it is often necessary to monitor, by visual or aural means, a d-c voltage level before the test can proceed to its completion. Although the actual value of this voltage may be unimportant, its presence is essential for the test to continue. If this presence could be detected automatically and in being noted cause the test to continue, or if the lack of this voltage could cause the testing to be stopped, it would remove part of the operator's task and allow for speedier testing.

The automatic testing system shown in Fig. 1 achieves this goal. Fundamentally, the method involves producing several pulses that are delayed in time, each by an amount proportional to a preset d-c level. The basic stages consist of a square-wave generator whose output is used to develop a linearly rising voltage with respect to time, and a comparator which allows a pulse generator to operate at a preset time interval dependent upon the d-c level impressed on the comparator.

If one comparator is adjusted to provide an output pulse that will be delayed in time by an amount equivalent to the lower d-c tolerance limit, the two pulses will be separated in time by an interval proportional to the prescribed d-c tolerance levels. The third comparator receives the measured voltage value and causes a pulse to occur if it is within the specified tolerance, some place between the upper and lower limit pulses.

The two tolerance pulses are applied to a flip-flop, where the

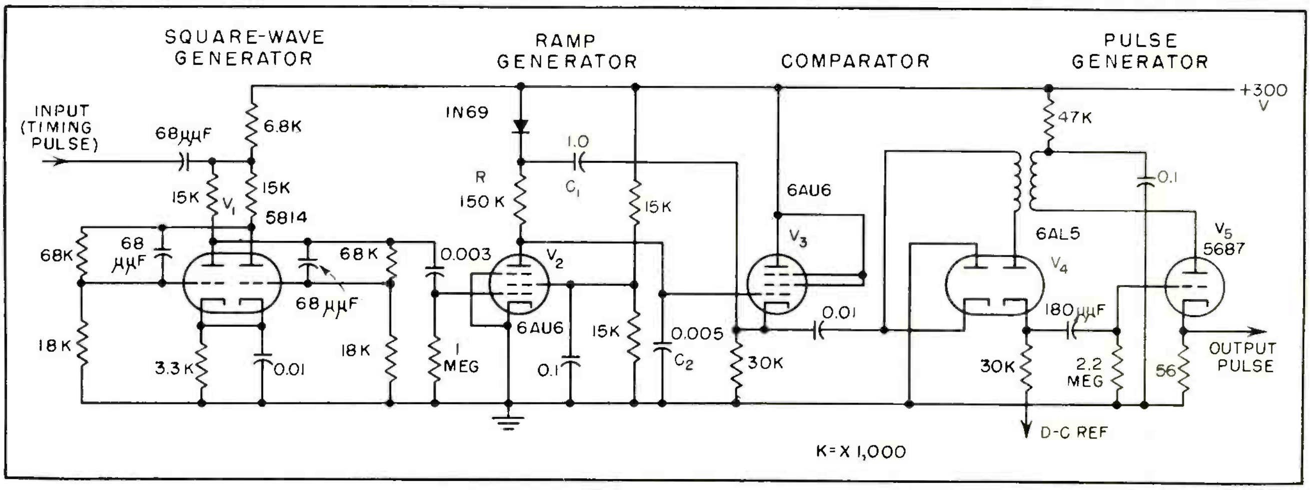
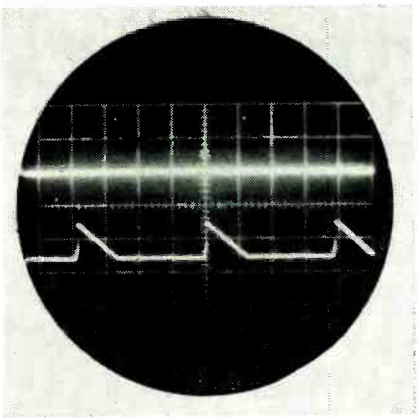
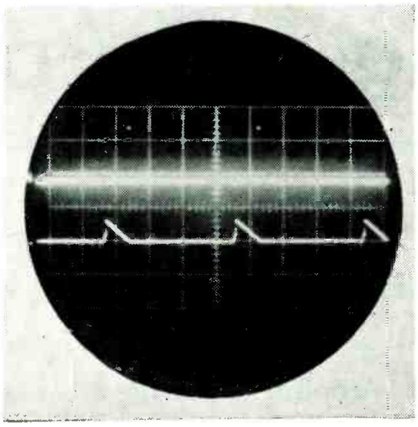


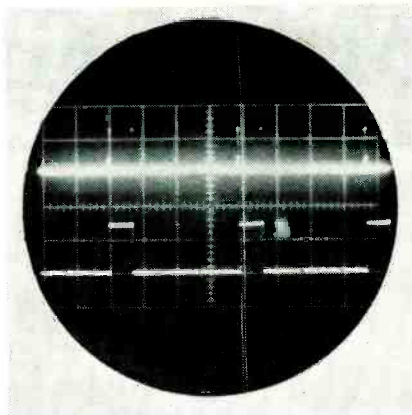
FIG. 2—Generator chain for one of the three identical channels used to feed flip-flop and gate



Upper pattern represents d-c level of sawtooth for lower tolerance limit to which automatic tester is set, and lower pattern shows pulse produced for that level



Sawtooth level and resultant pulses for upper tolerance limit. Best results are obtained with highest possible amplitude of input waveform to comparator



Lower pattern represents rectangular waveform at output of flip-flop as produced by upper and lower tolerance level pulses shown in upper half of pattern

# of Voltage Tolerances

SUMMARY — Test circuit is activated only when a measured d-c voltage is within specified tolerances. Generator chains produce pulses that are time-delayed in proportion to an applied d-c voltage

lower-limit pulse produces a positive-going pulse and the upper-limit pulse produces a negative-going pulse. The square wave so produced defines tolerance limits. The square wave is then applied to a gate tube that operates only when the pulse derived from the measured value falls within this gate derived from the upper and lower tolerance limits. When coincidence occurs between these pulses a relay tube is activated to cause an indicator lamp to light and at the same time provide a pulse to allow the test to proceed.

The circuit of the square-wave generator, ramp generator, comparator and pulse generator for the lower limit tolerance are shown in Fig. 2. Identical circuitry is used to provide the required pulse for the upper limit and the measured value.

Sweep Circuit

A timing pulse derived from a central source is applied to a standard driven multivibrator (V_1 in Fig. 2) which produces the negative-going pulse 500 microseconds wide. This negative pulse is applied to the grid of the input tube of bootstrap sweep circuit V_2 which serves as a ramp generator. During the period of positive input to V_2 the tube is bottomed (the plate voltage is near ground potential) and the 1N69 crystal diode is conducting.

When V_2 is cut off by the negative pulse, the plate voltage tends to rise at a rate dependent on the time constant of R and C_2. This rise is cathode-followed by V_3 and applied at the bottom end of diode V_4 through C_1. The diode ceases to conduct when the voltage at its cathode goes higher than that of its grounded plate.

If C_1 is sufficiently large so that a constant voltage is maintained across R, the charging current to C_2 is held constant, thus producing a linearly rising waveform. To discharge C_2 to its fullest extent, which gives a sharp sawtooth, the grid of V_2 should be allowed to go slightly positive. When C_2 is charged, the grid of V_2 should be cut off.

The comparator is used to develop a pulse that will be referenced in time by an amount proportional to the d-c level introduced at the cathode of the right-hand section of the double-diode V_4. This diode will remain nonconducting until such time as the voltage applied to its plate rises above the d-c reference voltage impressed on its cathode. Output voltage then is

$$E_o = (E_{in} - E)\frac{R}{R_2 + R_d} \qquad (1)$$

where E_{in} is input voltage, E is impressed voltage, R_2 is the diode load resistor and R_d is diode resistance.

This output voltage is impressed upon the grid of V_5, a standard blocking oscillator circuit which fires to produce a pulse that is delayed some amount in time proportional to the d-c level impressed on the cathode of the comparator.

The d-c restoration is used to make certain that the starting level of the input voltage is held at a constant level at all times. This tends to minimize errors caused by voltage variations.

Measuring R-F Parameters

SUMMARY —— Equipment and techniques for measuring small-signal h parameters of triode and tetrode junction transistors in the range from 1 to 24 mc are described. Amount of error introduced in measurement by output terminations is considered

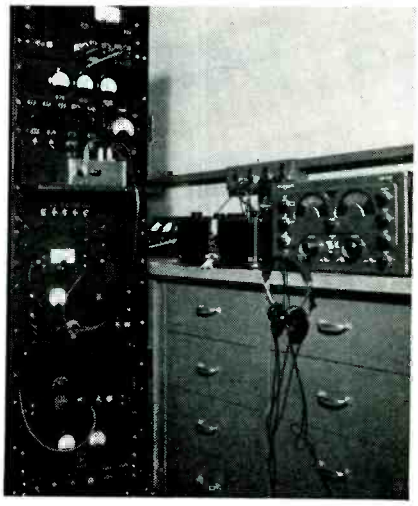
BECAUSE OF the inherent nature of the transistor, the most readily measured network coefficients are the series-parallel or h parameters.[1,2] Once the four h parameters are known at a given frequency and for a given set of d-c operating conditions, such quantities as power gain, voltage gain, input impedance and output impedance of the transistor in a transmission circuit may be calculated for the same frequency and d-c operating conditions.[2]

This article describes methods and equipment which can be used to determine the four grounded-base h parameters of junction transistors from 1 to 24 mc.

Under small-signal conditions the electrical behavior of a transistor can be described by considering it as a linear two-terminal-pair active network, with the four differential terminal voltages and currents related to four network parameters.

Short-Circuit Input Impedance

The electrical symbol for the transistor and the direction of instantaneous current flow and voltage rise, together with the two network equations, are shown in



Rack-mounted h-parameter measuring equipment. At the right may be seen one of r-f bridges and communications receiver. Both are mounted on a conducting ground-plane

Fig. 1. For convenience, transistors are shown as *npn* units, triode or tetrode; *pnp* transistors can be measured if the polarity of the bias supplies is reversed.

At radio frequencies the four h parameters are of the form $h_{ij} = a \pm jb = C \angle \theta$. In Fig. 1

$$a \pm jb = h_{11}\, i_1 + h_{12}\, e_2 \qquad (1)$$

$$i_2 = h_{21}\, i_1 + h_{22}\, e_2 \qquad (2)$$

where h_{11} is the short-circuit input impedance parameter and h_{12} is the open-circuit voltage-feedback parameter; h_{21} is the short-circuit current-transfer parameter and is equivalent to α, except for a 180-deg phase difference. The quantity h_{22} is the open-circuit output admittance.

A fifth parameter is the short-circuit output admittance, y_{22}. This quantity may be found in terms of the h parameters by setting $e_1 = 0$ in Eq. 1 and combining the result with Eq. 2 so

$$\frac{i_2}{e_2} = y_{22} = h_{22} - \frac{h_{12}\, h_{21}}{h_{11}} \qquad (3)$$

As can be seen in Eq. 1, driving-point impedance Z_{in} at the input terminals will be equal to h_{11} if e_2 is zero. This condition will prevail only if terminating admittance Y_{t2} at the output terminals is infinite. Since this condition can be approached but never attained, it is of interest to find the error introduced in the determination of h_{11} by a finite terminating admittance Y_{t2}. The following equation is therefore derived from Eq. 1 and 2. With

$$e_2 = -i_2/Y_{t2}$$

$$Z_{in} = h_{11}\left[1 - \frac{h_{12}\, h_{21}}{Y_{t2}\,(1 + h_{22}/Y_{t2})\, h_{11}}\right] = h_{11}\left[\frac{1 + y_{22}/Y_{t2}}{1 + h_{22}/Y_{t2}}\right] \qquad (4)$$

Hence if $Y_{t2} >> h_{22}$ and $Y_{t2} >> y_{22}$, then $h_{11} \cong Z_{in}$.

In the test circuit used for measuring h_{11}, Y_{t2} is the terminating admittance obtained from a bypass capacitor strapped between the collector and base connections

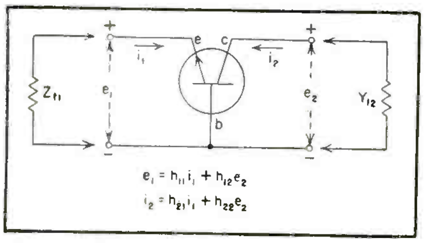


FIG. 1—Two-terminal-pair representation of transistor

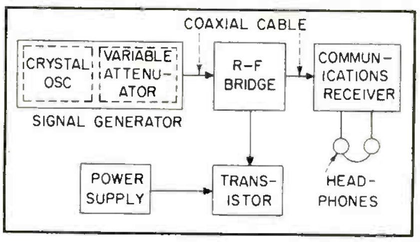


FIG. 2—Setup for measuring h_{11} parameter of transistors

# of Junction Transistors

By W. N. COFFEY
General Electric Research Laboratory
Schenectady, New York

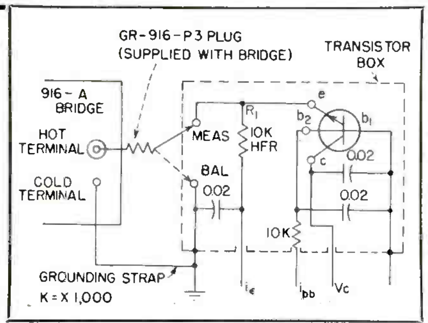


FIG. 3—Transistor-box circuit for h_{11} measurement

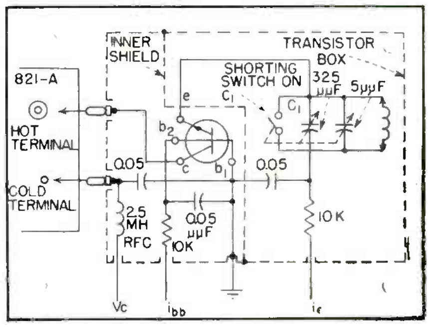


FIG. 4—Transistor-box circuit for h_{22}/y_{22} measurement

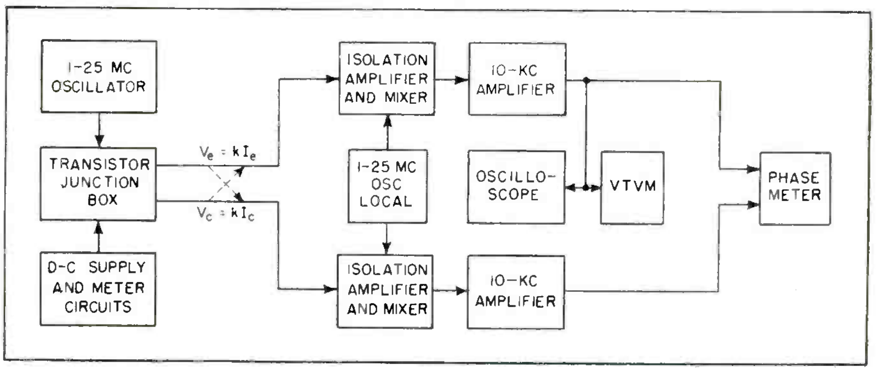


FIG. 5—Equipment necessary to measure α at high frequencies

of the transistor. The magnitude of Y_{t2} is maintained $\geq$ 0.1 mho over the frequency range and thus is many times greater than either h_{22} or y_{22}.

The short-circuit input impedance is of the form $h_{11} = r_{11} \pm jx_{11}$ in ohms and is measured with a General Radio model 916-A radio-frequency bridge as shown in Fig. 2. Additional equipment includes a crystal-controlled signal generator with 8 test frequencies from 1 to 24 mc and a communications receiver which serves as a detector. All of the equipment is placed on a sheet aluminum ground-plane. Connections to the bridge are made with double-shielded coaxial cable.

The transistor is connected to the bridge and its power supply as shown in Fig. 3. This circuit is contained in a 2 by 2 by 4 inch metal box fastened to the bridge close to the unknown terminals. Direct current for the emitter is fed in shunt with these terminals through R_1. The box is provided with a subminiature tube socket into which the transistor plugs.

Correction Factors

The admittance of the parallel combination of R_1, the shunt capacitance to ground of the emitter circuit wiring in the box and the shunt capacitance to ground of the GR-916-P3 connecting lead may have to be accounted for in determining the true h_{11} parameter. This will be required generally if $|h_{11}| >$ 200 ohms and if the frequency is greater than 10 mc. Corrections for the inductance effects in the bridge may be necessary if the frequency is greater than 14 mc.

The open-circuit output admittance, $h_{22} = g_{22} + j\omega C_{22}$ (μmho), can be measured as a driving-point admittance at the output terminals in Fig. 1 provided $i_1 = 0$, input terminals open-circuited. This parameter is measured with a GR model 821-A impedance-measuring circuit, in an arrangement similar to that shown in Fig. 2.

The transistor is connected to its d-c bias supply and to the impedance bridge by the circuit shown in Fig. 4. This circuit is contained in a small metal box and is provided with two banana jacks which plug into the bridge UNKNOWN terminals. The d-c collector current is fed through the inductance which forms part of a turned circuit within the bridge. This inductance is connected directly across the unknown terminals.

Likewise, the d-c emitter current is fed through the inductance of a parallel-resonant circuit used to provide a high impedance in the external emitter-base circuit. The error introduced by using a finite, but large, rather than infinite terminating impedance, Z_{t1}, is given in the following equation. With $e_1 = -i_1 Z_{t1}$, then

$$Y_{out-oc} = h_{22}\left[1 - \frac{h_{12}\,h_{21}}{Z_{t1}\left(1 + \frac{h_{11}}{Z_{t1}}\right)h_{22}}\right] = h_{22}\left[\frac{1 + z_{11}/Z_{t1}}{1 + h_{11}/Z_{t1}}\right] \qquad (5)$$

where z_{11} is the open-circuit input impedance, $(h_{11} - h_{12}h_{21}/h_{22})$.

For Y_{out-oc} to be a measure of h_{22} with small error, it is necessary that $Z_{t1} >> h_{11}$ and $Z_{t1} >> z_{11}$. In the test circuit used in this measurement, the minimum Z_{t1} afforded by the parallel-resonant circuit over the frequency range is 25,000 ohms, which is adequate.

Procedure

After the bridge is initially balanced with the junction box plugged in, the tuned circuit is adjusted to reasonance by placing it across the UNKNOWN terminals of the bridge and measuring its admittance. This is easily done by strapping through the transistor connection, emitter to collector. The strap is then removed and the transistor is inserted in the circuit for measurement. Correction for frequency effects within the bridge may be necessary above 14 mc.

As an alternative to measuring the h_{12} parameter directly, the short-circuit output admittance, $y_{22} = g'_{22} + j\omega C'_{22}$, ($\mu$mho), is measured. In this case the termination required at the emitter-base terminals is a very low impedance, ideally a short-circuit.

Parameter y_{22} is measured after the h_{22} measurement, before the bridge and the terminating tuned circuit are readjusted to a different frequency. To measure y_{22} it is only necessary to turn tuning capacitor C_1 in Fig. 4 to full mesh, so the bent tip of one of the rotor plates makes contact with the adjacent stator plate. This short-circuits the tuned circuit and drops the terminating impedance to a few ohms or less.

Open-Circuit Voltage-Feedback Parameter

The open-circuit voltage-feedback parameter, $h_{12} = |h_{12}| \angle \Psi$, is equal to the ratio e_1/e_2 if $i_1 = 0$, as shown in Eq. 1. To make $i_1 = 0$, an

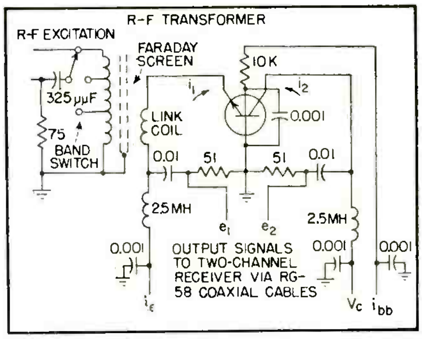


FIG. 6—Transistor junction box used for h_{21} measurement

infinite terminating impedance Z_{t1} is required. A voltage generator e_2 could be placed across the output terminals in Fig. 1 and the feedback voltage e_1 in the microvolt range, measured with a high-impedance voltmeter across the terminals. This voltmeter impedance, plus an additional parallel impedance to allow d-c emitter current to flow would result in a finite Z_{t1}. The error introduced by having a finite rather than infinite terminating impedance is determined from the relationship

$$\frac{e_1}{e_2} = \frac{h_{12}}{(1 + h_{11}/Z_{t1})} \qquad (6)$$

Probe-type vacuum-tube voltmeters which can measure in the microvolt region are available, but are accurate for frequencies up to only several mc. For measuring h_{12} with such a device one could provide a parallel-resonant circuit at the emitter-base terminals and tune out the capacitive reactance of the vtvm probe and associated wiring. At the same time, d-c emitter current could flow through the inductance. Moderately high values of operating Q in this circuit will make $Z_{t1} >> h_{11}$ so that a measure of e_1/e_2 will be a good measure of $|h_{12}|$.

Because of the frequency limitations involved with commercially available microvoltmeters as well as the difficulty in measuring the phase angle of h_{12}, it was felt desirable to measure h_{12} indirectly using the following relationship which involves the directly measured parameters already discussed

$$h_{12} = \frac{\frac{h_{11}}{h_{21}}(y_{out-oc} - y_{out-sc})}{\left[\frac{1}{1 + \left(\frac{Z_{t1-sc}}{h_{11}}\right)} - \frac{1}{1 + \frac{Z_{t1-oc}}{h_{11}}}\right]} \qquad (7)$$

If $Z_{t1-sc} << h_{11}$ and $Z_{t1-oc} >> h_{11}$, then

$$h_{12} \approx (h_{11}/h_{21})\,(y_{out-oc} - y_{out-sc}) \qquad (8)$$

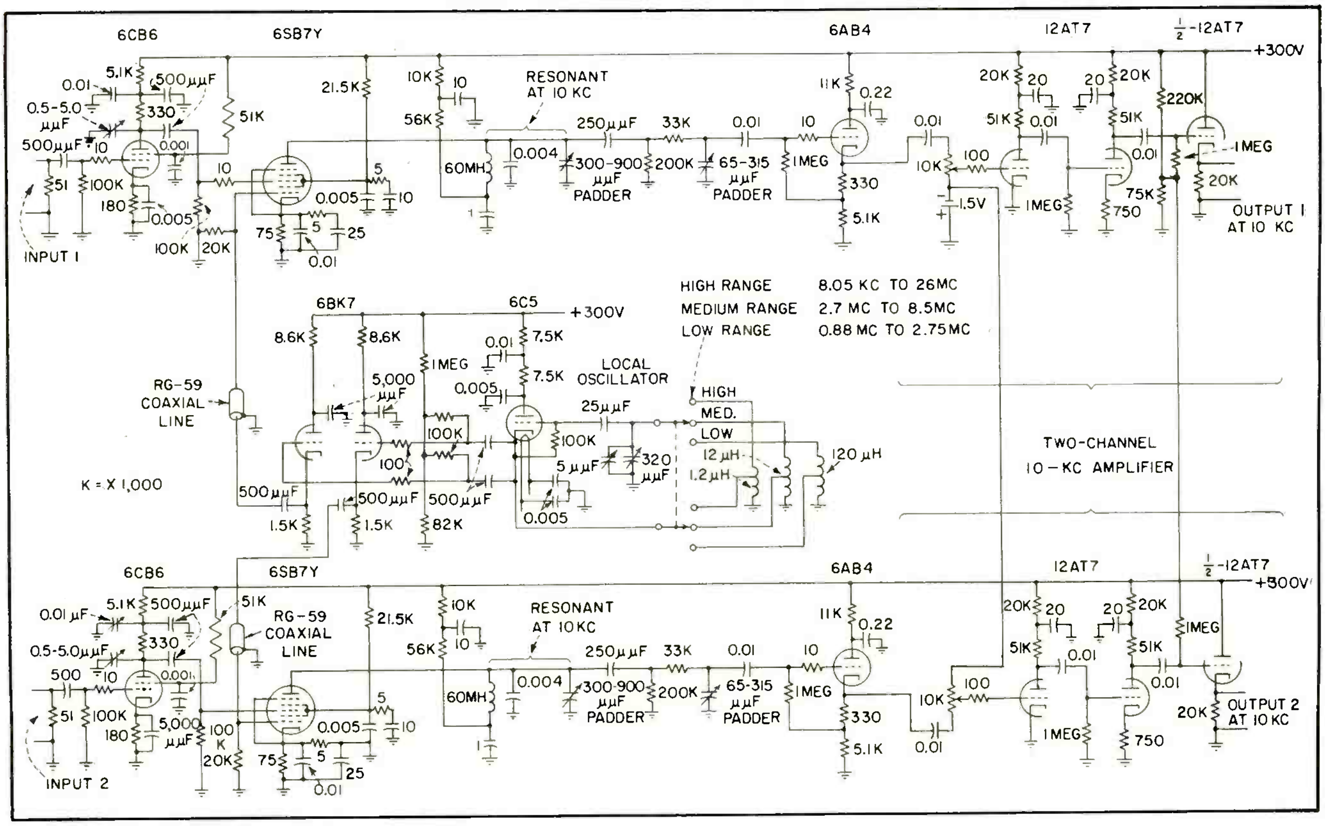


FIG. 7—Two-channel superheterodyne receiver covers frequency ranges of 8.05 to 26, 2.7 to 8.5 and 0.88 to 2.75 mc

If $Z_{t1-sc} = 0$ and $Z_{t1-oc} = \infty$, then
$$h_{12} = (h_{11}/h_{21})\,(h_{22} - y_{22}) \qquad (9)$$

Short-Circuit Transfer Parameter

The short-circuit transfer parameter is h_{21} or α, where $-\alpha = h_{21} = |h_{21}| \;\angle\theta$.

As shown in Eq. 2, $i_2/i_1 = h_{21}$ if $e_2 = 0$. This will be obtained if a short-circuit exists at the output terminals in Fig. 1. In the method of measurement to be described the two currents are measured as voltage drops across two low resistances of equal magnitude. Because each of these two voltages is developed across a low impedance, the circuit is not seriously disturbed when the reactance associated with the input capacitance of the vacuum-tube stage is connected across this impedance.

The value of h_{21} measured in this manner will have an error dependent upon the magnitude of the admittance used in the collector circuit Y_{t2} according to the equation

$$\frac{i_2}{i_1} = \frac{h_{21}}{1 + h_{22}/Y_{t2}} \qquad (10)$$

In the circuit used to measure h_{21}, Y_{t2} is 0.04 mho, hence $h_{22}/Y_{t2} << 1$.

One method of measuring the magnitude and phase difference angle of two r-f voltages in the microvolt range is to heterodyne these two voltages down to a much lower frequency, say to 10 kc.[3] The equipment used is shown in Fig. 5.

The r-f signal used to excite the transistor, as well as the d-c bias currents and voltages, is applied to the transistor in the circuit of Fig. 6. This circuit is contained in a brass box and includes an r-f transformer equipped with a Faraday screen. The primary is a tapped coil to cover the frequency range and is series-resonated at the operating frequency with the 325-$\mu\mu$f capacitor. The secondary is a two-turn link winding which is in series with the transistor emitter-base circuit.

The r-f voltage induced in the link winding causes an r-f current, i_1, to flow and the transistor in turn generates current i_2. A voltage e_1 proportional to i_1 is fed to a pentagrid-mixer tube and voltage e_2 proportional to i_2 is fed to a second pentagrid-mixer tube. If both mixers are excited with a common local-oscillator signal, 10 kc higher than the frequency of e_1 and e_2, the two difference-frequency signals will have the same amplitude ratio and phase-angle difference as e_1 and e_2, provided the amplitude and phase responses of the two channels are equal.

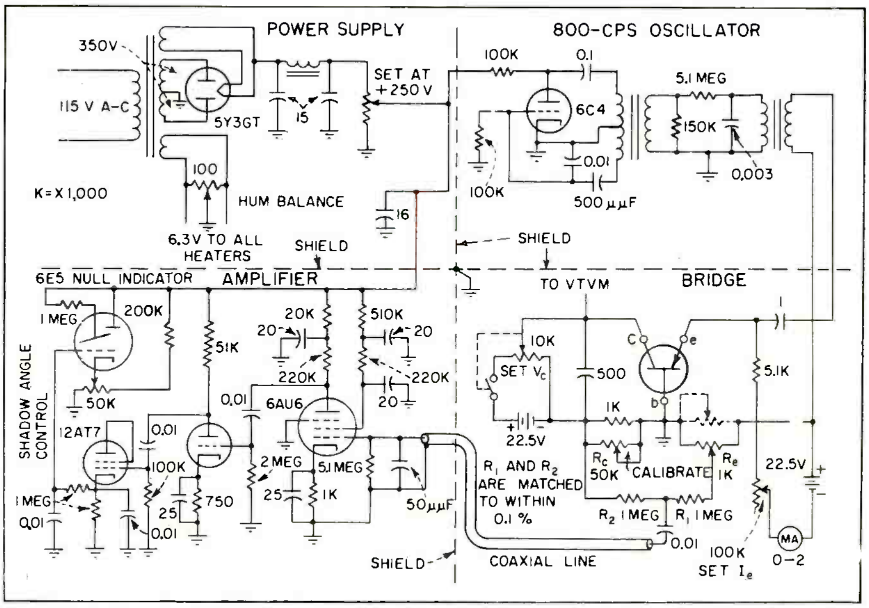


FIG. 8—Complete circuit of h-f α measurement meter

The bandwidth of the two 10-kc i-f channels is limited by a tuned circuit following the mixers to increase the signal-to-noise ratio of the system. An audio-frequency phasemeter indicates the angle of h_{21} directly.

To eliminate the necessity of having equal gain in both channels, voltages e_1 and e_2 are each switched into a common channel and the decibel ratio of e_2/e_1 is read on the Ballantine model 300 vacuum-tube voltmeter.

Two-Channel Receiver

The schematic diagram of the h_{21} two-channel receiver is shown in Fig. 7. The high-pass R-C filter shown following the tuned circuit at the output of each mixer stage attenuates the voltage induced in the inductance of this tuned circuit by stray 60-cps magnetic fields. The 65 to 315 $\mu\mu$f variable capacitor is used to equalize the phase shift between the two 10-kc i-f amplifier channels.

To determine the grounded-base alpha-cutoff frequency, the low-frequency h_{21}, designated as h_{21o}, must be known. The frequency at which $|h_{21}|$ is 0.707 of, or 3db down from, its low-frequency value (h_{21o}) is the alpha-cutoff frequency. The low-frequency value of α can be measured in a variety of ways.[4,5]

An instrument for obtaining a rapid answer is shown in Fig. 8. This is a bridge circuit, operating at about 800 cps. The bridge is balanced by adjusting multiturn-potentiometer control R_e until a null is observed on the 6E5 electron-ray tube. The value of h_{21o} is then read directly off the multiturn-potentiometer dial with an accuracy of $\pm$0.2 percent.

To insure that it is the small-signal h-parameters that are being measured, the amplitude of the r-f excitation from the generator is varied over wide limits by the attenuator. If the value of the parameter does not change with signal level, the transistor is operating as a linear or small-signal device.

The writer is grateful to R. H. Johnston for his help in the construction of the equipment and is also indebted to R. L. Pritchard for his criticism and encouragement during the writing of this report.

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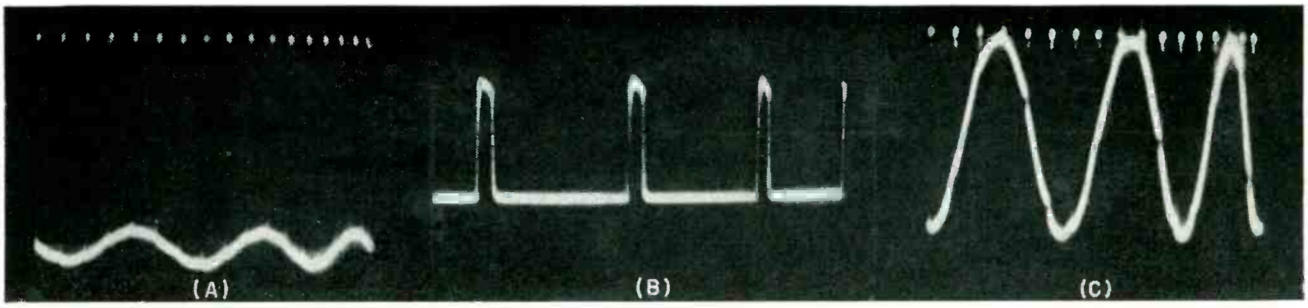


Comparison of limiter and audio silencer performance. Waveforms show input signal with pulses (A) and pulses alone (B); limiter

Silencer Kills Audio

SUMMARY —— Unique silencer circuit acts as electronic switch cutting off audio on noise peaks. This differs from Lamb silencer which acts on r-f and i-f stages. Article contrasts basic noise suppression techniques: filters, limiters and silencers. Waveforms compare limiter with audio silencer

By ALBERT A. GERLACH

Technical Director, Instrumentation Section
Cook Research Laboratories
Skokie, Illinois

NOISE SUPPRESSORS are based on frequency, amplitude and time filtering. Frequency filtering is employed where the undesired perturbations are continuous in time and confined to a relatively narrow frequency spectrum. Amplitude and time filtering are employed when the undesired perturbations are high-amplitude intermittent pulses in the time domain.

Figure 1A illustrates the operation of an ideal frequency-domain filter. The upper curve represents and ideal low-pass filter. The lower curve represents an ideal band-rejection filter. Such filters discriminate a signal from noise when the noise is outside the spectral range of the signal or is confined to small bands within the spectrum of the signal.

Figure 1B illustrates an ideal amplitude-domain filter. The upper curve represents an ideal low-pass amplitude filter such as a limiter or clipper circuit. The lower curve represents an ideal band-pass amplitude filter such as a slicer circuit. Amplitude filters discriminate between a desired message and high-level noise impulses.

Figure 1C illustrates the ideal time-domain filter. The upper curve represents an ideal low-pass time filter such as a switch in series with the signal line. The switch is closed up to time T_1, then is suddenly opened, blocking the passage of the

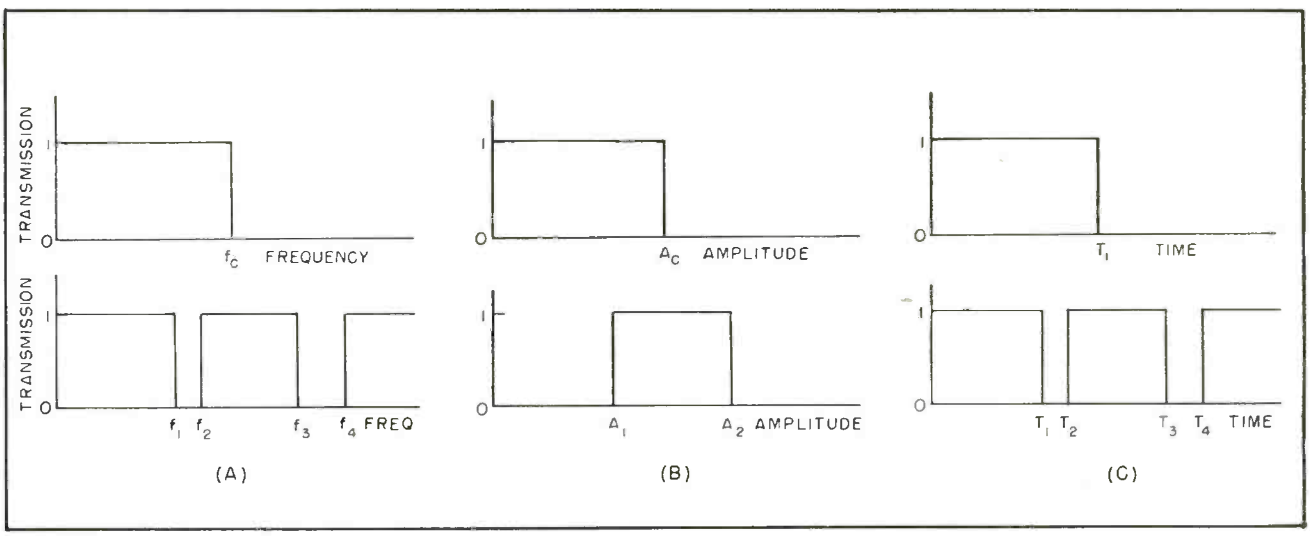
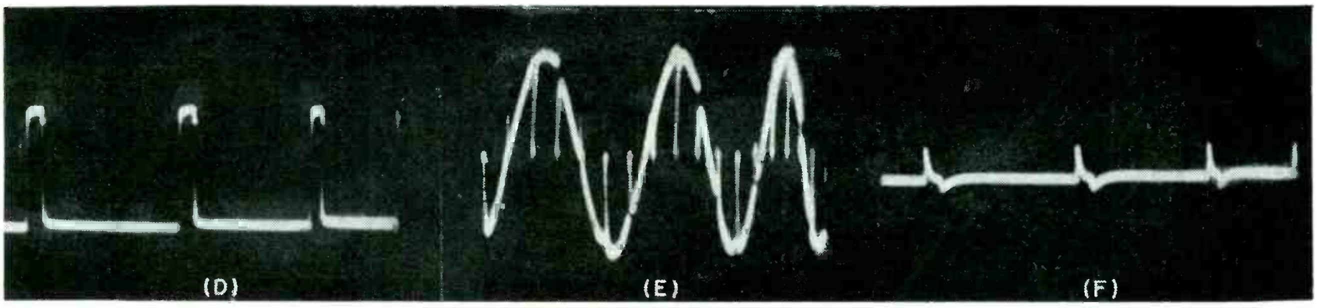


FIG. 1—Operation of ideal filter (A), limiter (B) and time filter or audio silencer (C)



output, signal and pulses (C) and pulses alone (D); silencer output, signal and pulses (E) and pulses alone (F)

Output on Noise Peaks

signal. The lower curve illustrates a band-rejection filter in the time domain. Such filters are desirable in suppressing high-level impulse noise.

Circuits

Figure 2A illustrates a simple time-domain filter for suppressing high-level impulse noise. The triode acts as a switch which is normally open in the absence of an interfering pulse. This allows the input signal to appear at the output. When a noise pulse appears, the grid is driven positive, closing the switch and shorting the output for the duration of the pulse.

Figure 2B illustrates a practical circuit for incorporating the time filter into the detector of a communications receiver. Such a circuit was constructed, and subjective listening tests made to compare the time filter with conventional limiters. Results indicated that the time filter was appreciably more effective in reducing the overall annoyance due to the noise impulses. This is due to the fact that there is much less average noise power in the output of the time filter than in the output of the limiter.

Oscillographs show the effect of both types of noise suppressors on a combined pulse and sine wave. In the absence of the sine wave, there still appears an appreciable pulse output from the limiter circuit while for the time filter the output is nearly free of interfering pulses.

Letting A be the peak level of the signal, $p(e)$ the amplitude probability distribution function of the signal and $e(t)$ the voltage of the signal $(-A \leq e(t) \leq A)$, the amplitude of the output noise pulse, for the amplitude filter will be

$$n_a = A - e(t) \qquad (1)$$

and for the time filter will be

$$n_t = e(t) \qquad (2)$$

The average noise output power in each case will be proportional to the average square of the noise-pulse amplitudes. From Eq. 1 and 2

$$\overline{n_a^2} = \frac{A}{2} + \frac{1}{A}\int_0^A e^2\, p(e)\, de \qquad (3)$$

since $p(e)$ is an even function. Also

$$\overline{n_t^2} = \frac{1}{A}\int_0^A e^2\, p(e)\, de \qquad (4)$$

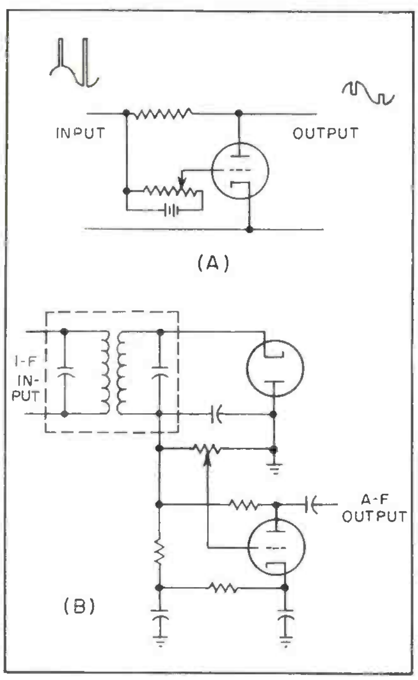


FIG. 2—Basic circuit (A) and circuit for use in communications receiver (B)

Thus n_a^2 is greater than n_t^2 by the quality $A/2$. The ratio of the noise-power outputs from Eq. 3 and 4 is

$$P_a/P_t = \overline{n_a^2}/\overline{n_t^2} = 1 + \left[A^2/2 \int_0^A e^2\, p(e)\, de\right] \qquad (5)$$

Assuming $p(e)$ is a normal distribution function with standard deviation equal to $A/2$, Eq. (5) reduces to

$$P_a/P_t \approx 1 + \left[\pi^{1/2}/\int_0^\infty x^2\, exp\,(-x^2)\, dx\right] = 5 \qquad (6)$$

Conclusion

Output noise power using the amplitude limiter is thus about five times greater than would be present if the time filter were employed. In practice the saving in noise power is generally greater because of speech pauses.

Time filtering of impulses has been employed in the past,[1] but only in the r-f and i-f portions of the receiver. Unfortunately, the effect is identical to amplitude filtering because zero transmission in the time domain on the signal space is equivalent to the negative peak of a 100-percent modulated wave. This is equivalent to peak clipping at the 100-percent modulation level.

The author acknowledges the assistance of M. J. Fenton and P. D. Padva in the construction and the testing of equipment.

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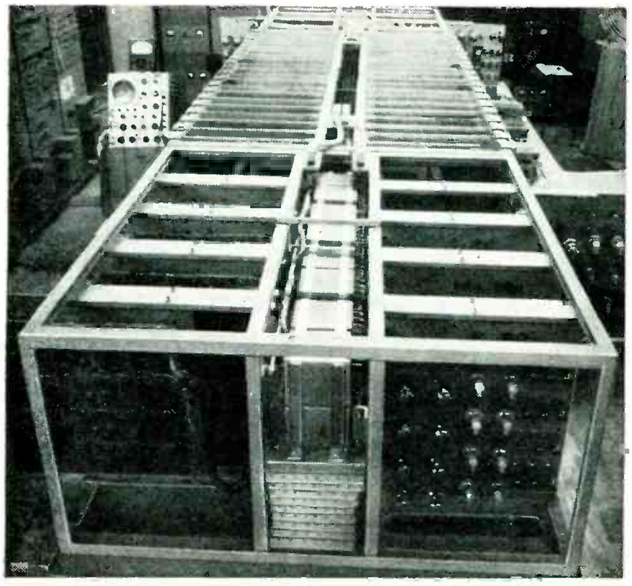
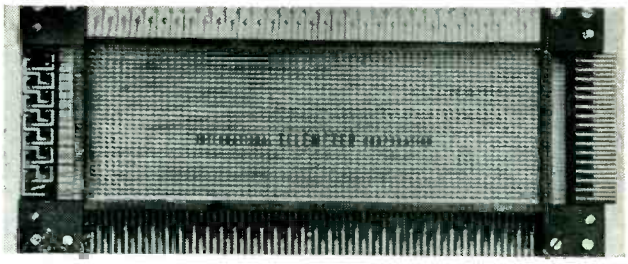
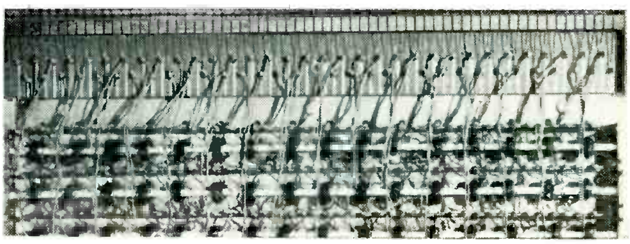


Ferrite-core memory is designed for JOHNNIAC computer



Magnetic switch



Storage matrix

Ferrite-Core Memory

SUMMARY —— Matrix wiring and pulse-switching circuits enhance reliability of 168,960-core memory for JOHNNIAC computer. Reading time is 4.5 microseconds, write time 10 microseconds. Mean error free operating time exceeds 35 hours

SQUARE-LOOP ferrite cores used in high-speed random-access memories for digital computers may be set in two remanent magnetic states. One of these states is defined as ZERO and the opposite state as ONE. Reading is accomplished by detecting the voltage induced in an output loop when the magnetic state of the core is changed.

In the usual arrangement, the cores are mounted in rows and columns. All cores in each row are linked by the common X line and all cores in each column by the common Y line. To select a given core (Fig. 1) it is necessary to energize each of two lines linking it with half the currrent necessary to change its magnetic state. Only the core at the junction of the selected X and Y lines will receive the necessary magnetomotive force. A current pulse sufficient to drive a core into the ZERO state is referred to as a P pulse; a pulse driving a core into the ONE state as an N pulse.

A reading winding linking all the cores detects a change in the magnetic state of the selected core. As the core changes its magnetic state, the flux will induce in the reading winding a voltage which is amplified. Other functions performed by the electronic circuits of the memory are selection of proper coordinate lines and generation of precisely controlled current pulses.

The memory to be described was designed to work with the Rand JOHNNIAC computer. A block diagram is shown in Fig. 2.

Design

The unit was designed to fit on top of the computer and is 10 feet

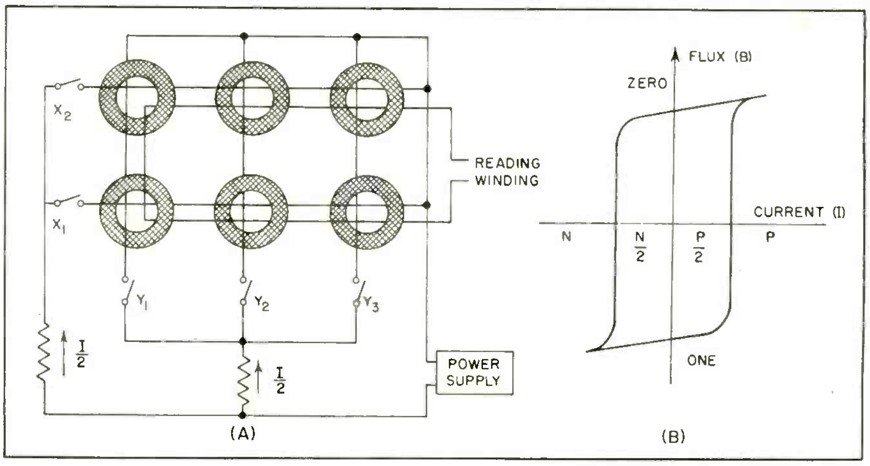


FIG. 1—Basic wiring of ferrite-core matrix (A) and square-loop magnetic characteristic of cores (B)

By M. A. ALEXANDER, M. ROSENBERG and R. STUART-WILLIAMS

International Telemeter Corp.
Los Angeles, California

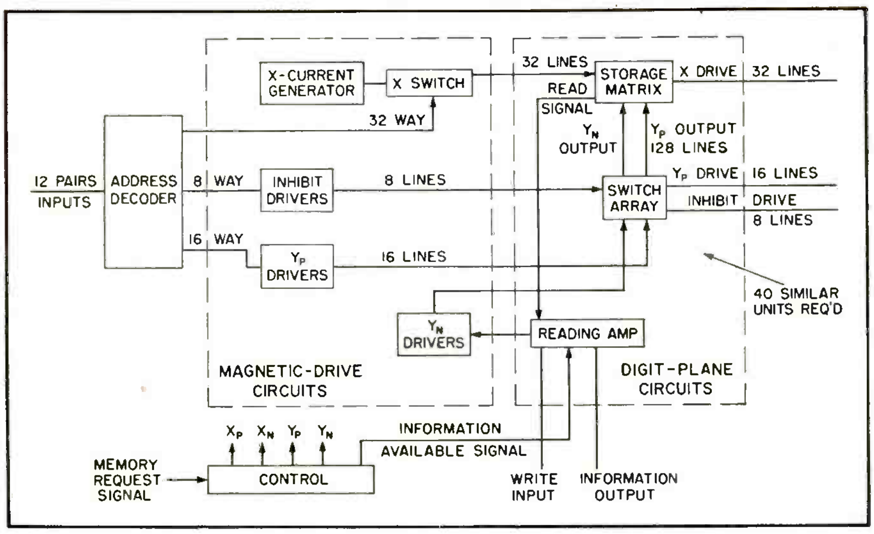


FIG. 2—Complete memory showing relation of electronic driving circuits to ferrite-core matrices

is Fast and Reliable

long, 39 inches wide and 19 inches high. The unit contains 1,207 tubes, 288 germanium diodes, 5,120 switch cores and 168,960 storage cores, some of which are built-in spares. The equipment consumes 6 kw of B+ power and 6 kw of filament power.

On a read order, the memory interrogates itself at the selected word address and makes 40 parallel bits available to the computer. This operation is completed in 4½ microseconds. During the next 10 microseconds, the memory writes back the information that was presented to the computer. On a write cycle, the memory readout signals are ignored and the write information is made available from the computer. The read-write orders are separated into four partial substitution groups of 8, 12, 13 and 7 bits each. An individual choice, read or write, may be made in each group.

The information is stored in 40 matrices of 4,096 cores each. One bit of each word is stored in each matrix. The matrices are rectangular and the selection of cores is made by drive currents applied to the *X* and *Y* coordinate drive wires.

In the *X* direction (32 lines) each core is linked by 3 turns and each line is common to the 40 matrices. Each matrix contains 132 *Y* lines, of which four are spares. The *Y* lines link each core with one turn. The *Y* lines drive only one matrix.

Each matrix includes a single-turn reading winding that links every core in the matrix. The winding is illustrated in Fig. 3.

Driving Waveforms

Waveforms which drive the memory are shown in Fig. 4. The *X* current is set up first and drives every core on the selected *X* line in the *P* direction of Fig. 1B. When all the electromagnetic and electrostatic disturbances due to the application of this pulse have died down, a pulse is applied on a selected *Y* line—also in the *P* direction. The core receiving the sum of these two currents is the selected core. The output of the matrix is sensed during the application of the Y_P pulse and the reading signal is affected only by the disturbances caused by the Y_P pulse.

The pulse applied to the *Y* line is routed through a magnetic switch of which the *Y* line is the output winding. There are 40 magnetic switches driven in cascade providing a drive pulse to each array. Since the *X* pulse is also common to 40 arrays, there are 40 selected cores providing 40 output signals in parallel.

In a single matrix 128 cores receive a half-excitation when the *X* pulse is applied. There are 32 cores similarly excited when the Y_P pulse is applied. Since the minor-loop disturbances in the *X* winding are allowed to die down before the core output is read, the problem is one of coping with the disturbances due to 32 cores on the selected *Y* line.

The reading winding links alternate cores on the *Y* line in opposite directions. Some cancellation also occurs in the *X* line due to the method of lacing the reading winding on a fold matrix.

Because of the matrix construction and program drive, the matrices are simplified since the reading winding does not have to be diagonally interlaced but runs parallel to the *X* lines. Since cancellation is required from only a single *Y* line of 32 cores it can be done accurately. This will improve the dynamic reading ratio which is a function of the cores on the selected *Y* line. The 32 × 128 configuration allows optimum design of

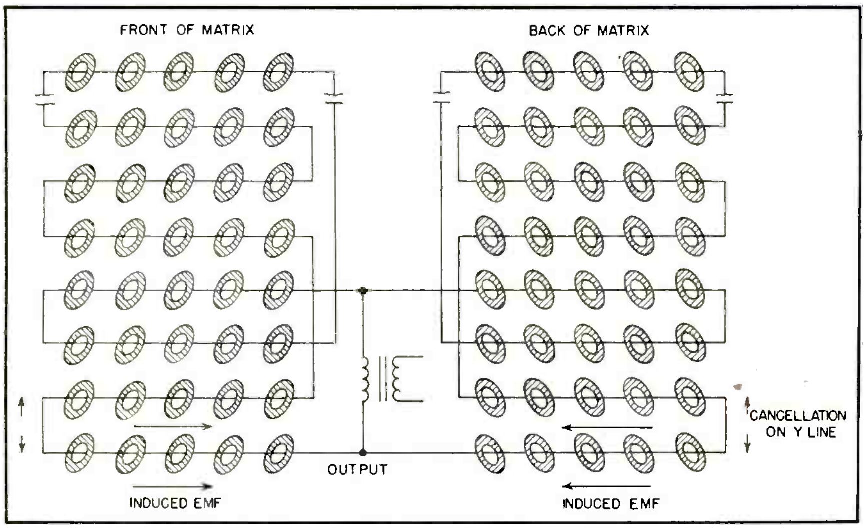


FIG. 3—Reading-winding layout contributes to memory's reliable operation

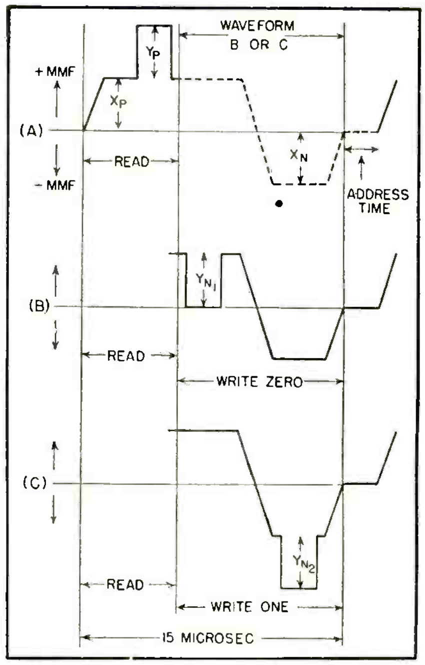


FIG. 4—Driving waveforms for memory

the driver circuits, particularly on the Y switch drive side.

Referring to Fig. 4, the part of the pulse cycle, up to and including the Y_P pulse, is the read part. The 40 output toggles which supply the outputs are either set into the ONE state by a ONE signal from the matrix or left in the ZERO state to which they have been cleared by a register-reset pulse at the beginning of each memory cycle.

These toggles are asociated with the reading amplifiers which feed them and with the Y_N core drivers which perform the write operation during the last 10 microseconds of the cycle. The binary state of the toggle will determine which of two Y_N pulses will be used. An individual decision is made in each of the 40-bit positions. At the end of the read part of the cycle, all the selected cores are in the zero state.

To write zero, the Y_N pulse, which is also routed through the magnetic switch, subtracts from the existing X_P pulse. The net mmf is zero and the core moves on a minor loop to the $+B_r$ or zero state. The write zero, Y_N pulse returns the switch core to its $-B_r$ value and closes the switch-core flux loop, see Fig. 5A.

To write one, the storage core must be driven from the $+B_r$ or zero state to the $-B_r$ or one state. The Y_N pulse is combined with an X_N pulse and the storage core is set in the one state. In each case, the driving switch core is reset.

The cycle is a symmetrical one. The net flux change is zero whether a read or write cycle is used.

The memory uses 4,096 $\times$ 40 storage cores and 128 $\times$ 40 switch cores.

Storage cores are of square-loop material with a one-microsecond turnover time and have dimensions of 100-mil o-d, 70-mil i-d and 30-mil thickness. The storage cores are 0.360 in. o-d, 0.245 in. i-d and 0.118 in. thick.

Drive Pulses

The storage-core drive pulses are $\frac{1}{2}$ P = 0.475 ampere-turn and full P = 0.95 ampere-turn. The output signals from a single-turn reading winding are shown in a photograph. The storage cores are tested and graded over a range of drive currents before they are built up into a matrix. Their working tolerance is distributed between the X and Y drivers, with more tolerance given to the Y drivers. This compensates for variations in switch-core characteristics.

A switch-core array consists of 128 cores divided into eight groups of 16. Each group is connected to an inhibitor circuit which biases the switch cores well into the $-B_r$ region. There are 16 Y_P pulse drivers which link one core in each inhibit group. Both the inhibitor and Y_P lines drive through the 40 switch arrays in series.

There are also 40 Y_N drivers, one for each switch array. The Y_N line links every core in its array. See Fig. 5B.

The 12-bit address inputs from

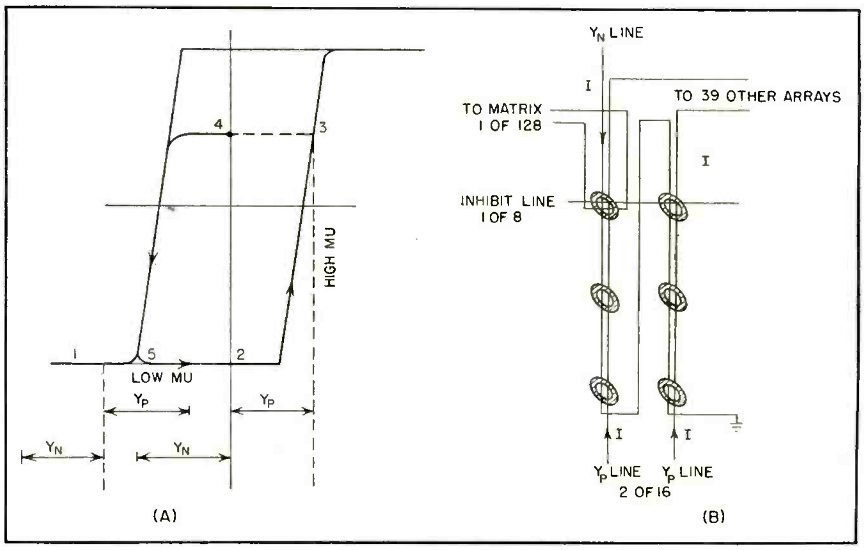


FIG. 5—Switch-core operating loop (A) and switch wiring scheme (B)

the computer are split into three groups. The five least significant bits select one of the 32 X lines. The next 4 bits select the appropriate Y_P switch driver. The last 3 bits select an inhibit circuit which removes the bias current from the switch row.

The Y_P circuits drive one switch core in each inhibit group and select one of the 128 Y lines in a matrix. The Y_{N1} or Y_{N2} pulse is applied to the switch driving every core in a direction opposite to the Y_P drive and only the selected switch core will generate the flux required to produce a Y_N pulse in the output line. This address information is set up before the memory request cycle is made.

The X winding and the reading winding are in parallel and employ quadruple Formvar-coated wire. The Y wires are quadruple Formvar-coated Nichrome.

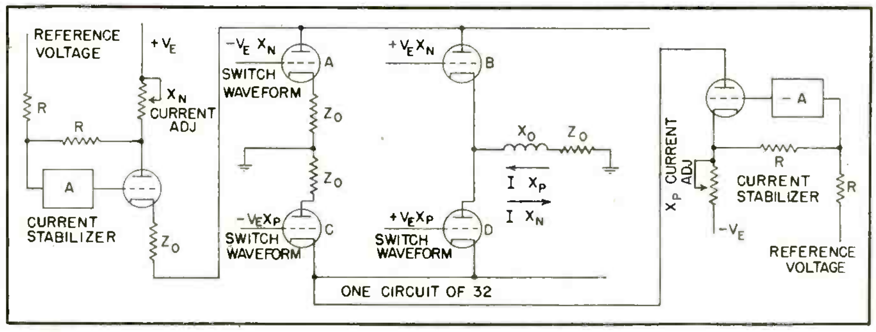
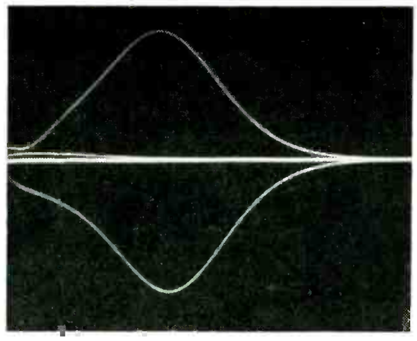


FIG. 6—Simplified X driver. Current stabilizers compensate for impedance variations from line to line



Output signals from reading winding

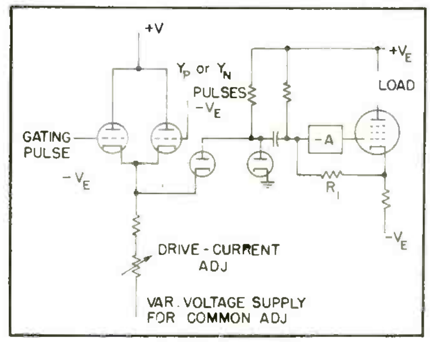


FIG. 7—Simplified Y driver

Electronic Circuits

The X line has a delay of one microsecond, a characteristic impedance Z_0 of 300 ohms and may be driven with a pulse whose rise time is 0.75 microsecond. Pulse amplitude is 160 milliamperes and the line produces a 48-volt drop.

The method of driving the memories is shown in Fig. 6. During an X_P pulse, the C tube is cut off and one of the 32 D tubes is switched on. This routes the X_P current through one X line of every matrix in the P direction. During an X_N pulse, the A tube is cut off and one of the 32 B tubes is turned on. This routes the X_N current through the matrix. The output impedance of the current stabilizers is high. This takes care of impedance variations from line to line and reduces to small proportions the change in line current caused by the increased voltage drop across the switch tubes as they age.

The Y_P and Y_N driver circuits are similar. A basic circuit is shown in Fig. 7. The tendency of the output-tube amplification factor and the cathode resistance to give a high variational impedance at the plate is increased by the feedback loop. The control of the current drawn through the feedback resistor, R_1, allows the pulse-current amplitude to be adjusted. Means are provided for individual or common adjustment of drive-pulse amplitude.

Readout Circuits

The reading circuits accept the output from each matrix and amplify it to a level which will set the output toggle circuits. This input signal may be positive or negative because of the canceling connection used in the matrix. The reading amplifier must deal with signals of either polarity and provide unidirectional outputs to the logical circuits.

The signal applied to the amplifier input is not the clean, well-defined signal which is obtained from a single core. The X-signal disturbance is large and high-frequency disturbances are coupled into the reading winding. Electrostatic pickup is present due to the Y signal.

Capacitive coupling between the X winding and the reading winding causes the reading winding to shift its d-c level by an amount greater than the turnover signal amplitude.

The reading winding is coupled to the amplifier input by a balanced low-capacitance stepup transformer. This transformer, in conjunction with additional components in the circuit, forms a low-pass filter with an appropriate passband.

The reading amplifier is a differential amplifier with a high common-mode rejection which deals with the d-c shift problem. Feedback gives defined gain and frequency response. The push-pull amplifier output is fed to a high-impedance differential-rectifier circuit which provides a single-polarity ONE signal of 15 volts at its output. The read signal is strobed after the signal has been subjected to a defined amount of integration in the reading amplifier. The control unit provides timing pulses to the rest of the equipment and the circuits follow standard computer procedures. Specifications called for a mean free time of five hours. However, in its first six months of operation, the memory has had an average mean free time in excess of 59 hours.

There was to be an acceptance test of 72 hours during which no preventive maintenance was permitted. During these 72 hours, the memory was not to make more than 14 random errors. The memory completed the 72 hours of continuous operation with no random errors and only one tube failure. In the first six months of operation, the memory has made only one random error.

Universal Shutter Tester

SUMMARY — Direct-reading device measures camera shutter-speed deviation in accordance with ASA rating method. Circuit incorporates d-c amplifier that has no drift with heater-voltage variations of up to one volt

By AUSTIN B. WESSEL

W. B. A. Chec-A-Shutter
Los Angeles, California

NEED HAS EXISTED for some time for a photographic-shutter tester that measures between-the-lens and focal-plane type shutters with equal facility.

This article describes an electronic shutter tester which provides a rapid indication of the speed deviation of both types of shutters.

Shutter Operation

The between-the-lens shutter is placed close to the optical center of the lens and consists of a number of interleaved blades that open from the center outward, remain open a set length of time and then close. The opening and closing times remain constant regardless of the length of time the blades remain in a fully open position. A light-transmission plot of duration and quantity will show a trapezoidal form, as in Fig. 1. Line *AB* represents the effective shutter speed, *CD* the total length of time any light passes through the shutter and *EF* the time the blades remain fully open.

The focal-plane shutter operates in front of the focal point of the lens and has two basic forms. One is made of several slots of different widths cut in a roll of opaque-fabric curtain.

The other type utilizes two curtains and constant curtain velocity. Exposure is varied by changing the distance from the leading edge of the second to the trailing edge of the first curtain, for shutter speeds above 1/25 of a second. At slower speeds one curtain completes its run before the other curtain is released. Effective exposure time for this type of shutter is the time required for the shutter slit to move its own width.

The effective shutter speed, line *AB* or the time it takes the slit to travel its own width, can be measured by placing the shutter in a beam of collimated light and measuring the duration of light passage by using an infinitely small light pickup whose energy, when illuminated, is transferred to a time computer. The block diagram of Fig. 2 outlines a practical modification of this concept.

The filament image of a standard 32-candlepower automobile lamp is focused with a 2-inch focal-length condensing lens upon a very narrow slit 0.004 to 0.005 inch wide. Positioned about ¼ inch below the slit is a germanium photodiode. Light falling on this transducer changes its resistance. This resistance change and the resulting voltage change are amplified by a d-c

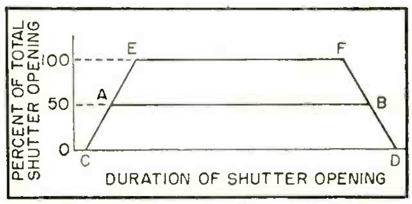


FIG. 1—Light transmission through shutter as function of shutter opening

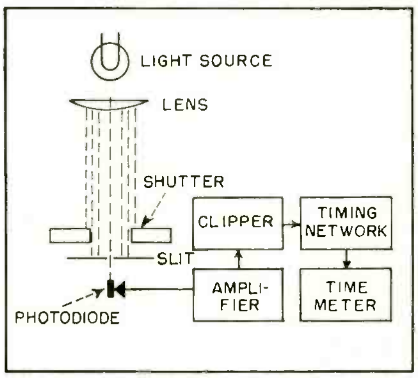


FIG. 2—System block diagram

amplifier to a potential of from 18 to 20 volts. This is clipped to a 15-volt level before being applied to the timing network, which consists of a number of fixed resistors, one for each indicated time interval, switched in series with a fixed capacitor. The amount of charge on the capacitor is measured by a meter calibrated 0 to 150. A reading of 100 on the meter indicates that the shutter being tested is 100 percent accurate; any deviation from this norm may be read directly as a percentage of shutter error.

Circuit

Light striking the germanium photodiode develops a voltage across load resistor R_1 in Fig. 3. This voltage is fed directly to the grid of amplifier V_{1A}. The other half of this tube, V_{1B} forms an arm of a bridge circuit. The output of V_{1A} is directly coupled to V_{2A}, it's replica except for bias. In a static dark-diode condition, the grid of V_{1A} is about 0.7 volt negative and the grid of V_{2A} is at chassis-ground potential. A light pulse striking the photodiode changes the 0.7-volt bias to approximately 0.5 volt and results in the grid of the V_{2A} being driven nearly to cutoff. Since the grid of the cathode follower V_{3A} is also at chassis ground under no light conditions, it is driven 20 to 22 volts positive.

For between-the-lens shutters and focal-plane shutters of the fixed-slit-width, variable-speed type, the readable accuracy of the meter is 3 percent. For 35-mm focal-plane shutters of the constant-velocity, variable-slit-width type, the same figure applies up to speeds of 1/250 second. At 1/500 second, accuracy is 4 percent and at 1/1,000 second it is 6 percent maximum.

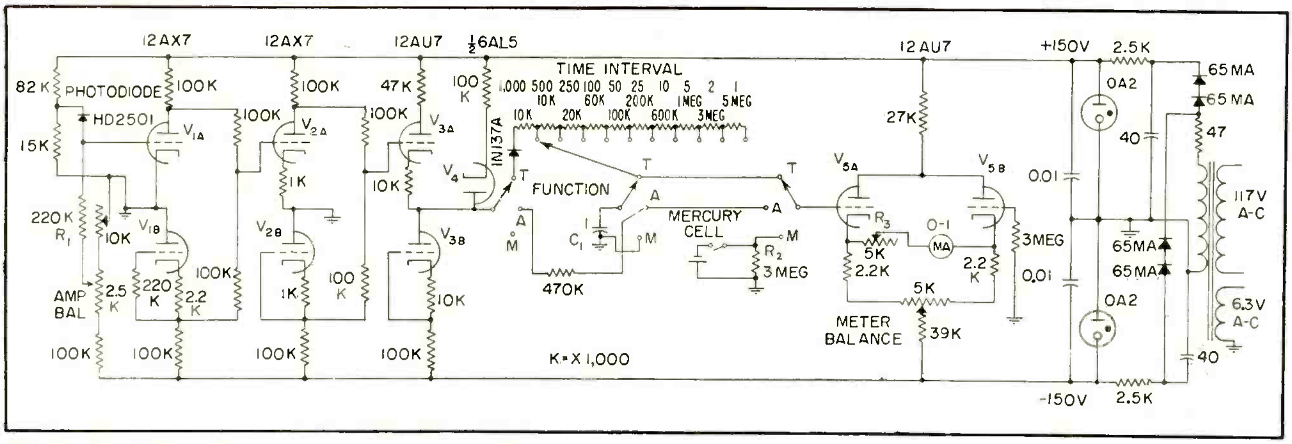


FIG. 3—Amplifier portion of circuit has gain of 300 and requires two +150-volt supplies or one tapped +300-volt supply

The variation in accuracy is tied in with the ratio of aperture-plate-slit width and curtain-slit width.

The overall gain of the d-c amplifier from the input grid to the grid of the cathode follower is 300. A 2,000 cps square wave shows no distortion. With 2,200-ohm cathode resistors in the second amplifier stage and a sine-wave input, the amplifier is flat to 22,000 cps and down 3 db at 26,000 cps.

When constructing this device a very low-noise photodiode must be picked. If a group to select from is not at hand, the safest thing to do is to eliminate the second amplifier stage. This will also require changing the clipper bias, reversing the polarity of the 1N137 diode, reducing the resistor values in the timing decade to 1/10 the values given and hand calibrating the meter as the scale will no longer be linear.

Diode load resistor R_1 should be just large enough to give the required 18 to 20-volt swing at the cathode-follower output. The 6AL5 clipper should be removed from its socket while making this test. The 220,000-ohm load resistor specified may have to be varied if another type of photodiode is used. Should this change be necessary, the grid resistor in the other half of the 12AX7 should be of the same value as the new load resistor.

The reference to chassis ground does not infer no bias at static condition. The cathode of the second amplifier is about 0.5 volt positive and that of the cathode follower is 4 volts positive.

This fulfills a requirement of the capacitor in the timing network that no potential exist across it prior to light striking the photodiode.

Timing

The timing network is designed around the equation $T = RC$. This formula is usefully solved only by the assumption of the application of a known voltage. Since the measured charge on C provides the visable indication of the time interval being measured, the voltage applied to the network must be of a constant value. To assure this condition, the 18 to 20-volt cathode-follower swing is clipped to a constant 15 volts positive by biased clipper V_4.

The time-interval switch has 10 positions each identified as the reciprocal of the actual time to be measured. Resistors inserted by this switch are ten times the $T = RC$ calculated value. This is allowable as the vtvm has a sensitivity of about 1.7 volts full-scale and the voltage applied to the timing network is 15. The result is operation on the most linear portion of the universal-time-constant curve allowing the use of a uniformly divided meter scale.

The 1N137A silicon diode connected between the arm of the timing switch and timing capacitor C_1 has negligible forward resistance and high back resistance. This allows the capacitor to be readily charged, but to be discharged slowly holding the meter needle deflection at peak capacitor charge long enough to be easily read. A secondary advantage of this discharge blocking action is the removal of any time-lag error, which might result from friction and inertia in the meter movement.

The vtvm circuit is extremely stable after warm up because of its balanced design and voltage-regulated B + supply.

Moving the function switch to the M position breaks the connection from the cathode follower, shorts out the timing capacitor and establishes contact between grid resistor R_2 and the input grid of the vtvm tube. This allows the voltmeter circuit to be zero balanced with the *METER BAL* potentiometer.

Indexing the switch to A allows the plate of the lower half of the cathode follower V_{3B} to be balanced to ground. The filtering action provided by the series R-C circuit is necessary to prevent needle jitter caused by random noise in the photodiode and also gives a slight amount of float to the *AMP BAL* control. In the time position, T, one or more resistors in the timing decade are placed in series with C_1 completing the $T = RC$ equation.

Calibration

Calibration is done with a master shutter of the focal-plane type driven by a synchronous motor. Potentiometer R_3 in series with the meter is used to bring the needle swing to the 100 mark on the meter dial. After proper adjustment the switch in series with the mercury cells is closed and the meter reading recorded.

Thyratron Inverter Uses

SUMMARY — Circuit permits control of a-c output voltage without cumbersome saturable reactor, with improved regulation, efficiency and response speed. One thyratron serves as control tube for extinguishing the conducting power tube at any desired time up to 180 degrees

By FRANCIS LAWN

Chief Engineer
Lawn Electronics Co.
Freehold, N. J.

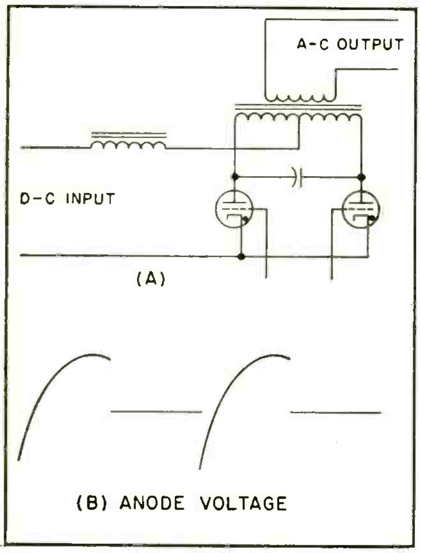


FIG. 1—Conventional thyratron inverter

STATIC INVERTERS using thyratron tubes have been used successfully for a number of years. They generally find application where loads are fairly constant or variations in load or d-c input voltages are relatively slow. This article introduces a new system for controlling thyratron-type inverters. The system increases the usefulness and reliability of the thyratron inverter by providing a fast, simple method of regulating the output voltage and therefore allowing greater and faster load or input voltage variation. This new method of controlling the output power of the inverter eliminates the need for cumbersome and bulky saturable reactors and also eliminates the time delay associated with these elements.

The important variation in this circuit is that the inverter power tubes are not required to conduct for a full 180 degrees of the frequency of operation. The circuit uses three thyratron tubes instead of the usual two. The function of the third or control tube is to extinguish the conducting power tube after any desired time up to 180 degrees. This unique feature can be utilized to provide regulation of the output voltage with an almost instantaneous response.

Figure 1A is the schematic of a conventional thyratron inverter circuit. Each tube is fired by a positive pulse from the grid circuit, and must continue to conduct current until its anode voltage is driven negative with respect to the cathode by the firing of the next or opposite tube. The output voltage of this inverter, after the component values are fixed, depends on the load and the d-c input voltage. The wave shape of the voltage on the anode of each thyratron tube is indicated in Fig. 1B.

Drawbacks of Basic Inverter

The regulation of this type of inverter is poor and constant output voltage is generally obtained by placing a saturable reactor in series with the load. The reactor can be controlled to keep the output voltage constant but there are many disadvantages to this system.

The conventional inverter must invert the v-a required for the reactor drop as well as the load, thus limiting efficiency and power that can be obtained from a given set of tubes or a given output transformer. Changing the reactor impedance to compensate for line or

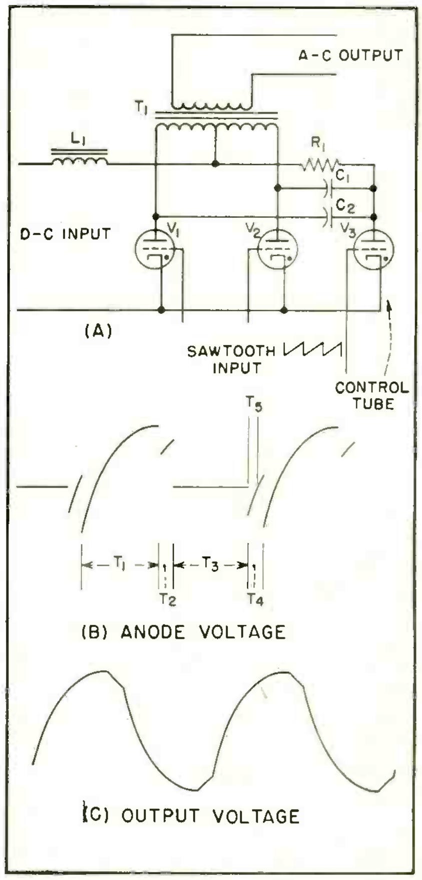
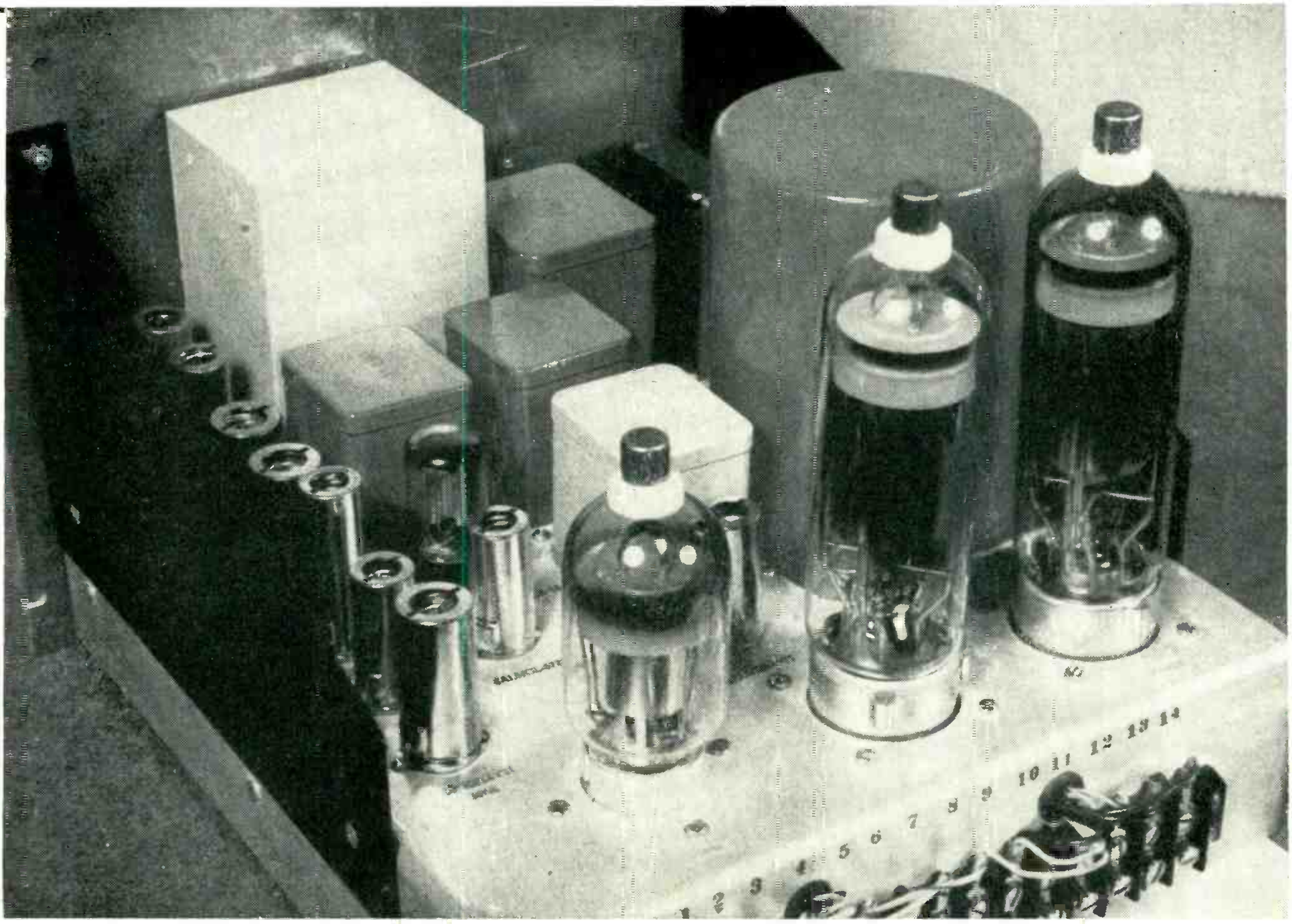


FIG. 2—Basic circuit of new controlled-firing-time inverter

Controlled Firing Time



Rear view of controlled-firing-time inverter, showing frequency-determining and wave-shaping tubes (left), control tube (at left rear on chassis) and power thyratrons serving as inverters for changing d-c input power to a-c output power at 60 cps

load variation changes the power factor of the inverted load, which limits the load range. Also, saturable reactor response is generally slow. This time lag limits the rate of allowable load variation.

Figure 2A is the schematic of a controlled-firing-time inverter, showing the third or control tube and the commutating capacitors between the control tube anode and the anodes of the power tubes. Power tubes V_1 and V_2 are fired alternately 180 degrees out of phase with each other. If the control tube is not fired the circuit operates the same as that of Fig. 1.

If the control tube is fired, its anode will drop to approximately 8 volts. The voltage across commutating capacitors C_1 and C_2 cannot change instantaneously. Thus the anodes of both power tubes will be driven in a negative direction.

The voltage on the anode of the conducting power tube was approximately 8 volts, so when it is driven in a negative direction the tube will cease to conduct. If this action takes place before the power tube has conducted for a full 180 degrees full power will not be delivered to the load.

When the control tube is fired at twice the frequency of the power tubes it will extinguish each power tube in turn and the firing of the next power tube will extinguish the control tube, thus completing the cycle of operation. The amount of power delivered to the load is a function of the length of time, or number of degrees, that the power tubes conduct. Therefore the amount of power delivered to the load can be controlled by changing the phase of firing of the control tube which in turn controls the conducting time of the power tubes.

Figure 2B indicates the wave shape of the voltage on the anode of power tubes V_1 or V_2 when these tubes are conducting for 150 degrees and control tube V_3 is conducting for 30 degrees each half-cycle. During time T_1 the opposite power tube is conducting. During times T_2 and T_4 the control tube is conducting. The power tube being viewed conducts during the time T_3, and T_5 is the time allowed for the power tube to deionize before positive plate voltage is reapplied.

Figure 2C indicates the wave shape of the output voltage under

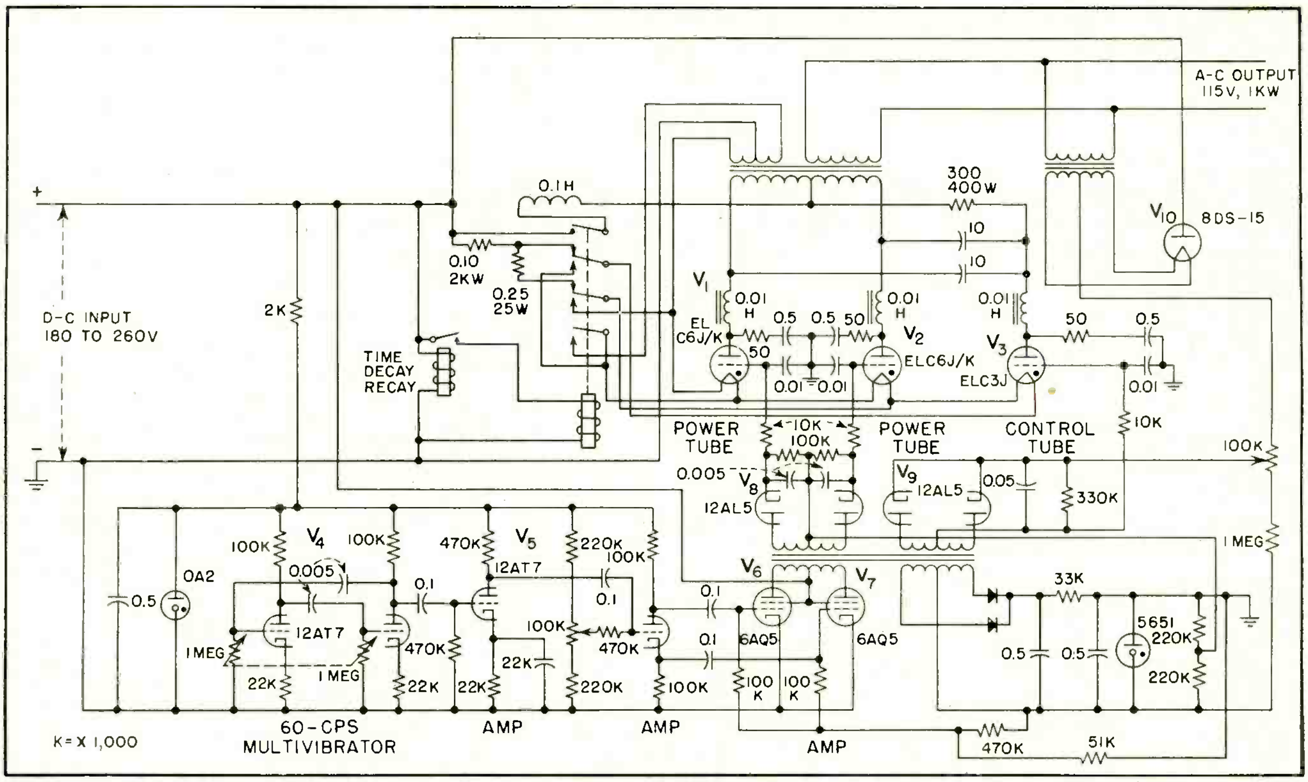


FIG. 3—Complete circuit of controlled-firing-time inverter, including frequency-determining multivibrator. Relay starts heaters or filaments on d-c, then changes over to a-c operation

the conditions of firing mentioned above. The sharpness of the breaks in this wave can be removed by cushioning circuits on the power tubes.

Advantages

Some of the advantages of this circuit are:

(1) The power tubes and output transformer provide only the v-a required at the load, and therefore more power can be obtained from a given set of tubes and a given output transformer.

(2) No saturable reactor is required. This fact in conjunction with a smaller output transformer leads to a smaller and lighter inverter.

(3) The power factor at the output of the inverter is dependent only on the load and is not affected by any reactor changes.

(4) The response time of this regulating system is limited only by the sensing element. The system can act within the half-cycle of operation.

(5) Deionization of the power tubes is more reliable because the anode is driven negative a second time by the firing of the opposite power tube of the inverter pair.

When the anode of a conducting thyratron tube is driven negative it does not remain negative, but immediately begins to rise as shown in Fig. 2B. The tube will start to conduct when its anode voltage becomes positive unless enough time has passed to allow the tube to deionize so that the grid can regain control. The time that the tube anode remains negative in Fig. 2B is determined by the values of commutating capacitors C_1 and C_2 and resistor R_1 of Fig. 2A. The values chosen depend on two important factors: (1) Large values of C_1 and C_2 and small values of R_1 keep the tube anode negative for longer periods, thus allowing time for deionization; (2) small values of C_1 and C_2 and large values of R_1 provide higher efficiency for the circuit.

The time constant of C_1 or C_2 and the load determines the rate of voltage increase on the anode of the tube but the time constant of R_1 with C_1 and C_2 determines the initial negative voltage on the anode of the tube. The values of C_1, C_2 and R_1 must be such that they allow ample deionization time but the circuit should be designed to obtain the shortest possible deionization of the power tube to obtain the highest efficiency from the circuit.

The amount of time required for the thyratron tube to deionize depends on a number of factors, some of which are the physical structure of the tube, the gas filling, the current it carries, the applied voltage, the grid circuit impedance and the negative grid voltage.

Choice of Thyratrons

The structure and the gas filling can be considered in the choice of a proper tube. The current and the applied voltage are determined by the required power output and the d-c input voltage. The grid impedance and the negative grid voltage can be determined by the designer. The grid impedance should be kept as low as possible but must hold the grid current within the limits for the tube being used. Some systems for obtaining the proper grid impedance are explained in the literature on thyratron operation.

The negative grid voltage should be as large as possible but again must be held within the limits of the tube. Tube ratings should be considered carefully because the allowable grid voltage is a function of the applied plate voltage.

Complete Inverter

Temperature and deionization time considerations led to the use of inert gas tubes (ELC6J/K) in the complete inverter circuit of Fig. 3. This circuit shows one simple method of obtaining the voltage for the grid of the control tube.

In this operating circuit inductors have been placed in series with the anodes of the thyratron tubes and capacitors and resistors have been connected across the tubes. These components were not mentioned in the theory of operation of the inverter because their purpose is to insure long tube life.

The rate at which current ceases to flow and inverse voltage is applied to inert gas tubes is limited. The limit, called the commutation factor, is the product of voltage change per microsecond and current change per microsecond.

The inductors and capacitors are included in the circuit to decrease the commutation-factor duty on the tubes and therefore increase tube life. If these components were not included in the circuit the anode of the conducting tube would be driven negative at a high rate when V_3 fired, and tube current would drop at a correspondingly high rate. The inductance in series with the anode of the tube causes the current to continue to flow for a short time after V_3 has fired, and the capacitor across the tube causes the anode voltage to change at a slow rate. The value of these components must be chosen so that oscillation does not occur and the commutation factor is within the tube rating.

The tubes used in this circuit have a high commutation-factor rating and do not actually require the capacitor-resistor combination, but most other inert-gas thyratrons do require this cushioning. The cushioning helps remove the sharp breaks in the output wave shapes.

Stability

The circuit shown operates from a d-c source that can vary from 180 to 260 volts. The unit supplies 1 kva at 115 volts, 60 cps. The output voltage remains constant within 2 volts for full input voltage swing and simultaneous load changes from full to 10 percent load. Frequency remains constant within 0.25 cps. The wave shape of the output voltage varies with the phase of firing of the control tube; in the range from 70 percent to full load the wave shape of the output voltage is nearly sinusoidal.

The 60-cps frequency of operation is obtained from multivibrator V_4. The plate voltage for this is held constant by a type 0A2 voltage-regulating tube to obtain reasonable frequency stability. The output is amplified by V_5, V_6 and V_7 for feeding the grids of power tubes V_1 and V_2 and the grid of control tube V_3 and for feeding a bias supply to hold the grids below ground.

The filaments of the tubes are supplied by the d-c input voltage to start the inverter. Once the inverter is started filament power is obtained from its output.

Rectifier Circuits

The wave shape with a sharp leading edge for firing the power tubes is obtained by feeding each power tube grid through a half-wave rectifier (V_8). The wave shape for firing the control tube is a sawtooth with a sloping leading edge and a sharply drooping trailing edge. This wave, having twice the output frequency, is obtained from the negative side of full-wave rectifier V_9, feeding a capacitor and bleeder resistor. The positive peaks of this wave lead the peaks of the grid waves on the power tubes by a few degrees. The lead should be as small as possible so that the power tubes will be under control up to nearly 180 degrees of conduction. A sloping front edge is used on the waveform of the grid of the control tube, so that varying the d-c potential on the grid circuit causes the grid wave to intersect the critical grid voltage at varying points, thus changing the phase of firing of the control tube.

The d-c potential for the grid of the control tube is controlled by temperature-limited diode V_{10} whose filament is fed from the output of the inverter. An increase in inverter output voltage increases the d-c voltage on the grid of the control tube, thus causing the tube to fire earlier in phase and decrease the output voltage.

Various systems of sampling could be used in place of the temperature-limited diode, which has some time lag. One fast method of control would be to use a full-wave rectifier fed directly from the output voltage and let the output of this rectifier feed the control tube grid. If this rectifier has a resistive load the peak voltage of the output would be controlled within each half-cycle of operation. Capacitance could be added to the circuit to control the average output voltage.

Conclusions

The regulation obtainable from the controlled-firing-time inverter is entirely dependent upon the reference voltage. The speed of response of the regulating system can be increased to the point where no peak output wave will go above a chosen limit. The frequency stability of the inverter depends on the frequency source, which could be crystal or tuning-fork controlled. The regulating system affects the time of extinguishing the tubes and therefore does not cause frequency jitter in the firing of the tubes.

This system has the advantage of inverting only the v-a required at the load, thus keeping the output transformer size at a minimum and obtaining the maximum power from the thyratron tubes. The smaller output transformer and the elimination of the saturable reactor lead to a much smaller and lighter inverter. The extremely fast regulating system leads to more dependable operation during line or load variations, even to the point of switching loads.

The efficiency of the system depends on the range of line and load variation for which the system must compensate, and is a function of the time allowed for storing energy in the commutating capacitors to deionize the power tubes. A considerable increase in efficiency will be realized in high-power units using ignitron tubes due to the deionization characteristics of these tubes.

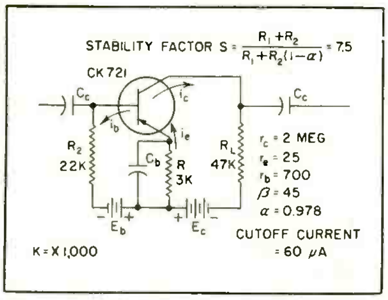


FIG. 1—Basic grounded-emitter transistor circuit used in amplifier, with design characteristics and data

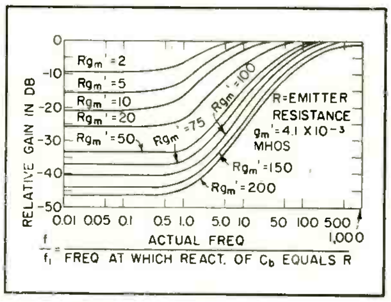


FIG. 2—Gain curves at low frequencies in R-C amplifier as result of resistance-capacitance emitter impedance

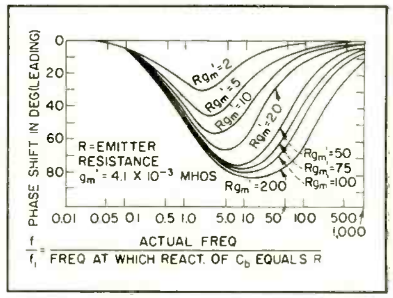


FIG. 3—Phase shift of output voltage at low frequencies in transistor amplifier having R-C emitter impedance

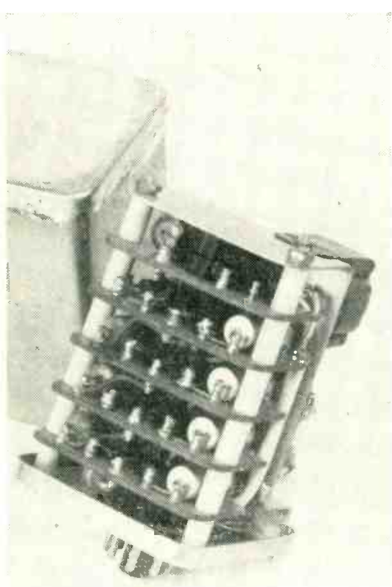
Transistor Preamplifier Feeds Tubeless Servo

SUMMARY —— Four-transistor circuit permits use of choppers, thermocouples or strain gages with 60-cps combination transistor-magnetic amplifier servo. Power gain of preamplifier is over 100 db for 40-cps bandwidth

WITH THE development of servo amplifiers using magnetic amplifiers and transistors there was a need for a high-gain preamplifier for the servo amplifier, to permit use with thermocouples and strain gages in conjunction with d-c to a-c converters. This article describes a flexible high-gain transistor preamplifier which has been used successfully with a 60-cps transistor magnetic servo amplifier and is adaptable to most carrier-type servo systems.

The unit is stabilized for temperature ambients of 0-50C in that this temperature range will not affect the operation of the amplifier by a severe shift of operating points. It has a minimum of 100-db power gain with a signal-to-noise ratio of 60 to 1. Passband is approximately 40 cps at 60 cps. Three identical stages and a transformer-coupled output stage make it possible to utilize one, two or three of the stages, depending on the gain requirements of the servo system.

The grounded-emitter R-C coupled amplifier stage used is shown in Fig. 1, with the various currents and voltages marked. For the amplifier to be stable over temperature ranges of 0-50C, the stability factor must be as low as possible since any change in the cutoff current of the transistor is multiplied by the stability factor and appears in the collector current, shifting the d-c operating points. For this amplifier a stability factor of 7.5 gave satisfactory results.



Complete four-stage transistor preamplifier for coupling low-level input transducers to standard servo amplifier

Design Criteria

The major difficulties in the development of a transistor amplifier for a frequency as low as 60 cps were the loss in amplification and the phase shifts associated with the R-C coupling networks and bypass networks. Due to the extreme sensitivity of the basic servo amplifier to the phase of the input signal, the phase shift of the preamplifier had to be a minimum and the gain a maximum to reduce the number of stages to a practical figure.

The emitter resistance must be bypassed by a capacitor of considerable size (100 μf) to reduce the

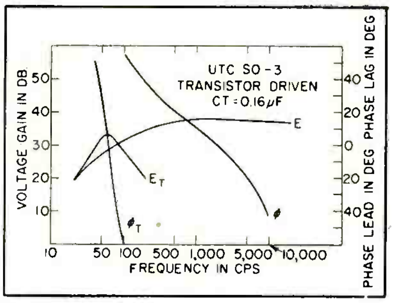


FIG. 4—Effect of tuned output circuit (T curves) on voltage gain and phase shift, as compared to untuned output

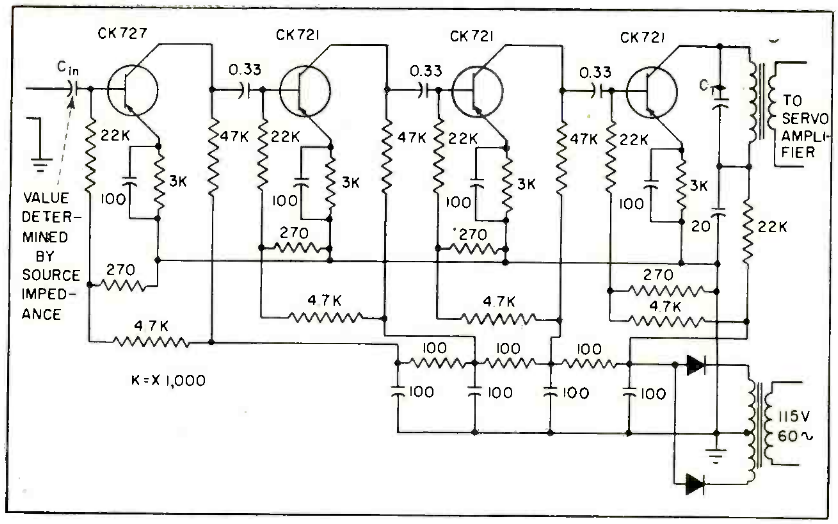


FIG. 5—Complete circuit of four-transistor preamplifier, operating from germanium-rectifier power supply

By H. R. ZELLER, JR.

Research Division
Raytheon Manufacturing Co.
Waltham, Mass.

phase shift and loss of amplification at low frequencies. Figures 2 and 3 show this effect on amplification and phase shift.

Another important component with respect to low-frequency gain is the coupling capacitance, which produces additional low-frequency attenuation and phase shift in the amplifier. A coupling capacitance of large physical size increases susceptibility to noise pickup. A coupling capacitance of 0.33 μf produces a minimum loss in amplification and minimum phase shift at 60 cycles, at a reasonable physical size.

Output Impedance

The output impedance of a grounded-emitter amplifier stage is high and the input impedance of the transistor magnetic servo amplifier is approximately 1,500 ohms. Therefore, transformer coupling was necessary between the preamplifier and the servo amplifier. A few commercially available miniature transformers are usable if tuned for 60 cycles with a capacitor across the primary winding.

This capacitor provides a convenient means of phase correction for the preamplifier when used in conjunction with a d-c to a-c chopper, due to the inherent phase shift of the chopper. The capacitor also reduces the noise level by narrowing the passband.

The effect of the tuned output stage is shown in Fig. 4. A small change in capacitance will provide phase correction without a great effect on the 60-cycle gain. This is necessary since the servo amplifier requires an input in phase or 180 deg out of phase with the line voltage applied to it.

The disadvantage of transformer-coupled output is that the output transistor is forced to swing over a large voltage range to compensate for the impedance ratio of the transformer. However, this can be done if the output is restricted to 3 volts peak to peak. This is more than sufficient for full output from the servo amplifier.

Gain

If four stages of amplification are required, coupling between these stages through the power supply can be reduced to a minimum by individual bleeder networks for each stage. These networks divide the supply voltage for the collector supply and the base bias. The power transformer and germanium rectifiers supply 50 volts d-c at 40 ma, which is filtered by three R-C networks.

The four-stage preamplifier shown in Fig. 5 is sensitive to inputs of 1 to 7 microvolts, 3 microvolts producing the required output of 3 volts peak to peak. The gain of the preamplifier depends largely on the transistors used, but is usually 120 db with a total phase shift of approximately 35 deg leading. At full output with approximately 10-percent distortion, the equivalent noise input is 0.012 microvolt, giving a signal-to-noise ratio of approximately 60 to 1. The passband of the amplifier is from 40 to 80 cycles, ± 3 db.

At this time the addition of more stages does not seem practical, due to the fact that the input stage is already close to noise level.

There are many types of input circuits which can be used with this combination. A d-c to a-c chopper has been mentioned previously, its main difficulty being its associated phase lag, which must be corrected by capacitance across the primary of the output transformer. An a-c strain gage is another possible input, as are differential transformers and potentiometers.

If potentiometer input is used, the input capacitor to the preamplifier must be of sufficient size in relation to the impedance of the potentiometer to minimize phase shift and loss in amplification.

Cross Pulse Pickup in Twisted-Pair Cable

SUMMARY — To reduce bulk and expense in station layouts, engineers are often tempted to use twisted-pair cable instead of coaxial cable. Chart showing pickup in various kinds of cable indicates when this practice is acceptable

By J. GREGG STEPHENSON

Airborne Instruments Laboratory, Inc. Mineola, New York

WHERE PULSED video signals must be connected to many different points in large electronic systems, the conservative approach is to use coaxial cables throughout. This ensures against cross pickup of signals between circuits, but can be expensive because of the cost of cable, terminations and installation labor. The bulk of the cable trunks can present problems in the layout of the system.

Tests on a sample length of twisted-pair communication cable and subsequent system experience have shown that certain types of pulsed signals, gate waveforms etc can be transmitted appreciable distances over twisted pairs without difficulty due to cross pickup. The feasibility of this method for a given application will depend on the steepness of pulses, sensitivity of other circuits to spurious interfering transients, length of cables etc.

It is important that the designer have some idea of the magnitude of the attenuation of cross pickup between pairs that can be expected under various conditions. The following information may help in deciding whether coaxial cable or twisted pairs can be used in a specific case.

A series of measurements was made on the cross pickup of pulses in a 100-foot length of standard, vinyl-jacketed, 26-pair communication cable, made with No. 22 solid copper wire with plastic insulation.

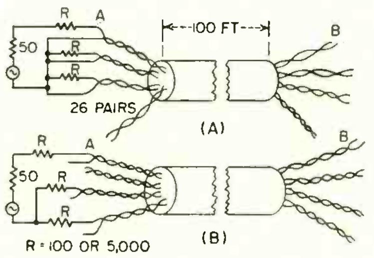


FIG. 1—Method for observing cross pickup in twisted pairs (A) and in single wires (B)

The connections for testing are shown in Fig. 1. Pair No. 25 was driven by a pulse generator with 10-microsecond pulses at 1,000 pps and 50 volts amplitude. The internal impedance of the generator was adjusted until the rise time of the pulse on the driven pair was 1 microsecond. Under these conditions the decay time was also found to be approximately 1 microsecond. The peak amplitude and nature of the transient on each of the other wires or pairs in the cable was then observed and recorded on a wide-band oscilloscope.

Various impedance levels on the other wires or pairs were set by the value of resistors *R*. The attenuation data plotted in Fig. 2 were taken at the sending end of the cable, point *A*. Cable reflections complicate the nature of the transient observed at the far end of the cable, point *B*, but the general level of peak transients is about the same as that recorded at point *A*. The attenuation figures refer to the level of the observed peak of the transient due to cross pickup in decibels below the 50-volt input pulse on the driven pair. The attenuation figures actually represent a voltage ratio $20 \log_{10} 50/V_a$ where V_a is the peak voltage amplitude of the transient due to cross pickup. Strictly speaking, this is not in decibels because of the differing impedance levels.

Typical transients observed as a result of cross pickup are shown in Fig. 3.

Conclusions

The measured results lead to the following conclusions, which apply specifically to a 100-foot length of standard communication cable.

(1) With no grounded wires

(Continued on page 172)

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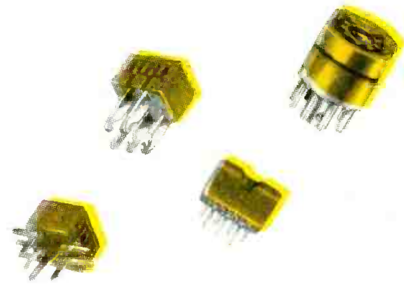

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Quantity production of low loss Mica components. Finest molding machines and equipment operated under most experienced guidance and engineering supervision with adequate and unequaled facilities has advanced CINCH to the foremost in production of low loss Mica components in quantity.

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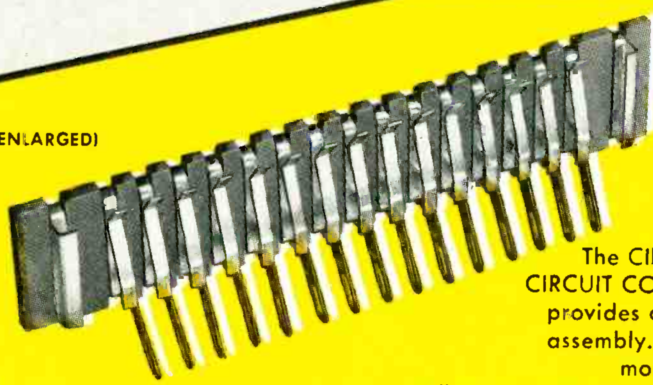

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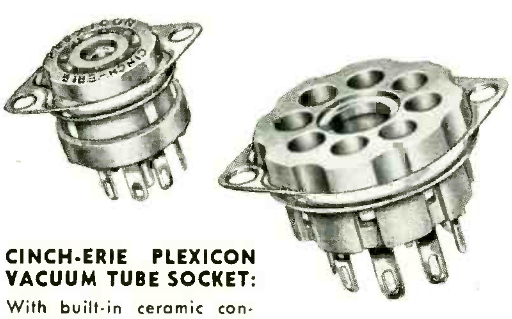

CINCH-ERIE PLEXICON VACUUM TUBE SOCKET: With built-in ceramic condensers, Plexicon Tube Sockets, no larger than standard receiver socket, provide the most effective method of by-passing . . . with condenser close to tube element providing shortest path to the ground . . . capacity up to 1,000 MMF — the tube element may be coupled or by-passed as desired.

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CINCH MANUFACTURING CORPORATION
1026 South Homan Ave., Chicago 24, Illinois
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Cross Pulse Pickup in Twisted-Pair Cable

(Continued from page 170)

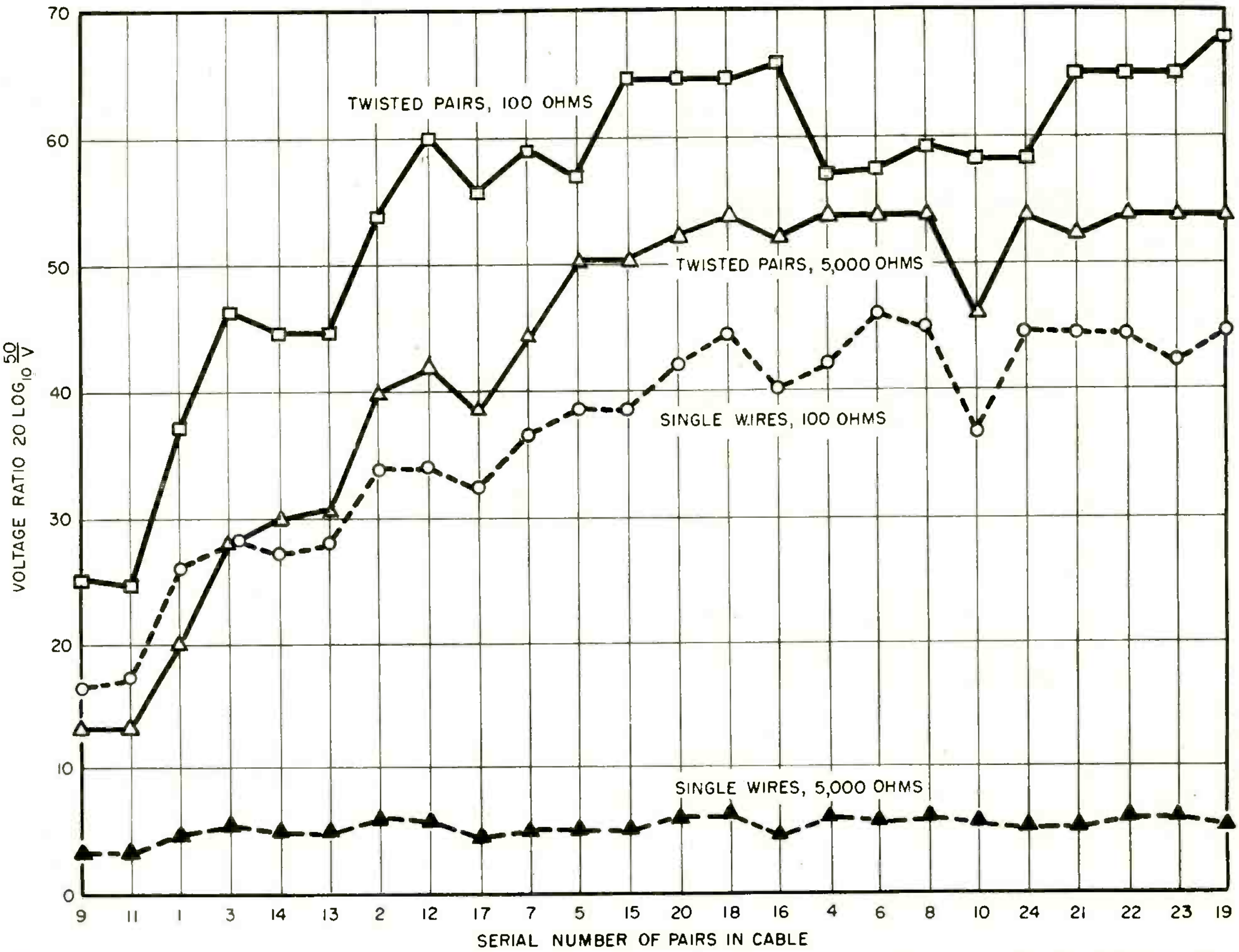

FIG. 2—Attenuation versus serial number of pairs in Alpha 1312 cable 100 ft long with 26 pairs of No. 22 solid wire; 50-v input pulse is applied to pair No. 25

in the cable, the cross pickup on individual wires of the other pairs is attenuated only 3 to 6 db.

(2) With no grounded wires in the cable, the cross pickup on individual wires of the other pairs improves to a level between 16 and 44 db when the impedance level is reduced to 100 ohms.

(3) Using twisted pairs, with one wire of each twisted pair grounded and serving as a partial shield, the attenuation of cross pickup increases markedly. At a 5,000-ohm impedance level, twisting improves the attenuation by 10 to 48 db. At a 100-ohm impedance level, twisting increases the attenuation by 9 to 26 db.

(4) The best conditions for attenuation of cross pickup were observed at a 100-ohm impedance level with twisted pairs. The total attenuation varied from 24 to 68 db on various pairs. At a 5,000-ohm impedance level with twisted pairs, the attenuation varied from 13 to 54 db.

(5) The worst cases of cross pickup were observed on the pairs physically nearest to the driven pair in the cable lay (pairs 9 and 11). The really bad cases appear to be limited to about 10 percent of the pairs in the cable. All others show at least 10 db more attenuation than the few worst pairs.

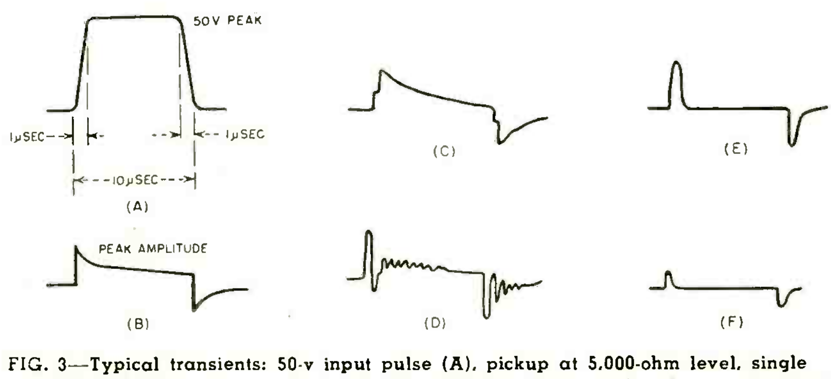

FIG. 3—Typical transients: 50-v input pulse (A), pickup at 5,000-ohm level, single wire (B), 5,000-ohm level, twisted pair (C), 5,000-ohm level, single wire at unterminated end (D), 100-ohm level, single wire (E) and 100-ohm level, twisted pair (F)

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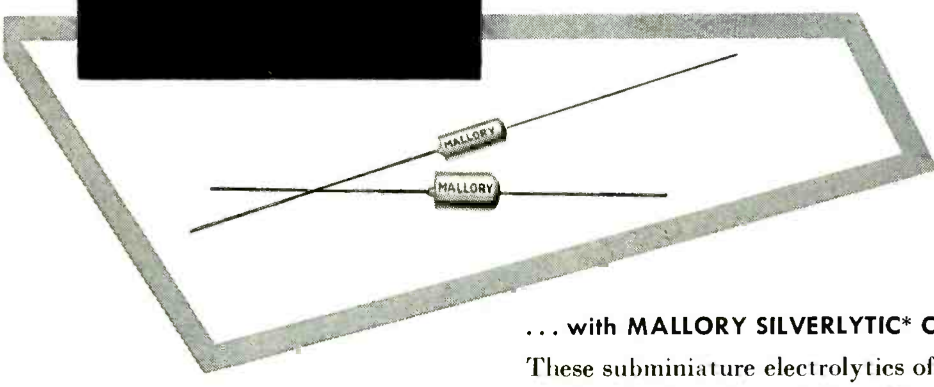
The pioneer producer of miniature mercury batteries, Mallory supplies a complete line of batteries and Power-Paks for transistor equipment. The constant-voltage, constant-current characteristics of these unique power sources provide peak transistor performance. Noted for their long service and shelf life, Mallory Mercury Batteries can withstand ambient temperature extremes from —55°C. to +120°C. without impairment of output.



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Plan to utilize the excellent electrical performance of these Mallory miniature components in your transistor equipment . . . or in any low-voltage electronic circuits where space must be conserved. For complete technical data, write or call Mallory today.

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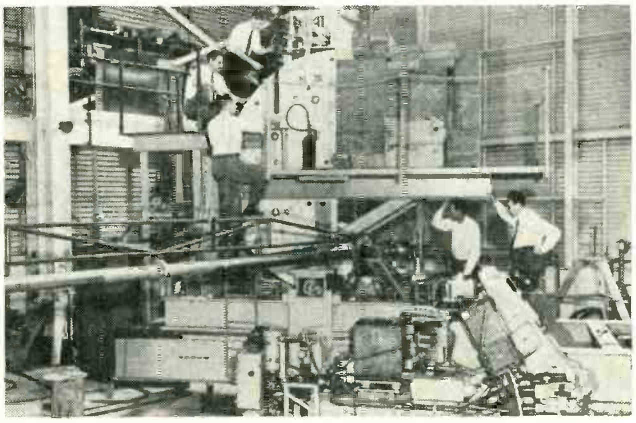
Electrons At Work

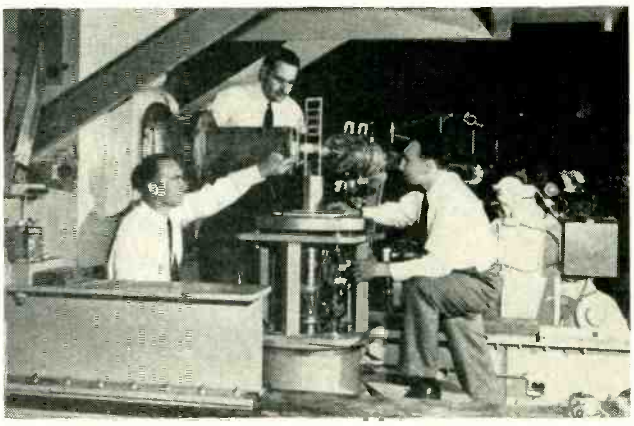
Edited by ALEXANDER A. McKENZIE

Trans-Caribbean Television Broadcast

Bridging the 250-mile distance between Havana, Cuba and the mainland of Florida, radio engineers used an aircraft flying at 11,000 feet to relay television signals. Signals from CMBF on channel 7 were picked up in a C-47 plane of Cubana de Aviacion. A directive receiving antenna was trained by hand as the operator watched a field-strength meter. Engineers of the CMQ network used another directional array to retransmit the signal on channel 13 with 18 watts on sync peaks. Picked up at Miami Beach, the program was put on the NBC network. Enriques Pages of CMQ and Lew Hathaway of NBC are shown seated before the equipment in the aircraft

Proton Measurement Uses New Nuclear Microscope





Stanford University physicists hope eventually to measure protons using a technique developed under a contract to the Air Research and Development Command. Instrumentation involves use of a 220-foot electron linear accelerator coupled to a 55-ton, 16-foot-high magnetic spectrometer. The equipment is said to make nuclear particles appear about 100,000 times bigger

Propagation of VHF and UHF TV Signals

ANOMALIES in earlier propagation theory brought about the so-called freeze of television allocations. An Ad Hoc committee completed, in 1949, a statistical study from which new empirical propagation curves were evolved, although the basic data were scanty.

In a recent FCC report entitled "Present Knowledge of Propagation in the VHF and UHF TV Bands" by William C. Boese and Harry Fine it is noted that present FCC uhf tropospheric curves do not adequately represent data collected since 1949.

In particular, quantitative data concerning propagation in the vicinity of the horizon are needed. However, the brochure points out, since the establishment of a reference file last June by FCC, no broadcast data has been filed.

(*Continued on page* 176)

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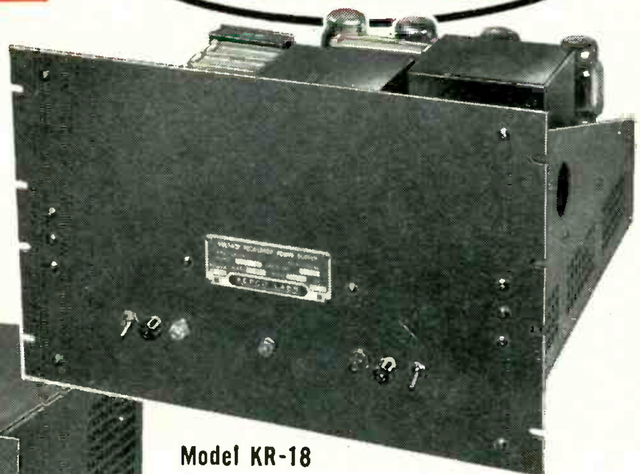

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VOLTAGE REGULATED POWER SUPPLIES

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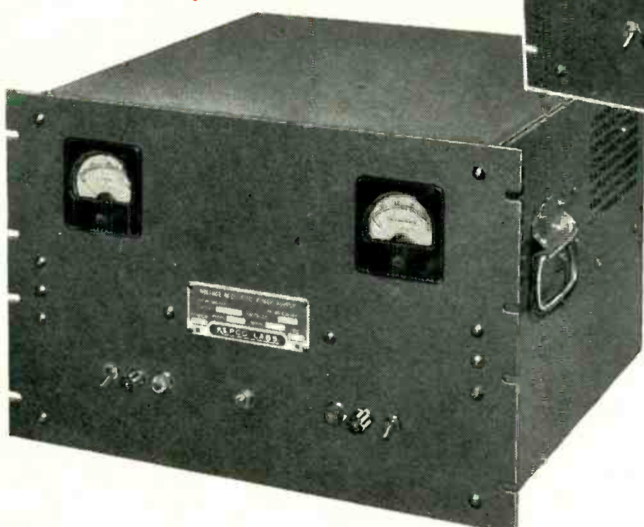

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- Guarantee One Year.

Build these compact Power Supplies into your equipment!

KR Voltage Regulated Power Supplies are conservatively rated and are designed for continuous duty at 50°C ambient.

REGULATION: Less than 0.2 volts for line fluctuation from 105-125 volts and less than 0.2 volts for load variation from 0 to maximum current.

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To Include 3" Current and Voltage Meters, Add M to Model number (e.g. KR 16-M) and Add $30.00 to the Price.
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Model	Volts	6.3V AC	Rack Mount W	Rack Mount H	Rack Mount D	Price
KR16	0-150	Each supply	19"	12¼"	17"	$625
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KR18	195-325	15 Amp.	19"	12¼"	17"	$695
KR19	295-450	outputs	19"	12¼"	17"	$695

The KEPCO KR SERIES in the above voltage ranges are available in 600 Ma. — 300 Ma. — 125 Ma. series.

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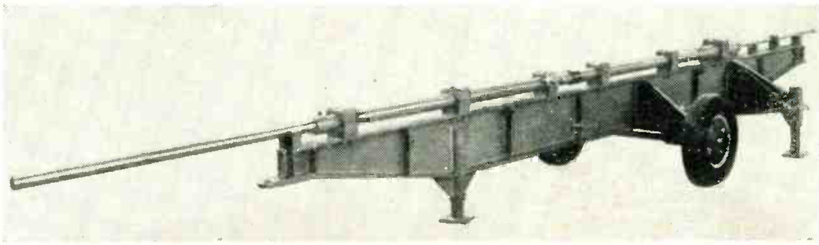
Supersonic Gun Aids Missile Research

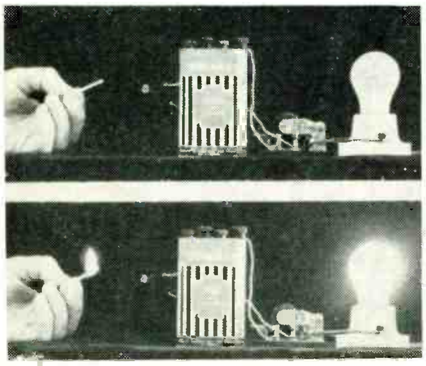


Hypersonic research weapon for study of the heat barrier as it affects electronic equipment in space vehicles

PROJECTILES fired at velocities many times the speed of sound point the way to proper design of missiles and rocket ships. The gun recently developed by Universal Winding of Providence, R. I., for Aberdeen Proving Ground is capable of firing 1-ounce projectiles at speeds up to Mach 11 (12,000 feet a second).

Low density and high acoustic velocity of hydrogen gas makes this a suitable propelling medium. The gun becomes an important research device in studies of the heat barrier, described as the crucial limiting factor in design of hypersonic missiles and electronic cargoes.

Transistor Processing Improved



New photodiode, relay and 1.5-volt battery turn on bulb when the photosensitive device is triggered by light from a match

IMPROVED technique for making transistors and other solid-state devices has been announced by Clarence Zener of Westinghouse Research Labs. Originated by R. L. Longini, the development is an improved means of making junction-type *pnp* germanium transistors.

He explained that a thin slice of *n*-type germanium is ordinarily placed between two layers of the metal and heated. Metal atoms dissolve inward through the germanium, forming two outside layers of *p*-type germanium and leaving a very thin layer of *n*-type between. The thinner and more uniform the *n* layer, the better the performance of the finished transistor.

Too high a processing temperature melts away the layer; too low a temperature leaves the layer too thick. The Westinghouse process is said to involve a cooling off period during the heating of the transistor. This treatment allows the critical *n*-layer to build up to the desired thickness and uniformity instead of being dissolved.

Applied to photodiodes, the new process is said to have produced devices that are supersensitive to light. Although not yet used in production manufacture, the technique has permitted laboratory fabrication of transistors that can be operated at high radio frequencies.

Field Emission Cathode

INEXPENSIVE and simple, a newly developed method for producing electrons can lead to better flash x-ray photography and generation of electromagnetic waves shorter than those now in common use.

The principle of field emission is not new, having been reported in 1897 by Robert W. Wood, but attempts toward practical application were unsuccessful. Newer techniques have been employed by the physics department of Linfield College, McMinnville, Oregon, under the direction of W. P. Dyke.

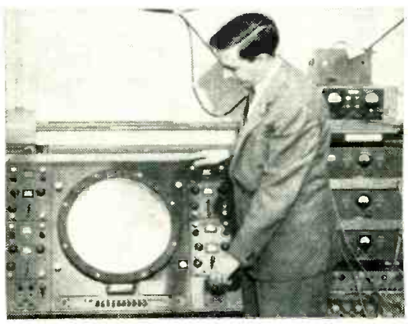
Electrons are customarily produced by heating a metal filament in vacuum. The field emission technique releases electrons by application of difference of potential. The field emitter developed under Office of Naval Research contract is a tiny tungsten needle less than 0.0001 inch in diameter. When several needles are mounted in a comb array, currents up to 20 amperes at a peak power of more than a million watts have been obtained.

Aircraft Approach Speed

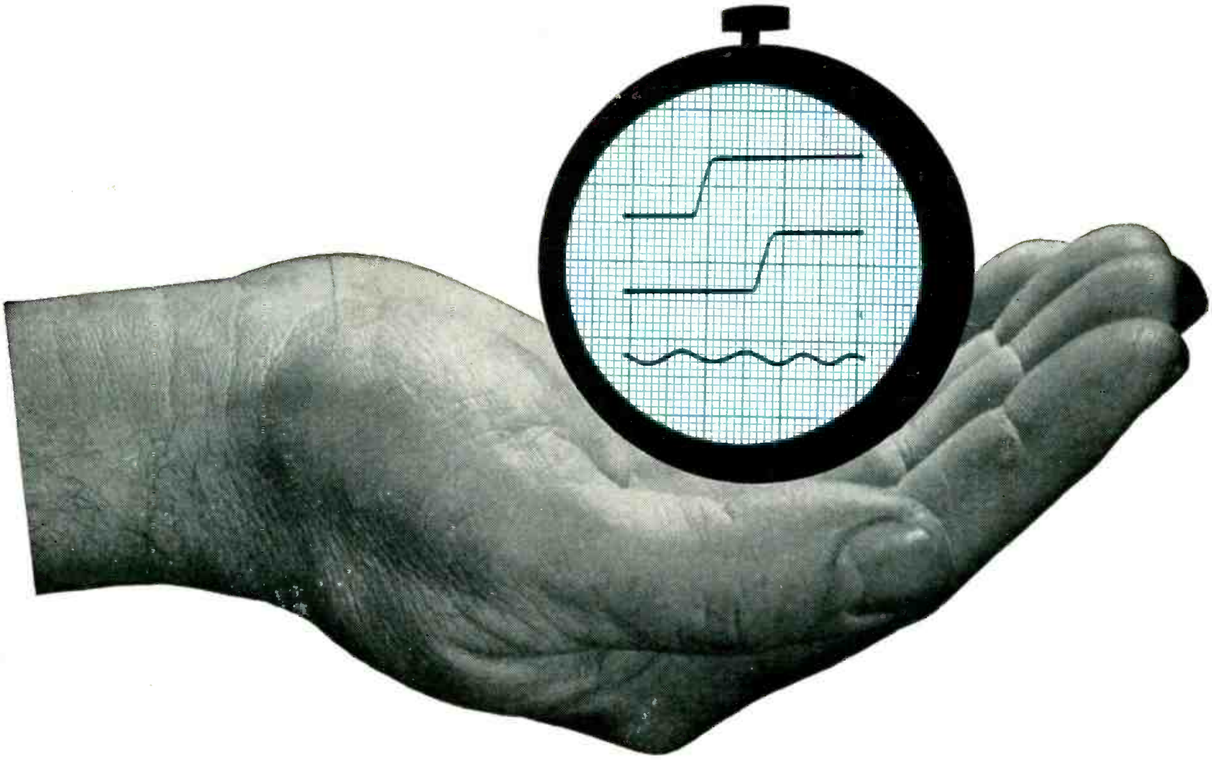
EYES focused on the carrier deck instead of the instrument panel may assure a pilot safer touchdown. Such procedure may be possible by adoption of a system under consideration by Bureau of Aeronautics and scheduled for tests at Naval Air Development Center, Johnsville, Pa.

If his speed is correct, the pilot

Emergency Navigation Aid



Exact position of aircraft can be determined using new equipment that projects a map of the desired area on a cathode-ray screen. Lines emanate from direction-finding units to corresponding points on the map. Built by Bendix for Rome Air Development Center, the device helps airport personnel to spot exact location of plane in nearly zero-zero conditions



time on our hands

Here's a handful of microtime... doled out in hundredths of a millimicro-second. It's our new HELIDEL* delay line.

It's precise... wide-band ... continuously variable. This is not an adwriter's pipedream... it's an engineer's, come true.

Which means that definitions are in order.

Precise = delay increments of only 2 x 10^{-11} sec; resolution 0.01% and better; linearity "better than ±1%"... actually, so fine it can't be measured.

Wide-band = transmission of pulse signals up to 20 mc with negligible phase-distortion, overshoot, or distortion of waveshape.

Continuously variable = a distributed-constant, electromagnetic type ... dreamed up in 1946... developed in helical form since 1951, by Helipot and DuMont.

The HELIDEL is already used successfully in color-TV broadcasting and oscilloscopes... and as a trimmer in transmission systems.

What can you dream up?

Helipot *first in precision potentiometers*

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To help you dream, there's a 10-page technical paper on the HELIDEL, *presented at the 1954* WESCON... *and a new data sheet, with complete specs. For your copies, write for Data File 201.*

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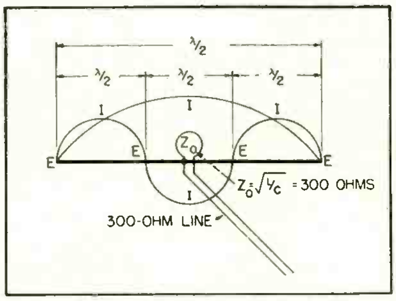
approaching the carrier hears a steady tone in his earphones. If approaching too fast, he hears a high-pitched pulsed tone. The tone is low pitched if speed is too slow. Rate of tone pulsation increases with departure from desired approach speed. Such a system is already in use on British carrier aircraft.

Checking Impeller Stress

If the natural frequency of a particular blade in an inducer wheel is excited by aerodynamic disturbances, the blade will vibrate and may interfere with operation of the jet power plant. The engineer at Fairchild Engine Division draws a cello bow across the part and measures its frequency to check characteristics

Plug-In Antenna

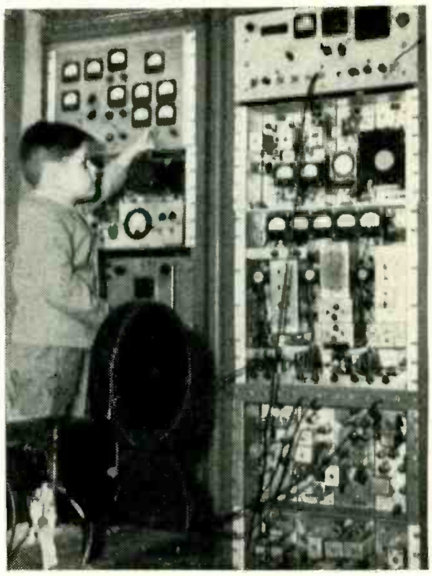
NOVEL means suggested for picking up television programs uses a coupling loop and folded dipole equivalent to a half wave at the lowest frequency. The device plugs into a wall outlet, the most effective one being chosen by experiment.



Impedance of the coupling loop is independent of frequency

Most favorable location is the outlet situated at a current-loop position of standing waves on house wiring and conduit system. As shown in the circuit drawing, the colinear antenna is coupled to a loop having an impedance Z_0 that can be adjusted. Designed by A. L. Munzig, the unit is manufactured by Rytel.

Automatic Dial Calibrator Speeds Standardization



So simple a child can operate (see photograph) an electronic device developed by Lavoie Laboratories at a cost of $100,000, calibrates and standardizes metered devices 48 times faster than human hand and is accurate to one part in 100,000. In one application, a frequency meter is provided a direct-reading film dial that shows markings of a master frequency standard

Time-Voltage Pulse Discriminator

By CHARLES E. LOWE
Fenton, Michigan

MOST SYSTEMS of measurement or difference detection compare the order of magnitude of the two quantities being measured. Sensitivity to small differences becomes less as the values increase in magnitude. In the method of error detection to be described here, a voltage difference that is detected at repeated time intervals is given a discrete interval of time in which to create an output signal.

By not sharing the output signal time with the main magnitudes formed of the equal quantities in the values being compared, an existing difference is set apart as a discrete unit, a pulse, that is definitely present or is not present. Thus time and voltage can be used to separate a difference quantity from a voltage and error detection becomes a function of the small circuit voltage required for pulse formation.

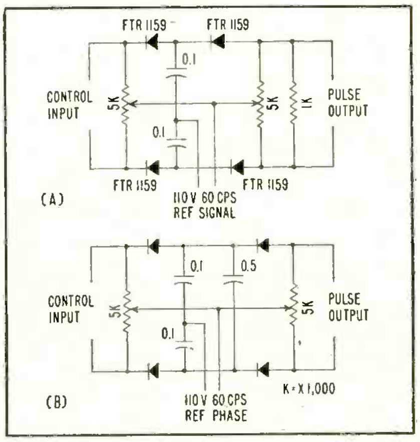


FIG. 1—Basic discriminator circuit (A). Addition of 0.5-μf capacitor (B) increases height and width of output pulse. Null indicating meter replaces resistance across potentiometer

The basic circuit is shown in Fig. 1. It is a simple network of passive components. The input portion is similar to conventional discriminator circuits in the charging of two identical capacitors. It is the voltage-controlled switching action of the output half that is different.

Under balance conditions, the two capacitors are equally charged and discharged by the reference alternating potential and produce no output signal. Since the discharge rectifiers are turned off on the charging cycle, balance is indicated by a highly undisturbed zero. Input and output potentiometers permit separate adjustment for the initial balance.

Since the charging paths of each capacitor include resistance, the capacitor voltages will lag the voltages of the reference phase. On each cycle as the charging voltage reaches its peak and starts to decline, it will meet and pass the rising capacitor voltages. When the

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When you have applications requiring accurate resistance values at 85C and 125C operating temperatures, in units of truly small physical size—you'll find the resistor you want is one of the 46 standard Permaseal designs in tab and axial lead styles.

They meet or exceed requirements for all types of military and industrial electronic apparatus and instruments. They are "extra-protected" by a special Sprague-developed plastic embedding material that performs beyond the severe humidity resistance specifications of MIL-R-93A and Proposed MIL-R-9444 (USAF).

Permaseal winding forms, resistance wire and embedding material are matched and integrated to assure long term stability at rated wattage over the operating temperature range.

These high-accuracy units are available in close resistance tolerances down to ±0.1%. They are carefully and properly aged for high stability by a special Sprague process.

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capacitor voltages rise above the main charging voltage from the reference phase, the charging rectifiers are turned off and the discharge rectifiers are turned on.

If charging conditions are such that the two capacitor voltages rise equally, or are equal at a particular instant of time, the decreasing charging voltage will meet and pass both capacitor voltages simultaneously. Then both capacitors will start to discharge at the same time. This equal form of discharge does not produce an output signal.

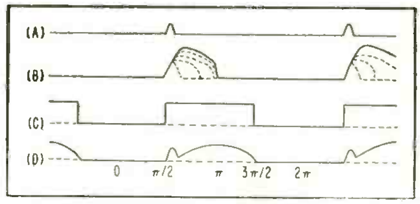

FIG. 2—Normal pulse output (A) larger pulse produced by adding capacitor across discharge circuit (B) and square wave produced by adding d-c bias voltage (C). Waveform (D) shows normal pulse masked by unbalance in discharge circuit

However, if one capacitor is charged to a higher value than its companion, it will start to discharge first. This single discharge is not balanced by one in the parallel discharge path and the resultant current flow across the output resistance provides an output signal.

If the declining charging voltage should reach the voltage of the second capacitor before the first had completely discharged the difference in voltage that existed at the start of discharge, an equal form of discharge between the two capacitors may never occur. Under these requirements it is desirable to have the lesser charged capacitor wait for the two capacitor voltages to become equal before it starts to discharge.

If fast time constants are used, the discharging capacitors may be able to follow the reference voltage all the way down and become equal to each other in voltage without waiting. But when this is not allowable, the lesser charged capacitor may be made to wait for its companion by a voltage balancing action of the discharge rectifiers as they vary their resistance with voltage and with back voltages im-

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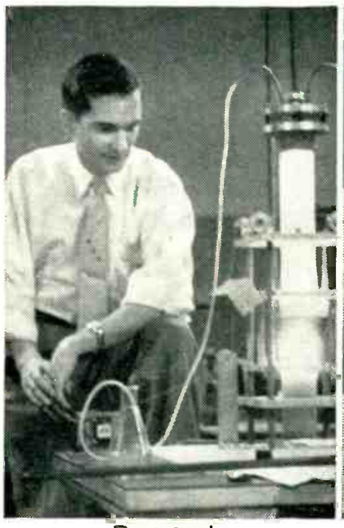
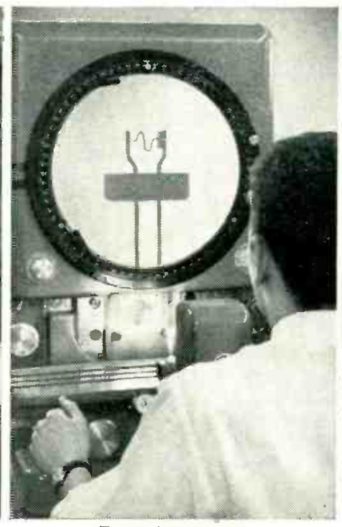

Research


Design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pressed upon them, to hinder the discharge of the lesser charged capacitor until both capacitor voltages are approximately equal.

This voltage-balancing action is encouraged by the presence of a low resistance across the output terminals. The lower this load resistance, the more effective is the application of a back voltage on the opposite discharge rectifier by a discharge current in the neighboring discharge path.

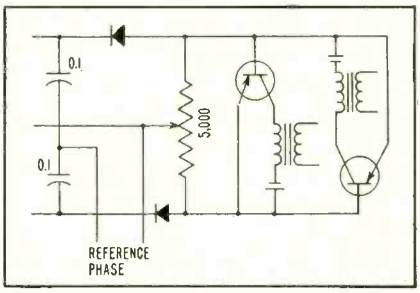


FIG. 3—Discharge circuit of discriminator replaced by transistors to amplify and separate positive and negative pulses

The width of the output pulse is a function of the time it takes the excess voltage on one capacitor to discharge. It is controllable to some extent by the use of large or small capacitors and discharge resistances.

The normal type of output pulse is shown in Fig. 2A. It occurs at approximately the peak of the charging half-cycle of the reference phase voltage because, normally, fast capacitor charging and discharging time constants are used.

The addition of a third capacitor of larger value as shown in Fig. 1B will increase the height and width of the normal pulse output. This added capacitor gives more effective pulses for meter operation. However, it has a loading effect upon the input that makes the circuit less responsive to small energy inputs.

The waveform at Fig. 2B is the type of undirectional pulse output obtained when this third capacitor is used.

Connected across the two capacitors, it charges to the difference in voltage between them. To discharge, it attempts to send discharge current through a discharge rectifier in the back direction since the rectifiers are connected back to back in its particular discharge

Carboloy Trends and Developments for Design Engineers . . .

• How complex permanent-magnet assemblies are built to desired field patterns from simple magnet shapes

G-E Alnico magnets provide unlimited design flexibility

The fundamental problem in designing with permanent magnets is how to provide a specific magnetic flux in a desired field pattern.

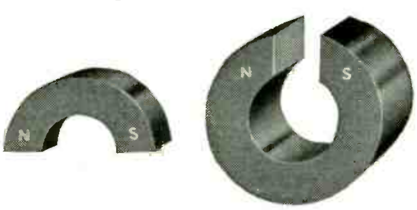
In solving this problem, a designer can choose from seven General Electric Alnico grades, hundreds of styles, weights from a fraction of an ounce to a hundred pounds. He can use magnets with two poles – or many poles; with poles at the ends – or anywhere along the magnetic axis.

This all gives tremendous flexibility to the design of permanent magnets and magnet assemblies. But precisely because there are so many sizes, shapes, strengths, and other factors to be considered, this flexibility can make the designer's job far more complicated.

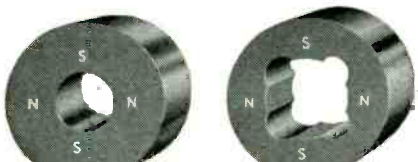
So, to help give a clearer understanding of what can and cannot be done with G-E Alnico permanent magnets, we have prepared this description of basic magnet shapes.

The simplest forms of a permanent magnet are the bar and rod. They are normally salient (i.e., the poles occur at the ends), and may be of any cross-sectional area.

U- and C-shaped magnets are simply bars "bent" to bring both poles to the same plane.

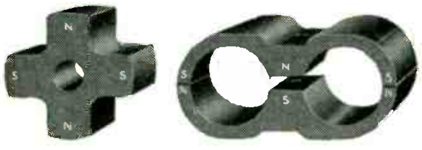


Carry the bending process to its ultimate conclusion and you have the cylinder (see top of next column) with or without the hole. A cylindrical magnet can be magnetized with as many poles as desired on the outside diameter (A), or the inside diameter (B). Not only can the size and shape of the hole be varied, but the magnet can be made salient (B), or nonsalient (A).



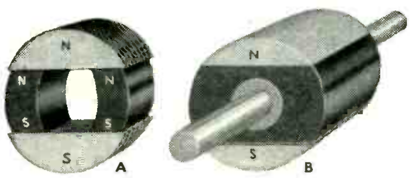
A B

All other forms are merely variations on the original themes, even to such nonstandard shapes as these:



Use of pole pieces adds to design possibilities

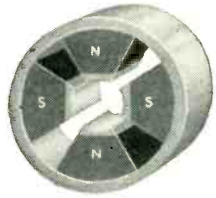
One basic use of pole pieces is to provide a return path for the magnetic flux. Pole pieces may be solid (B), or laminated, like this generator magnet (A).



A B

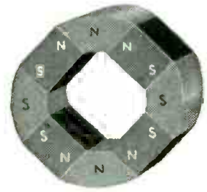
Designers can easily assemble pole pieces and properly shaped permanent magnets to obtain their required field patterns.

One version is this stator assembly, designed to provide inner poles. The

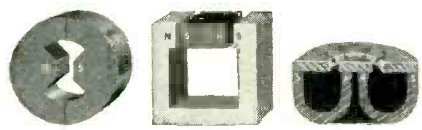


design can be altered in various ways, depending on mechanical, space, magnetic, or physical properties required.

For example, here is another 4-pole magnet using soft steel. It is also possible to construct an assembly with as many poles as required—by using a number of bar magnets or by using one 2-pole magnet.



Perhaps the most important consideration in the design of magnetic assemblies is the amount of flux across the air gap. These air gaps may be single (A), double (B), or annular (C).



A B C

Soft-steel pole pieces are often used to complete the magnetic circuit, allowing maximum flux density though the air gap, with a minimum amount of permanent-magnet material. However, there are a considerable number of variations possible, either with or without pole pieces.

Our G-E magnet engineers have broad knowledge and experience in the design and construction of permanent magnets, pole pieces, and air gaps. They will be more than happy to share their knowledge with you. There is no obligation, and all information is held in strictest confidence. A letter to us will get them to work on your problem immediately.

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path. The relatively long time of discharge may hold the opposing rectifier in a nonconducting state for a period up to a half-cycle of the reference operating phase.

A small direct potential applied across this capacitor, or the two capacitors in series will produce a square-wave output signal, such as shown in Fig. 2C.

The square-wave output pulse signal is 90 degrees out from the

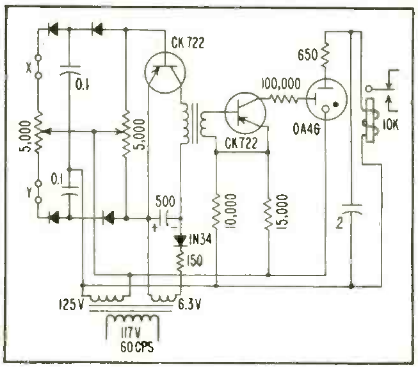

FIG. 4—Electronic switch using discriminator circuit to fire cold-cathode tube. Transducers can be inserted at points *X* and *Y* to control output

reference phase operating the circuit. It could provide a source of two-phase motor control signals in response to millivolt direct potentials.

A mismatch in the discharge portion of the discriminator circuit produces a half-cycle pulse that may mask the normal pulse. This waveform is shown for one direction of component unbalance at Fig. 2D. It can be removed by adjustment of the output potentiometer.

All of the pulse waveforms shown in Fig. 2 have been shown in the same polarity for comparison. A reversal of the conditions producing them will invert them, or completely change their polarity.

Although the circuit components are not critical as to value, some important considerations should be observed. The discharge resistances as represented by the two halves of the output potentiometer should be maintained large enough so the input signals that are used cannot send too large currents directly through the rectifiers and output resistances. The rectifiers are used at below normal current ratings with subsequent high re-

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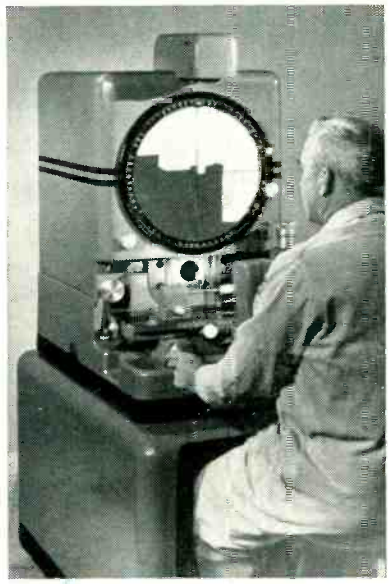

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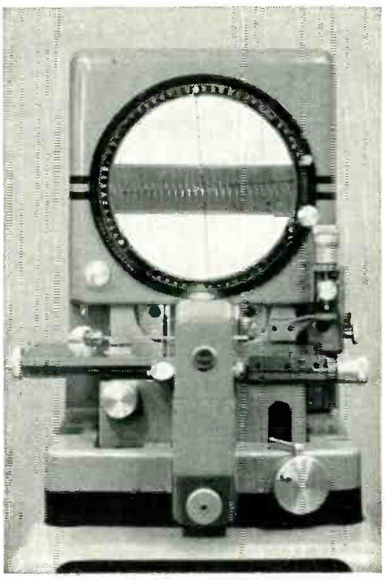

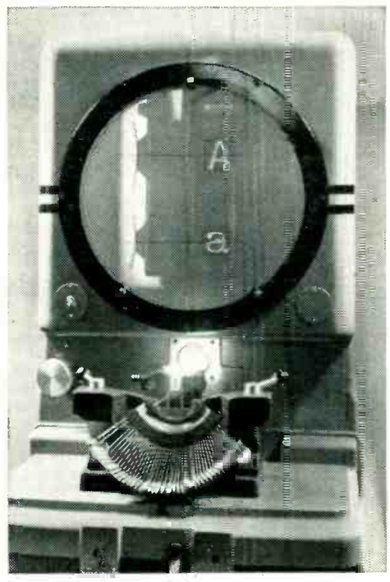

In production? A lot of people don't think of optical gaging in terms of production inspection. A typewriter maker did. To check the alignment of type bars to ±.0002″, they placed a Kodak Contour Projector next to the soldering jigs on which bars are mounted on their arms. Catching errors at this point and correcting the jigs reduced alignment time in final assembly 25%. Install Kodak Contour Projectors next to production equipment and you have a fast, continuing check that insures machine settings are correct. That's a good way to keep scrap costs down and quality up.

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sistance in the forward direction. This high rectifier resistance in combination with the capacitors forms a natural filter circuit that helps to keep the input signal from injecting itself directly in the output.

Reference phase operating voltage should be maintained large enough to keep control over the charging and discharging cycles. If the input signal is limited in magnitude, the reference phase can be operated at small voltage levels.

If inductance is present in one or more charging paths it should have less reactance than its associated capacitor at whatever frequency is used for the reference phase. If not, the direction of control may reverse for the input controlling variable. Too large an inductance will promote a highly damped oscillation in place of the unidirectional pulse output.

This circuit provides a sensitive detector of small phase shifts and its output signal is formed of pulses that give one-cycle response. These current pulses are ideally amplified by transistors without delay or resorting to d-c amplification techniques. By using transistors unbiased and back-to-back across the output, pulses of opposite polarity indicating unbalance in opposite directions are easily separated.

Fig. 3 shows the application of transistors to the output of the discriminator circuit. The input resistance of the transistors replaces the output resistor across the output terminals. The transistors will respond only to those pulses of correct polarity.

Fig. 4 shows a complete electronic switch utilizing this pulse circuit to trigger a gas tube. It is a strictly on or off device with provisions for connecting various transducers. This arrangement makes cold-cathode tubes very sensitive to small currents.

Multivibrator 500-Kc Sweep Circuits

By Lawrence Fleming
Falls Church, Va.

RECURRENT SWEEP GENERATORS used in ordinary oscilloscopes present special design problems. The circuit

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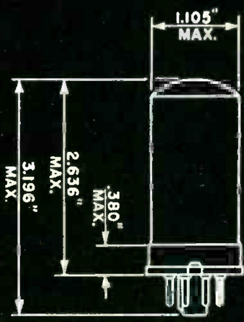
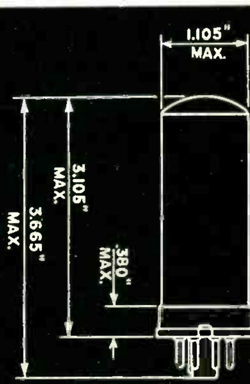


Type HG Relay



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must operate over a wide frequency range (10 cps to several hundred kc) it must be simple and inexpensive and the sawtooth amplitude must be inherently independent of frequency. In addition it must synchronize well and the sawtooth amplitude must not depend much upon the synchronizing voltage.

The gas-triode relaxation oscillator meets these requirements well except for its upper frequency limit of about 50 kc.

Displacing the gas-tube generator, in recent years the Potter multivibrator[1] has been used almost universally in general-purpose oscilloscopes. The main disadvantage of this circuit is that its upper frequency limit is in the order of 100 kc. While inherently simple, it does require simultaneous variation of two resistances and switching of two capacitors for frequency variation.

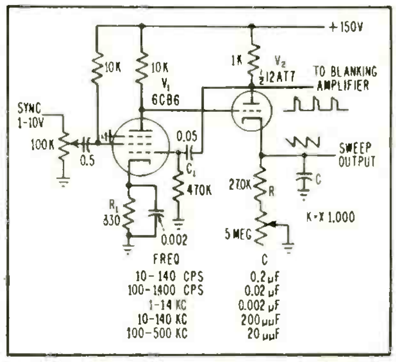
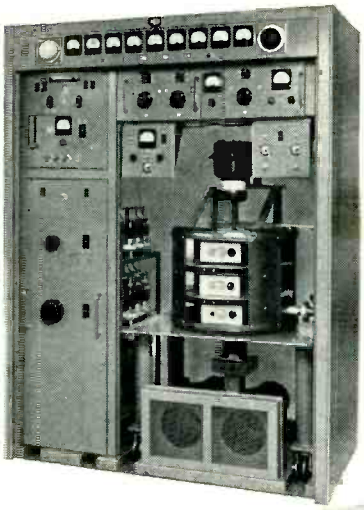


FIG. 1—Low-cost multivibrator circuit with range up to 500 kc. Sync injection is through screen of V_1

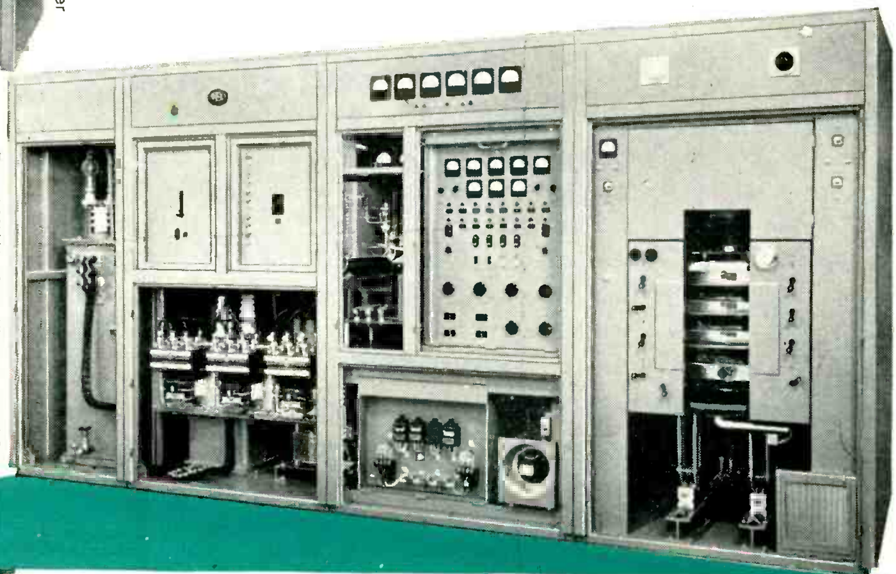
The most widely-published sweep generator[2,3] for oscilloscopes is that described by Puckle. Until recently it has not been put to much practical use in this country. Part of the reason is that the practical versions published have been relatively complicated.

A version of this circuit has been designed, however, which is cheaper than the conventional multivibrator circuit, has somewhat better synchronizing properties and operates easily up to 500 kc.

Figure 1 shows one version. Tube V_2 is the discharge tube. The frequency-determining elements R and C are in its cathode circuit. Tube V_1 can be called the control tube. During the sweep period V_1 is fully conducting and V_2 cut off. When the



Type 825WA 1 kw Klystron amplifier



Type 799WA 10 kw Klystron amplifier

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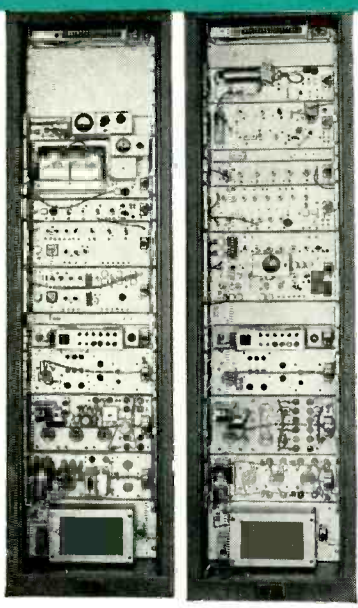

Type 798WA exciter (left), and Type 800CWA combining receiver

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Eighth in a series describing REL versatility cathode potential of V_2 falls enough to start plate current flow, its plate potential drops. This drop is communicated to V_1 through C_1 and the regenerative cycle causes V_1 to cut off and V_2 to become fully conducting in a quick pulse—the retrace period.

The negative pulse appearing at the plate of V_2 during retrace is the best source for retrace blanking. A one-stage blanking amplifier is generally necessary. The plate of V_2 does not carry any sync-signal information, while the plate of V_1 does.

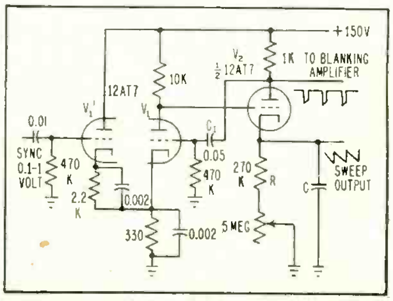

FIG. 2—Sweep generator circuit with provision for cathode sync injection

The amplitude of the sawtooth output is determined basically by the quiescent plate potential of V_1 which in turn depends on the screen voltage and the cathode resistor R_1.

Since this plate potential determines in part the point on the discharge curve of *R-C* at which recharging occurs, it affects also the frequency and the linearity of the sawtooth, in the usual way. A practical operating condition comprises an average cathode-to-ground potential for V_2 of about 80 volts and a sawtooth output of about 8 volts peak-to-peak.

Coupling capacitor C_1 transmits only negative pulses of short duty cycle, so that there is little clamping action at the grid of V_1.

Sync voltage may be introduced into the cathode, screen or suppressor of V_1. A commercial version uses screen injection, as shown. From 1 to 10 volts of sync is required. The suppressor requires a higher voltage. The sync has less effect on the sawtooth amplitude than in other comparable circuits.

Cathode sync injection requires only about 0.1 volt, minimum, with little shortening of the sweep up to 1 volt of sync. Figure 2 shows a

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circuit of this type, with an extra triode V_1 to feed the sync. Overall performance is equivalent to the circuit of Fig. 1. Sweep frequency is somewhat more stable with respect to cathode temperature than with the pentode circuit.

The circuit is highly tolerant of variations in tube and circuit parameters. Particular care must be taken to minimize stray sources of time modulation, such as hum in the power supply and in the sync voltage.

The output circuit of the sweep oscillator must look into a resistance that is high compared with the maximum value of the timing resistance *R*. Otherwise, the linearity suffers. Output circuit capacitance is in parallel with *C* and affects only the frequency.

Cathode followers, which usually form the load circuit, tend to produce small bursts of oscillation at some point of the cycle if they are designed for high input impedance and a gain close to unity. This effect of the negative reactance component of the cathode follower input impedance is readily removed by inserting a resistance in series with the cathode follower grid. A value of 2,200 ohms is typical.

Valuable suggestions were contributed by P. G. Sulzer and the late H. E. Anthony of the Heath Company, for whom the work was done and with whose permission the information is presented.

REFERENCES

(1) J. L. Potter, Sweep Circuit, *Proc IRE*, 26, p 713, June 1938.
(2) O. S. Puckle, "Time Bases", 2nd ed., Wiley, 1951.
(3) W. A. Edson, "Vacuum-Tube Oscillators", p 278, Wiley, 1953.

Staircase Generator

BY STANLEY I. KRAMER
Project Engineer
Fairchild Guided Missiles Div.
Fairchild Engine and Airplane Corp.
Wyandanch, L. I., N. Y.

A VARIATION of the classical, compensated, staircase generator, which generates a negative-going staircase is shown in Fig. 1.

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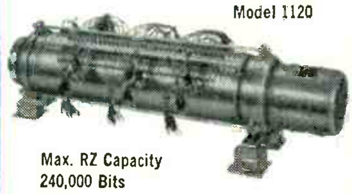

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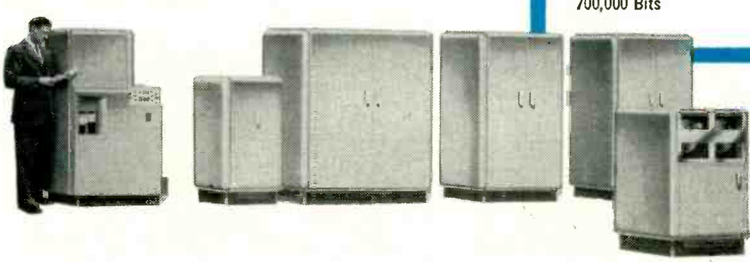

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step amplitude appearing on storage capacitor C_2 is $C_1V/(C_1+C_2)$.

The cathode follower is designed to have a gain as close to unity as practicable and causes the diode to clamp at this voltage. Thus the voltage applied with each succeeding pulse is not diminished by the charge on C_2. The cycle is terminated by the discharge of C_2 through a blocking oscillator or thyratron V_2.

The circuit described above provides a completely satisfactory gen-

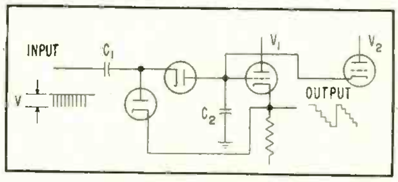


FIG. 1—Circuit that generates a negative-going wave

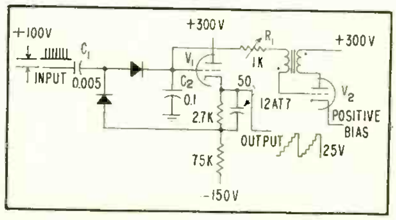


FIG. 2—Complete circuit used with positive pulse generator

erator for a negative-going stircase providing the period between pulses is short compared with the time constant of C_2 and the leakage resistance. The latter is determined, principally, by the heater-cathode leakage of V_2. This is a characteristic shortcoming of recycling a negative-going waveform.

If the diodes are reversed and a positive pulse generator is used, recycling tube V_2 is coupled to the storage capacitor by means of its grid and the heater-cathode leakage of V_2 is replaced by that of the series diode. If a silicon-junction diode is used, leakage current can be reduced to less than 10^{-8} amp at room temperature, which corresponds to a time constant of approximately 30 seconds with a 0.1μf storage capacitor and a 10-volt step amplitude.

To minimize grid current, the bias on the cathode follower should never be less than 1 or 2 volts. The maximum capacitance of the storage capacitor is limited by the abil-

ity of the recycling tube to discharge it. The shunt diode may be a conventional type or it may be another silicon unit since it is in series with the other diode. Figure 2 shows the complete circuit. The feedback is taken from a tap on the cathode follower to prevent conduction of the diodes. This results in a slight reduction of gain and linearity but if the cathode can be returned to a negative potential, a gain of 0.95 can be obtained with a tube having a short grid base.

Adjustment of step size may be made by varying either C_1, C_2 or V and the number of steps is varied by controlling the magnitude of the recycling pulse with R_1. The bias on the blocking oscillator can be used to set the level of the staircase.

Slide-Rule Computation of Guide Wavelength

BY JORGEN P. VINDING

Cascade Research Corp. Los Gatos, Calif.

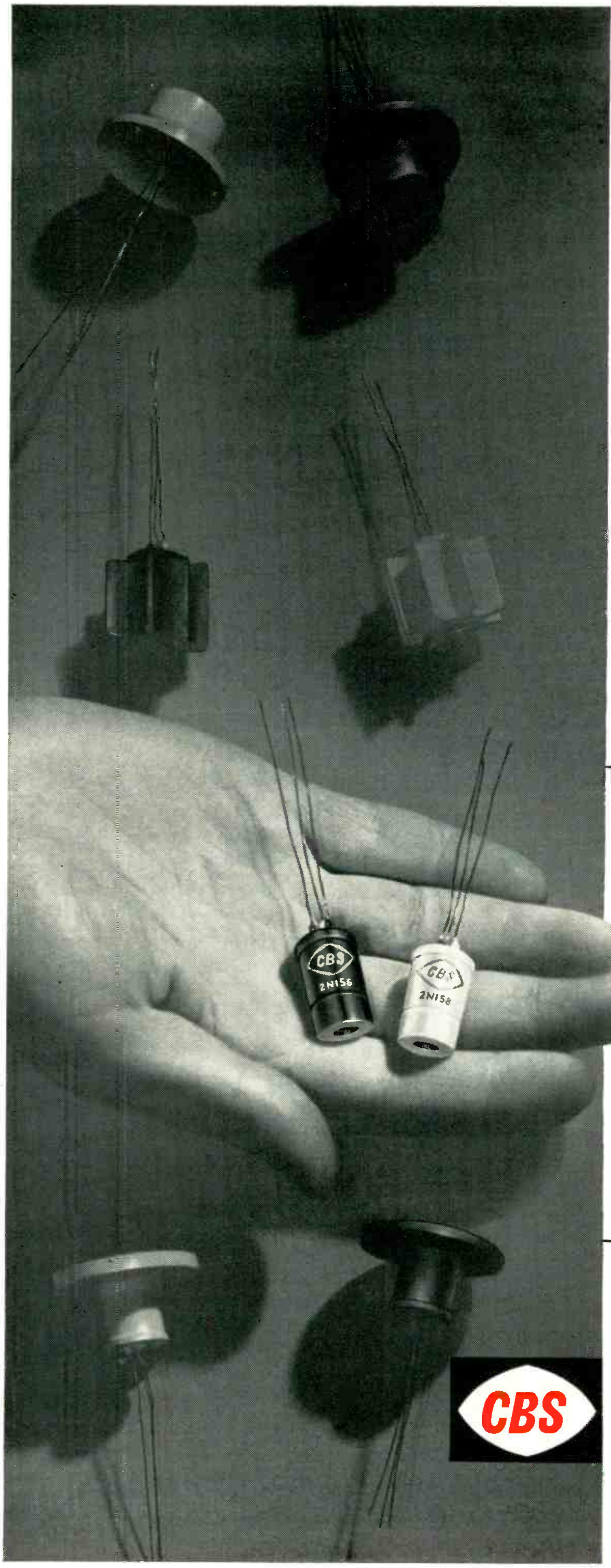
IN MICROWAVE engineering it is often necessary to compute the waveguide wavelength from the free space wavelength and the cutoff wavelength, particularly when working with a nonstandard waveguide for which curves or tables are not available.

This process involves squaring, subtraction, square rooting and division and is not very accurate because a small difference between two large numbers is used.

By introducing an angle θ as defined below it becomes possible to carry out this computation on a slide rule with little or no mental calculation depending on the type of slide rule used. In cases where better accuracy is required a logarithm table can take the place of the slide rule, particularly when the frequency is near the cutoff frequency.

λ_g = guide wavelength
λ_0 = free space wavelength
λ_c = cut-off wavelength = $2a$
a = wide dimension of rectangular guide

$$\left(\frac{1}{\lambda_g}\right)^2 = \left(\frac{1}{\lambda_0}\right)^2 - \left(\frac{1}{\lambda_c}\right)^2 \qquad (1)$$



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3. Stable, uniform characteristics (special selection unnecessary)
4. Low input impedance
5. Low saturation voltage
6. Low saturation current
7. Choice of hermetically sealed designs

TYPICAL CHARACTERISTICS

Characteristic	2N156	2N158
System voltage	12	28 volts
Current amplification Ic = .25 amp. Ic = 1.0 amp.	 48 33	 45 27
Collector dissipation*	5	5 watts
Collector peak inverse voltage	−40	−80 volts
Max. junction temperature	−40—85°C	−40—85°C

**With suitable heat sink*

Quality products through Advanced-Engineering.

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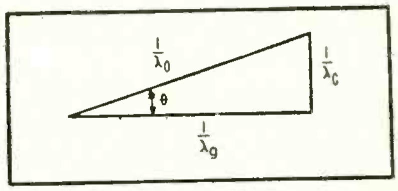

Angle defined by wavelength considerations aids calculation

Define angle θ by

$$\sin\theta = \frac{\left(\frac{1}{\lambda_C}\right)}{\left(\frac{1}{\lambda_0}\right)} = \frac{\lambda_0}{\lambda_c} \qquad (2)$$

Then

$$\cos\theta = \frac{\left(\frac{1}{\lambda_g}\right)}{\left(\frac{1}{\lambda_0}\right)} = \frac{\lambda_0}{\lambda_g} \qquad (3)$$

The form of Eq. 1 is similar to the Pythagorean theorem and suggests the right-angle triangle shown.

This is simple enough so that engineers who do not use it often enough to remember the procedure given below can derive it and use it in less time than the conventional procedure would take.

Procedure using a slide rule follows:

(1) Set λ_c on scale C opposite 10 or 1 on scale D

(2) Set cursor over λ_o on scale C and read θ on sin scale

(3) Move cursor to θ on cos scale or to $(90 - \theta)$ on sin scale

(4) Set λ_o on scale C under cursor

(5) Read λ_g on scale C opposite 10 or 1 on scale D

A similar technique can be used to find λ_c or λ_o.

Direct Current Signal Source

By Rufus P. Turner

Consulting Engineer
Los Angeles, Calif.

In development and maintenance of industrial electronic equipment, the need often arises for an accurate source of d-c test signals in the range extending from 1 volt downward to 1 millivolt or less.

Such a voltage calibrator is needed for checking the performance of, or presetting fix-tuned

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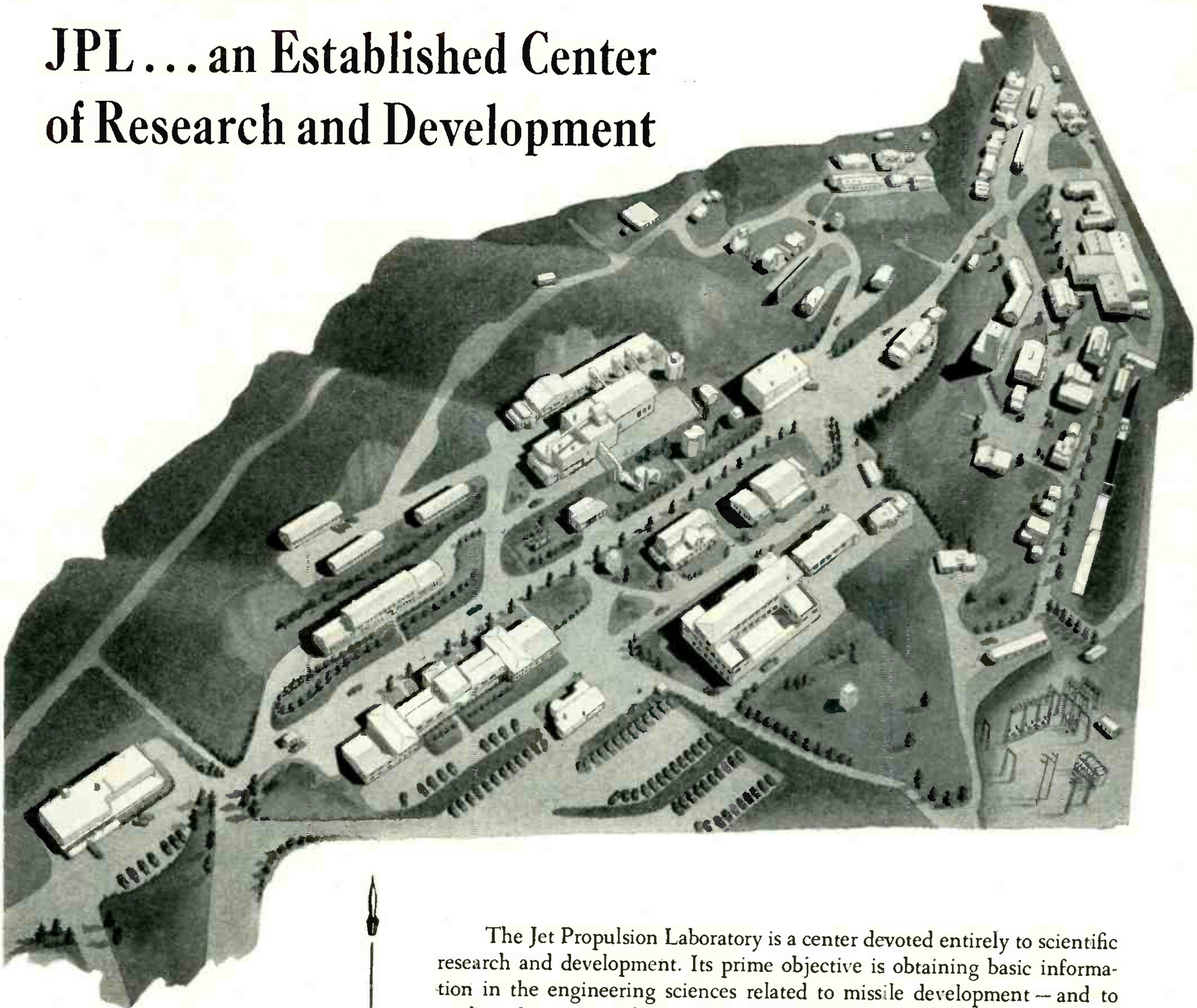

★ At this time we are particularly interested in interviewing graduate engineers and scientists in the fields of aerodynamics, aircraft structures, mechanical engineering, chemistry, chemical engineering, heat transfer, electronics, systems analysis, electromechanical instrument design, instrumentation, metallurgy, nuclear physics and solid state physics.

These men should be definitely interested in scientific research and development relating to the problems of the future.

The Jet Propulsion Laboratory is a center devoted entirely to scientific research and development. Its prime objective is obtaining basic information in the engineering sciences related to missile development — and to explore the various phases of jet propulsion. In addition a large share of its program is devoted to fundamental research in practically all of the physical sciences.

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PASADENA, CALIFORNIA

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controls in d-c oscilloscopes; oscillographs and similar recorders; d-c amplifiers used in conjunction with thermocouples, strain gages, accelerometers, and other transducers; automatic control devices utilizing d-c control signals; and

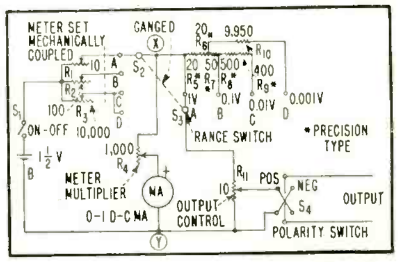


FIG. 1—Complete circuit of the d-c signal generator

d-c vacuum-tube voltmeter and millivoltmeters.

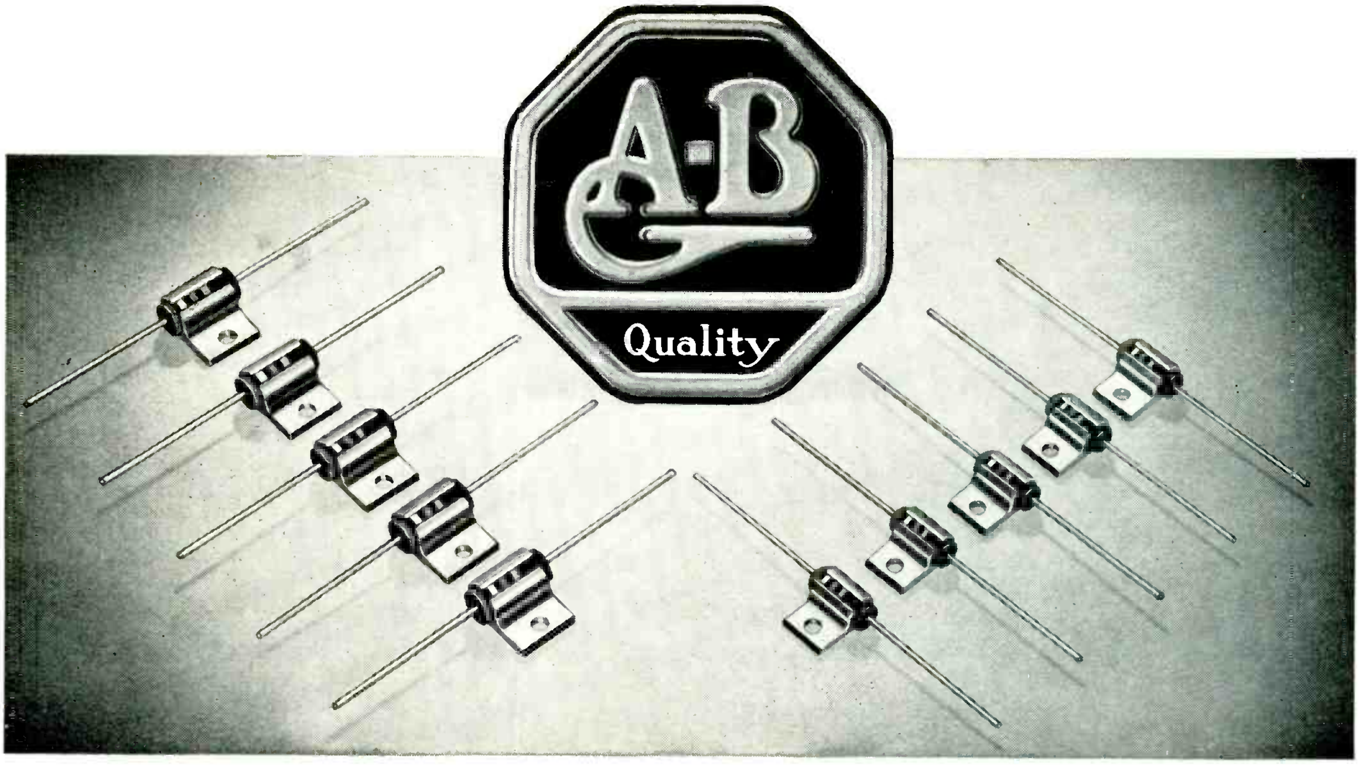
In most such applications, it is desirable that the d-c signal source have a low-resistance output circuit, and the numerous field applications of the instrument dictate its operation from a self-contained battery.

Figure 1 shows the circuit of a simple d-c signal generator. Basically, the instrument consists of a moderately heavy-duty 1½-volt source, a voltage divider comprising both stepped and continuous variation and a means for continuously monitoring the input voltage to the voltage divider and of setting this voltage to a standard reference level of 1 volt.

Operated from a single, No. 6 dry cell, the instrument is completely portable. The resistance across its OUTPUT terminals is 1 to 10 ohms, depending upon the setting of the output-control potentiometer, R_{11}. Output voltage may be varied smoothly between zero and 1 volt in four ranges: 0-0.001 v, 0-0.01 v, 0-0.1 v, and 0-1 v.

The voltage applied to the voltage divider is adjusted to 1 volt by means of one of the rheostats R_1, R_2 or R_3. These rheostats are ganged mechanically (metal belt-driven, since an inexpensive 3-gang wirewound unit is not available in the 10, 100, and 10,000-ohm combination required) and operated by a single knob.

The proper rheostat is switched into the circuit by arm S_2 of the RANGE switch. The monitoring



ALLEN-BRADLEY COPPER CLAD MOLDED RESISTORS

rated at 3 and 4 watts at 70C Ambient Temperature

A new and important addition to the Allen-Bradley line of radio, electronic, and television components are these Types GM and HM copper clad Bradleyunits, each fitted with a heavily tinned copper clamp. These new resistors are designed to be attached to a metal panel or chassis with rivets, bolts, or self-tapping screws. If attached to a metal panel four inches square and 0.050 in. thick at an ambient temperature of 70C, the maximum continuous wattage rating of the Type GM Bradleyunit is 3 watts; the Type HM Bradleyunit is 4 watts. At 40C ambient temperature, the ratings are 4 and 5 watts, respectively. However, if these copper clad Bradleyunits are suspended by their leads without being bolted to a metal panel, their respective ratings are 1 and 2 watts.

The copper clamp does not completely encircle the Bradleyunit, thus leaving a slot through which the color-code bands are plainly visible. Type GM Bradleyunits are available in all RETMA values from 2.7 to 22 megohms and Type HM Bradleyunits from 10 ohms to 22 megohms.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Limited, Galt, Ont.

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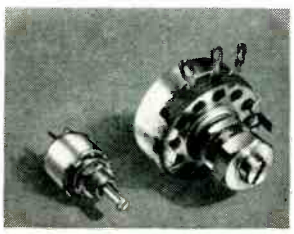

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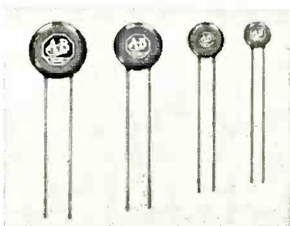
½ & 2 WATT



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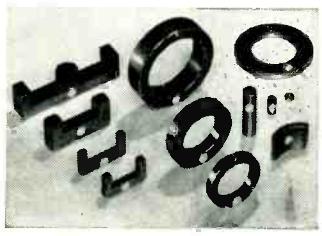

FERRITE COMPONENTS
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voltmeter consists of the 0-1 d-c milliammeter and multiplier rheostat R_4. The latter is set initially after completion of the instrument. An accurately known 1-volt d-c potential is applied temporarily between circled points X and Y in the circuit. With switch S_1 open, R_4 is set for full-scale deflection of the meter.

Rheostat R_4 is provided with a slotted shaft for screwdriver adjustment and is mounted inside the instrument case for protection against accidental readjustment.

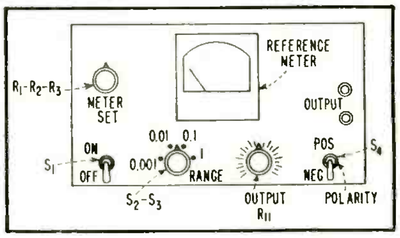


FIG. 2—Front panel layout of the d-c source

In addition to the METER SET rheostat (R_1, R_2 or R_3), the voltage divider consists of a fixed resistance (0 for the 1-volt range, $R_5R_6R_7$ for 0.1 v, $R_5R_6R_7R_8R_9$ for 0.01 v and $R_5R_6R_{10}$ for 0.001 v) in series with the 10-ohm potentiometer R_{11}. The fixed resistors, selected by arm S_3 of the RANGE switch, thus determine the output-voltage ranges, and potentiometer R_{11} provides smooth variation of the output voltage from zero to maximum in any selected range.

The values of range resistors R_5 to R_{10} have been selected to permit use of the minimum number of stock precision resistors to obtain the required resistance values. These values are: 1 v = 0, 0.1 v = 90 ohms, 0.01 v = 990 ohms and 0.001 v = 9,990 ohms.

The dial attached to potentiometer R_{11} is graduated 0 to 1 according to its resistance settings.

A dpdt switch S_4 is provided for reversing the polarity of the output voltage without disturbing the battery and meter connections.

Figure 2 shows arrangement of meter and controls on the front panel of the case which is 12 in. long, 7 in. high and 4 in. deep.

In use, throw switch S_1 to its ON position. Set RANGE switch S_2-S_3 to

FORD INSTRUMENT

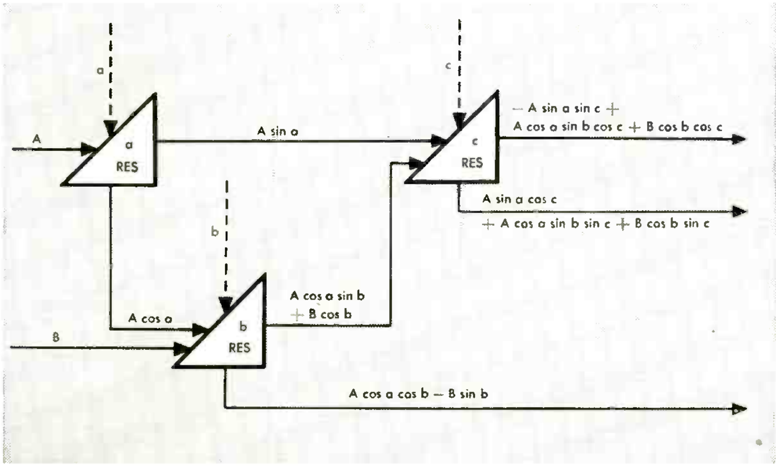
solved one design problem by

CASCADING RESOLVERS WITHOUT ISOLATION AMPLIFIERS

To get around a problem that arises in almost every resolver application Ford engineers recently designed a computer which, among other things, employed a chain of cascaded resolvers to solve complex trigonometric equations, without the use of isolation amplifiers. They solved such an equation as:

$$A \sin a \cos c + A \cos a \sin b \sin c + B \cos b \sin c$$

This was successfully done, without use of vacuum tubes or amplifiers in this circuit:



In view of the widespread use of resolvers to generate sine and cosine functions in modern electro-mechanical analogue computers, it is of great practical significance. Resolvers produced by the Ford Instrument Company have now reached such a high degree of precision, that it is possible to obtain, from an unloaded resolver (which accommodates a single angular quantity only), an accuracy to within less than one tenth of one percent. But most computing circuits call for the use of several resolvers, and once an ordinary resolver is loaded by another resolver, no matter how high its precision, the overall accuracy of the resolver cascade is seriously affected.

The conventional method of avoiding this difficulty is to use an isolation amplifier for each resolver, so that the resolver continues to operate under no-load conditions regardless of the size of the cascade. The importance of cascading without amplifiers is readily appreciated if we realize that the isolation amplifier usually increases the cost of the equipment, more than doubles the size and generates many times more heat that must be dissipated to prevent breakdown of the components. Furthermore, the use of vacuum-tube amplifiers always raises the problem of tube ruggedness and reliability, and requires an additional source of d-c plate voltage.

Have you problems which the engineers at Ford might solve by designing and manufacturing computers, controls or their elements? Write for further information.

85

FORD INSTRUMENT COMPANY

Division of Sperry Rand Corporation

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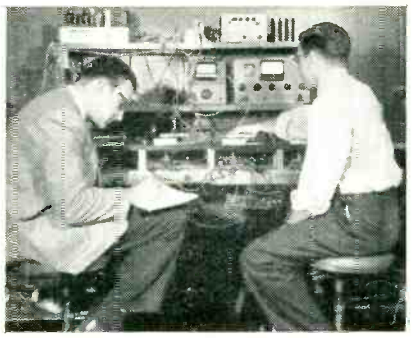
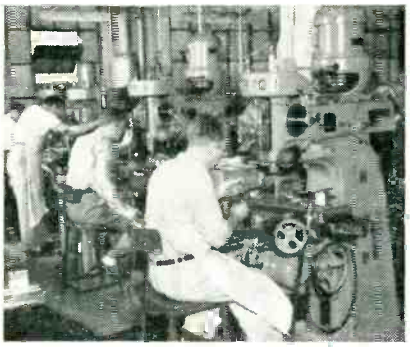
Ford's capabilities are among the finest in the country



One of the Ford laboratories where a particular design project has called for careful study of resolvers and resolver cascading. Two of the engineers assigned to this project are here checking results. From this work will come one of the new, highly classified weapon systems for the armed forces.



For accuracy and reliability—both vitally necessary in military instruments—experienced machinists must work to fine precision—in the order of .0005 of an inch. Here in one section of the shops of Ford Instrument Company, men are milling parts for an airborne computer.

During the past year Ford Instrument Company has been busy working on many contracts for the U. S. Air Force and the U. S. Navy Bureau of Aeronautics, designing and manufacturing complex computers, controls and their components. For over forty years, Ford Instrument Company has devoted most of its efforts in working for the government to the many problems of weapon controls.

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the desired output-voltage range. Set meter to full scale by adjusting METER SET control $R_1R_2R_3$. Set switch S_4 for the desired polarity of the OUTPUT terminals. Set OUTPUT control R_{11} for the desired output voltage level. Connect the device under test to the generator OUTPUT terminals. Readjust the METER SET control for full-scale deflection of the meter if deflection has shifted.

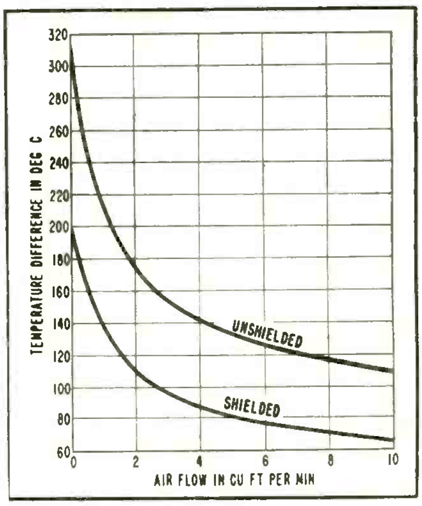
Whenever the instrument is in use, the meter should be watched for any shift from exact full-scale deflection.

When the instrument is in use, internal current drain from the 1½-volt cell is 100 ma on the 1-volt range, 10 ma for 0.1 v, 1 ma for 0.01 v and 0.1 ma for 0.001 v.

Internal Shielding Effects on Bulb Temperature

By M. MARK and R. C. MACGEE, JR.
Raytheon Mfg. Co. Newton, Mass.

COOLING OF VACUUM TUBES has received considerable attention with the advent of high-speed aircraft. The use of ram air for cooling becomes impractical at high speeds because of kinetic temperature rise. Therefore, if air is to be retained as the cooling medium, a refrigeration system becomes necessary. This emphasizes the need for effi-



Difference in bulb temperature and inlet air temperature versus air flow for shielded and unshielded tube. Tubes, mounted in 1 7/16 in. chimney, had power input of 17.45 watts

Thomas Kearns, Traffic Manager for Garrett Corp.'s AiResearch Div., in high-altitude lab. He tells

"How we cool off a hot pilot!"

"Above the speed of sound, air friction heats up the metal skin of the newest jets to several hundred degrees. *How do you keep the pilot cool?*

"AiResearch's answer: a refrigeration system including this miraculous 2-lb. turbine. Turning at 100,000 rpm's, it cools the air entering the cabin to 40° in 2/10 of a second!

"The extreme precision required in manufacturing such devices takes time. Yet, military contract schedules call for speed. Deliveries naturally have to be fast and sure — to plane companies located all over the country.

"How can we do it? By Air Express!

"Air Express proves its worth to us dozens of times a day, both incoming and outgoing. We literally could not maintain our schedules without it.

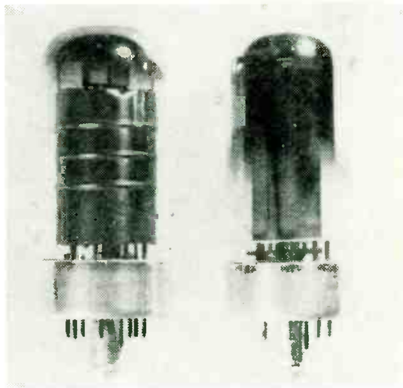
"Yet on most of those shipments, *Air Express saves us money*. A 10-lb. shipment from Los Angeles to Kansas City, for instance, costs \$6.34. That's 17¢ less than the next lowest priced air service!"

Air Express

GETS THERE FIRST *via U.S. Scheduled Airlines*

CALL AIR EXPRESS . . . *division of* RAILWAY EXPRESS AGENCY cient cooling since the air used for equipment cooling penalizes aircraft performance.

To obtain the desired life and performance from a vacuum tube, the hot-spot bulb temperature must be maintained below some predetermined level. To accomplish this, a hollow cylinder or chimney is sometimes placed over the tube and air forced between cylinder and tube. By properly selecting the air flow and the inner diameter of the chimney with respect to the tube diameter, the heat transfer from the tube surface can be controlled to give the required bulb temperature.



Internally shielded (left) and tube (right) without internal shield

Since maintaining the proper hot-spot bulb temperature with a minimum of coolant is important, the effect of internal shielding on bulb temperature is of interest. Basic thermal tests were performed on two similar tubes, both pentode amplifiers with T9 bulb types, to find a satisfactory chimney design for forced convection air cooling. One of the tubes was internally shielded, while the other was internally unshielded.

The tube socket was mounted on a plywood panel which fitted into a plenum chamber. This allowed mounting and interchanging of tubes without disturbing socket and wiring. Air entered the chimney and exhausted through the tube socket. Input power was adjusted and measured for each test and the air flow was determined with a gas meter. Bulb temperatures were measured with temperature-sensitive paints.

The chart shows maximum bulb temperature less inlet air tempera-

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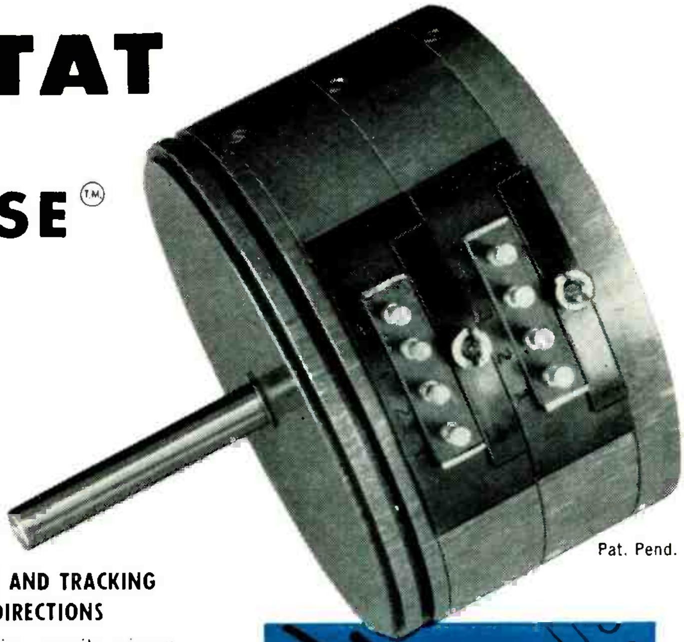
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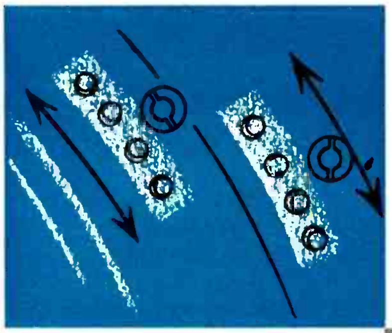

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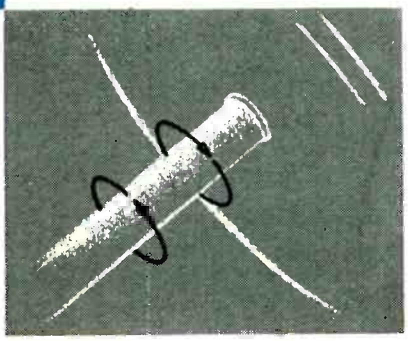
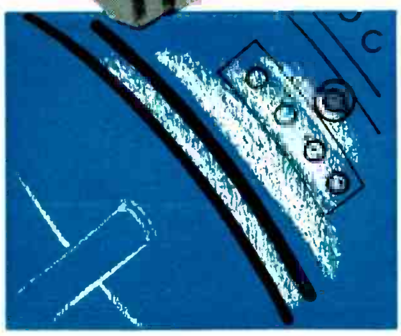
Simplified phasing—External independent phasing of each cup without effecting the relationship of the others.—To phase, loosen clamping nut, move terminal board in desired direction, tighten clamping nut and it's done. Speedy phasing saves time and money. Reduced overall diameter by elimination of clamping rings.

EQUAL TORQUE AND TRACKING IN BOTH DIRECTIONS

Unique contact design permits micrometer tension adjustment at factory and assures equal torque and tracking in either direction at all times.





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Materials selected for lightest weight possible. Design assures highest performance. Five sizes available—7/8", 1-1/16", 1-5/8", 2" and 3" diameters.

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*Aircraft Industries Associated.

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ture with respect to flow for the two tubes. Bulb temperature for the shielded tube was found to be practically uniform with no hot spot. The unshielded tube had a hot spot on the tube bulb opposite the plate. At a given air flow the bulb temperature rise of the unshielded tube was approximately 50 to 70 percent greater than that for the tube with the internal shield.

Internal shielding can prevent hot spots and the accompanying large temperature gradients on the envelope by conducting heat to the entire area of the shield, reducing the heat concentration.

When possible to incorporate it into the design, the advantages of internal shielding with respect to bulb temperature and bulb temperature gradient may be significant for airborne equipments.

Electronic Controller for Voltage and Current

By H. L. Armstrong and A. Kochman
Pacific Semiconductors, Inc.
Culver City, Calif.

There is occasionally need to control fairly large direct currents, or alternating currents or voltages, for which the usual type of controller is unsuitable. While magnetic amplifiers and the like are suited to such applications, they are not always readily available.

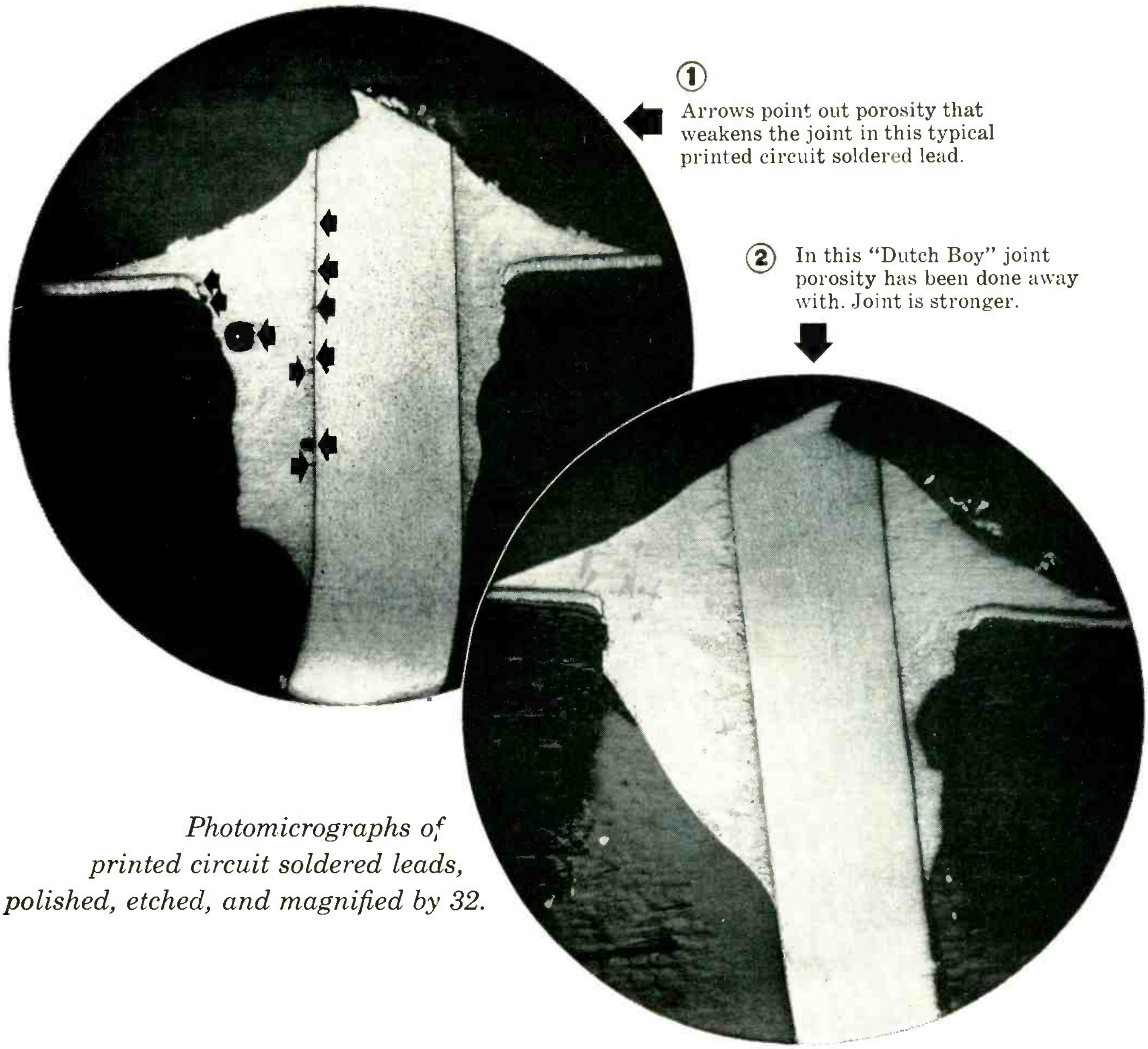
The circuit described here was devised to fill such a need for an instrumentation application and was required to control up to about 1 ampere d-c at two or three volts. Other capacities can be obtained by using other sizes of components.

The circuit used is shown in Fig. 1. Transformer T_1 is an ordinary power transformer, with a 115-v primary and 240-v c-t secondary rated 50 ma. It has, as well, 5-v and 6.3-v secondaries. It supplies 240 volts each to two windings of transformer T_2. This is a small power transformer with a 115-v primary, a 117-v 50-ma secondary and a 6.3-v 2-amp secondary.

The 115 and 117-v windings are in series with the 240-v windings

(1) Arrows point out porosity that weakens the joint in this typical printed circuit soldered lead.

(2) In this "Dutch Boy" joint porosity has been done away with. Joint is stronger.



Photomicrographs of printed circuit soldered leads, polished, etched, and magnified by 32.

"Dutch Boy" gets <u>inside</u> story on printed circuit soldering

...develops solders and fluxes that give stronger joints, coat more uniformly, show higher conductivity

"Dutch Boy" researchers keep a close eye on printed circuit soldering.

For example, they cross-section soldered leads, polish, and examine the polished sections under the microscope.

Most such joints prove too weak

The photomicrograph above left shows why. Notice this typical joint is honeycombed with porosity. Arrows point to holes.

Now look at the photomicrograph on the right. This joint is strong. Non-porous.

How was joint on the right made stronger?

No great trick. A "Dutch Boy" Solder Specialist simply worked out slight improvements in flux and solder formulae and operating conditions.

Maybe this would help improve *your* printed circuits.

"Dutch Boy" solders develop maximum surface tension. They don't form "tear drops" when coated boards are lifted from the bath...they improve coating uniformity. The residual flux is both non-corrosive and non-conductive, and can be left on the soldered board.

So, if you feel there is room for improvement in your printed circuit soldering, look first to "Dutch Boy". Write, giving details if possible, to National Lead Company, 111 Broadway, New York 6, N. Y.

Dutch Boy®
SOLDER AND FLUXES

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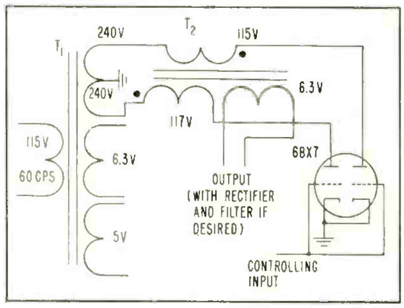


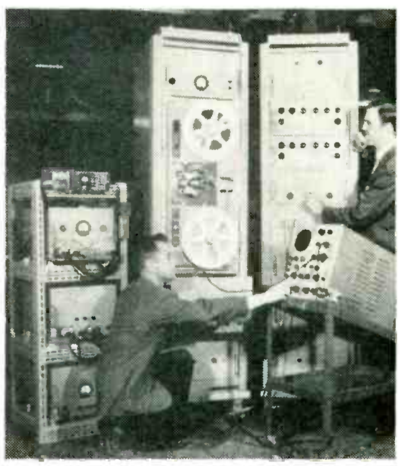
Basic circuit of the controller

of T_1 and with the tubes. On each half cycle, a current pulse, whose amplitude is controlled by the voltage applied to the grids, passes through one or the other of the high voltage windings of T_2.

Since these two windings are connected in phase opposition, the effect is the same as that of an alternating current in one winding, thus an a-c output is induced in the 6.3-v winding. The amplitude of this output depends on the voltage applied to the grids; thus the a-c output can be controlled. If a d-c output is desired, the a-c can be rectified and filtered.

There is no significance in the slight difference in the two high-voltage windings of T_2. They should have been identical; such a transformer, however, was not available and the amount of unbalance actually introduced was too little to cause any trouble.

Recording The ICBM



Airborne wide-band magnetic tape recorders manufactured by Bing Crosby Enterprises will record video ground return signals from intercontinental missiles

NO. 1 OF A SERIES

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The consolidation of all the engineering resources of Bendix-Pacific into one ultra-modern facility has now become a reality at the new Pacific Division Engineering Center in North Hollywood.

Bendix-Pacific is making certain that its traditional leadership will continue in the specialized electronic fields of radar, missile guidance, telemetering and sonar as well as in hydraulics and electro-mechanics.

The new Center represents another important step in the integration of Pacific Division's engineering and development skills under the Weapons System Concept.

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Production Techniques

Edited by JOHN MARKUS

Parts-Bin Ferris Wheels Permit Quick Changes of Job Setups

Single-station portable ferris-wheel bin setup, with color transparencies of finished wiring board mounted in light box overhead to guide operator

Large five-station permanent ferris-wheel bin setup, with bins independently controlled by the five operators. All bins are clearly labeled for quick identification when bins are run up or down for new job setup

TOWERING VERTICAL parts bins, mounted on endless chains so they can be moved up or down by operators at the flip of a switch, speed assembly of military electronic units and save floor space at General Electric's Light Military Electronic Equipment Department in Utica, N. Y.

The bin system, developed for specific needs of job-lot military electronic assembly work, brings the parts to operators instead of their having to move to different benches for varied assembly operations. Operators take components from the bins one by one and insert them in printed wiring boards which later are dip-soldered for use in radar, navigation and other equipment.

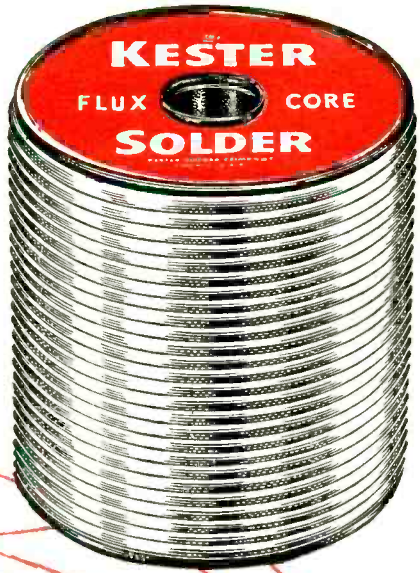
The ferris wheel with its 3,000 individual bins occupies 150 square feet of floor space. Conventional workbenches with fixed, stacked bins would take up about 900 square feet. Between 50 and 60 job setups are carried in each of the five sections of the ferris wheel.

▶ **Portable Version** — A semiportable single-section vertical parts bin is also in use. This can be shifted to different sections of the factory area readily as required. As a further aid in changing job setups frequently with minimum training time, color transparencies of a completed subassembly are often used in connection with the single-section ferris-wheel bin. The transparencies are slid into a frame on a light box mounted directly over the work station and ferris wheel.

▶ **How To Build**—Both small and large ferris wheels employ the same construction. A special link fitting, which replaces a standard link in the chain belt, carries the bracket that in turn carries the conveyor bin support rods. This fitting allows the entire unit to go around the top and bottom sprocket wheels with ample clearance. Bins therefore remain upright, swinging freely from the rods, as they go over the top and come down the back side.

Bins resemble home gutters, but actually are fabricated from steel for this application in the firm's Utica plant. The partitions are held in position by a bolt going through

tunes UP TIRED ASSEMBLY LINES



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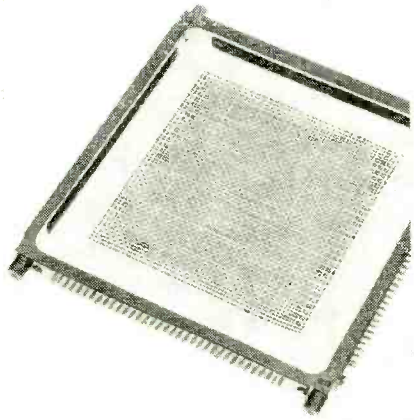
COMPANY 4204 Wrightwood Avenue, Chicago 39, Illinois; Newark 5, N. J.; Brantford, Canada the rolled-over top of the partition piece; the front end of the bolt is a hook going over the edge of the bin. The fastening nut is at the rear. A locating pin punched with the partition goes into a mating hole in the bottom of the bin. Each bin may have any combination of sections from one to twelve.

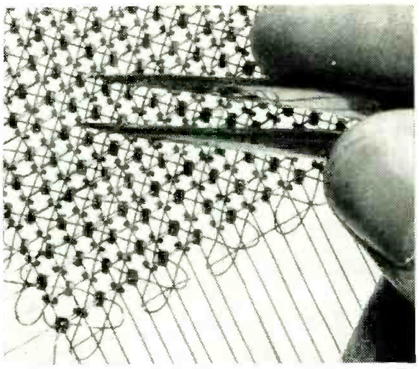
The operator at each station controls the up or down motion of her bins by a stop-go lever at the lower right under her bench. The drive is one-speed and slow enough that bins can be positioned precisely simply by moving the lever to the stop position when the desired bin is in position.

A metal screen mounted at the rear of the ferris-wheel bin array prevents other personnel from brushing against the bins and possibly upsetting them. Bins are loaded from the front, either during the second shift or during down time. The entire plant is air-conditioned, hence dust is not a problem.

Vacuum and Vibration Speed Assembly of Core Memory Planes



Assembly and wiring of this early 64 x 64 ferrite-core memory plane required 1 to 2 technician-weeks of tedious labor



Closeup of early memory plane design, showing how four wires pass through each core—for X, Y, digit and sense

Pouring ferrite cores on to fenced-in area of vibrating form while vacuum cleaners are pulling air at full speed down through flexible hose at lower left. During pouring, form may be tilted and rotated to get one core into each of the 4,096 pockets

By E. A. GUDITZ and L. B. SMITH
Staff Members, Lincoln Laboratory Massachusetts Institute of Technology

UNTIL RECENTLY, assembly of tiny ferrite rings into high-speed random-access memory arrays for digital computers has been an expensive and time-consuming process. As an example, assembly of a 64 x 64 (4,096-core) memory plane for the MIT memory test computer occupied a technician for between 1 and 2 weeks. The techniques to be described have resulted in over a 5 to 1 reduction of assembly time through the use of inexpensive, easily obtained fixtures.

▶ **Core Holder**—The first requirement for an improved plane-wiring procedure was a fixture capable of holding the cores in fixed alignment for the four wires which had to be passed through each of them. The earlier technique required that the cores be counted and threaded a row at a time. The cores would then be aligned and cross-wired.

A fixture to hold 4,096 cores in orientation is a complex machining job. For this reason, a male mold was machined from which plastic forms could be pressed as needed. The machining task was simplified by milling into the basic mold piece the shaped projections running in one direction and milling receiving slots for those running at right angles. The remaining projections

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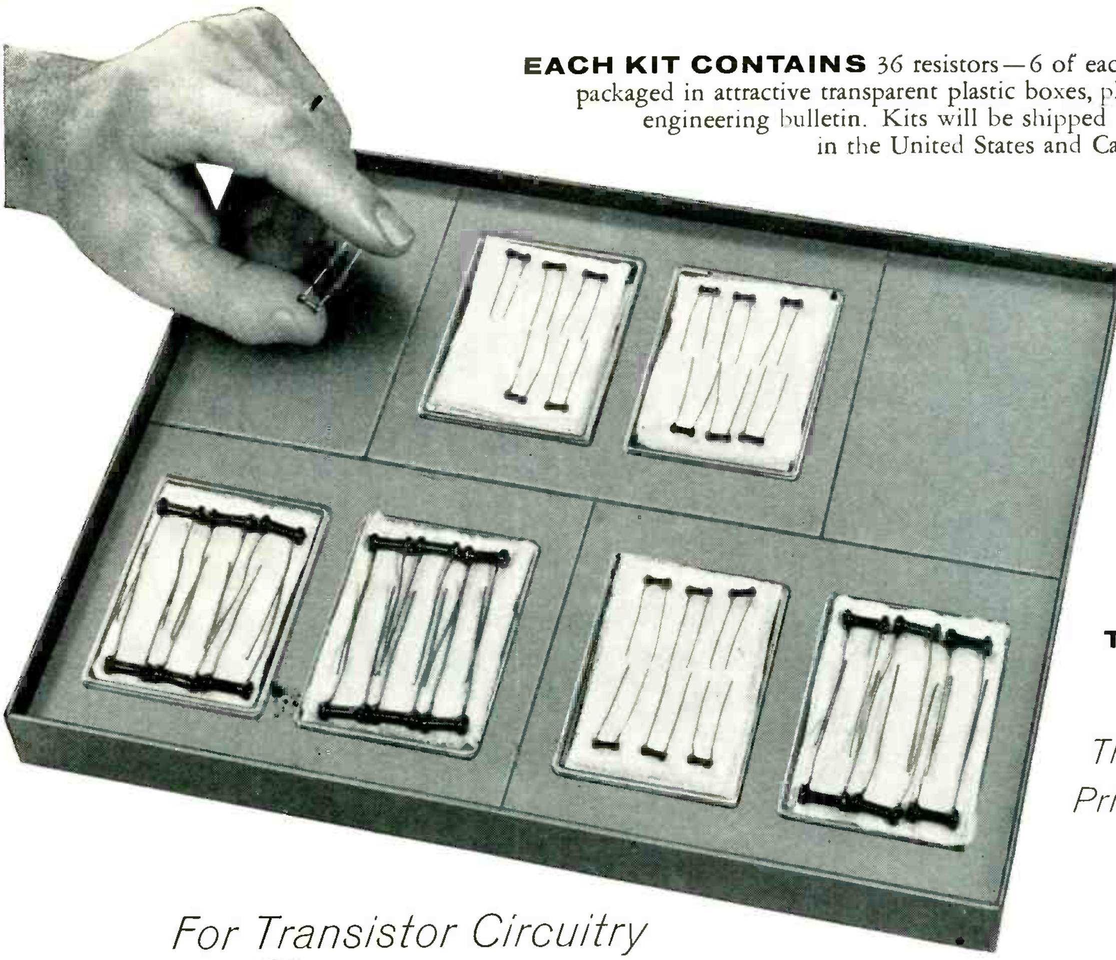

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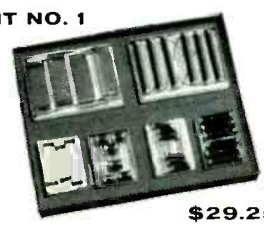

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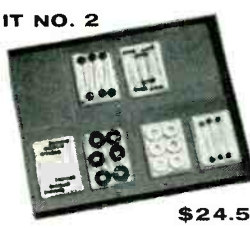

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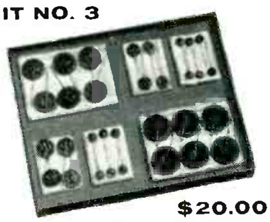

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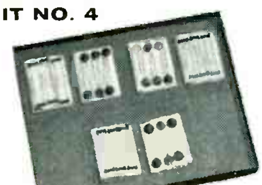

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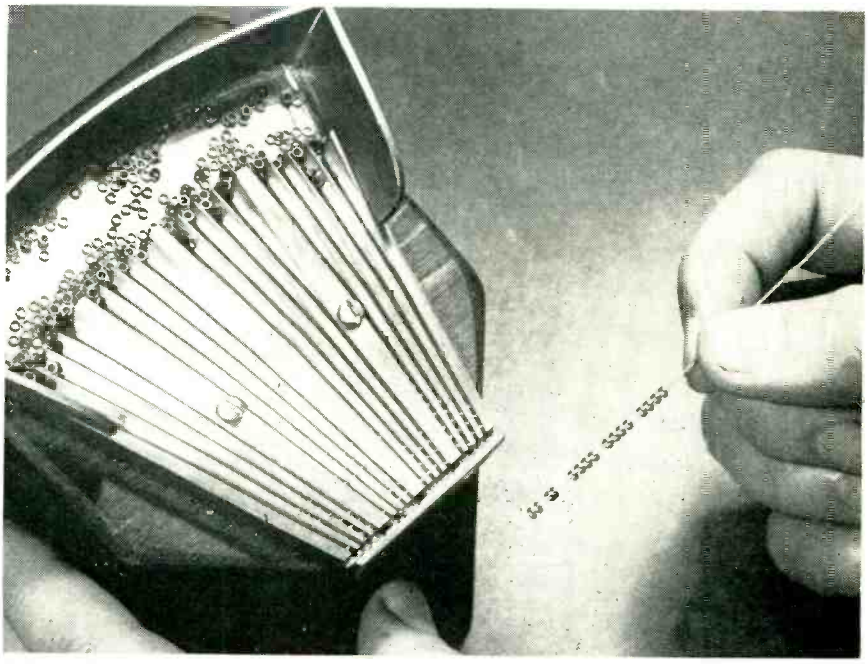
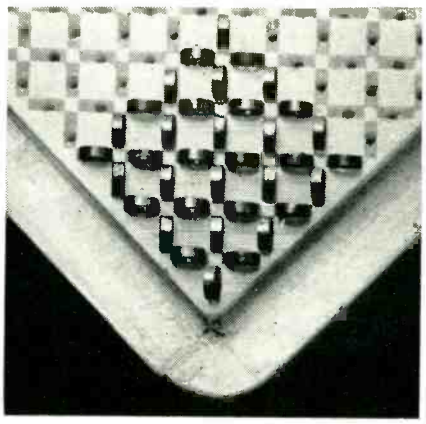
were machined in strip form and later soldered into the slots.

Tests of various plastic compounds resulted in the selection of Plexiglas for the forms; several types of this material were successfully pressed in the mold and removed in one piece.

▶ **Bouncing and Vacuum**—A technique was devised to load one of these plastic forms with 4,096 individual cores in less than 15 minutes. The form, which has a hole in the bottom of each core pocket, is mounted as the cover of a metal box connected to a commercial vacuum cleaner. The cores are slowly poured onto the form while a vibrator within the box shakes the entire fixture. As the cores are bounced, they are caught in the air stream and pulled into the pockets where they are held by the suction stream. When the form is filled with cores a thin plastic sheet, pulled down tightly against the tops of the cores by the suction, helps to hold them all in place for wiring. It is then possible to pass a needle through a row of cores without flipping any from



Older technique required that cores be threaded on a long needle and wired into large frame manually. The only significant mechanized aid was the counter threader shown here, which presented 16 cores at a time to operator. Cores gradually turn to vertical position as they slide down contoured chutes to threading position at bottom



Corner of plastic form, showing 36 cores in correct orientation in the pockets. Air is sucked through hole in bottom of each core pocket at a high rate during core positioning and at a lower rate during wiring of a 4,096-core plane

Corner of brass master mold used in producing plastic assembly forms. Vertical rows of half-disks are machined out of solid sheet with milling cutter, after which parallel slots are cut and individual horizontal strips inserted

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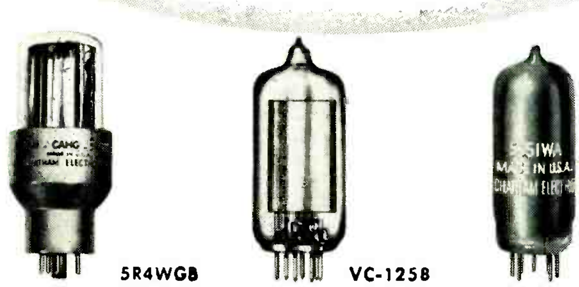

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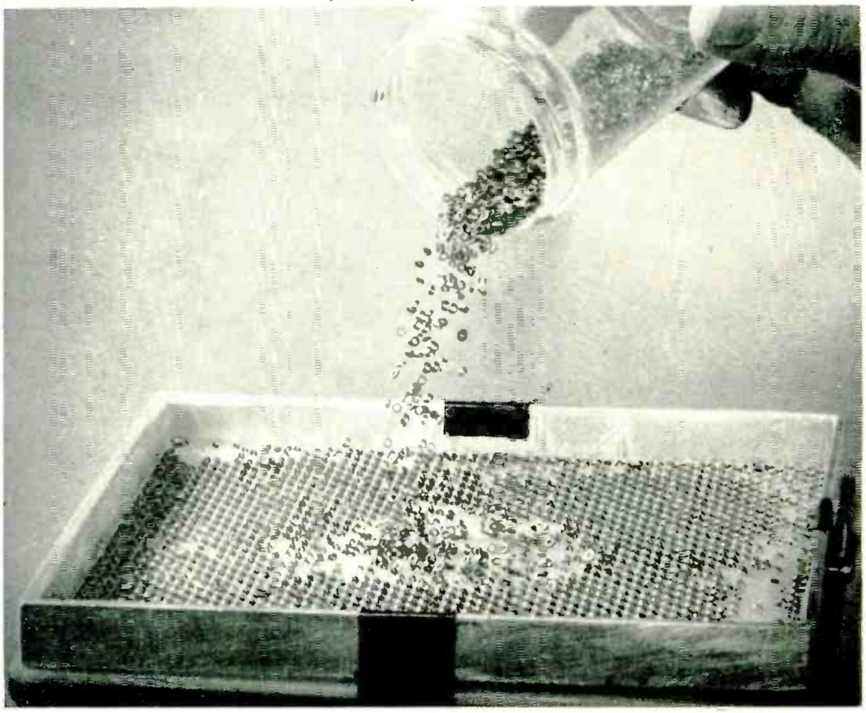
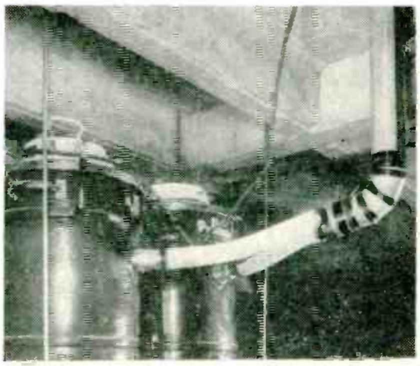
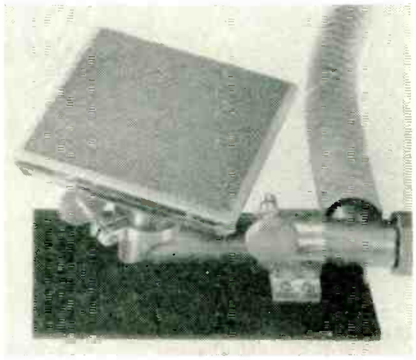


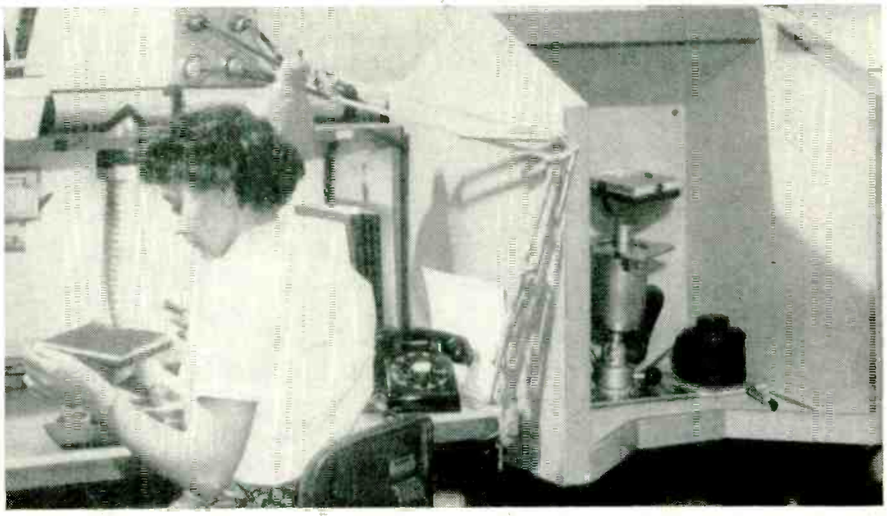
Appearance of plastic frame when most of the 4,096 cores are in position. Artist's hairbrush and tweezers are used to place the last few cores in the empty pockets, after which the assembly is covered with Saran-wrap. Core-positioning takes 15 minutes



Method of mounting two Pullman industrial vacuum cleaners on platform below assembly area and coupling to single stovepipe duct running up to assembly benches



Holding fixture, showing cores in position on plastic form ready for wiring with aid of hypodermic needle. Saran-wrap covering is left in position during wiring

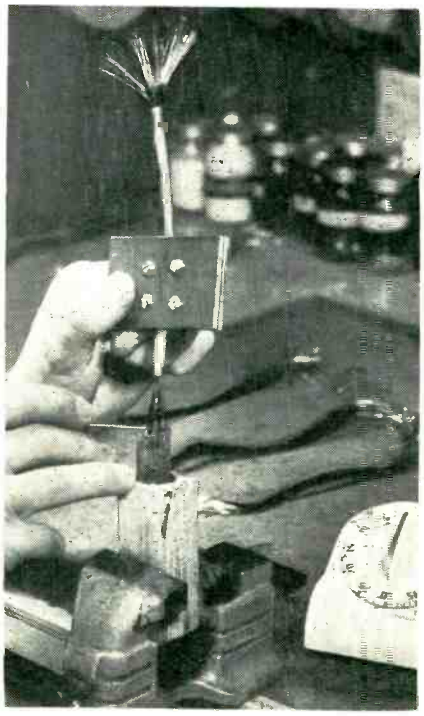


Wiring station, showing operator threading wire through cores held by frame of work fixture on bench. Core-positioning station at right is acoustically treated to reduce noise from vibrating jig

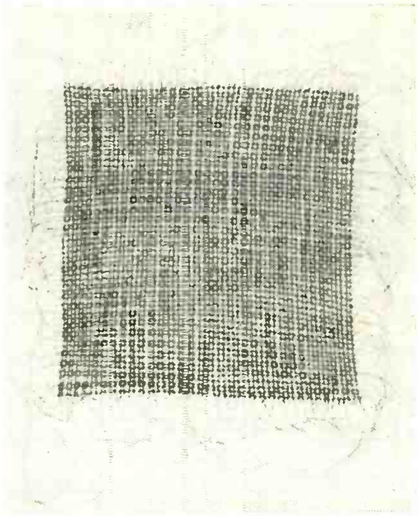
their positions in the pockets.

▶ **Threading**—The filled form is moved to another vacuum station for wiring; the first station is used for the positioning process only. Each core is threaded by an X wire, a Y wire, the digit winding

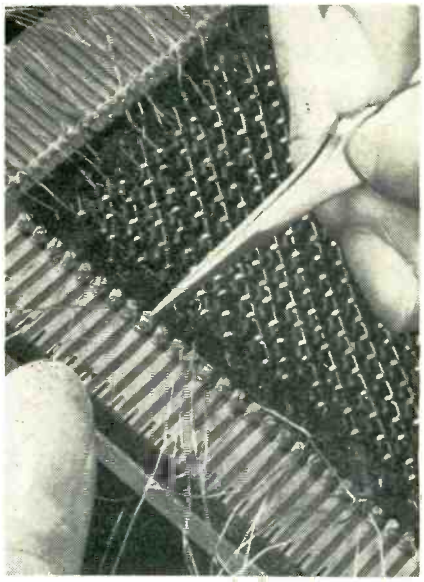
Method of using long 26-gage hypodermic needle to pull wires through 50-mil inside diameter of cores. An X wire and the Z winding are being pulled simultaneously



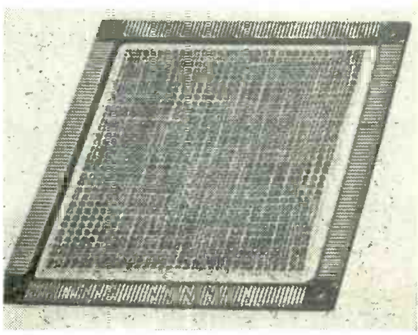
Method of using X-Var chemical stripper in test tube for stripping Formvar or Formex insulation from wires to be used in mat. Spaghetti tubing with tape seal at one end prevents stripper from creeping up too high. Squares of laminate bolted over spaghetti control depth of immersion when wire is dropped



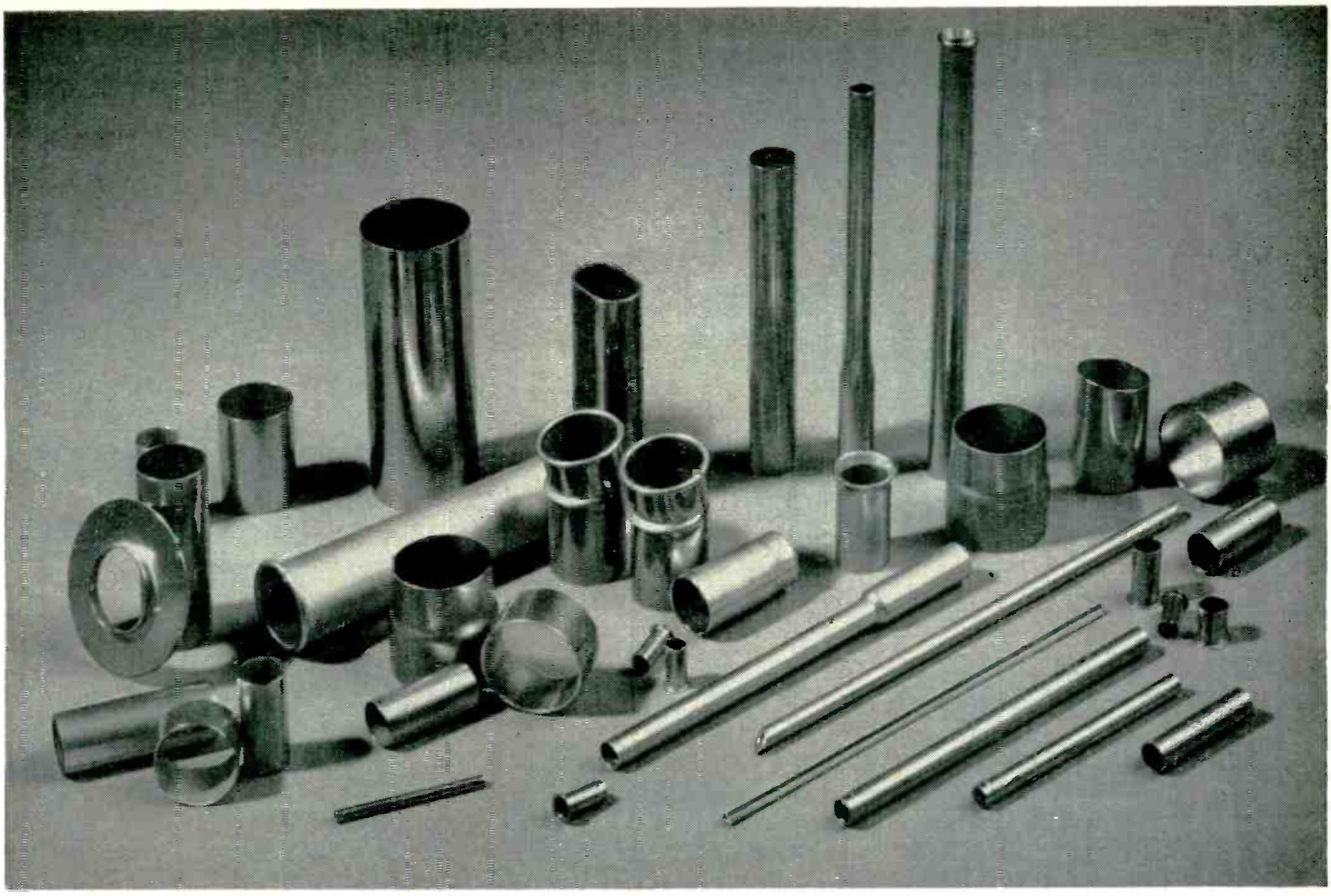
Appearance of completed mat when removed from wiring form, ready for connecting to a frame. Each mat now is produced in only 4 to 5 technician-hours, using quadruple-Formex No. 32 and No. 34 wire. Four of these wires go through each core



Method of using tweezers to aid in placing second loop of a Y wire in slot of subminiature lug on etched-wiring frame of memory plane. Between 2 and 3 hours are required to make these connections, straighten out lines of mat and clip off surplus wire



Complete memory plane ready for dip soldering of leads wrapped around lugs positioned over etched-wiring terminals



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and the sense winding. The X and Y wires are short and go from one edge of the plane to the other. The digit wire is continuous and passes through each core parallel to each

After dip soldering each of the four edges of the plane in turn, unit is ready for inspection and test

Pouring diluted Amphenol Polyweld over dip-soldered mat to cement each core at its four-wire junction below for later use

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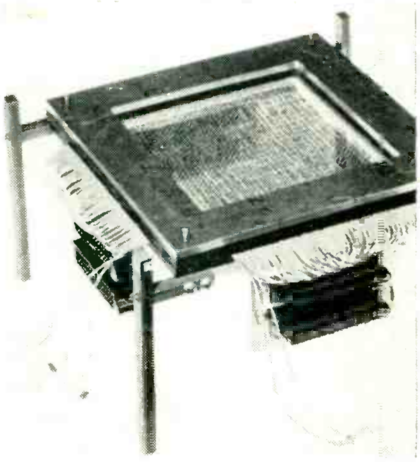
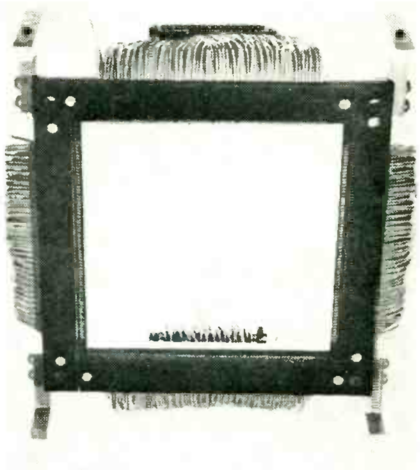
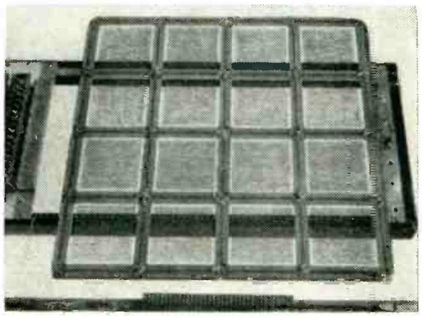


Test fixture for completed memory plane, with plane in position



Test fixture without plane



Array of 16 memory planes, interconnected by copper shims to give 256x256 memory plane. Complete random-access memory under development will have 38 of these large planes

Y wire. The sense wire also passes through each core, but in a different manner; one half of the winding is threaded through each core along alternate diagonals, while the other half is rotated 90 degrees and passed similarly through each of the remaining cores.

▶ **Finishing**—The wired assembly of 4,096 cores, called a mat, may be

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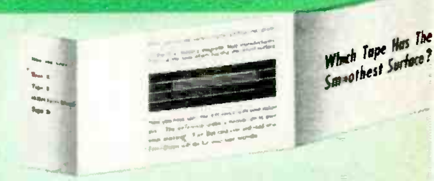

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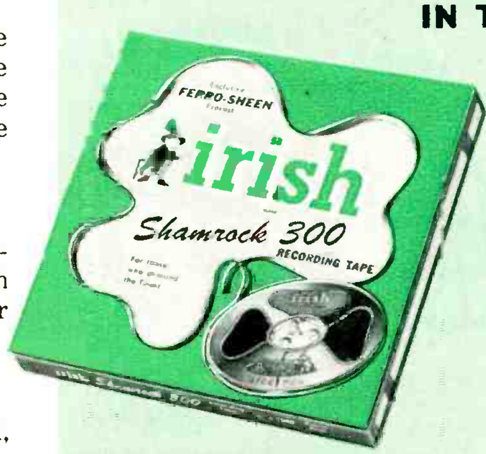

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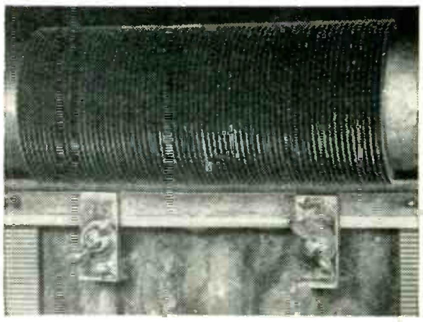
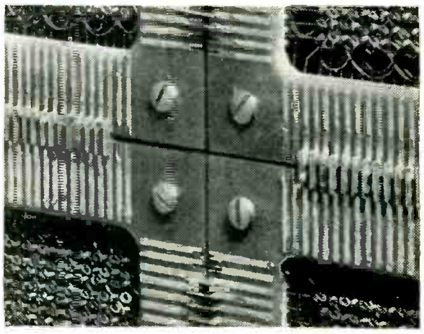
removed from the plastic form and connected to a simple frame. After dip-soldering the connections at the four edges, the plane is complete and ready for testing. The cores may be immobilized to prevent future possible abrasion damage to the wires by pouring a dilute solution of electrical dope or cement over the mat.

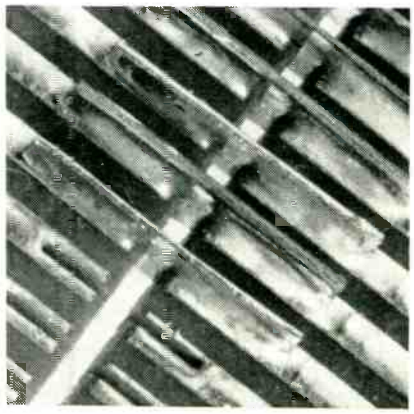
The 64 × 64 memory plane is a complete unit ready for stacking in a 4,096-word memory array. More than this, however, it is designed so that several units may be conveniently joined to form a larger plane. For example, 16 may be



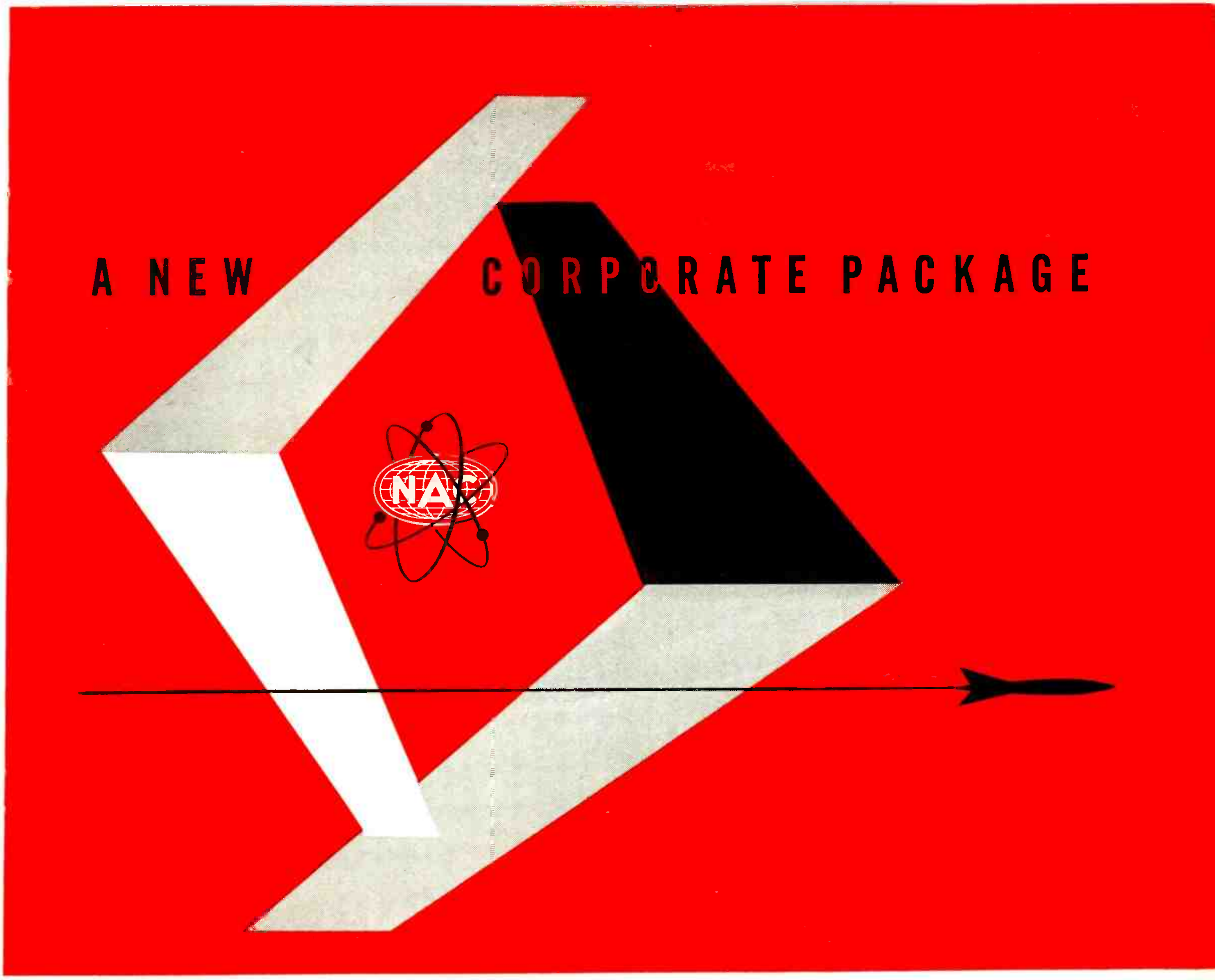
Use of gang saw to slot etched-wiring terminals of memory plane, in preparation for insertion of interconnecting shims



Junction of four memory plane units, showing use of interconnecting shims



Shims are soldered to etched wiring terminals all at once by induction heating or by heating each shim individually with a soldering iron



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MARVELCO ELECTRONICS DIVISION... research and production of electronic components, missile guidance systems, computors, automation, germanium transistors, silicon power rectifiers, diodes, and associated items . . . formerly, Semi-Conductor Division of Hydro-Aire, Inc.

MAG-ELECTRIC... magnetic amplifiers, transformers, power supplies, toroids, and associated items . . . wholly owned subsidiary.

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AIRCRAFT DIVISION... airframe modification, overhaul and repair of all types of aircraft . . . formerly West Coast Division of Florida Aircraft.

AIRCRAFT ACCESSORIES DIVISION... hydraulic, pneumatic, oil, fuel, mechanical, and electro-mechanical accessories.

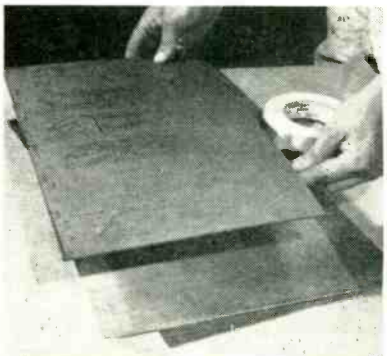
joined to form a 256 by 256 plane. These large planes may then be stacked in a 65,536-word memory array.

The research described was supported jointly by the Army, Navy and Air Force under contract with the Massachusetts Institute of Technology. Acknowledgement is expressed to Lloyd Sanford of Lincoln Laboratory for the photographs of the arrays and assembly equipment.

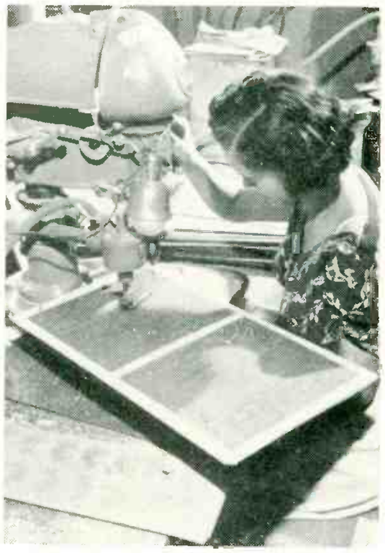
Drilling Template For Etched Wiring Boards

SMALL sample runs of large and complex etched wiring boards requiring plated-through holes are economically drilled in multiple by using an etched board as a drilling template. The etched board is placed over two or more unetched pieces of laminate and the sandwich is taped together around the edges. Two holes at diagonally opposite corners are drilled first. Steel pegs are inserted in these to insure accurate alignment during subsequent drilling. The operator then positions the sandwich manually over each terminal position in turn and drills the hole through the etched and plain boards simultaneously. Before drilling, she brings an air-actuated foot down on the boards to prevent movement during drilling, by operating a foot valve.

After all holes have been drilled, the unetched boards are ready for hole-plating, followed by conventional etching. The etched board is discarded or saved for reuse as a template since its holes cannot



Placing etched template board over two unetched boards to prepare sandwich for drilling



Method of drilling tape sandwich while air-operated foot presses boards firmly down on table of drill press

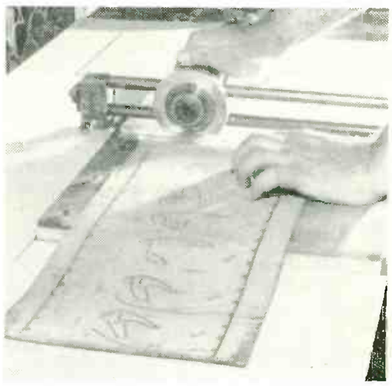
be plated once the conductive path is broken up by etching the wiring.

This technique greatly reduces the cost of producing sample boards needed for submission with price quotations.

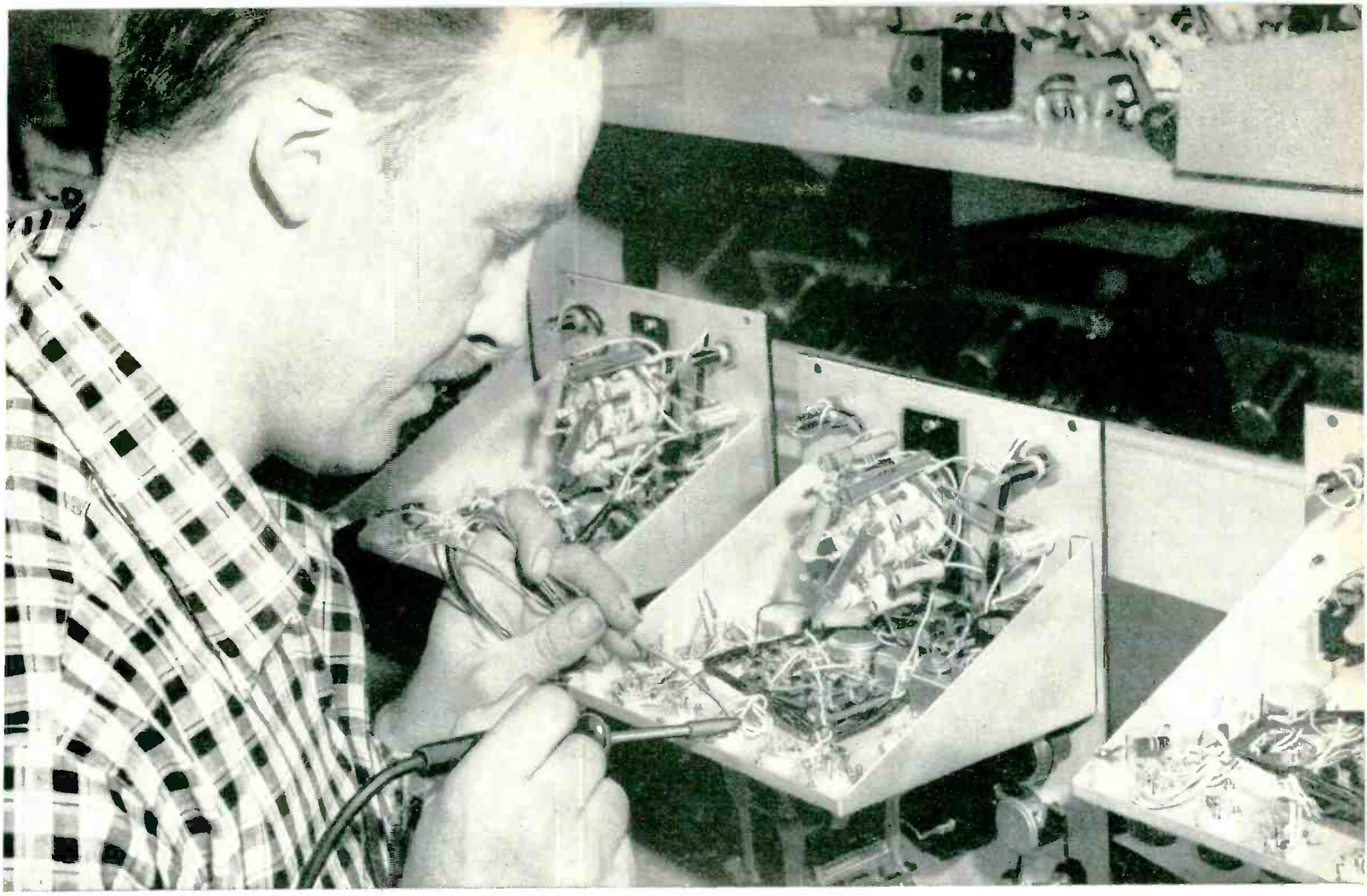
Cutting Glass Cloth

ETCHED wiring patterns produced in multiple on glass cloth are cut into the required smaller sizes with a rotary knife designed and built in the Glen Cove, N. Y. plant of Photocircuits Corp. The resulting pieces are subsequently curved and rigidized by molding techniques, for use as etched wiring boards in missile subassemblies and other subminiature equipment.

The glass cloth is slipped under a Lucite hold-down strip and positioned against a metal guide strip, much as when using an ordinary

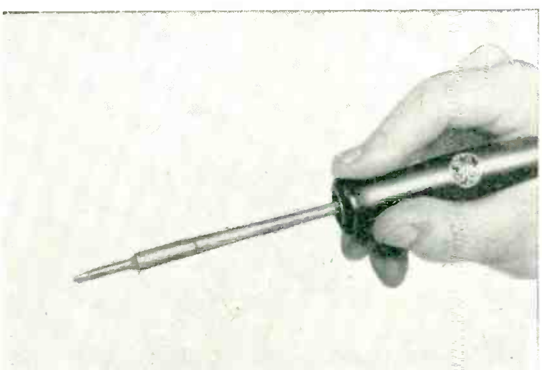


Method of using rotary knife to cut glass cloth having etched wiring

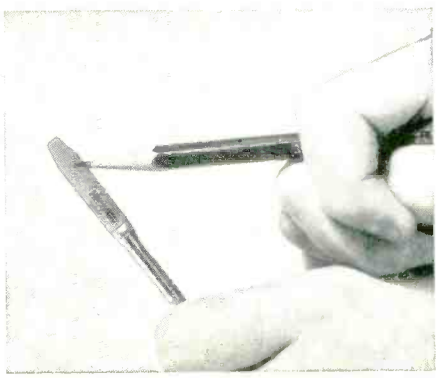


"BEST IRON WE'VE HAD in the plant," says William Fish, a production supervisor of General Radio, Cambridge, Mass. This company has switched to G-E Midget irons for soldering *both* delicate and heavy joints in their Type 1862-B Megohmmeters —jobs which formerly required *both* a heavy and a light iron. G-E Midget iron's light weight also helps reduce fatigue.

50 G-E Midget irons do work of 100 former irons at General Radio Co., boost production 25%



HANDLES LIKE A PENCIL—Weighing less than a package of cigarettes, the General Electric Midget soldering iron speeds production by reducing operator fatigue.



RAPID HEAT TRANSFER is achieved by locating the heater directly in the iron-clad-copper tip. Result—the G-E Midget iron's heat efficiency is 90%.

THREE-IN-ONE IRON with $\frac{1}{8}$", $\frac{1}{4}$", $\frac{3}{16}$" tip sizes gives you greater versatility to meet your soldering requirements. Tips can be changed in only 5 seconds.

For more information write for GED-2263, G-E Midget Soldering Iron, Section 724-3, General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC

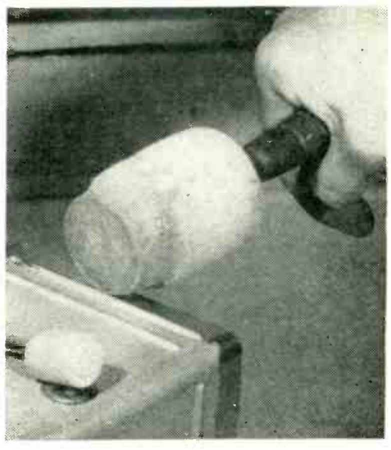
paper cutter. The rotary knife is then moved along its overhead carriage to produce the required high-precision cut. This technique serves admirably for producing sample quantities, where the cost of producing cutting dies would not be justified.

Applying Tinning Compound With Felt Rollers

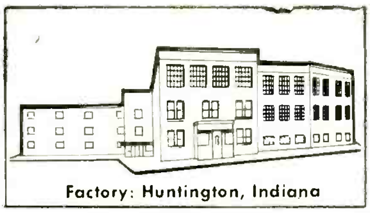
COMBINATION solder-flux paste for pretinning mating surfaces of hermetically sealed housings is quickly and neatly applied with rotary applicators designed and

Examples of felt applicators for tinning compound

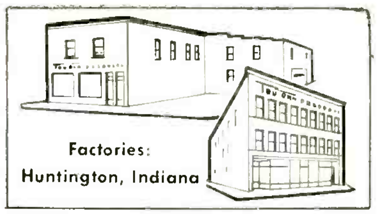
Applying tinning compound inside a hole with a small applicator. The compound is here applied to the felt with a small brush



Applying compound along outer edge of housing with free-turning applicator



TRU-OHM NEWS

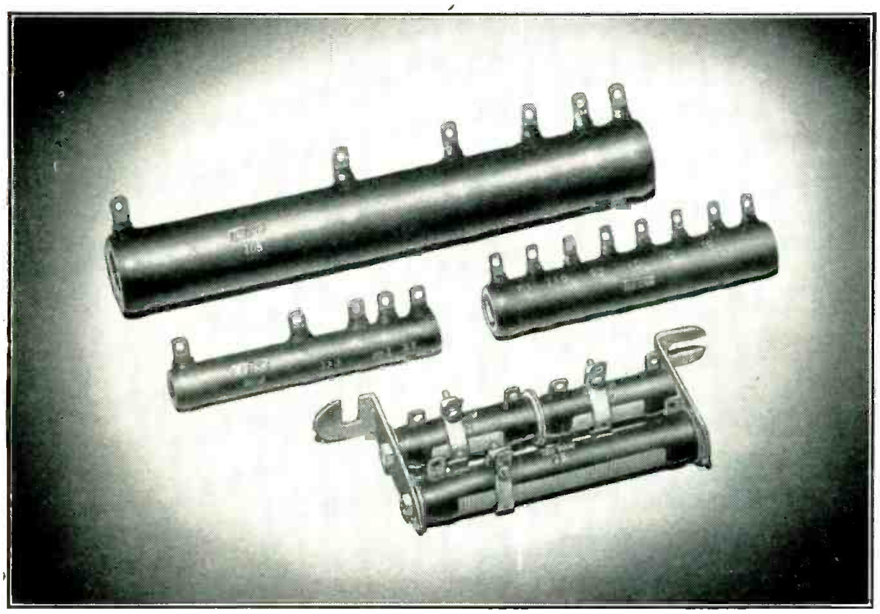


TRU-OHM PRODUCTS, *division of Model Engineering & Mfg. Co., Inc., General Sales Office: 2800 N. Milwaukee Ave., Chicago 18, Ill.*

Vol. 80,000,000 — 1955-56 — No. 80,000,000

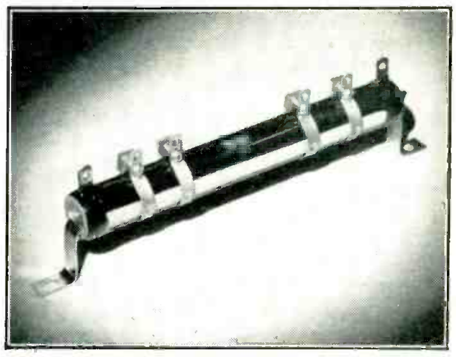
80 MILLION SOLD!

TRU-OHM is Now the World's Largest Producer of Wire-Wound Resistors!

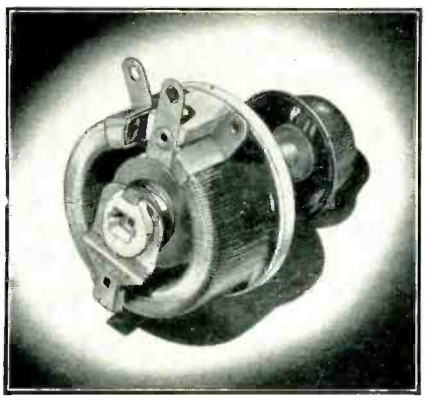


Special size resistors: Tru-Ohm's highly skilled factory trained technicians turn out large varieties of special resistors. Complete data of these special size resistors is available.

Chicago . . . From Tru-Ohm's general sales office. Since starting just a few short years ago, TRU-OHM PRODUCTS has grown phenomenally to ten times its original capacity. Having just produced its 80,000,000th wire-wound resistor, Tru-Ohm is now the world's largest growing and largest producers of wire-wound resistors.



Resistor No. 80,000,000. One of many wire-wound resistors which are turned out by the thousands daily.



Complete line of power rheostats . . . of finest quality with UL approval; variety from 25 watts up.

High Quality, Speedy Delivery Sets Record

Over 50,000 square feet of the most modern manufacturing facilities, including a brand new furnace, enable volume production . . . assure faster delivery, finer quality, better prices. And TRU-OHM EXPEDITES FOR YOU . . . ships on time.

Inquiries Invited. You can get the complete story of Tru-Ohm's tremendous growth and why, by writing to 2800 N. Milwaukee Ave., Chicago 18. Let Tru-Ohm's experts solve your resistor and rheostat needs.

For Original Equipment or Replacement Needs

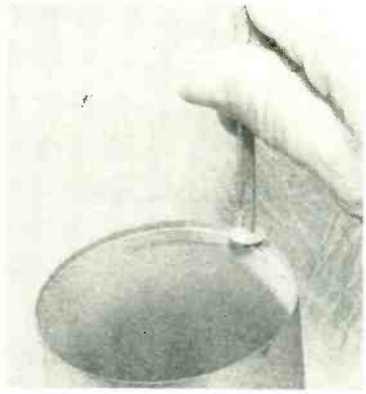
A complete line of resistors as well as a complete line of power rheostats are now produced for the finest industrial manufacturers in the world . . . for replacement applications . . . sold through parts jobbers.

Want more information? Use post card on last page.

made especially for this purpose in the Long Island City, N. Y. plant of Ford Instrument Co. under the direction of Gerard Olsen.

The applicators are turned to the desired shapes on a lathe, working from standard mounted-felt polishing wheels. Most of the applicators are stepped to fit two or more diameters for applying flux inside a cylinder, inside a hole or around the edge of a hole in a housing.

The tinning compound employed is a powder form of solder com-



Applying compound to inside edge of cylinder to precisely controlled depth with Fiberglas brush having depth-controlling disk

bined with a flux to give a paste having the consistency of heavy paint. One example of this is Eutec-Tin Weld I. The applicator shank is held with the fingers for dipping the felt into the paste, after which the felt is inserted in the hole and rotated to leave a neat ring of compound where tinning is required. For critical locations the paste is sometimes applied to the felt with a brush to insure an even coating.

► **Roller-Type Applicators**—For pretinning the edges of a housing, one large applicator is equipped with a handle and ball bearing. After dipping in the can of compound, this applicator is rolled along the edge of the housing to coat base and edge simultaneously.

When tinning compound is to be applied in a narrow stripe around the inside edge of a component, a Fiberglas brush with a revolving disk to control depth is used.

Contoured felt applicators are used for applying the compound to

PERHAPS WE'LL HAVE TO ADD A PINCH, FOR YOU . . .

Just ask us for an alloy we haven't got — we'll be delighted.

Because that's how each of the more than 112 resistance and electronic alloys Driver-Harris makes had its beginning. Each of these highly specialized alloys is custom-made . . . produced exactly to the specifications of our customers.

The physical and chemical properties of an electrical resistance alloy can be altered greatly by a minute difference in its constituents. Often just a few ounces to the ton can make the difference you need.

One thing you can always rely on in any Driver-Harris alloy: it is made to the most precise metallurgical checks and controls known to the industry. It is these exclusive quality controls that have made Nichrome V and Nichrome* the standard for over 50 years by which all other electrical resistance alloys are measured.

Perhaps in a sense Nichrome is *too* well known. For we don't want people to forget that we make many other resistance alloys of sustained high quality to meet other special needs. And that, as we said at the outset, our engineers will be more than delighted to start afresh tomorrow to devise a new one, custom-made for you. Just tell us as exactly as you can what you wish to accomplish.

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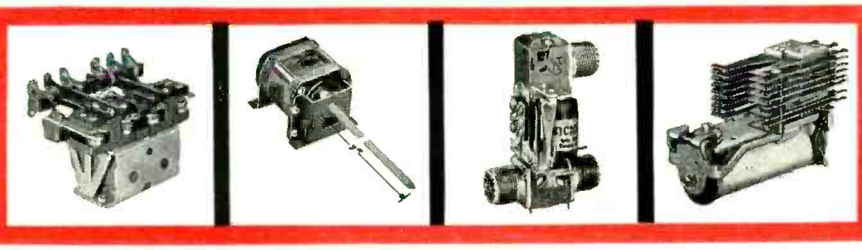


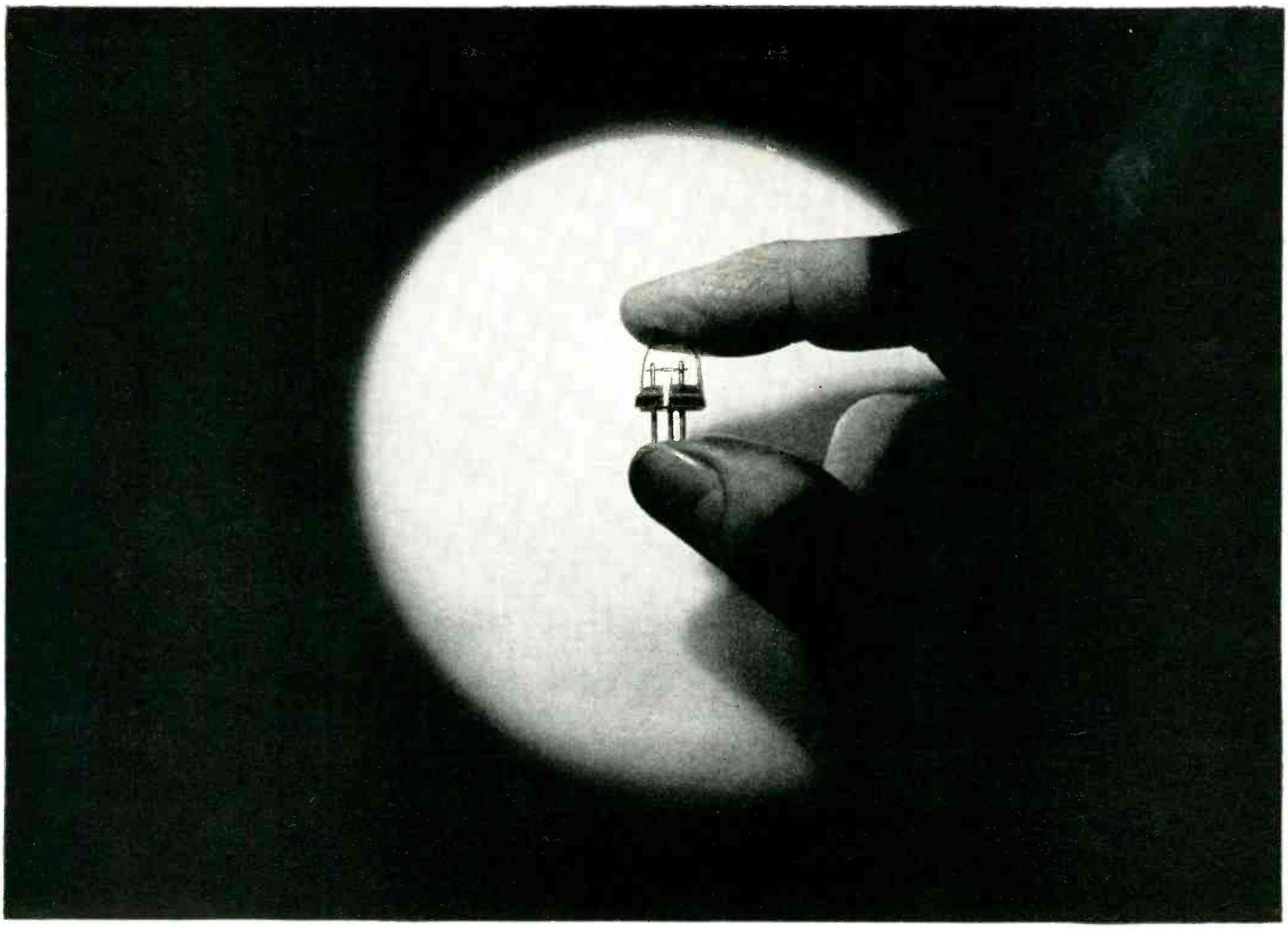
Quick turn of cylinder inside block-type applicator applies compound neatly in uniform band on outside

Removing cylindrical housing from 500 F oven after tinning compound has fused

dimples and to irregular window areas.

▶ **Block-Type Applicators**—A felt block applicator is used for applying an even stripe of compound to the outer edge and end of a metal cylinder simultaneously while keeping the inside edge clean. The applicator is made by nailing a ½-inch board over a 1-inch board, boring a large hole in the two-layer block, lining the hole with felt, then cutting away half of the ½-inch board along with its felt. The tinning compound is applied to the felt with a brush. Rotating the end of the cylinder 180 degrees in the applicator applies the compound in a matter of seconds, with half of the felt circle taking care of the end and the other half applying paste to the outside.

After the tinning compound is applied, the mating parts are fitted together and placed in a 500 F oven. The parts are removed when the bright shine of molten solder re-



Experimental model of Bell's new high-frequency transistor. It has a cut-off frequency of at least 500 mc and can be used to amplify 2500 independent voices simultaneously.

THE TRANSISTOR

that smashed a frequency barrier

A new transistor invented at Bell Telephone Laboratories can provide broadband, high-frequency amplification never before possible with transistors. The big leap in frequency is made possible by a diffusion process that earlier enabled Laboratories scientists to create the Bell Solar Battery.

This transistor is a 3-layer semiconductor "sandwich." High-frequency operation is obtained by making the central layer exceedingly thin. This was difficult to do economically by any known method.

The new diffusion process, however, easily produces microscopic layers of controllable thickness. Thus it opens the way to the broad application of high-frequency transistors for use in telephony, FM, TV, guided missiles, electronic brains and computers.

The new transistor shows once again how Bell Laboratories creates significant advances and then develops them into ever more useful tools for telephony and the nation.

A Bell scientist checks temperature as arsenic vapor diffuses into germanium, creating 4/100,000-in. layer.

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IMPROVING AMERICA'S TELEPHONE SERVICE PROVIDES CAREERS FOR CREATIVE MEN IN SCIENTIFIC AND TECHNICAL FIELDS

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Method of using water-soaked felt pad in block to prevent previously soldered windows in cover from melting during final solder sealing

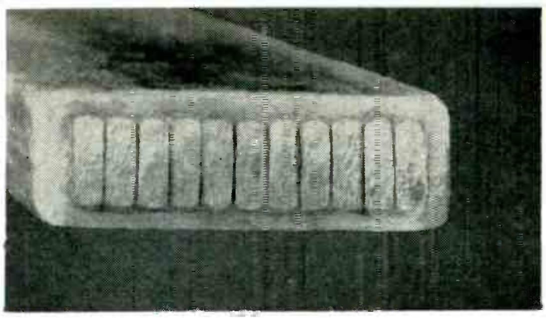
places the dull appearance of the paste. After tinning, the part is rinsed twice in water at 140 F to prepare it for the actual soldering, which is done with a rosin-alcohol flux.

The foregoing techniques are used in producing the outer case for the ASN-6 ground-position-indicator unit used in aircraft for navigation.

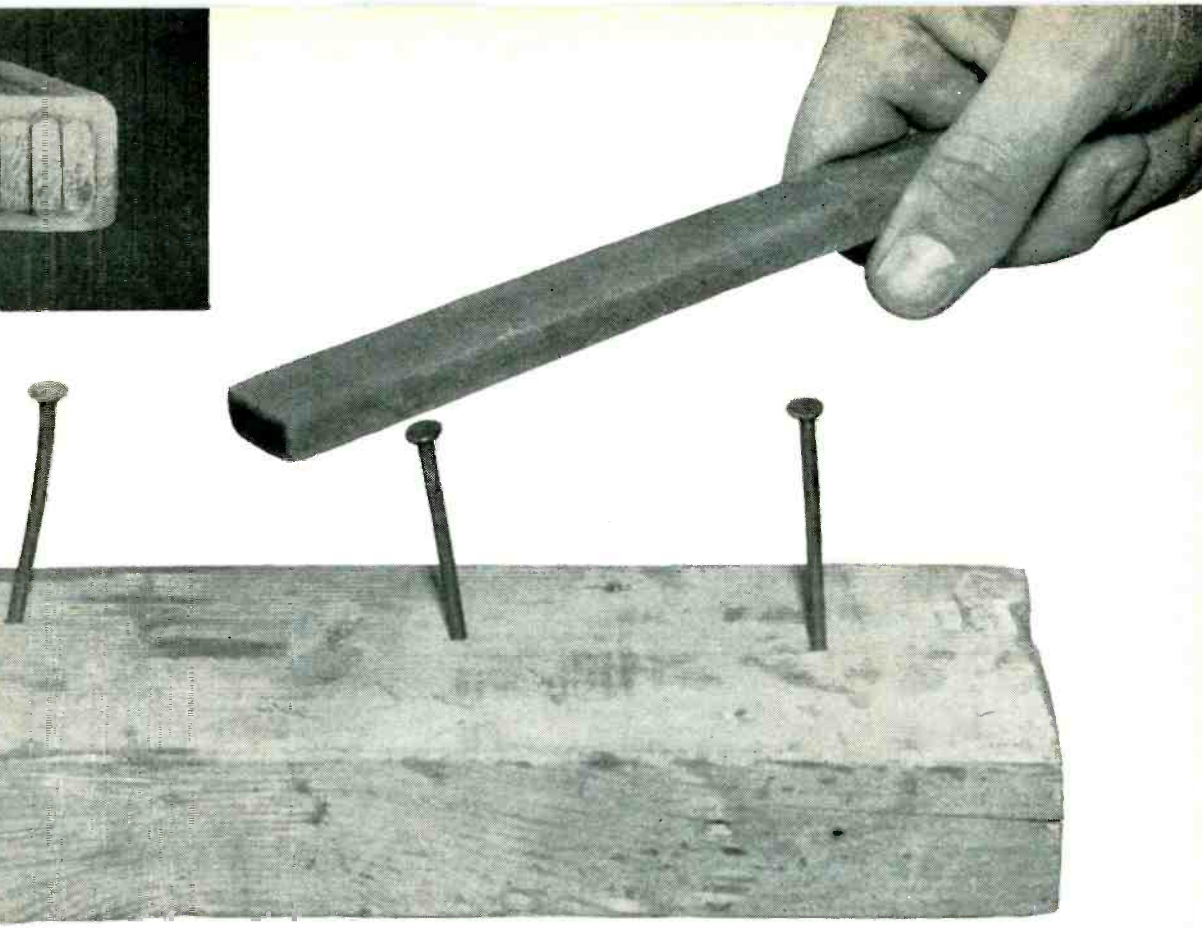
During soldering, felt-lined blocks are used in another way, to prevent loosening of previously soldered assemblies. As an example, windows are first soldered into the top cover asembly with 50-50 solder. The felted block is saturated with water, the cover is placed in it and the body tube set down into the cover for conventional hand soldering with 60-40 solder. The wet felt keeps heat away from the previously soldered windows.

Air Gun Inserts Trimmer Disks in Printed I-F Coils

A METAL holding fixture for etched wiring boards used as i-f strips in black-and-white television receivers serves in conjunction with an air gun to drive trimmer-disk mounting screws in to a predetermined distance above the i-f coils that are etched directly on the wiring board. This technique greatly reduces the amount of time needed later for final adjustments at alignment positions on assembly lines in RCA's



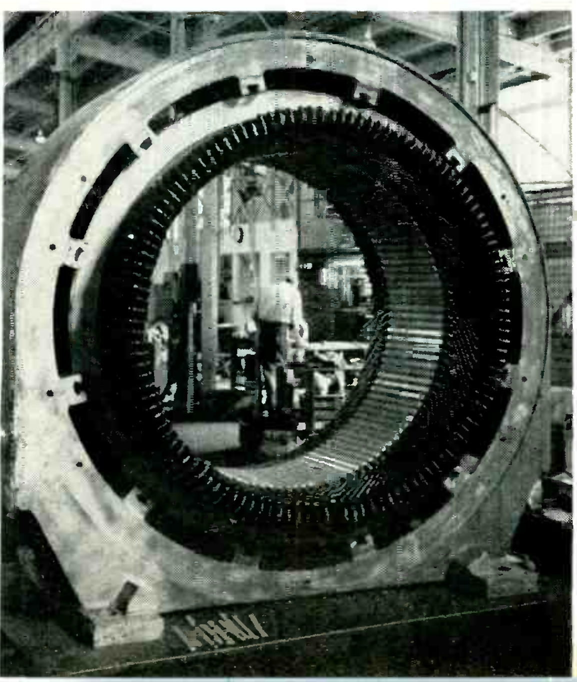
Cross-section of "Epoxylite" Molded Coil made by **Epoxylite Corp.**, Montebello, California.



Driving nails in toughness test, epoxy molded coil gets scarcely a surface dent. Conventional coil would be worthless after such treatment. Cross-section (upper left) shows sturdy construction.

Tough epoxy molded coil nails lid on motor breakdowns

Large (600 h.p.) Banbury motor coil after rebuilding with epoxy molded coils. Old coils wrapped with conventional materials failed after repeated carbon black penetration.



The working life of a big electric motor depends on the insulation on its form coils. Big motors develop heat and vibration that open crevices in ordinary coil wrappings. Contaminants get in, a coil fails, the motor stops.

This new coil ends that problem because it's insulated with glass cloth and a mica-filled compound based on BAKELITE Brand Epoxy Resin. This liquid resin is hardened with heat and pressure, and develops an extremely strong bond to the conductor. High corona resistance is one result. Tensile strengths often reach 100,000 psi.

Dense and void-free, this insulation shows the advantages of encapsulation with BAKELITE Epoxy Resins. It's not brittle or subject to stress cracks and can be formulated with a thermal expansion matching that of the conductor.

Moisture, caustics, acids, and other contaminants are sealed out. The glass cloth – epoxy combination even withstands immersion in boiling lye and sea water. It's effective up to 160 deg. C. Electrical properties are excellent.

BAKELITE Epoxy-Resins may give *your* product the advantages of long, trouble-free working life. For information, write Dept. MG-50.

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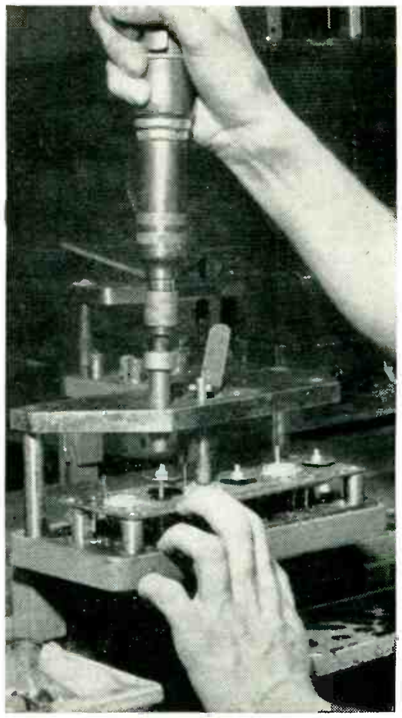
Indianapolis television set plant.

The assembled and dip-soldered strips come to the operator on a rubberized conveyor belt moving over the back of the bench. A strip is picked off the belt and placed on the positioning pegs of the fixture, wiring side up. These pegs are sufficiently high so that parts already mounted on the other side of the board will clear the base of the fixture. Metal anvils project up from the base under each of the three i-f transformers, to support the board while pressure is being applied with the air gun. Holes in the anvils provide clearance room for the screws of the trimmers.

After loading a board, the operator releases a spring-loaded pin to apply gentle pressure to the center of the board, just enough to keep it down on the positioning pins. She then places an insulating washer on a trimmer screw and manually positions the screw in its hole. This is repeated for the other two trimmers.

An air gun suspended overhead on a spring is brought down through a pilot hole in the top of the fixture and used to drive in the first trimmer. A metal collar on the shaft of the gun stops downward



Method of lowering air gun through pilot hole in top plate of fixture in preparation for driving in trimmer disk for printed i-f transformer. Hold-down pin for board is at right of gun

Want more information? Use post card on last page.

movement of the wrench when it hits the top of the fixture plate or the bottom of a counterbored hole in the plate. This counterboring technique permits driving the three trimmers to different depths while using the same fixed stop on the air gun. When the gun reaches its stop, the operator allows it to spin just enough longer so that the trimmer turns itself out of the socket of the gun and stops rotating.

When all three trimmers have been driven, a self-locking lever is pushed to bring up the board-holding pin, permitting removal of the finished board and reloading.

Clamping Fixture Holds VHF Tuners

ASSEMBLY of metal frames for vhf television tuners is expedited in RCA's Indianapolis plant by mounting a standard quick-action holding clamp on a welded metal fixture that is attached to the assembly bench. The fixture provides a recess into which the operator places the partially assembled tuner.

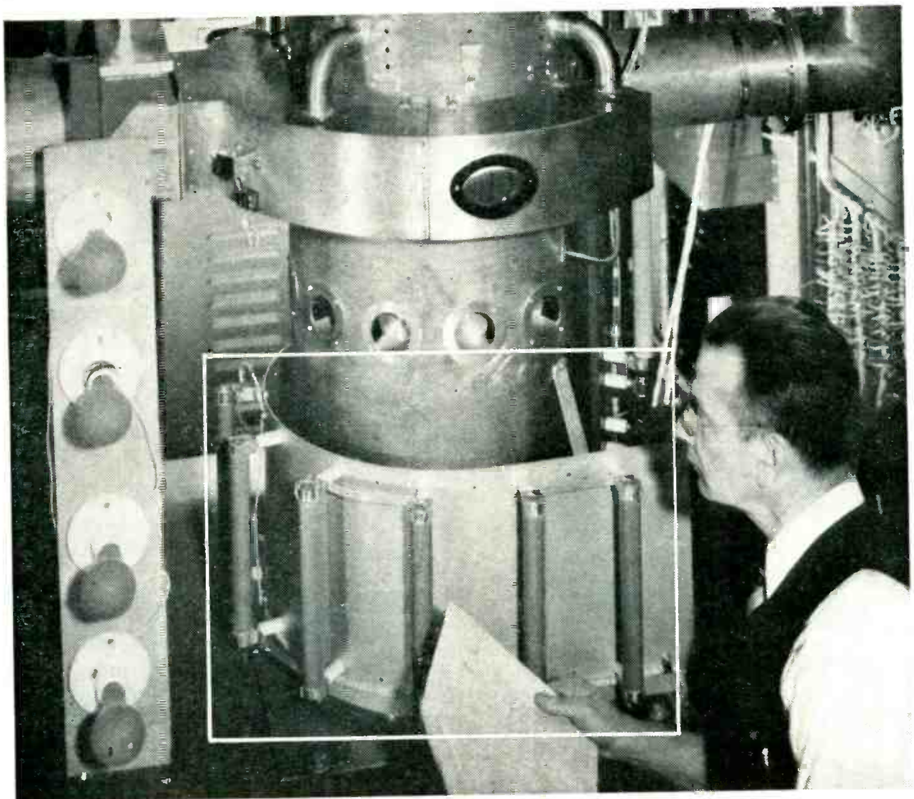
The end plate of the tuner is set in position and the handle of the clamp is pushed down to hold the plate in the correct position for alignment of mounting bolts. Self-tapping screws are then quickly inserted with an air gun to complete the assembly.

An upward flip of the clamp handle brings the clamp straight

Inserting mounting bolts in tuner with air gun while clamp on welded support holds end plate in position

★ Control Components Digest ★

News and notes on resistors, rheostats, relays, motor controls, dimmers and other control components



BIG MOON RADAR undergoing tests. Ward Leonard resistors—like those in foreground—help this gear stay on the air—or, rather, on space.

New moon radar to explore outer space

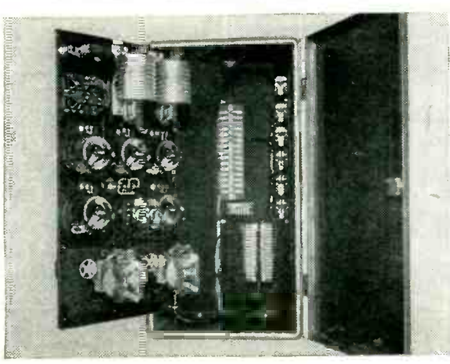
The U.S. Army Signal Corps hasn't got a transmitter in outer space—yet.

So, for their continuing studies of radio wave propagation in space and the upper atmosphere, they bounce radio waves from their new high-powered radar, Diana, off the moon and planets and study the return pulse.

Designed and built by Radio Engineering Laboratories of Long Island City, N. Y., the new radar transmitter puts out 50 kilowatts, continuous wave, and may be pulse modulated at various pulse widths and repetition rates. Receiver gain is 170-db at better than 3-db noise figure.

Throughout the equipment, high-stability Ward Leonard resistors, like the big Vitrohm resistors shown above, do duty as high-voltage bleeders, surge and current limiting resistors, and protective meter shunts in high-voltage circuits.

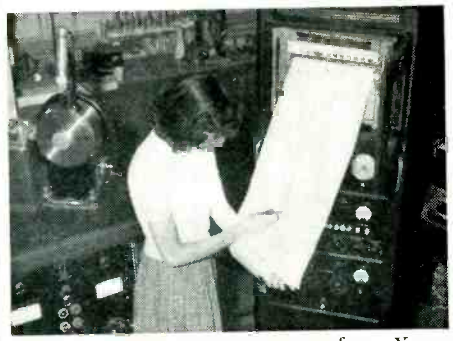
You'll find Ward Leonard Vitrohm resistors completely described in our 64-page Catalog No. 15, together with nomographs and charts to help select them. Write for your copy today.



Relays mastermind traffic lights

Sun, rain, sleet, snow, and continuous 24-hour-a-day duty is the lot of this master traffic light controller. Four dependable Ward Leonard relays select automatic timing cycles. Two more relays allow remote control of off-duty flashing amber signals and signal shut-down. Learn more about these rugged relays in Ward Leonard Bulletin No. 110.

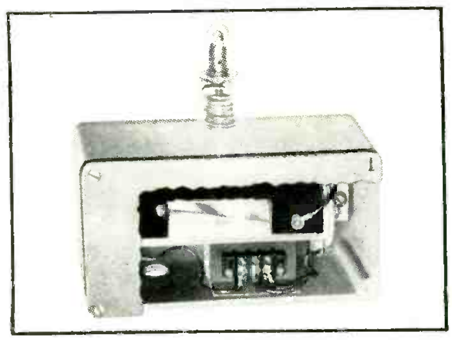
Photo courtesy Crouse-Hinds Co.



SHE'S CHECKING CHART RECORD from X-ray spectrometer in Ward Leonard's test lab.

Plant X-ray speeds quality control and helps catch crooks

X-ray diffractometer and spectrometer tests insure high quality and uniformity of both raw materials and fabricated components at Ward Leonard. These instruments check crystal structure in ceramics, magnetic amplifier cores, contact metal, and resistance wire. In off hours, they help the Mount Vernon Police and Fire Department put the finger on crooks and arsonists.



AUTOMATION FOR MACHINE TOOLS is simplified by this precision control potentiometer.

Control for machine tools

Accurate electronic control component for cutting tools, winders and processing machine drives is provided by this compact, precision potentiometer.

A half-inch plunger movement drives the metal alloy contact across the special resistance element. Enclosure is compact; calibration is permanent. Standard resistance—10,000 ohms; up to 25,000 ohms on special order. Write for Bulletin 68.

6-3

WARD LEONARD ELECTRIC COMPANY
31 SOUTH ST., MOUNT VERNON, N. Y.

Result-Engineered Controls Since 1892

RESISTORS · RHEOSTATS · RELAYS · CONTROLS · DIMMERS

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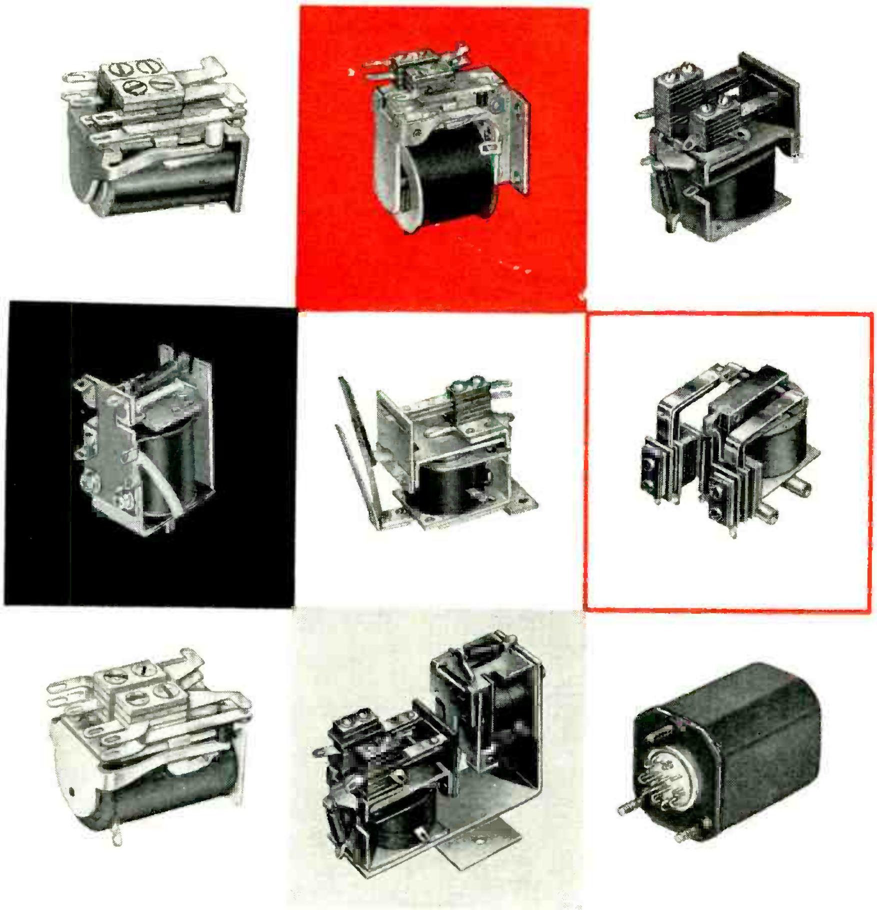
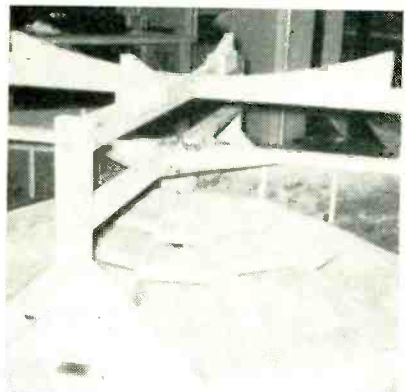


up, entirely clear of the tuner, for easy removal and reloading. Parts needed for this assembly are stored in gutter-type pans having metal straps that hook over the rail bolted to the front of the bench.

Making Plastic Reflectors for Microwave Antennas

By RICHARD E. GILDERSLEEVE
Electrical Engineering Department
Syracuse University
Syracuse, New York

USE OF spun-glass-reinforced plastic for molding microwave antenna reflectors results in strong, lightweight, durable reflectors. This method of constructing reflectors is especially advantageous when non-standard shapes and sizes are desired, since the plastic assumes the shape of the mold and the latter can readily be made in any desired shape and size.



Form for plaster mold and template assembly

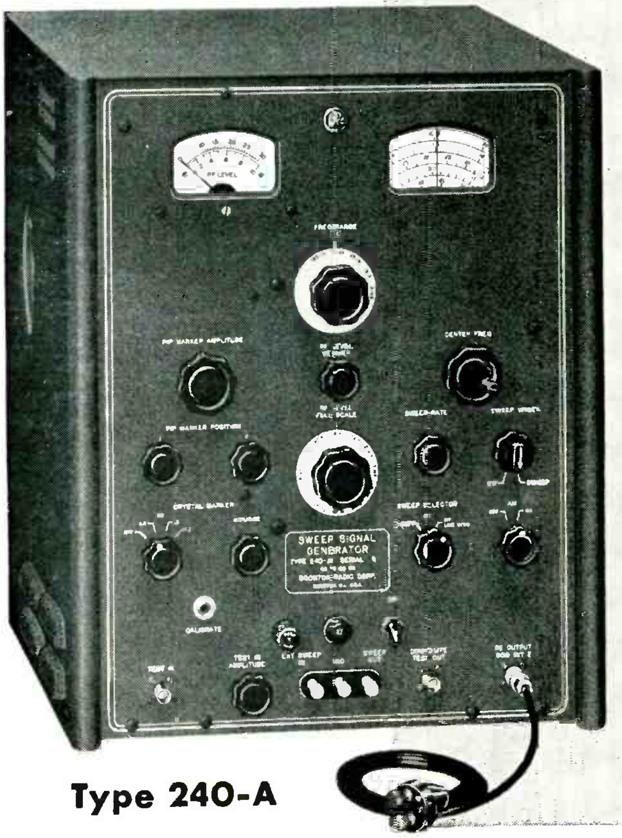
Several nominally paraboloidal reflectors 6 feet in diameter were required, each having specified deviations from the true paraboloid. To fabricate these reflectors by standard spinning methods would require the construction of a hardwood pattern for each reflector, making the cost of the reflectors prohibitive.

▶ **General Description**—The reflectors were fabricated in essentially the same manner by which certain car bodies, boats and other large objects are made. A plaster mold was constructed to the desired shape. After drying, the plaster was coated with floor wax, buffed, then sprayed with a parting agent to assure a clean separa-

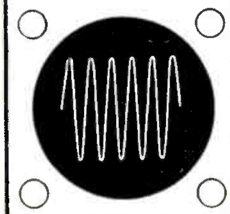
New! **MULTI-PURPOSE**

Sweep Signal Generator

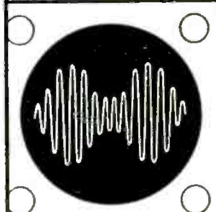
4.5 to 120 mc.



Type 240-A

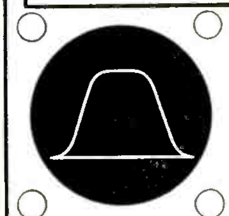


CW Output
4.5 to 120 MC
0.1 to 300,000 μv

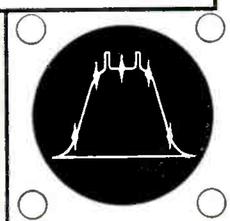


AM Modulated CW
30% at 1000 cps.

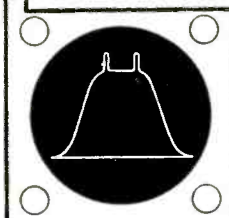
- **A wide range of continuously variable linear-frequency sweep widths.**
- **Crystal controlled frequency identification.**
- **Adjustable frequency-interpolation pip marks.**
- **Internal mixer for forming composite display signal.**
- **Accurate continuously-tuned CW with choice of internal AM.**
- **Internal crystal calibrator for CW.**
- **Wide range of calibrated output voltage.**



Broad Band Sweep
±1% to ±30% of
Center Frequency



Crystal Controlled
Identification of
Frequency—0.1, 0.5,
2.5 MC Spacing



Interpolation Pips
Mark Frequencies
From Crystal
Identification

The Sweep Signal Generator Type 240-A is a continuously-tuned, accurate CW Signal Generator with internal AM. The output voltage is continuously monitored, indicated and calibrated over a wide range. The CW Signal can be calibrated against an internal crystal. Electronic sweep circuits are included which produce an output signal having an AGC-controlled constant-amplitude and a wide range of continuously-variable linear-frequency sweep widths. Two systems are included for frequency identification while sweeping. One of these is crystal controlled and the other is an interpolation system. An internal mixer adds the frequency identification information to the test receiver output signal prior to its connection to the display oscilloscope.

SPECIFICATIONS:

RF FREQUENCY RANGE: 4.5 to 120 MC continuously variable in five ranges.

RF FREQUENCY ACCURACY: ±1%.

RF OUTPUT VOLTAGE: 1 to 300,000 microvolts. 0.1 to 30,000 microvolts with external attenuator.

AMPLITUDE MODULATION: Factory adjusted to 30% from internal 1000 cps oscillator.

RANGE OF SWEEP WIDTHS: Continuously variable from ±1% of center frequency to ±15 MC or ±30% of center frequency whichever is smaller.

LINEARITY OF SWEPT RF FREQUENCY: Within 10% over middle 80% of sweep excursion, within 20% over remainder.

FLATNESS OF SWEPT RF OUTPUT: Within 7% under all conditions.

FREQUENCY IDENTIFICATION MARKS: Crystal frequency identification spaced 0.1, 0.5, 2.5 MC. Tuning dial identifies center mark. Two adjustable-position interpolation pip marks.

PRICE: $1375.00 FOB BOONTON, N. J.

BOONTON RADIO *Corporation*
BOONTON · N · J · U · S · A ·

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Burlap dipped in plaster and laid on wire mesh provides base for plaster

tion of the plastic from the mold. A thick coat of surfacing plastic was then sprayed on the mold, which furnished a smooth finish to the reflector surface, free of air holes. Two layers of spun-glass mat and plastic were then applied, the plastic being thoroughly worked into each layer of mat to remove all air bubbles.

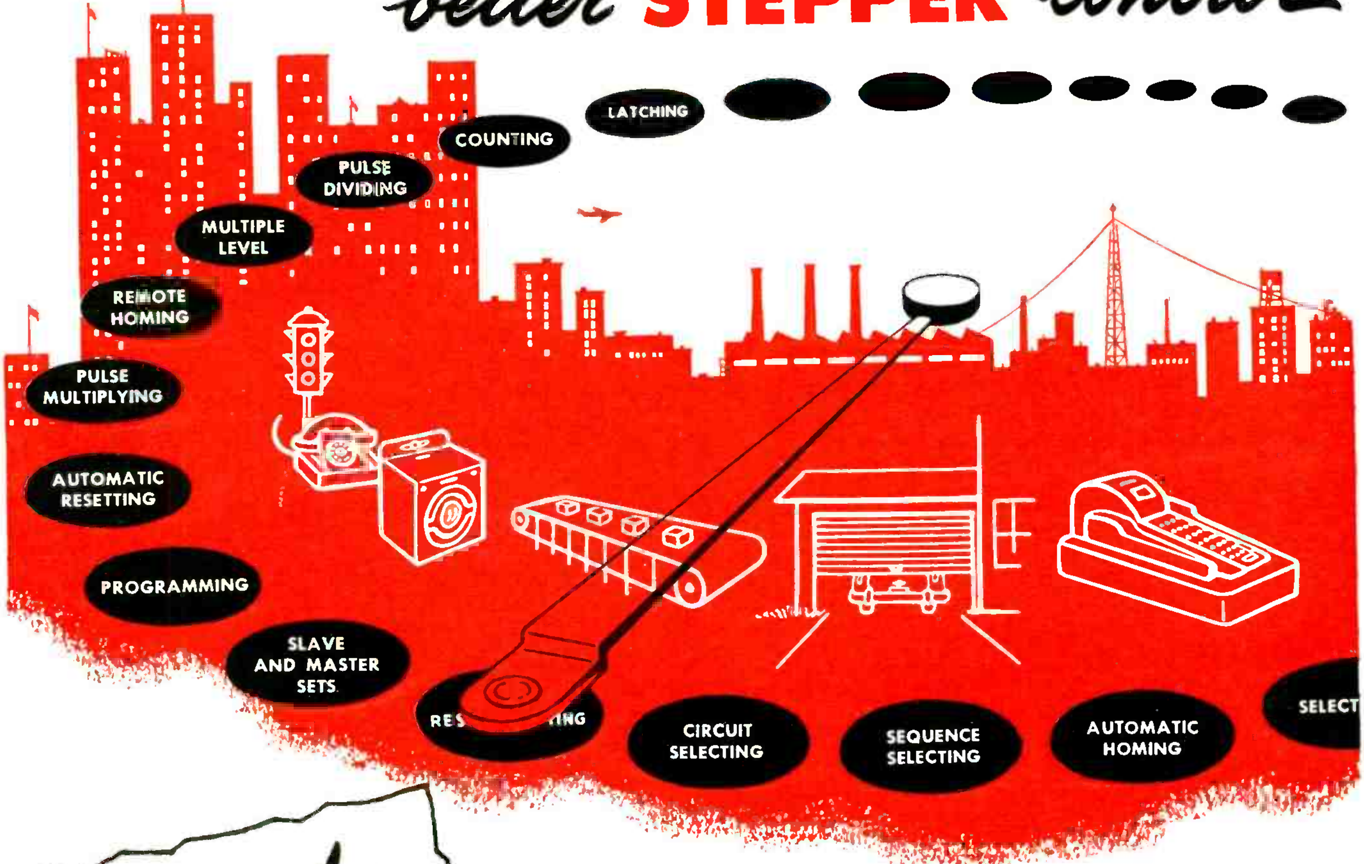
To obtain a reflecting surface for electromagnetic waves the plastic must be metallized in some manner. Several methods were considered but the method finally used employed gummed aluminum foil, which was rolled on the plastic to give a smooth finish. Adjacent strips of foil were lapped, one edge being folded under to make an electrical contact between strips. The edges were then sealed with gummed plastic tape

▶ **Making the Mold**—In making the plaster mold, a framework of wood was fabricated to conform roughly to the shape of the mold, and covered with ½-inch wire mesh. A template was cut from ⅛-inch sheet aluminum to conform to the desired reflector contour. This was mounted on a supporting framework which could be adjusted in height and level by bolts mounted on each of four legs. The legs slid in guides which provided support without constricting vertical motion. The template revolved about a central vertical axis, a sheet metal pressure plate preventing motion in any but the circular direction. This was later modified to a half template for improved operation.

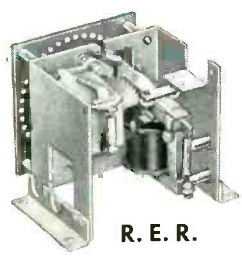
The wire mesh was covered with burlap dipped in plaster to give a surface upon which plaster was

join the "inner-circle" of . . .

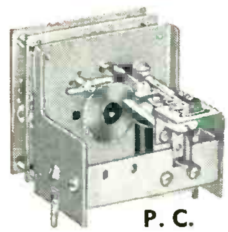
better STEPPER *control*



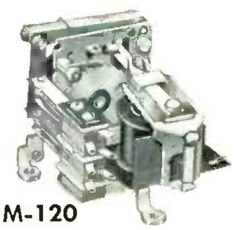
Specify GUARDIAN® STEPPERS



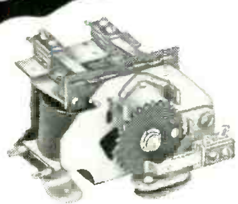
R. E. R.
ELECTRICAL RESET



P. C.
CONTINUOUS ROTATION



M-120
CYCLING RATCHET



M. A. S. ADD AND SUBTRACT

for selection and control of multiple circuits

At Guardian we strive relentlessly for perfection as exemplified here by the most versatile Stepping Relays obtainable. A dozen models, from midget types to powerful solenoid-driven units, are available in an infinite variety to meet your specific needs. Operating speeds up to 20 pulses per second. Up to 40 active contact points per disc. Up to 4 discs on some models. Included are electrical reset, continuous rotation, add/subtract and ratchet types in a variety of design groups originated by Guardian. All units are especially constructed to resist wear and vibration for dependable, long-life performance.

write — for your free copy of Guardian's Stepping Relay Bulletin P-84

GUARDIAN ELECTRIC

1625B W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF CONTROLS SERVING AMERICAN INDUSTRY

Shaping plaster by rotating template

built up to the final shape. As plaster was added the template was rotated until the plaster conformed everywhere to the template. White molding plaster was used to give a rough shape, a smoother finish surface being obtained with a finer grade plaster. The framework supporting the template was then lifted away to give working freedom.

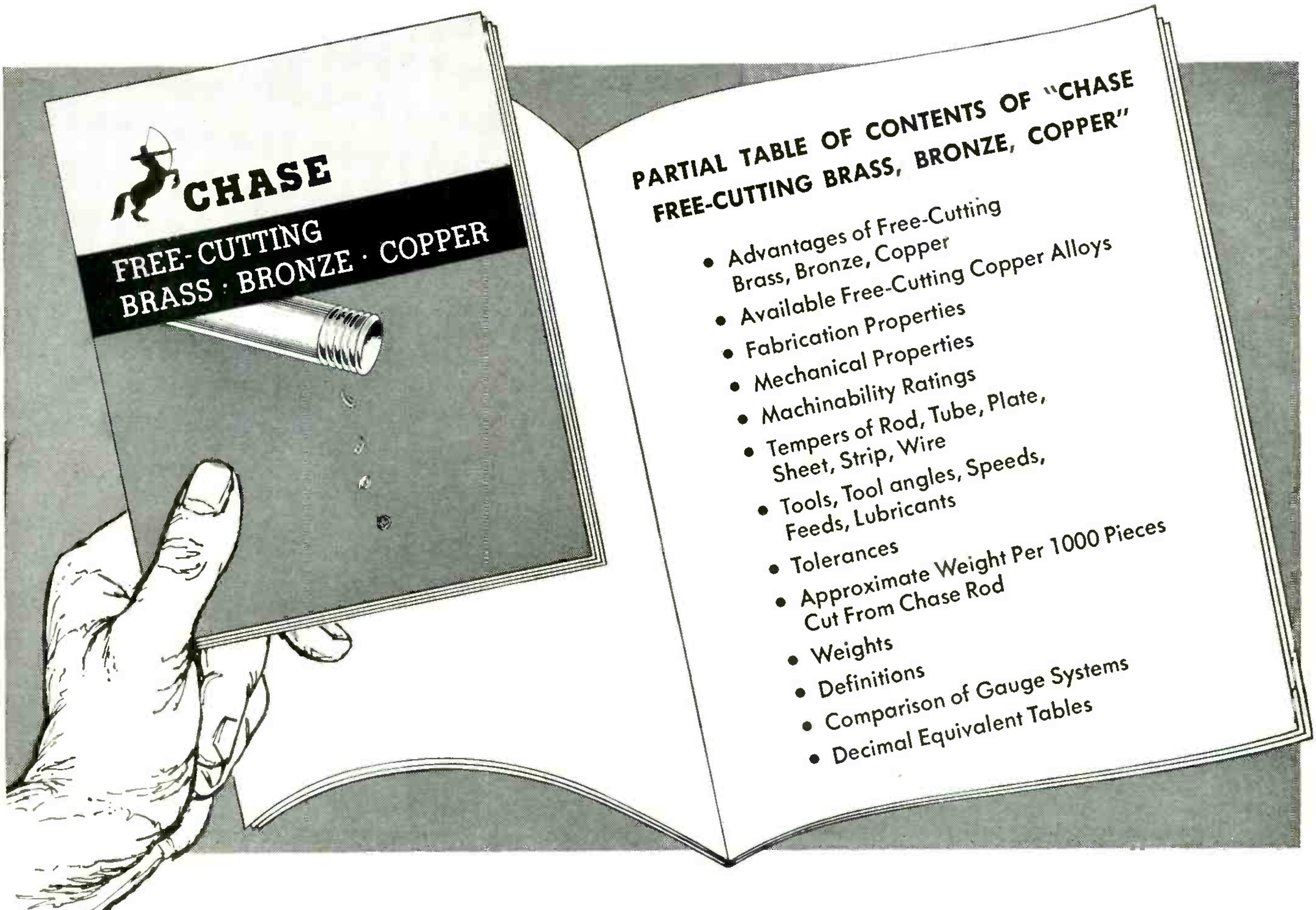
The plaster was waxed and buffed, using two coats of floor wax paste, then sprayed with a parting agent. The combination of wax and parting agent permitted easy separation of plastic and plaster.

► **Applying the Plastic**—A special surfacing plastic was next sprayed on the prepared mold. This prime layer of plastic not only served to prevent air bubbles in the base plastic from breaking through but also eliminated the possibility of exposed loose ends of fiber glass.

A layer of fiber-glass mat was then shaped to the contour and impregnated with plastic. The mat was cut and lapped to con-

Spraying mold with initial coat of plastic over plaster

THIS FREE BOOKLET CAN CUT YOUR METALWORKING COSTS



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NAME ....
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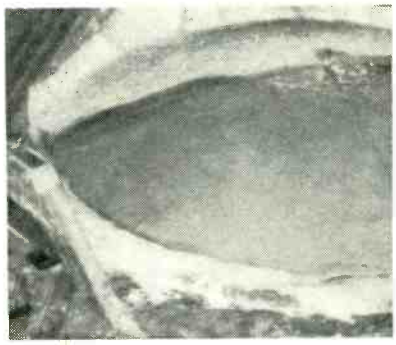
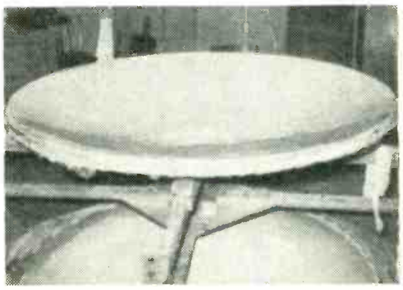


Glass mat partially impregnated with plastic



Appearance of plastic reflector after it is removed from mold

form to the mold. Several such cuts were necessary. The seam did not appear on the reflecting surface.

The plastic used was a polyester resin to which catalyst and accelerator were added just prior to use. The plastic was worked into the glass with a brush to insure a thorough impregnation and a minimum of air bubbles. As many layers of mat and plastic may be used as desired to give the required strength. Two layers were found to be sufficient for this particular application.

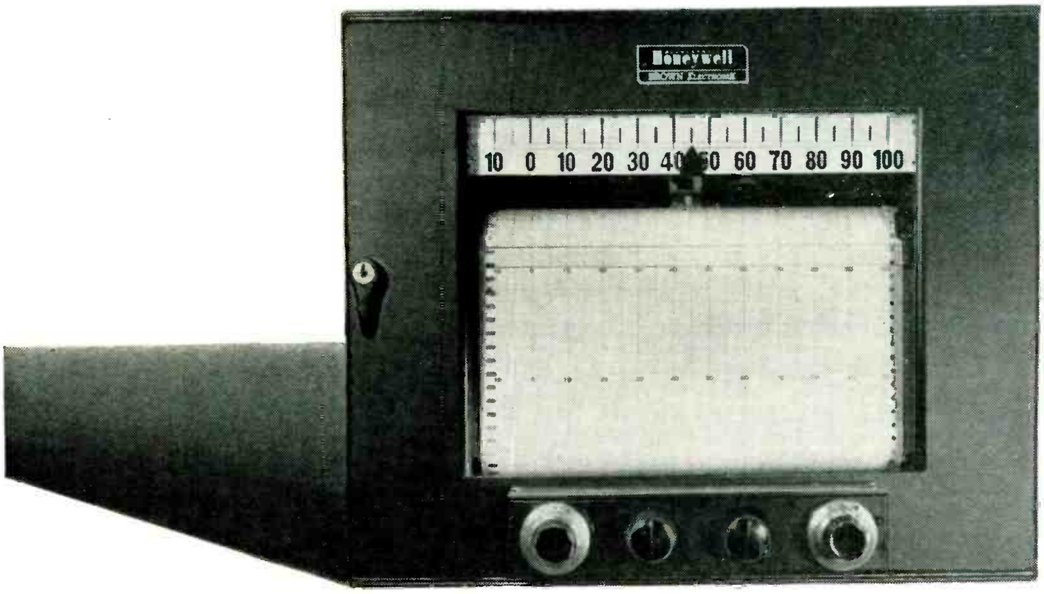
The plastic has a setting time of about 15 minutes after the catalyst is added, hence mixtures should be made in small quantities, about 5 pounds per man if the hand lay-up process is used. In this process the plastic is applied with a paint brush.

The reflector can be removed from the mold in about one hour.

▶ **Applying Aluminum Foil**—The metalization of the reflecting surface presented problems which were solved satisfactorily for this application by applying 6-inch-wide strips of gummed aluminum foil. The foil was applied with a roller to smooth out the wrinkles. To provide electrical contact between strips one edge of each strip was folded under and lapped ¼

It's a dozen test instruments in one!

—the Adjustable Span *ElectroniK* Recorder



Here's a recording potentiometer that is a real jack-of-all-trades (and master of each one) in any development or test laboratory. Just turn the dials, and in seconds, you can set it up for the exact range and sensitivity you want. You don't have to do any rewiring or changing of calibrating circuits.

50-to-1 span adjustment. Millivolt span of the recorder is continuously variable over as much as a 50:1 range. Span adjustment is independent of zero setting.

Variable zero suppression. Coarse and fine adjustment dials let you move the electrical zero point up and down scale, to concentrate recording on only the part of the span in which you're interested. Zero adjustment does *not* affect span setting.

Sensitivity adjustment makes it easy to get the recording characteristics you want to match the span being used.

Many optional features: you can choose from recording speeds of ½, 1, 2, 4½, 12 or 24 seconds full scale . . . fully automatic, push-button, or solenoid-actuated remote or locally controlled standardization.

Find out how this versatile instrument can save time in your test work, by calling your local Honeywell sales engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

H HONEYWELL

● **REFERENCE DATA:** Write for Data Sheet No. 10.0-10a, "Adjustable Span Recorder."

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First in Controls

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inch over the adjacent strip. The seam was closed with a ½-inch-wide strip of plastic tape to insure contact. The strips were oriented in the direction of polarization of the primary feed.

▶**Method of Mounting**—Mounting the reflector on a pedestal is not a difficult problem since the reinforced plastic can be machined in the same manner as metal. It is not necessary to do any machining, however, if provision is made for imbedding mounting brackets in the plastic. The brackets can be removable, if desired, by forming pockets into which the brackets may be inserted prior to the actual mounting of the reflector.

Reflector surfaced with aluminum-foil tape to obtain conductive surface

The plastic reflector is strong and light-weight but more flexible than the aluminum counterpart and hence must be mounted firmly to prevent whipping or bending.

▶**Cost Figures**—The cost of materials used in fabricating a plastic reflector are small, the principle expense arising from labor costs. It is estimated that the cost of materials for a 6-foot-diameter reflector is about twenty dollars, not including the mold, molding equipment and metal surfacing. No special tools are required and no highly skilled workmen are necessary. Two men, after a little experience, could make a reflector in about half a day, including spraying parting agent on the mold.

Since plaster molds are not too satisfactory if several reflectors of the same size and focal length are to be made, a plastic mold can readily be made which will not be damaged by repeated usage, thus saving costs of repair of the plaster mold.

ANOTHER FIRST BY *Federal*

METAL ENVELOPE TRAVELING WAVE TUBES

—opening a new concept of ruggedness, dependability and long-lasting performance

Featuring:

- Plug-in design
- Greater reliability
- RF connectors as integral part of tube structure
- Tube self-aligned in the solenoid
- No adjustments necessary
- Conservative ratings

Traveling Wave Tube with associated solenoid

Federal presents the most advanced traveling wave tube design . . . the result of continuous development by Federal since 1946.

Bringing to designers the *first all-metal envelope,* this new TWT provides greater-than-ever ruggedness, a new high in reliability and performance and longer service life.

Federal traveling wave tubes are designed for quantity production . . . are now available in these two types:

F-6658—2000-4000 mc. amplifier, 1 watt CW output with 30 db gain.

F-6825—2400-3600 mc. amplifier, 1 kw. pulse output with 30 db gain.

(Other types currently in final development for production—including "S" and "X" band applications—will be available in the near future. Inquiries for special design applications are invited.)

Designers: For the quality, craftsmanship and performance you want for your application, get the facts about Federal metal envelope traveling wave tubes . . . *first* in the field . . . and *Certified by a World of Research."*

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GRID VACUUM TUBE
1906—1956
50th Anniversary
ELECTRONICS INDUSTRY

For complete engineering data on Federal's TWT's, write to Dept. K-913

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New Products

Edited by WILLIAM P. O'BRIEN

87 New Products and 53 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

POWER SUPPLY

0 to 500 ma output

DELTRON INC., P. O. Box 192, Glenside, Pa. Models 900 and 900R regulated power supply have a voltage range of 0 to 500 v continuously variable, either positive or negative grounded. Output current d-c is 0 to 500 ma. Regulation is less than 0.5 percent during a-c supply fluctuation of from 105 to 125 v rms and from zero to full load current, under any combination of supply voltage and load current within these ranges.

▶ **Other Specifications**—Ripple voltage is less than 10 mv rms; internal impedance, less than 2 ohms; duty cycle, 24 hr continuous. Also featured is a relay controlled preset voltage.

Price of the model 900 is $340, and the model 900R, which is slightly smaller, is $330.

ELECTRONIC FILTER

with mode-selector switch

SPECTRUM INSTRUMENTS, INC., 44-05 30th Ave., Long Island City, N. Y., has developed a new, direct-coupled, variable electronic filter with cut-off frequency tunable from 0.2 to 20,000 cps. Model LH-24 can be used as either high-pass or low-pass filter by a panel mode-selector switch.

It is completely self contained, including a double regulated power supply for stable operation from a-c lines. High input impedance permits bridging operation in most cases, while low output impedance allows direct connection to the majority of possible loads.

▶ **Analog Filter**—This term is derived from the mathematical equivalence of the input-output voltage-frequency characteristic to that of a properly terminated inductance-capacitance filter. The filter, however, employs no inductances achieving the desired result with resistance and capacitive elements in an active network. It is free of the familiar impedance matching problems in coupling to source and load and in cascading of units. Since tuning is accomplished with a precision wire-wound potentiometer assembly, undesirable effects associated with inductor Q-change are avoided. Price is $445.

H-V POWER SUPPLY

small package, low price

NEUTRONIC ASSOCIATES, 87-16 116th St., Richmond Hill 18, N. Y. Model 75BR is a complete, self-contained, r-f h-v power supply housed in a cabinet 7¼ in. high by 8 in. wide by 8 in. deep, and equipped with a 3-in. voltmeter as standard equipment.

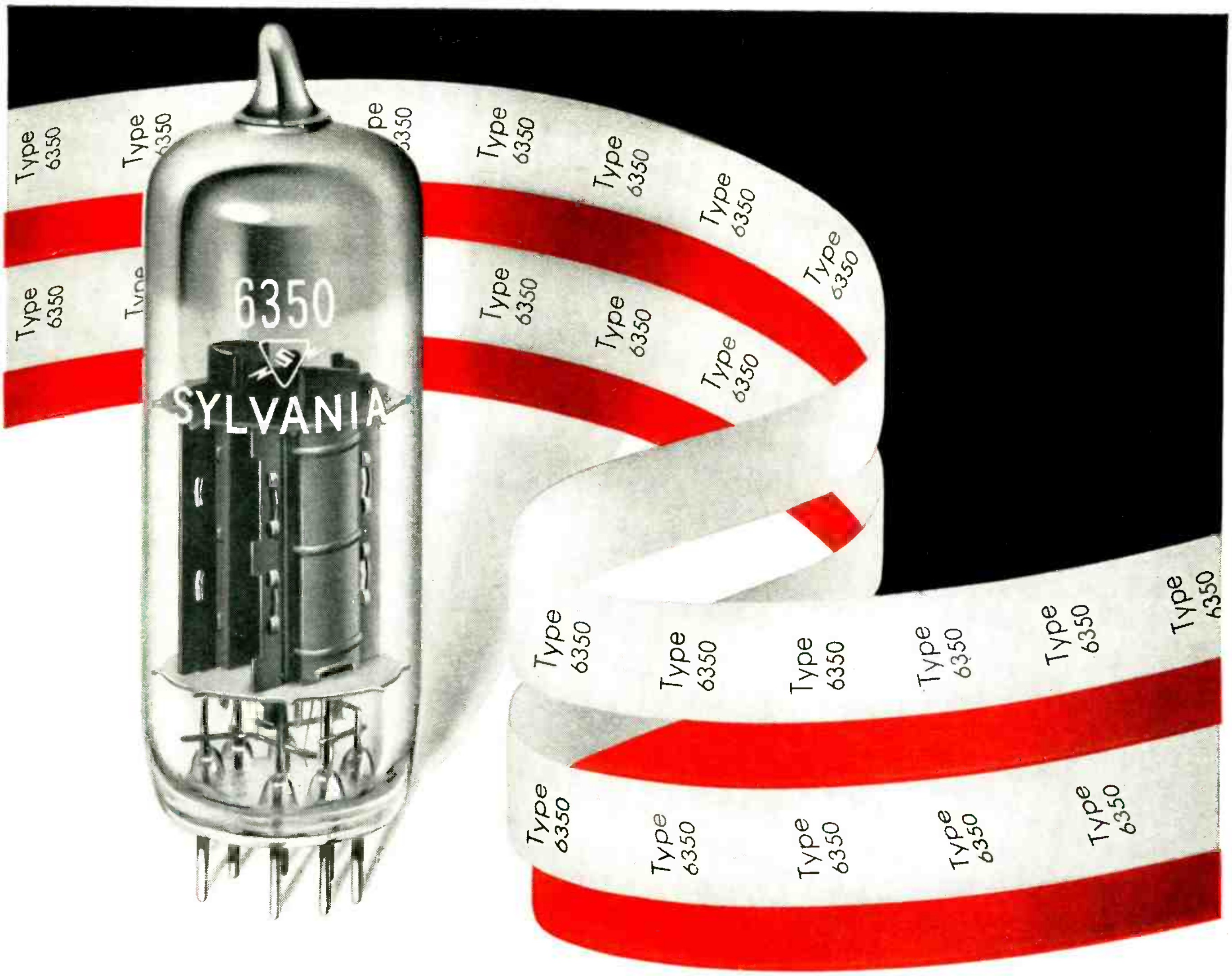
▶ **Features**—Voltage range is 2 kv to 7.5 kv d-c; current, 1 ma at 6 kv; and regulation, better than 1 percent.

Net price of the model 75BR is $89.75 ($79.75 less meter); and the model 75B is $69.75 unregulated ($59.75 less meter).

DETECTOR TUBES

simplify tv circuits

RADIO CORP. OF AMERICA, Harrison, N. J. The 6DT6 and 3DT6 f-m de-



More "soup" where you need it...

to drive magnetic cores, drums, computer read-outs

Here is a high perveance twin triode designed for heavy duty computer applications. It is capable of delivering peak cathode currents of 300 ma and will dissipate up to 7 watts.

The Sylvania type 6350 features separate cathodes for each section and controlled grid cutoff. Separate cathodes provide maximum flexibility in equipment design.

Cutoff is held to close tolerances facilitating the design of circuits for optimum cutoff signals. Minimum interface formation assures operation even after periods of extended cutoff.

DESIGN CENTER RATINGS FOR THE 6350

Peak Positive Plate Voltage (Abs. Max.)	1000 Volts
Peak Negative Grid Voltage	400 Volts Max.
Peak Positive Grid Voltage	13 Volts Max.
Peak Positive Grid Current	100 Ma Max.
Peak Cathode Current	300 Ma Max.
Plate Dissipation	
Each Plate	3.5 Watts Max.
Both Plates	7.0 Watts Max.

OTHER SYLVANIA COMPUTER TYPES

Type 5844	Medium mu triode
Type 5965	Medium mu twin triode
Type 6211	Medium mu twin triode
Type 5687	Low mu twin triode
Type 7AK7	Sharp cutoff pentode
Type 5915A	Dual control heptode
Type 6145	Sharp cutoff pentode
Type 6814	Medium mu triode

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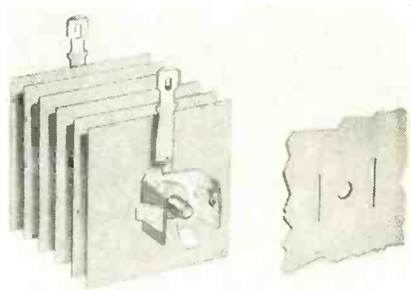
r-f electrode terminals insulated from each other by low-loss ceramic bushings; relatively low output capacitance; low feedback capacitance; and a multistrand thoriated-tungsten filament for economical operation, high emission capability and long life.

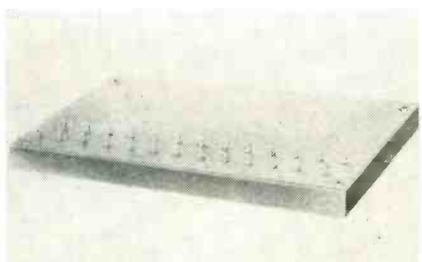


CLIP-IN RECTIFIER
for rapid installation

FEDERAL TELEPHONE AND RADIO Co., 100 Kingsland Road, Clifton, N. J. Selenium rectifiers equipped with a new spring-steel, snap-action mount permitting increased ease of assembly have been announced.

▶ **Advantages**—The clip-in rectifier features minimum installation cost and rapid installation. These rectifiers can even be mounted two at a time using both hands. No mounting hardware is required, and there is no need for installation tools. The rectifier can be inserted or removed instantly from the accessible side of the chassis. Terminals may be used for both soldered and solderless connections, and the mount is self-adjusting to all standard panel thickness.

The new mount can be adapted to rectifiers rated from 25 to 195 v a-c and from 65 to 750 ma d-c.



DELAY LINES
for multiplex communications

ESC CORP., 534 Bergen Blvd., Palisades Park, N. J., has available a

TESTED 200% *plus!*

YOU'VE probably noticed the steadily growing preference for Stackpole fixed composition resistors in critical military uses as well as in a high percentage of today's television, radio and industrial electronic equipment.

There are two main reasons: Outstandingly dependable products backed by equally dependable, personalized service.

Dependability is assured by the most modern manufacturing techniques *plus* constant testing. From preliminary sorting tests to the final 100% test and numerous quality control tests extending from raw materials through production, it is conservative to say that Stackpole resistors are tested well over 200%.

As for service in meeting resistor requirements accurately and when promised—this is a Stackpole factor that is just as carefully controlled and tested as the manufacturing processes themselves.

And it is our sincere aim to keep it that way.

Electronic Components Division
STACKPOLE CARBON COMPANY
St. Marys, Pa.

Canada: Canadian Stackpole Ltd., 550 Evans Ave., Etobicoke, Toronto 14, Ont.

ELECTRICAL TESTING— Each Stackpole fixed composition resistor gets a final test on automatic machines like these. Other tests before and during production bring the total test percentage to well over 200%.

SERVICE IN THE MAKING— A portion of the huge fixed composition resistor stock Stackpole strives to maintain to assure prompt deliveries.

THIS IS OUR 50th Year STACKPOLE FOUNDED 1906

STACKPOLE
FIXED COMPOSITION RESISTORS

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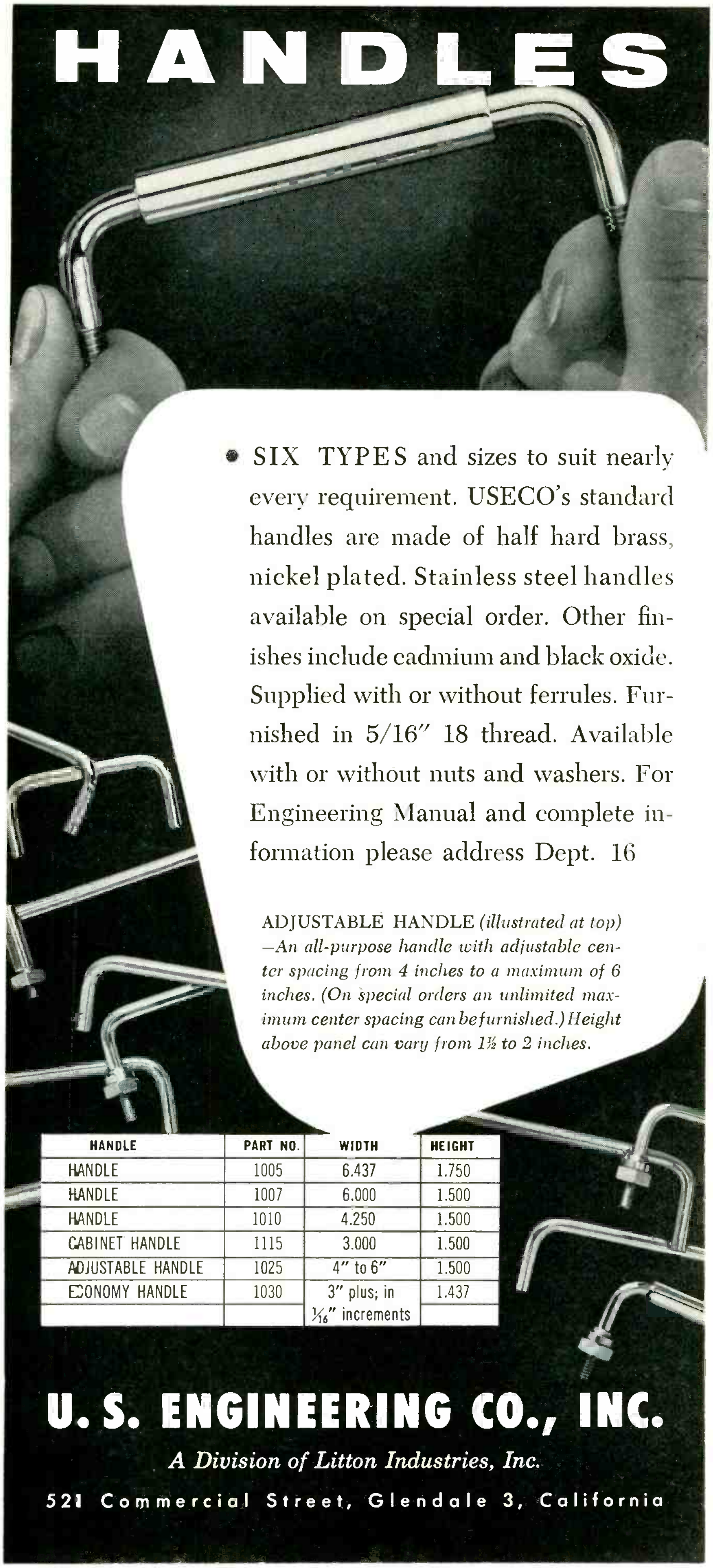
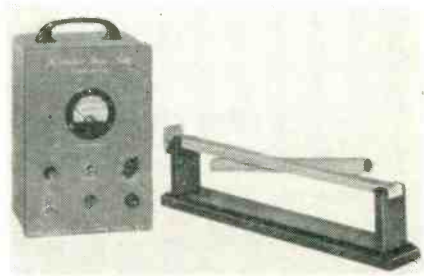


series of custom-built portable ptm multiplex communication system delay lines.

▶ **Features**—Specifically intended for use as timing units, they feature: 125 μsec delay; 3,300 ohms impedance; 1-percent accuracy; tapped in increments of 5.2 μsec; and they meet all applicable MIL specifications.

A complete catalog is available upon request.



RANDOM NOISE SOURCE
for microwave frequencies

KAY ELECTRIC CO., Pine Brook, N. J., has announced a new line of Mega-Nodes, calibrated random noise sources for microwave frequencies. The new Mega-Nodes will utilize fluorescent tubes only and will cover the following frequency ranges: WR770, 960 to 1,450 mc; WR650, 1,120 to 1,700 mc; WR510, 1,450 to 2,200 mc; WR430, 1,700 to 2,600 mc; and WR340, 2,200 to 3,300 mc.

▶ **Other Specifications**—Noise output (all guides) is 15.8 db; accuracy, to ±0.25 db; power source, 117 v, a-c ±10 percent, 50-60 cps; power consumption, approximately 40 w.

Prices are as follows: WR770 and WR650 $595 each; the other three types, $495 each.

LAB POWER SOURCE
for transistor circuits

NJE CORP., 345 Carnegie Ave., Kenilworth, N. J., announces a flexible new laboratory power source especially intended for use in transistor circuit development. Completely tubeless, the supply provides three entirely independent floating output voltages, each well regulated against line or load changes. Low

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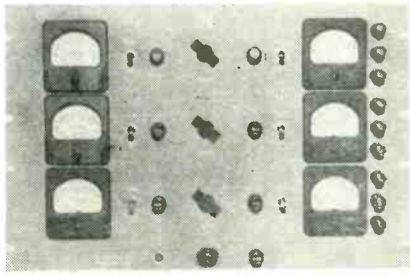


ripple and internal impedance simulate battery conditions without the expense and inconvenience of batteries.

▶ **Specifications**—Each of the three channels is continuously adjustable from 0 to 50 v at 0 to 10 ma, with less than 1 mv of ripple, and 0.5 percent absolute regulation at 50 v. Higher current models are available, up to 1 ampere.

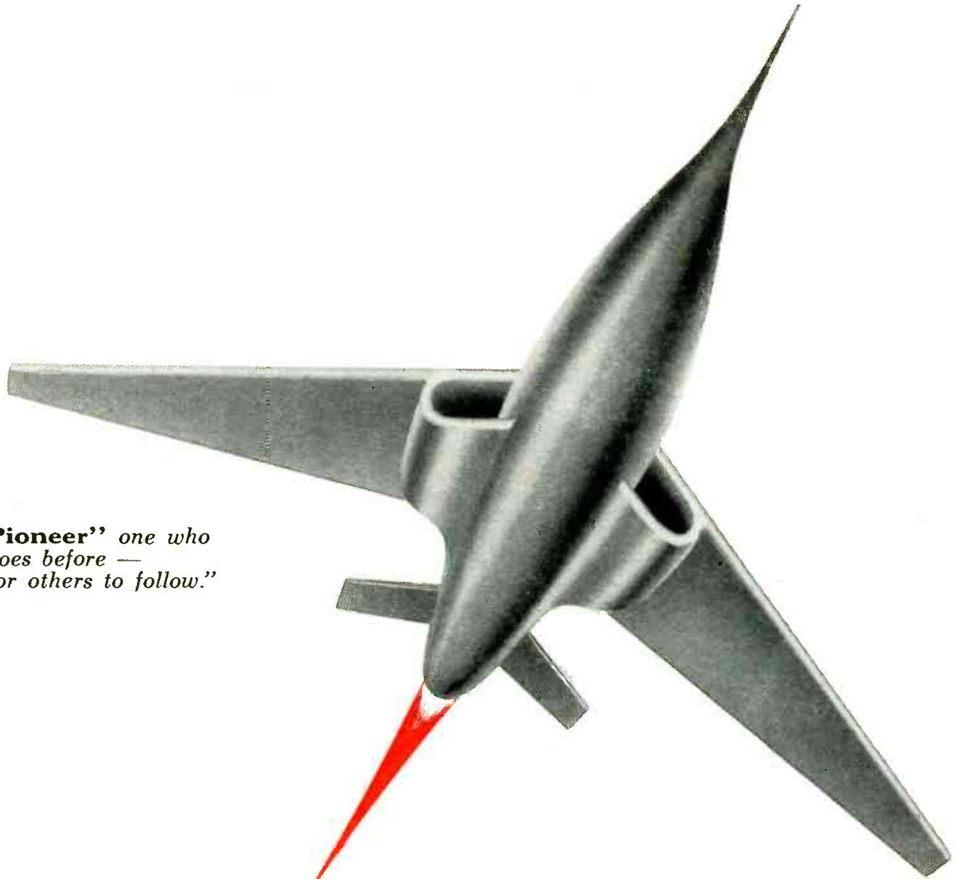
Dual-range voltage and current meters are provided for each channel. The model CS-3667 is enclosed in a bench-mounted steel cabinet, and is also available for rack mounting. Meters are optional.

POWER TRANSISTOR
made from silicon

Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Texas. Type 970 *npn* grown junction silicon power transistor has a maximum power dissipation of 3.5 w at the temperature of boiling water. It is ideally suited for the output stages of servo amplifiers, which convert small electrical variations into mechanical motion at a remote location.

▶ **Dimensions**—Type 970 weighs less than $\frac{3}{4}$ oz complete and is hermetically sealed in a disc approximately $\frac{1}{2}$ in. in diameter by $\frac{1}{2}$ in. high. The mounting plate heat sink extends outward from the transistor itself to cover an area of about $\frac{3}{4}$ in. by $1\frac{1}{4}$ in.

▶ **Ratings**—Power dissipation is 8.75 w maximum at 25 C, with 3.5 w maximum at 100 C. Power gain



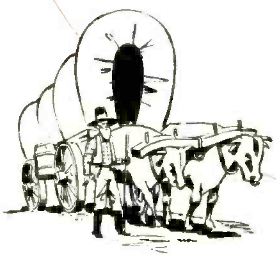
"Pioneer" *one who goes before — for others to follow."*

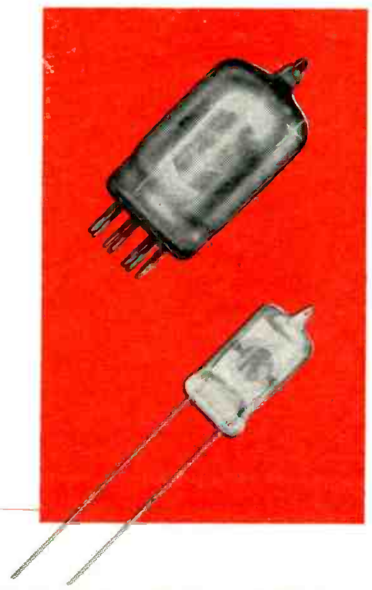
IF WEBSTER IS RIGHT —

Then Midland Has Done It Again, this time with

glass holders for crystals!

Absolute and permanent vacuum attainable *only* with glass, isolates the crystal from all factors detrimental to dependable performance. Truly, here are crystals designed with the future in mind — future requirements of application and design as well as the long life of the unit far into the future.

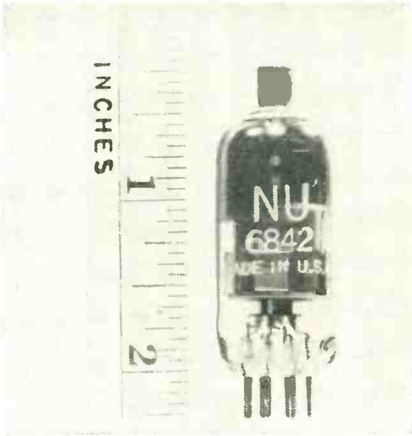




Midland MANUFACTURING COMPANY, INC.

3155 Fiberglas Road • Kansas City 15, Kansas

World's Largest Producer of Quartz Crystals at 100 C ranges from a guaranteed 28 db at 1 w output, class A operation, to a guaranteed 18 db at 2.5 w output, class B operation.



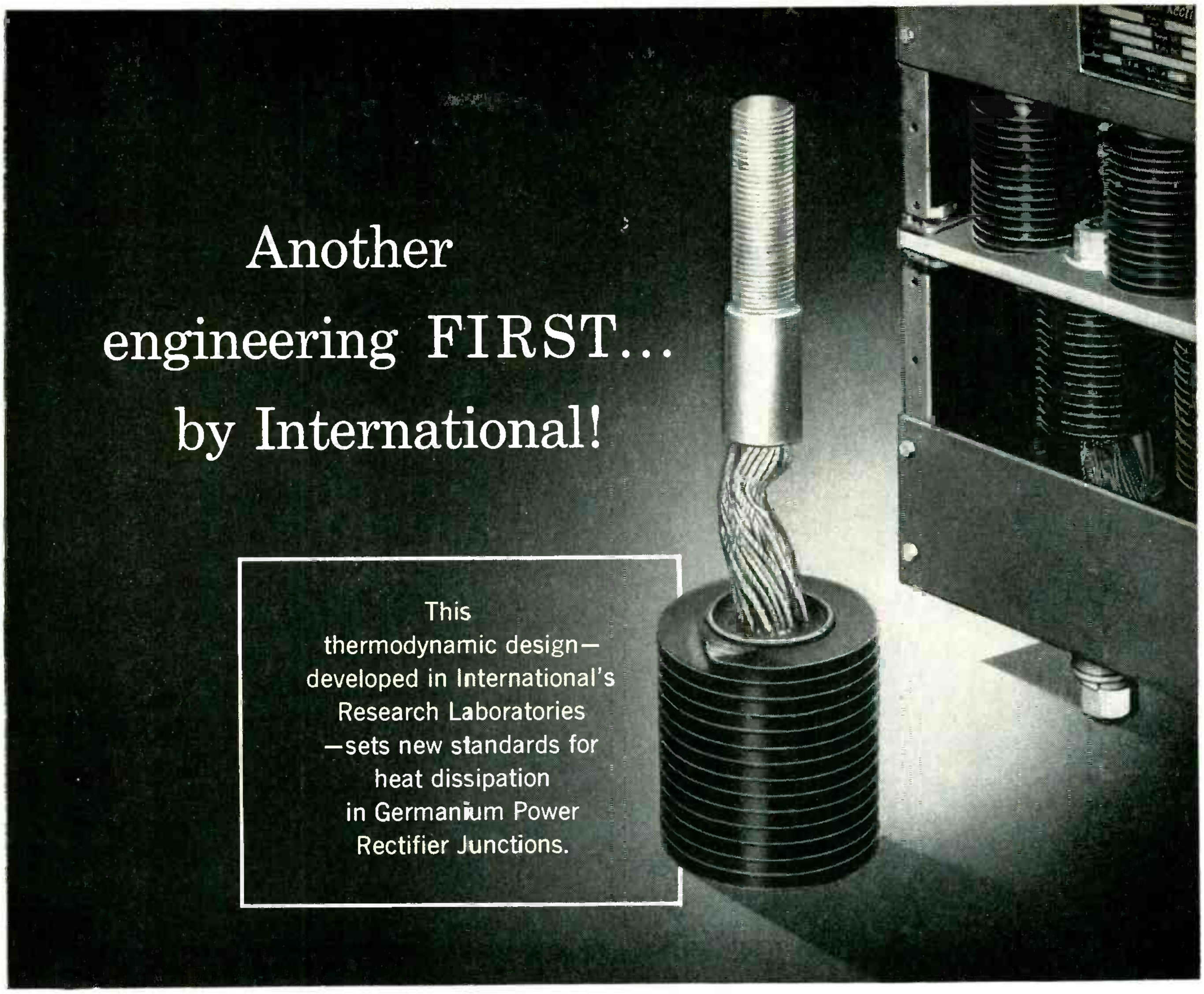
MINIATURE TUBE
for regulator operation

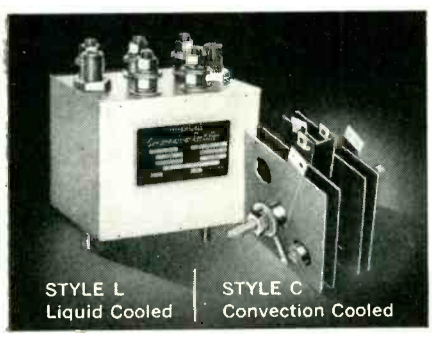
NATIONAL UNION ELECTRIC CORP., Orange, N. J. The NU6842 is a T-5½, 7-pin miniature tube with an overall height of 2¼ in., designed for use in regulated power supplies or voltage amplifier circuits operating at plate potentials of 300 v to 4 kv. It is useful as a shunt regulator or in a series regulator circuit in equipment that requires a stabilized voltage essentially independent of line voltage variations and variations in load current. It is capable of providing up to 10 ma average plate current and of dissipating as much as 8 w.

The low capacitances, high gain, and high voltage ratings also make it well suited for tv and oscilloscope sweep circuits employing electrostatic deflection.

H-V POWER SUPPLY
electronically regulated

SCIENTIFIC SPECIALTIES CORP., Subsidiary of the Norden-Ketay Corp., Snow & Union Sts., Boston





International offers a complete line of Germanium Power Rectifiers. For complete details on all types, request Bulletin GPR-1.

Finned copper housings—the most efficient heat exchangers yet adapted to power rectifiers—measuring less than 2" in diameter, provide a total cooling surface of 58.3 sq. inches! International's Style F Germanium Power Rectifier utilizes this junction, which has been acclaimed by leaders in the engineering profession as the most advanced rectifier design in the industry.

International's Research Laboratories and Production Facilities have produced a line of Germanium Power Rectifiers offering unexcelled performance. Four years of field testing indicate efficiency up to 97%, with unlimited life expectancy. 12,000-hour tests show no change in forward or reverse resistance. Extremely low leakage current and low forward drop (lowest of all available metallic rectifiers) emphasize the advantages of these units. D.C. output current ranges up to 2250 amps per assembly, and up to 100,000 amps in combination. The input voltage ranges up to 66 volts rms per junction, with an operation temperature range from −55° C to +75° C.

The far-reaching research and development program of International assures you of greater rectification efficiency and reliability. A wire, letter or phone call to Application Advisory Department will bring an immediate and experienced recommendation for your application.

A WORLD OF DIFFERENCE ...THROUGH RESEARCH

International Rectifier
CORPORATION

EXECUTIVE OFFICES: 1521 E. GRAND AVENUE, EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281
NEW YORK: 501 MADISON AVE., PLAZA 3-4942 • CHICAGO: 205 W. WACKER DR., FRANKLIN 2-3889
IN CANADA: ATLAS RADIO CORP., LTD., 50 WINGOLD AVE. W., TORONTO, ONTARIO, RU 1-6174

THE WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS

35, Mass. The PS-22 electronically regulated supply is designed for use with multiplier-photo tubes, counters and other devices requiring a closely regulated, well stabilized voltage. The use of a zero-drain, thermally insulated battery voltage reference allows excellent long term stability and high absolute accuracy in setting output voltage. Both positive and negative are insulated from the chassis, and either can be grounded.

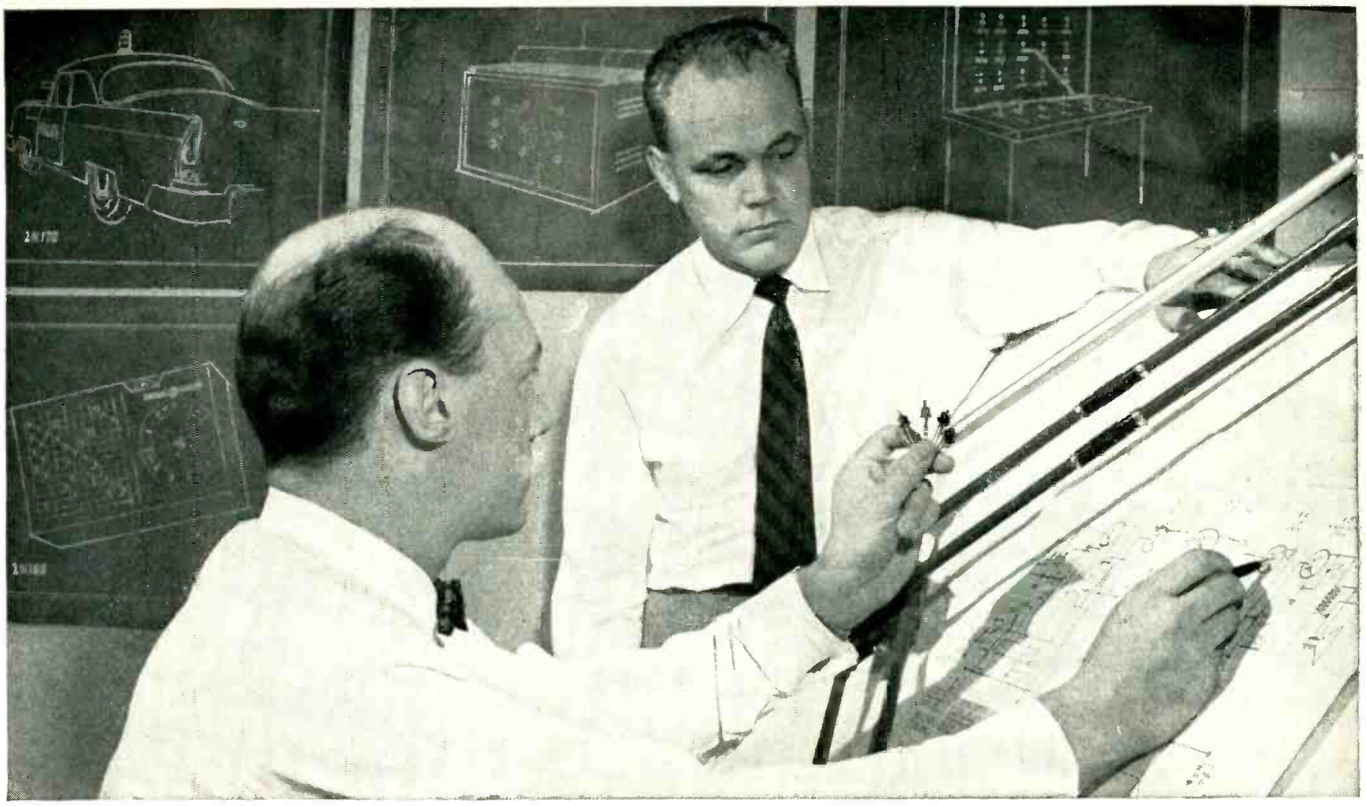
▶ **Technical Data**—Output voltage changes less than 0.01 percent from 0 to 1-ma load. A 10-percent change in input voltage causes less than 0.05-percent change in output. Ripple is less than 0.003 percent of output voltage.

The front panel is standard relay rack mounting 19 in. by 7 in. An extra set of output terminals is located at the rear of the instrument. All exposed components are well insulated. Price is $195.

PANORAMIC RECEIVER for vhf applications

CGS LABORATORIES, INC., 391 Ludlow St., Stamford, Conn. Covering the range from 100 to 150 mc, this Trak all-electronic receiver (model PAN-1) features three controllable inductor tuned r-f stages in a double-superheterodyne circuit which provides more than 60 db attenuation of all spurious responses and a noise figure no greater than 13 db throughout the tuning range.

▶ **Performance**—Seven tracked Increductor controllable inductor tuned circuits operate without moving parts to provide vibration-free operation and virtually unlimited



Four New G-E Controlled Characteristic NPN Transistors Offer Opportunities Now For Practical Applications

The new General Electric NPN's — 2N167, 2N169, 2N170, 2N78 — cover a broad range of circuit applications

Now there are four NPN transistors in the G-E Semiconductor line. All are new. All designed for up-to-date circuitry needs where dependability and reliability are required. These new transistors offer a strong combination of ratings to provide everything you want from an NPN in a circuit.

All four new NPN's are produced under the exclusive G-E rate growing process, *all-welded and hermetically sealed* against impurities and contamination. General Electric's *full year warranty* assures long life, top performance.

For full specifications and application engineering assistance call in your G-E Semiconductor Specialist, your G-E distributor, or, write: *General Electric Co., Semiconductor Products, Section X426, Electronics Park, Syracuse, N. Y.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

THE GENERAL ELECTRIC NPN TRANSISTOR LINE

G-E NPN 2N167: The first G-E NPN transistor designed specifically for computer and data processing machine circuitry. All characteristics controlled. Provides a combination of high frequency and high voltage operation, 5 mc at 30 V. Can be used in RF and IF amplifier stages.

G-E NPN 2N169: An NPN transistor for use in radio design. Carries characteristics needed for excellent results as a 2nd detector in broadcast receiver amplifiers.

G-E NPN 2N170: Designed for low level amplifiers and switching circuits. Of particular interest to novelty electronic circuits. Priced extremely low.

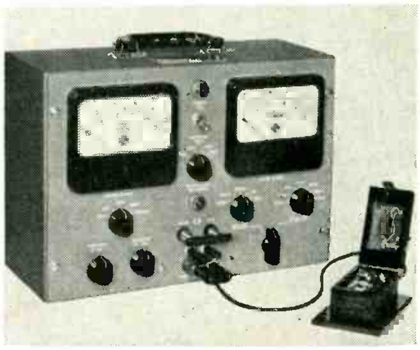
G-E NPN 2N78: A general purpose transistor of particular interest in RF and IF amplifiers. Exceptionally stable operation at junction temperatures up to 85° C.

Want more information? Use post card on last page.

life. A precision marker circuit permits frequency measurements on observed signals to an accuracy of better than 1 percent.

Received signals are displayed logarithmically on a 5-in., flat-face crt. A dynamic range of 60 db is presented as a 6 to 1 variation in observed amplitude.

Price of the model PAN-1 is $5,850.



DIODE TESTER
shows overload automatically

TELETRONICS LABORATORY, INC., 54 Kinkel St., Westbury, L. I., N. Y. Particularly useful for measuring the static characteristics of germanium, low power selenium and power type germanium diodes, the DT-100A has the added feature of a current meter overload protective circuit. Forward voltages from 0.5 to 2.0 v d-c up to 500 ma and reverse voltages from 0 to 150 v d-c up to 5 ma are provided. The reverse control also has three fixed positions normally preset at 10, 50 and 100 v for making rapid tests.

A 3-position spring return switch allows rapid transfer from forward to reverse test positions. An automatic overload circuit detects shorted or reversed diodes and indicates this condition by a lamp while limiting the current to a safe value.

RECEIVERS
for special-purpose uses

NEMS-CLARKE, INC., 919 Jesup-Blair Drive, Silver Spring, Md., has designed the 1670 series of special-purpose receivers to replace the series 167. Principal improvement consists of a complete redesign of the i-f amplifier strip. A new de-

TAYLOR Shop Talk

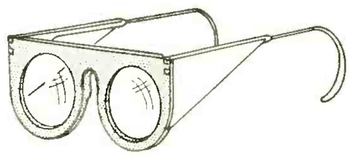
Laminated Plastics
Vulcanized Fibre

TAYLOR FIBRE CO.

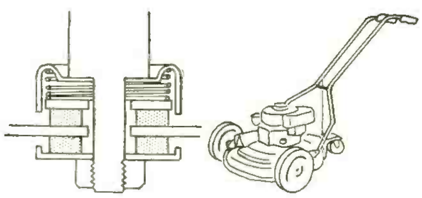
Plants in Norristown, Pa. and La Verne, Calif.

PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD

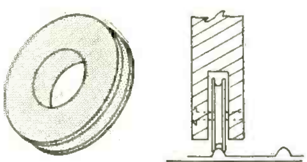
Tips for designers



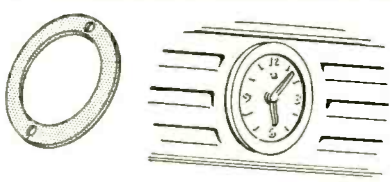
Frames for industrial eye-glasses, of Taylor Phenolic Laminate . . . are resistant to moisture and acids, possess high physical strength.



Rotary lawn mower utilizes abrasion resistance of Taylor Phenolic Laminate washer in slip-clutch attachment of drive shaft to cutting blade.



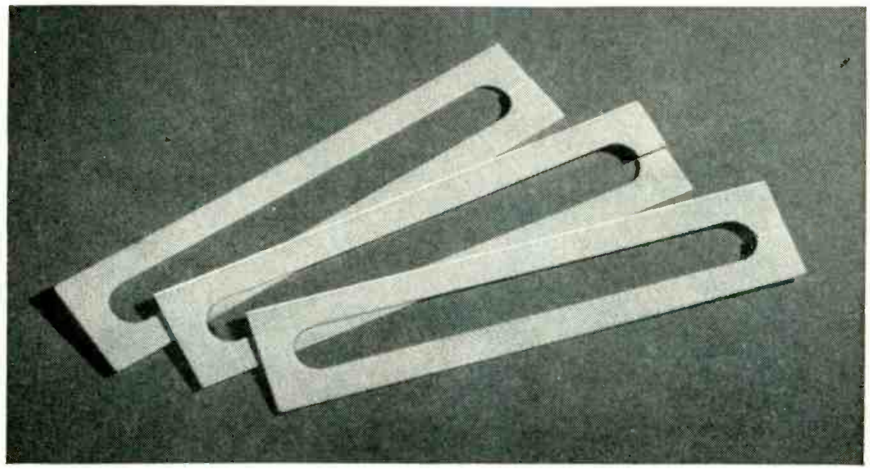
Rollers for flush doors are now being made from Taylor paper base tubing with ball bearing insert . . . providing smooth, silent operation at a low cost.



Automobile clock is securely and economically mounted on inside surface of metal dashboard, with a spacer fabricated from Taylor Vulcanized Fibre.

TAYLOR FABRICATING FACILITIES

Your production problems can often be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts of vulcanized fibre and laminates to your specifications. Efficient, modern facilities are ready to serve you. Write to Taylor about your specific requirements.



Jack & Heintz engineers selected Taylor glass base silicone laminates for dependable insulation of rotor windings in a DC generator for aircraft.

For critical insulation requirements use Taylor glass base laminates

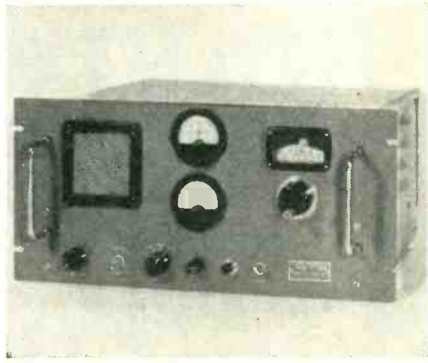
Looking for exactly the right laminate to handle a particularly tough electrical insulation job? You'll find what you need in the many grades of Taylor glass base laminates . . . each using a special formulation of Taylor phenol, melamine, silicone, or epoxy resin. Possessing a broad range of stable insulation qualities and high mechanical strength, these laminates are standard Taylor products rather than "specials" made up at infrequent intervals.

From this group of materials you can select not only the insulation characteristics you need but also any desired combination of: prolonged service at elevated temperatures, resistance to chemical action, retention of physical properties, and low moisture absorption. And they are available in sheets, tubes and rods, in sizes that afford maximum economy of material usage in your manufacturing processes.

Equally important in your consideration of these laminates are the specialized techniques and facilities of Taylor's Fabricating Division . . . capable of producing parts to your own specifications, promptly and economically.

Plan to take advantage of these high-performance laminates in your present products or those which you are now designing. Call on Taylor for a discussion of your specific requirements . . . for glass base laminates and for efficient fabrication service.

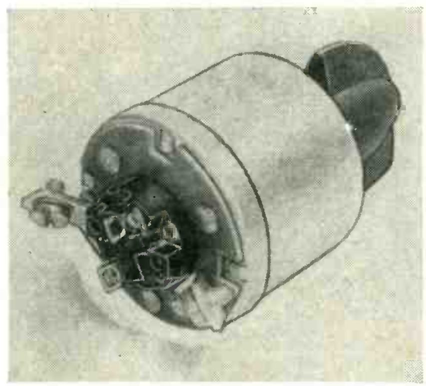
Want more information? Use post card on last page.



sign of i-f transformers provides greater stability, both mechanically and electrically. The new i-f strips are much easier to align. Both the i-f and discriminator transformers are temperature compensated to a high degree. Sensitivity has been improved by use of better limiters.

The output amplifier has been redesigned to provide better frequency response and substantially lower hum level.

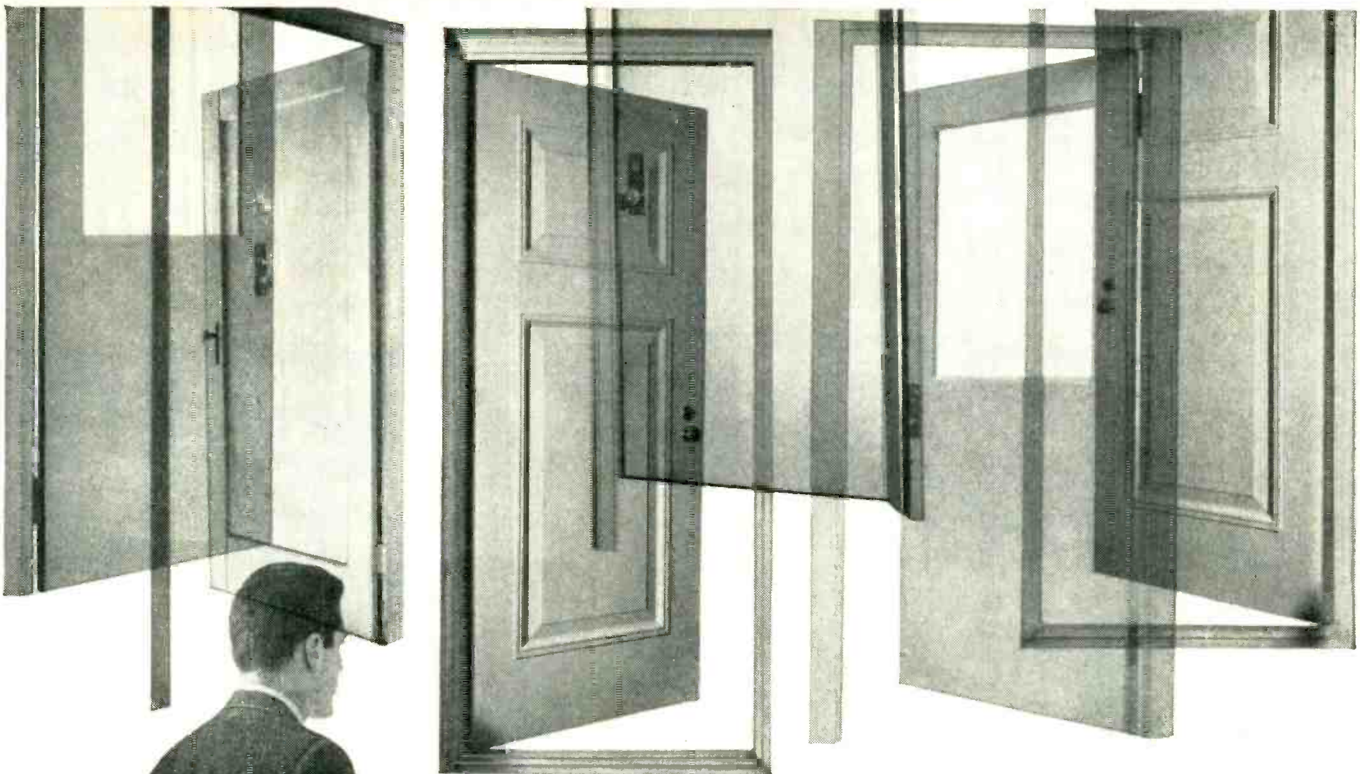
► **Applications**—The 1670 series will find wide use in the fields of telemetering, guided-missile monitoring, radiosonde reception, television-sound rebroadcasting, and related fields.



POWER RHEOSTATS with power switch

CLAROSTAT MFG. CO., INC., Dover, N. H. To meet the demand for a power rheostat which incorporates a switch for multicircuit applications, the company announces its series 25GS and 50GS units. These are basically the aircraft type of encased power rheostats of the series AN-3155, modified to accommodate power switches of spst, spdt or dpst construction.

Operating functions are combined in one unit. This is an important engineering factor in the aircraft



DO ENGINEERS GET JOBS TOO EASILY?

Never before has it been so easy for an engineer to get a job. Just because jobs are so abundant, it's harder than ever to choose the *right* one—and that means choosing the *right field* and the *right company!*

One of the most striking trends in America today is the growing reliance of science, government and industry on computers.

Future growth in this field appears certain to be spectacular—offering virtually limitless opportunities to engineers.

Nowhere are prospects brighter than at IBM, creator of the first automatic large-scale digital computer. More than that, the world's largest computer is the product of IBM inventiveness. Hundreds of IBM electronic data processing machines are already in use, and many more will be installed in 1956.

IBM's proud history of electronic achievement is a direct and positive outgrowth of a distinctive engineering climate—an atmosphere that stimulates and fosters the fresh approach, the new concept.

There is unprecedented opportunity waiting for you at IBM—experience that money couldn't buy.

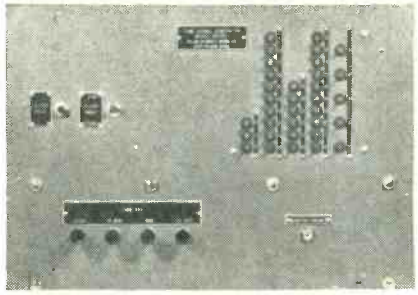
You owe it to yourself to investigate.

IBM®

Producer of electronic data processing machines, electric typewriters, and electronic time equipment.

Write, outlining your interests and qualifications to:
W. M. Hoyt, **International Business Machines Corp.,**
Room 402, 590 Madison Avenue, New York 22, N. Y.

industry where manual operation of controls of all types must be kept to a minimum. The switches operate under standard military environmental conditions, while the rheostats meet MIL-R-6749 specifications.



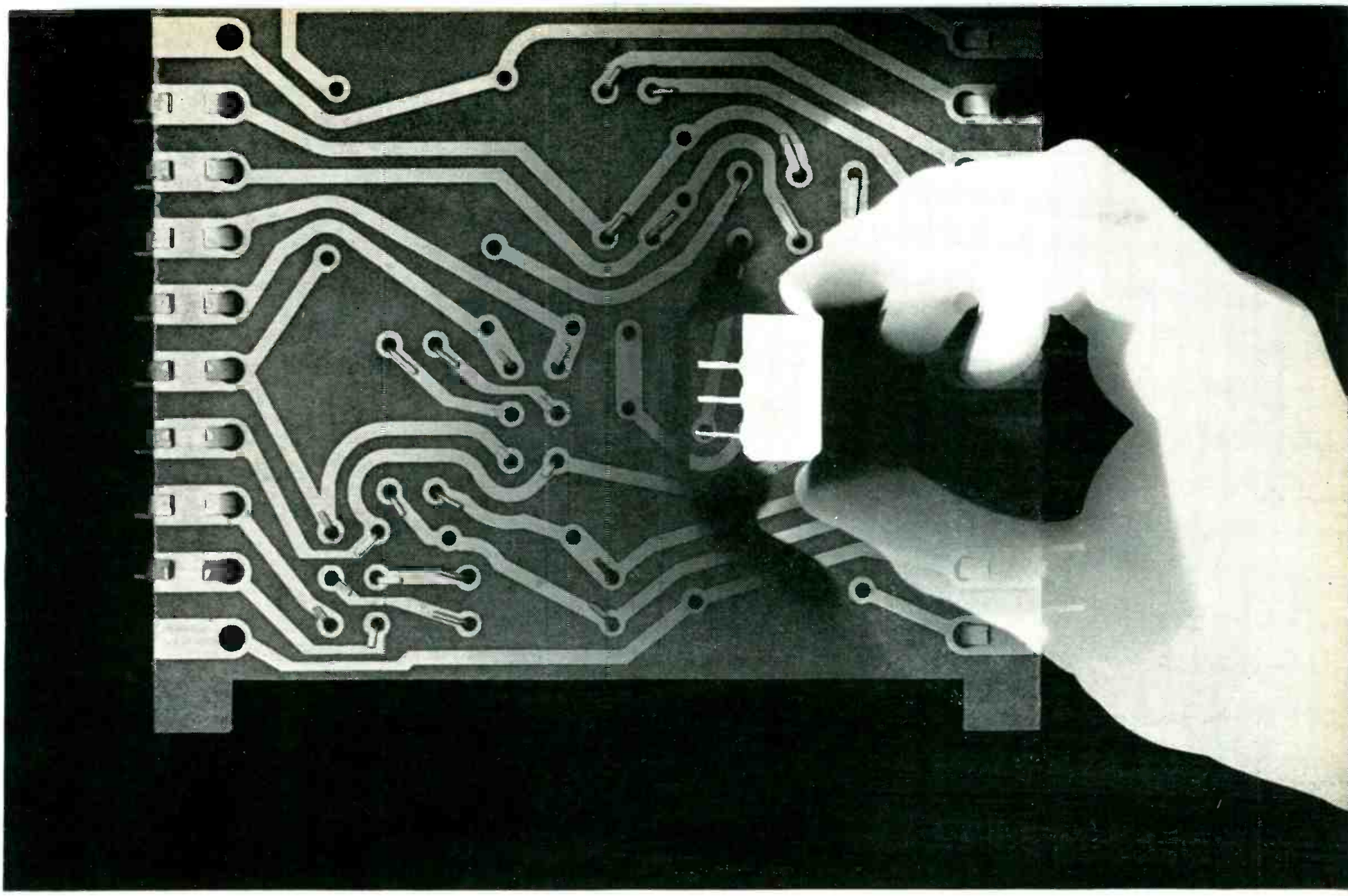
TIME SIGNAL electromechanical generator

HALLER, RAYMOND & BROWN, INC., 124 N. Atherton St., State College, Pa. The new time signal generator system is an electromechanical device which generates a coded time signal for use in applications where a moderately accurate time reference is required. The time signal is presented as a group of 5 digits corresponding to the 24 hour clock notation. The digits are produced electromechanically in the form of an audio tone which is keyed according to a modified dot and dash Morse code.

▶ **Power Supply**—The standard frequency power supply, with a frequency accuracy of 0.001 percent, is used to drive the internal timing device in applications where the accuracy of the supply-line frequency is inadequate.

PHASE OSCILLATOR for 50 to 6,000-cps range

COMMUNICATION MEASUREMENT LABORATORY, INC., 350 Leland Ave., Plainfield, N. J. Model 1440-D will provide low distortion, single,



Westinghouse miniature rectifiers plug in for printed circuits

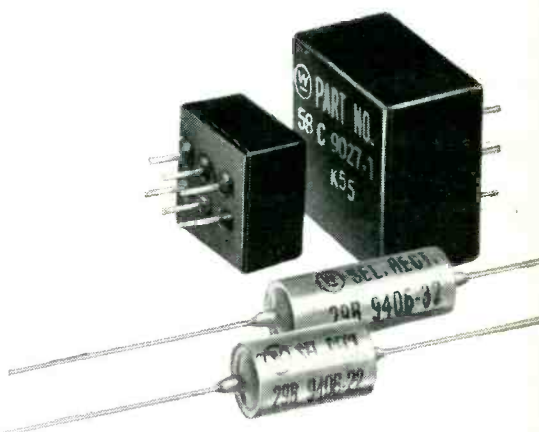
Reliable, low-cost, d-c power supply for your military or commercial electronic and electric equipment calls for Westinghouse selenium rectifiers. A new-design enclosure featuring plug-in terminals makes them particularly well suited for printed circuits. Optimum circuit versatility is obtained through multiple terminal headers.

Westinghouse selenium rectifiers are compact, lightweight; save precious space; contribute to easy accessibility. They have low forward drop and low reverse leakage, are also available as a unit with magnetic amplifiers. Packaged in resin-sealed Moldarta* boxes for use in potted assemblies, or hermetically-sealed nickel silver boxes for open mounting.

A wide range of Westinghouse selenium rectifiers in stack, boxed and cartridge form is ready to serve your design engineering needs. More information? Send coupon below. J-01001

*Trade-Mark

Input 0 - 33 VAC per cell
Current 0.03 - 0.2 amp
Bridge units available to 150 VAC
Size: ¼- and ½-inch cell diameter
Operation up to 75°C ambient temperature.



YOU CAN BE **SURE**...IF IT'S

Westinghouse

Westinghouse Electric Corporation
3 Gateway Center, P. O. Box 868
Pittsburgh 30, Penna.

I'm interested in more information about:
☐ Selenium rectifiers ☐ Cypak* control
☐ Magamp* magnetic amplifiers.

NAME ________________ TITLE ________
FIRM ________________________________
ADDRESS _____________________________
CITY ________________ STATE ________

two or three-phase signals over the 50 to 6,000-cps range.

The displacement between phases is adjustable from 0 to 360 deg and output level is 5 v maximum across 6,000 ohms.

▶**Other Features**—A test jack on the front panel allows visual monitoring of the output signals and the improved metering circuit allows measurement of both the phase voltages and the phase-to-phase voltages. The unit operates from 115 v ±5 percent 60 cps single phase.

Catalog E is available upon request.

REMOTE CONTROL MOUNT
for industrial television

DIAMOND POWER SPECIALTY CORP., Lancaster, Ohio. Designed for use with either the Diamond UtiliVue or any other industrial tv camera, this remote control pan and tilt mount features rugged construction. It is being successfully used on both outdoor and indoor installations.

▶**Specifications**—Rotation is full 360 deg or it can be limited to any arc desired. Tilt is 45 deg above horizontal and 45 deg below—90 deg in all. Complete 360-deg rotation is accomplished in 36 sec while 90-deg tilt requires 15 sec.

Pan and tilt motions are driven by separate motors individually and remotely controlled from a control panel located at any desired point. The mount is especially useful

MARCH 19 – 22

How BIG must the show be?

When a facetious critic asked, "How long should a man's legs be?" Abraham Lincoln replied, "Long enough to reach the ground!"

The 1956 Radio Engineering Show is big only because it *must be big* to be truly representative of a gigantic industry. 704 exhibitors, 1 out of every 5 firms manufacturing for the industry, will be present.

But these 704 firms represent over 80% of the industry's production. A smaller Show would give only an inadequate picture of the year's progress and new developments.

Being BIG pays off! This truly great event brings out the best...in people, effort and products!

Registration—IRE Members $1.00
Non-members $3.00

What you get out of it!

- You see what is new in radio-electronic products and engineering!
- You meet the men who make these products!
- You save time...seeing in days a whole year's productive effort!
- You hear the best technical papers in subjects of your own specialty!
- You meet old friends and make new ones, enjoy association and social events!

The IRE National Convention

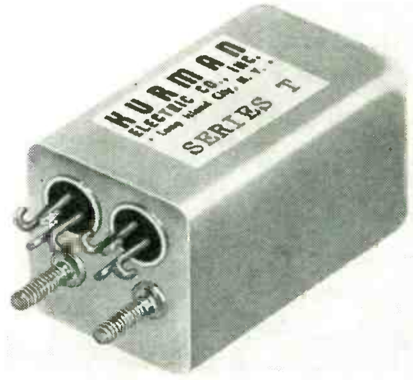
Waldorf Astoria Hotel, New York City

and RADIO ENGINEERING SHOW

Kingsbridge Armory & Palace, New York City

®

where it is necessary to have one camera cover a wide area.

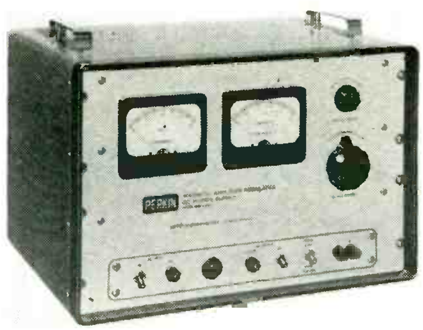


RELAY
coil resistance to 12,500 ohms

KURMAN ELECTRIC CO., INC., 35-18 37th St., Long Island City, N. Y. The series T relay is available with a 1 Form A through 2 Form C contact arrangement with contacts rated at 2 amperes 28 v d-c, 115 v a-c. It is supplied in an enclosure 1 in. by 1 in. by 1¾ in. high, weighing only 3½ oz.

▶ **Other Specifications**—It can be adjusted to operate with as little as 5 mw of coil power. Coil resistances of up to 12,500 ohms are available with a maximum dissipation of 1.5 w. Contact resistance of less than 0.03 ohm is exhibited throughout the life of 100,000 operations minimum.

The series T relay can be supplied for high-speed keying. It is designed for −55 C to +100 C operation.



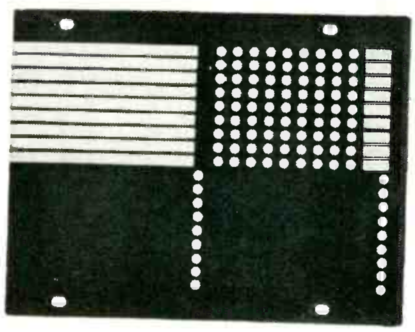
POWER SUPPLY
is mag-amp regulated

PERKIN ENGINEERING CORP., 345 Kansas St., El Segundo, Calif., has developed a compact, light weight magnetic-amplifier regulated 2 to

Why the leaders choose **RESINOX* 3700**
for molding profit-making electrical parts

Arrow-Hart & Hegeman are making profitable use of critical electrical parts molded of Resinox 3700 in their combination starter where high arc-resistance is a must.

Wells Manufacturing ignition coil top molded of Resinox 3700 outperformed all others in racing car tests on Utah salt flats. Because of Resinox 3700 no spark power was lost at speeds up to 140 m.p.h.



IBM specifies Resinox 3700 for cross bar emitter —and cuts production costs of this vital "Check Prover" part in half because Resinox 3700 has outstanding dimensional stability.

American Bosch uses this distributor plate molded of Resinox 3700 where its superior arc-resistance is giving top performance in the field. (Part made for them by Specialty Insulation Mfg. Co.)

THE PREFERENCE FOR RESINOX 3700 grows every day. This thermosetting mineral-filled molding powder was developed by Monsanto for superior performance in magneto ignitions, motor control and transmission circuits, and countless other electrical applications. • It combines high arc-resistance with outstanding dimensional stability. • It eliminates undesirable after-shrinkage. • Its moldability is excellent and its impact resistance is good. • It has good transfer molding properties. • It offers superior heat resistance. For full information on Monsanto's Resinox 3700, write today to Monsanto Chemical Company, Plastics Division, Dept. E-2, Springfield 2, Massachusetts.

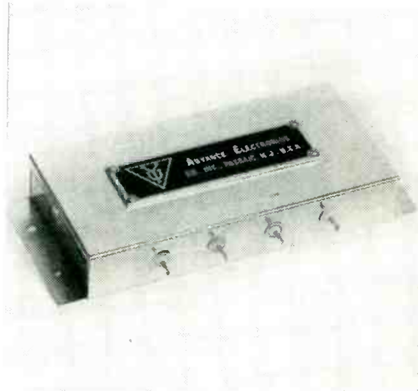
MONSANTO

Serving Industry . . . which serves mankind

*RESINOX: REG. U. S. PAT. OFF.

36 v at 15 ampere power supply. It is identified as model MR532-15A.

▶ **Specifications**—The d-c output range is 2 to 32 v; a-c input, 105 to 125 v, 1 phase, 60 cycle; ripple, 1 percent rms; voltage regulation, ± ½ percent over the range of 5 to 32 v, ± 2 percent from 2 to 5 v and 32 to 36 v; response time, 0.1 to 0.2 sec maximum.



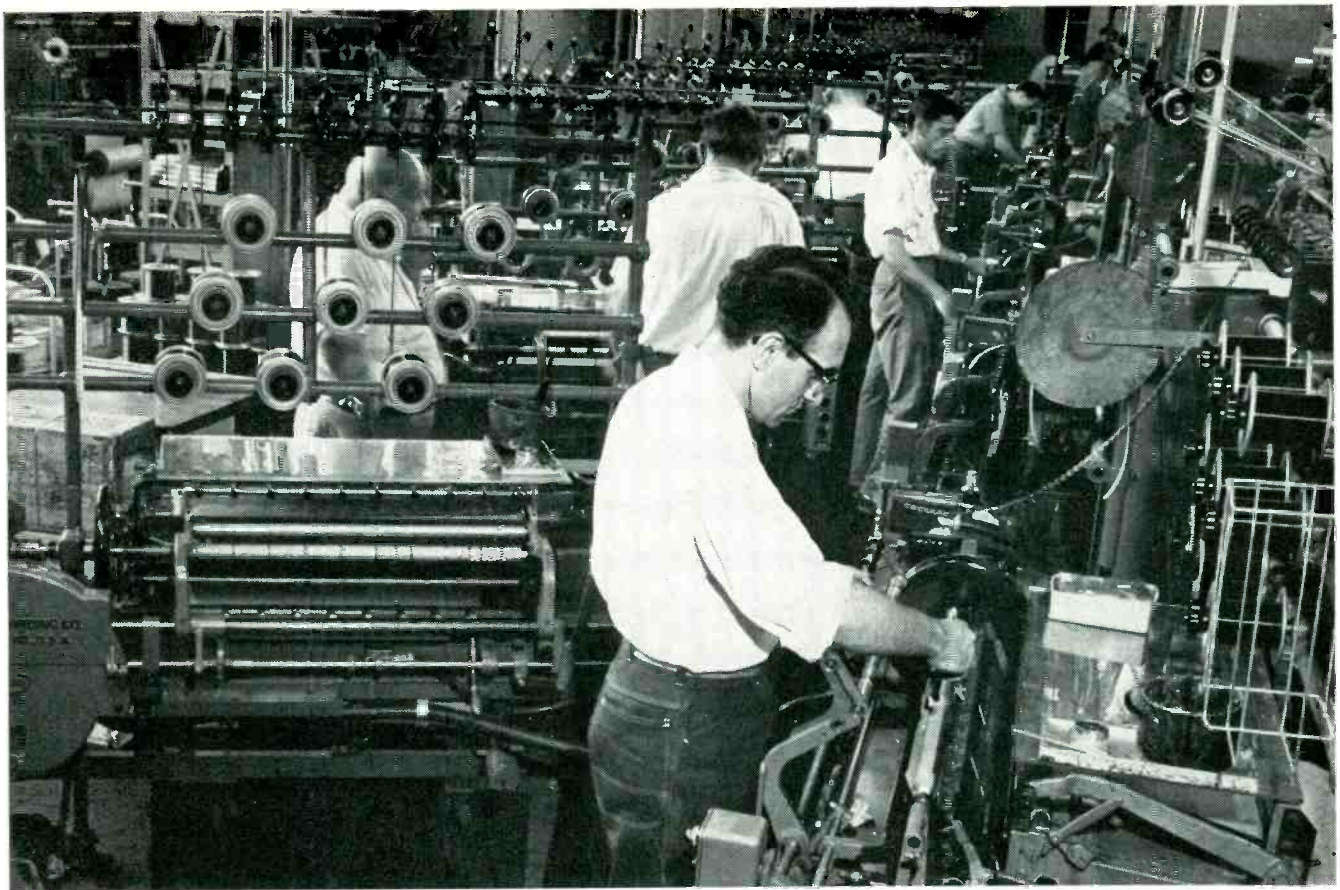
TAPPED DELAY LINES
linear phase shift type

ADVANCE ELECTRONICS CO., INC., 451 Highland Ave., Passaic, N. J. Series 7T linear phase shift tapped delay lines have been announced. A unit of these consists of 30 sections of m-derived L-C networks. Each of these networks was especially designed to achieve (1) linear phase shift beyond 70 percent of the cutoff frequency, and (2) frequency-amplitude response curve approaching Gaussian in shape. For this reason, both rise time and overshoot are much less than other delay lines with equal time delay. Temperature coefficient is less than 50 parts per million for variation of 1 deg C.

▶ **Features**—They are particularly suitable for corporation into electronic equipments where time delay is needed, because both weight and size are small. These delay lines can also be plotted for hermetical sealing to meet all applicable military specifications.

▶ **Types**—There are 66 types available with total time delay equal to 0.3, 0.4, 0.5, 0.75, 1, 1.5, 2, up to 10 μsec in steps of 1 μsec.

The characteristic impedance can be chosen from the following values



Installation of Leesona No. 107 Coil Winders at Ford Motor Company's Ypsilanti, Michigan, plant. New Paper Miss Detector enables operator to tend two machines.

Now FORD Motor Co. winds ignition coils on Leesona No. 107 winders

Machines stop automatically if there's a paper miss . . . one operator tends two machines . . .

These Leesona No. 107 Coil Winders, equipped with the new Paper Miss Detector, make quantity production of high-quality stick-wound coils virtually foolproof.

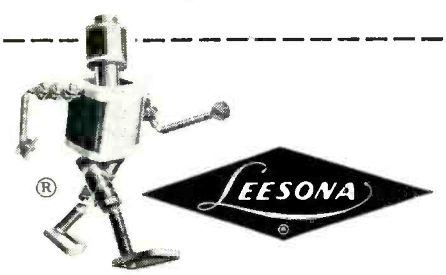
Humidity changes can cause the paper to curl and miss an insert. Ordinarily, if there's a paper miss, and the machine is unattended, it continues to wind. Result . . . a worthless stick plus money wasted in wire and time. So an operator must be in constant attendance on each machine.

The new Leesona Paper Miss Detector cures this . . . by automatically stopping the machine. Thus, constant machine attendance is unnecessary.

- One operator can handle two or three machines.
- Operator's coil production increases.
- Rejection rate is reduced . . . when the machine stops at a paper miss the operator re-inserts the paper, starts the machine which continues to wind an excellent stick of coils.

For the full story on Leesona No. 107 Coil Winders, and other helpful information write or get in touch with Universal.

B.5.2



FOR WINDING COILS IN QUANTITY . . . ACCURATELY . . . AUTOMATICALLY . . . USE UNIVERSAL WINDING MACHINES

UNIVERSAL WINDING COMPANY

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—50, 70, 75, 95, 100, 150, 200, up to 1,000 ohms in steps of every 100 ohms. Rise time is less than 8 percent of the time delay at any tap. Time delay accuracy is better than +2 percent at any tap. Size is $5\frac{1}{2}$ in. by $2\frac{5}{8}$ in. by $\frac{7}{8}$ in. and weight is less than 10 oz.

MINIATURE TUBE
for d-c power supplies

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y. Type 5651 cold-cathode discharge miniature voltage reference tube is designed for use in d-c amplifiers, stable regulated power supplies, oscilloscope calibrators and similar applications.

Special processing of the tube and its elements insures extremely stable operation and freedom from long and short-term drift.

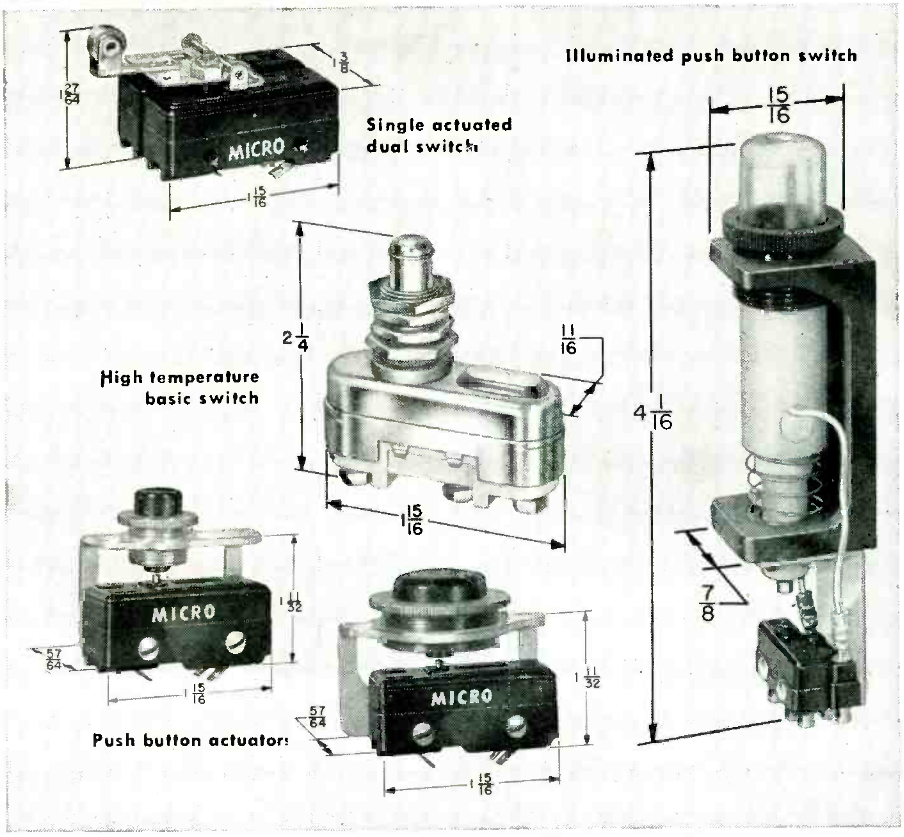
Operating voltage range of the 5651 is 82 to 92 v; current range is from 1.5 to 3.5 ma.

H-F/D-F SYSTEM
can be operated remotely

SERVO CORP. OF AMERICA, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y., has designed a h-f/d-f system to be operated remotely—antenna site and airport control tower can be as much as 5 mi apart. The tower operator automatically obtains a visual indication of an aircraft's bearing without interrupting his normal duties. He could continuously monitor the

MICRO precision switches

...THEIR USE IS A PRINCIPLE OF GOOD DESIGN



A continuous flow of Precision Switch developments anticipates designers' needs

Function of MICRO SWITCH Engineering, both at the factory and in the field, is to supply the precision switch which most exactly meets the design requirement.

Shown here are just a few recent MICRO SWITCH developments that designers have found useful in a wide variety of applications. Write to any branch office or to Freeport, Illinois for more detailed information.

The Single Actuated Dual Switch consists of two basic switching units operated by a roller lever actuator. The operating point of one of the basic switches is field adjustable so either simultaneous actuation or a definite sequence of operations is possible.

The Illuminated Push Button Switch is a low force, high pre-travel switch with an indicating light as an integral part of the push button. The high pre-travel permits movement of the button before the contacts snap over. This switch is designed for use in electronic, aircraft, mobile, marine, railway and other low voltage a-c or d-c applications.

The High Temperature Basic Switch is a precision snap-action switch which will operate satisfactorily in a temperature range of from −50° to plus 1000° F. It is useful in such industrial applications as found in distilleries, foundries, vulcanizing plants and other industries which require high temperature components.

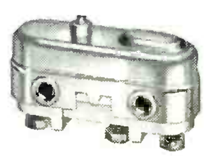
Push Button Actuators are of a new series available to designers of electrical computers and other types of commercial and industrial devices which require reliable panel-mounted, manually-operated switches. They are available with ½″ or 1″ buttons and combine attractive appearance and extremely long life with an exceptionally good actuation "feel".

Manufacture of precision switches is not a side line with MICRO SWITCH. It is our entire *business*. That is why industrial designers come to us more and more each year with switch problems of amazingly diverse types. MICRO SWITCH branches are conveniently located to serve you.

Illuminated Push Button Switches allow mounting on one inch centers

MICRO SWITCH Illuminated Push Button Switches are outstanding for ease of operation, high pre-travel, compact design (which permits mounting on one inch centers), smooth appearance and easy-to-see pilot light. Switches are provided with sockets for a single contact miniature bayonet lamp. Removable translucent push buttons are available in clear, red, or frosted white.

High Temperature Switch comes in three actuator types



In addition to the type shown at the left, MICRO SWITCH high temperature switches are also available with pin plunger actuators for use where space is limited and small operation motion is available and roller plunger actuators for applications where cam or slide action is required.

How Push Button Actuators are mounted to a panel

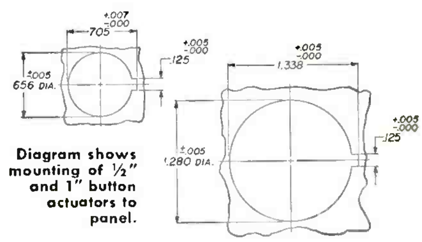


Diagram shows mounting of ½″ and 1″ button actuators to panel.

Knurled bushing assembly is inserted through the panel and threaded into the switch mounting bracket. The mounting bracket in turn is keyed to the panel, using Mounting details A or B.

MICRO SWITCH Engineering Service is available to help you select the exact switch to meet your design problem. Call the MICRO SWITCH branch nearest you.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

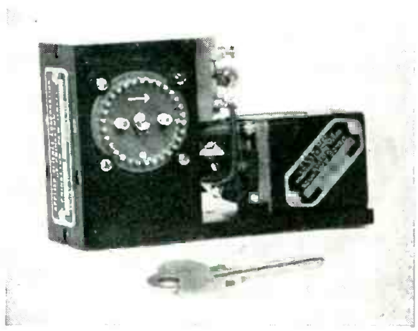
In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

Want more information? Use post card on last page.

bearings of all aircraft in h-f communication with him.

The control equipment is normally preset for 5 selected crystal-controlled reception frequencies. Up to 10 channels can be accommodated by the installation of additional components at the remote site. Simultaneous operation of several channels is possible.

▶ **Installation**—The equipment is installed in two locations. The indicator and control panel are installed in a control console at the tower. The remainder of the equipment is at the remote antenna site. Interconnecting cables carry all control and data transmission between the remote and control sites. An intercom is provided to facilitate adjustments. Power requirement for the remote installation is 2,000 w and only 1,000 w at the control point. The equipment operates from a 115/230 v, 50/60 cycle source.



SAMPLING SWITCH for general instrumentation

APPLIED SCIENCE CORP. OF PRINCETON, N. J., announces a new line of small lightweight rotary sampling switches with integral d-c drive

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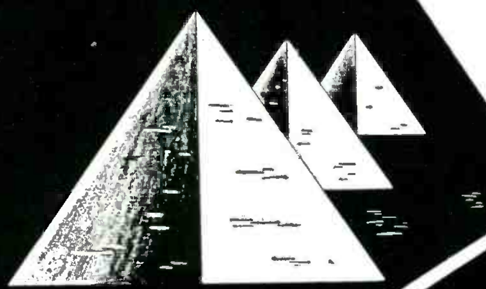
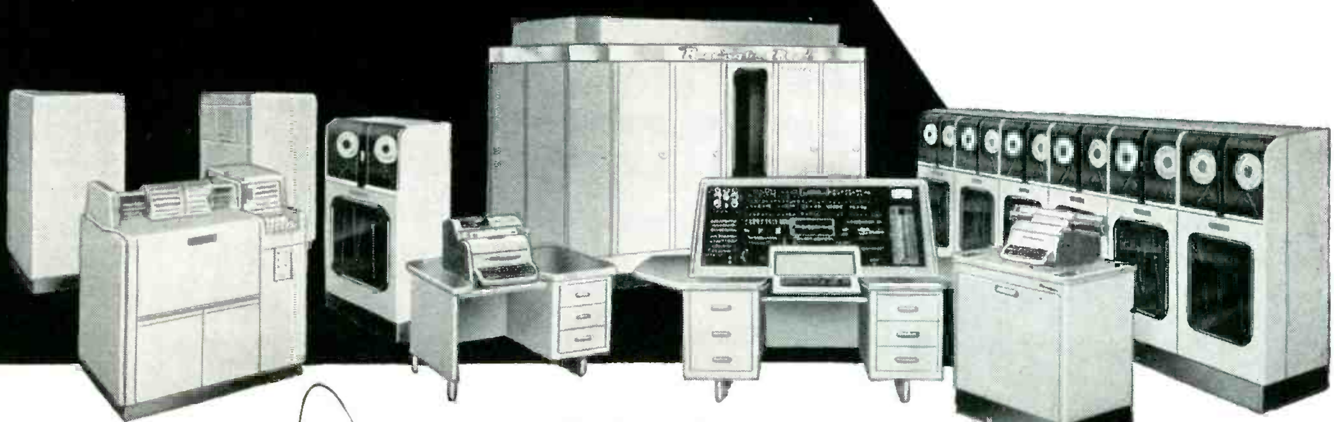
At Remington Rand Univac you will enjoy creative, challenging work in research and development on important new applications in mechanical and electronic engineering. You will work on a project team and learn all aspects of your project. Pulse circuits, magnetic cores, transistors, printed wiring, miniaturization, and precise mechanisms are used in designing computers, automatic data handling and control systems and special weapons. There are other excellent production, testing, specifications, quality control, contract administration, logical designers and technical writing positions.



In ancient times it took 100,000 men over 30 years to construct the great Pyramid of Cheops.

In this Modern era, Remington Rand's Univac, operating for the United States Bureau of Census can compress 4,000 minutes of clerical time into one minute of machine time.



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- Mechanical Engineers
- Mathematicians
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- Industrial Engineers
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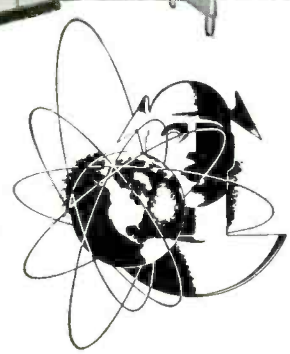

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Remington Rand Univac

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motor for use in airborne and general instrumentation applications. The phasing between poles can be manually adjusted while the switch is in operation.

▶ **Varieties**—This switch is available with 1, 2, 3, or 4 poles containing 24, 30 or 32 shorting (12, 15, or 16 nonshorting) contacts per pole. Motor voltages of 6, 12, or 27.5 v d-c at sampling speeds ranging from 0.1 to 10 rps can be provided.

DIELECTRIC OVEN
is fully automatic

ERDCO ENGINEERING CORP., Addison, Ill. This dielectric oven was primarily designed for experimental laboratory use for instantaneous drying of sample quantities of various solid and liquid materials. It is a radio-frequency generator of 2 kw rated high-frequency power output.

Fully automatic, the oven has a patented electronic load matching system which automatically compensates for variations in the physical properties of the heated material during the heating cycle. Thus it assures a constant power input into the sample. The power level can be adjusted from zero to full rated power, according to the need for individual tests.

▶ **Application** — Radio-frequency heat can be used in both industrial and university laboratories for testing biochemical samples and cultures, as well as for research in

ACCURATE FREQUENCIES

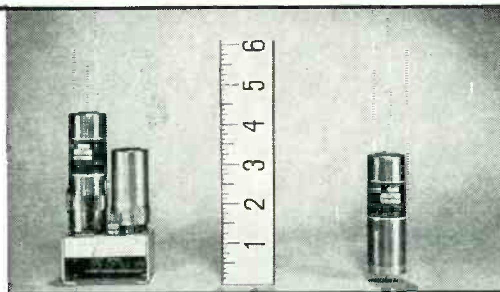
HIGH RELIABILITY
HIGH PRECISION
HIGH QUALITY

LOW WEIGHT
SMALL SIZE
ECONOMICAL

FREQUENCY STANDARD
240 to 800 Cycles

Type 50 C
± .02% at — 65° to 85°C

Type R 50 C
± .002% at 15° to 35°C



8 oz. 4 oz.

PRECISION FORK UNIT
240 to 800 Cycles

Type 50
± .02% at — 65° to 85°C

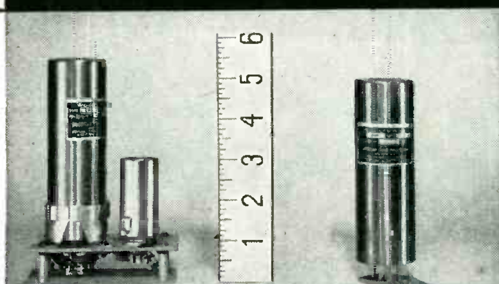
Type R 50
± .002% at 15° to 35°C

FREQUENCY STANDARD
200 to 4000 Cycles

Type 2003 C
± .02% at — 65° to 85°C

Type R 2003 C
± .002% at 15° to 35°C

Type W 2003 C
± .005% at — 65° to 85°C



10 oz. 6 oz.

PRECISION FORK UNIT
200 to 4000 Cycles

Type 2003
± .02% at — 65° to 85°C

Type R 2003
± .002% at 15° to 35°C

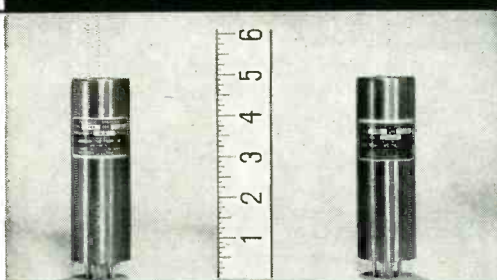
Type W 2003
± .005% at — 65° to 85°C

FREQUENCY STANDARD
200 to 2000 Cycles
Sub-miniature Tube

Type 2007
± .02% at — 65° to 85°C

Type R 2007
± .002% at 15° to 35°C

Type W 2007
± .005% at — 65° to 85°C



6 oz. 8 oz.

FREQUENCY STANDARD
240 to 1000 Cycles
Transistorized

Type 2007 T
± .02% at — 65° to 85°C

Type R 2007 T
± .002% at 15° to 35°C

Type W 2007 T
± .005% at — 65° to 85°C

FREQUENCY STANDARD
200 to 3000 Cycles

Type 2001-2
± .001% at 20° to 30°C

[WHEN REQUESTING INFORMATION PLEASE SPECIFY TYPE NUMBER]

26 oz. 15 oz. av.

ACCESSORY UNITS
for Type 2001-2

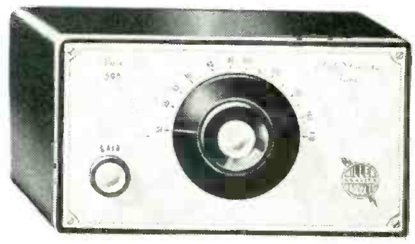
L—for low frequencies, multi-vibrator type, 40-200 cy.
D—for low frequencies, counter type, 40-200 cy.
H—for high freqs., up to 20 KC
M—Power Amplifier, 2W output
P—Power Supply.

American Time Products, Inc.

580 Fifth Avenue ***New York 36, N. Y.***

OPERATING UNDER PATENTS OF WESTERN ELECTRIC COMPANY building materials, rubber, food, chemicals, pharmaceutical products and other materials.

The standard model has an accurately rated output of 2 kw and is available with rated outputs up to 20 kw. Overall dimensions are 25 in. by 34 in. by 63 in. It is available at $3,600 complete.



BROADCAST TUNER
germanium diode type

J. W. MILLER CO., 5917 S. Main St., Los Angeles 3, Calif., has announced the No. 595 high-fidelity, germanium diode broadcast band tuner. Coils used therein have a Q in the order of 600. The audio output of the tuner is proportional to the input signal and will vary from 0.07 v to 0.7 v for stations within a 20 to 25-mile radius.

It can be used as a selective crystal set in rural areas. With sufficient outside antenna and external ground, signals in excess of 600 air miles have been received. Requiring no power or battery supply, it is an ideal unit for civilian defense broadcasts.

Other features are tonal quality, selectivity (20 kc) and sensitivity.

RIB-WOUND RESISTORS
with spot-welded terminals

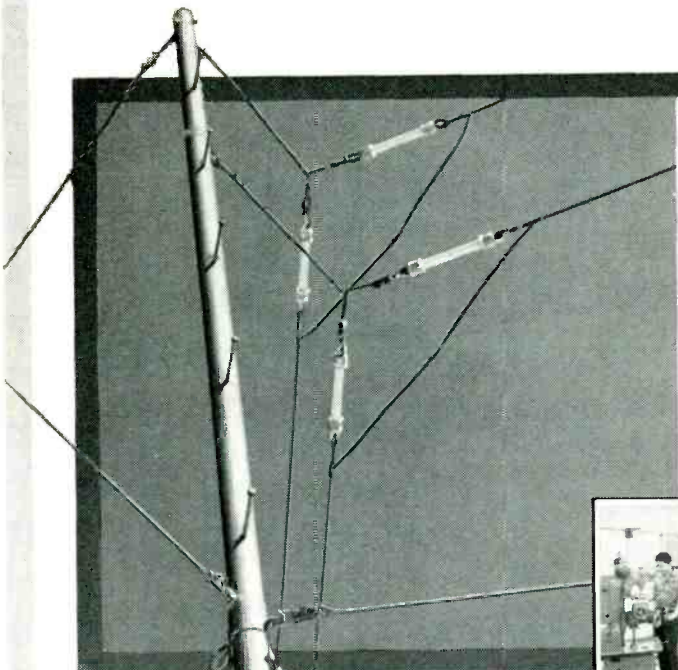
REON RESISTOR CORP., Yonkers, N. Y. Spot-welded terminals and windings are among the features found in the company's new rib-

ADVANCED

Communications

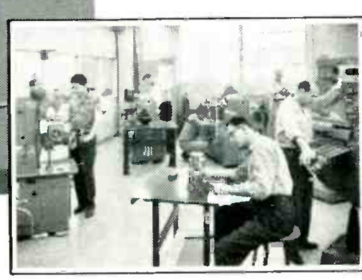
The design of modern communications equipment involves much more than electronic circuit techniques. Keyboards and coders are often required to translate the intelligence to be transmitted into "machine language." Recording and reproducing devices store intelligence until the equipment is ready to transmit it, or hold received intelligence until it can be translated back into human language by a printer or other output display device.

The combination of such mechanical and electromechanical techniques with the better known but still developing techniques of electronic circuit design makes of modern communications a much broader field than is commonly recognized. When such technical tools are used to provide equipment tailored to our rapidly improving understanding of propagation phenomena and information theory, the resulting practical improvements in communication are sometimes little short of spectacular.



The growing communications activities of The Ramo-Wooldridge Corporation have generated requirements for additional physicists and engineers with substantial experience in research, development, or production engineering on advanced airborne and ground-based ...

- Communication, Navigation and ECM Systems
- HF, VHF, and UHF Transmitters and Receivers
- Precision Electro-Mechanical Equipment
- Magnetic Recording Systems
- Signal Analysis Equipment
- Video and Pulse Circuitry
- Miniaturization and Packaging



Part of Communications Equipment Pilot Production Activities

The Ramo-Wooldridge Corporation

5820 BELLANCA AVENUE • LOS ANGELES 45, CALIFORNIA

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wound power wire-wound resistors. The special treatment of the terminals and windings add durability and life to the component.

▶ **Features**—A larger proportional increase in cooling area in comparison to tubular resistors of equal size is achieved by the corrugated edgewise wound ribbon wire. High thermal conducting Reon vitreous enamels permit operation at higher temperature rise without deterioration or damage.

Standard available units are up to 2,000 w and up to 200 ohms in resistance value, and are designed for high power circuits requiring units of high current and a wattage rating at low resistance values. These are adaptable to starter duty as well as continuous applications in great variety.

POWER CONNECTORS with polarizing screwlock

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. Continental E-Z release power connectors can now be supplied with the polarizing screwlock feature to provide a positive mechanical means of locking plug and receptacle against vibration or accidental disconnection. The screwlock also eliminates any need to force or pry apart plug and receptacle when disconnecting the connector.

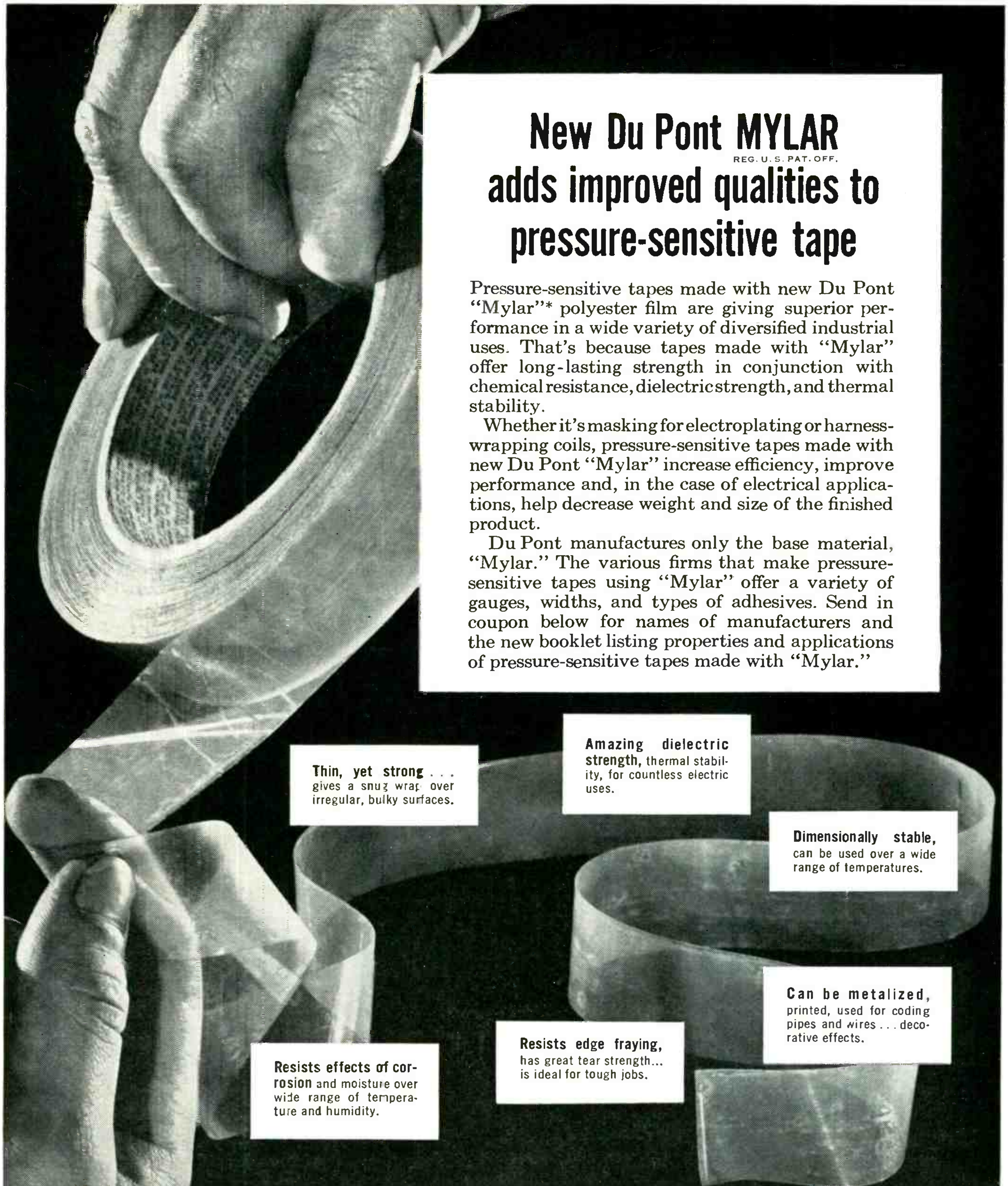
▶ **How Available**—The E-Z 16 may be had in 12, 18, 24 and 34 contacts with solder cup for No. 16 Awg wire or solderless wiring taper pin for AMP series 53. Individually spring loaded pin contacts assure quick release with low insertion force and

New Du Pont MYLAR
REG. U. S. PAT. OFF.
adds improved qualities to pressure-sensitive tape

Pressure-sensitive tapes made with new Du Pont "Mylar"* polyester film are giving superior performance in a wide variety of diversified industrial uses. That's because tapes made with "Mylar" offer long-lasting strength in conjunction with chemical resistance, dielectric strength, and thermal stability.

Whether it's masking for electroplating or harness-wrapping coils, pressure-sensitive tapes made with new Du Pont "Mylar" increase efficiency, improve performance and, in the case of electrical applications, help decrease weight and size of the finished product.

Du Pont manufactures only the base material, "Mylar." The various firms that make pressure-sensitive tapes using "Mylar" offer a variety of gauges, widths, and types of adhesives. Send in coupon below for names of manufacturers and the new booklet listing properties and applications of pressure-sensitive tapes made with "Mylar."



**Registered Du Pont trademark for its brand of polyester film*

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REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

DU PONT
MYLAR ®
POLYESTER FILM

☐ Please send me further information on the basic properties of "Mylar."

☐ Please send me your new booklet on pressure-sensitive tapes made with "Mylar" and names of manufacturers.

E. I. du Pont de Nemours & Co. (Inc.)
Film Dept., Room E-1, Nemours Bldg., Wilmington 98, Del.

Name ____________________

Firm ____________________

Street Address ____________________

City ____________________ *State* ____________________ practically no disengagement force. Aluminum hoods, with cable clamp and cable mounting bracket for top or side cable opening, can also be supplied on order.

A choice of molding compounds includes mineral filled Melamine, Plaskon reinforced (glass) Alkyd 440A or Orlon filled diallyl phthalate.

MICROWAVE GENERATOR
features high r-f stability

MICROWAVE DEVELOPMENT LABORATORIES, INC., 90 Broad St., Babson Park, Wellesley 57, Mass. Model 10X ultrastable microwave generator is an ideal source for Q measurements, phase measurements or any other measurements requiring a high degree of r-f stability. It consists of a klystron oscillator, a tunable reference cavity, a frequency stabilizing circuit and a power supply. The novel Strandberg stabilization circuit is simple and practical.

▶ **Condensed Specifications** — Frequency coverage is 8,500 to 9,600 mc X-band; short-term deviation, 1 part in 10^8; long term deviation, 1 part in 10^6 relative to reference cavity; power output, 10 mw; power consumption, 50 w; size, 5¼ in. by 9 in. by 10 in.; weight, 15 lb.

V-R TUBES
versatile gaseous types

CBS-HYTRON, a division of Columbia Broadcasting System, Inc., Danvers, Mass., has developed types 6626 and 6627 highly versatile gaseous voltage regulator tubes

ENGINEERS AND SCIENTISTS...

HELP US SOLVE TODAY'S MOST ADVANCED PROBLEMS

Here is the basic challenge at Autonetics: to make missile and aircraft electro-mechanical systems and components smaller and lighter—yet able to function perfectly under blistering heat, "earthquake" shock and extreme humidity conditions.

AUTONETICS—North American's separate electro-mechanical division—currently has nearly 100 projects in startling new concepts of systems design... principles of guidance and control—now under development and in production—that haven't yet been printed in journals or texts.

There are many projects in guidance and control for North American's SM-64 Navaho Intercontinental Guided Missile. Projects in ingenious autopilots and fire-control systems for today's and tomorrow's ultrasonic manned aircraft. And many other projects equally exciting and challenging.

The tools at your command at Autonetics include the most advanced research and test facilities... latest digital and analog computers. You'll enjoy the professional recognition of working in this advanced atmosphere with leading scientists and engineers.

It will pay you to look into a career at Autonetics today. From every point of view, you'll find it *the most advanced state of your art.*

Immediate openings for:

Computer Specialists
Electro-Mechanical Designers
Environmental Test Engineers
Electronic Component Evaluators
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Flight Control Systems Engineers
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Inertial Instrument Development Engineers
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Write:
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Autonetics, Dept. 991-20E, 12214 Lakewood Blvd.
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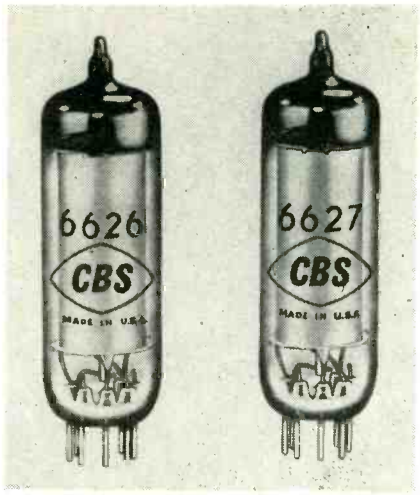
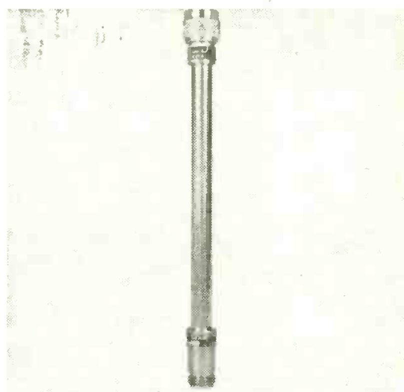


featuring greatly improved reliability.

► **Applications**—The tubes have important applications in the military and high quality commercial products fields, offering longer life, improved dark starting, and elimination of voltage shifts. They are currently recommended in such critical applications as voltage reference circuits where extreme stability and repeatability are vital factors.

When the older type tubes are shielded from all sources of radiation they become unreliable in starting. This problem has been overcome in the 6626 and 6627 by incorporating a small amount of radioactive nickel in the starting electrode.

Complete data are available on the new tube types by requesting bulletins E-253 and E-254.

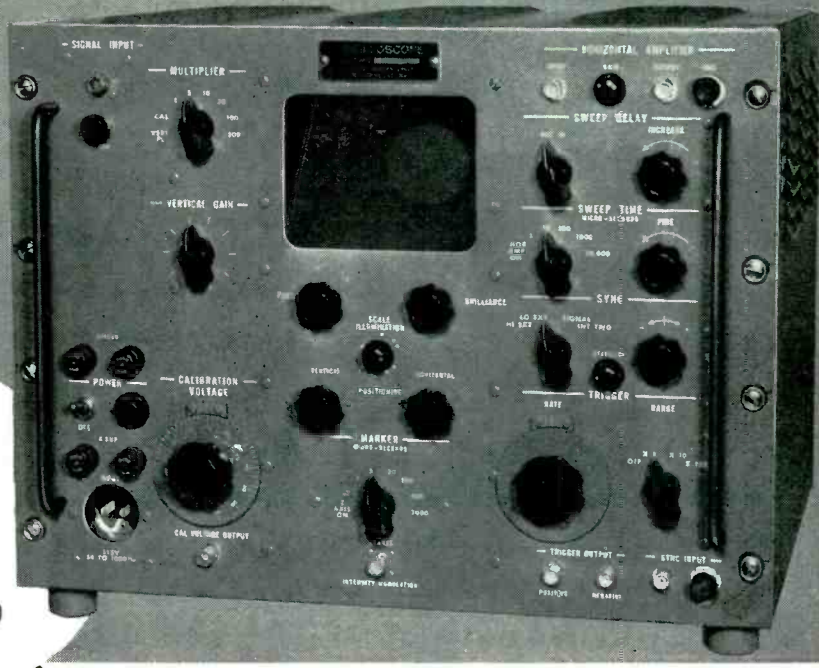


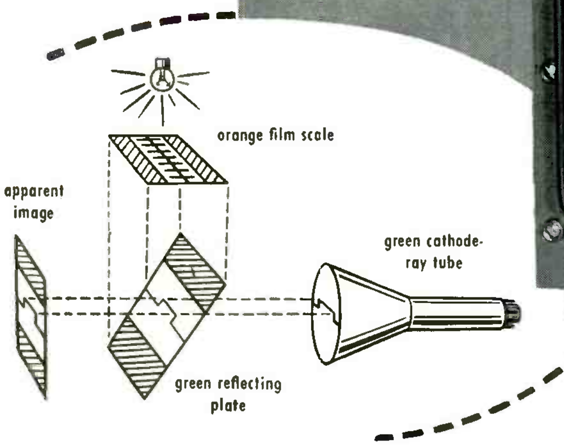
ATTENUATOR PAD
50 ohm impedance

WEINSCHEL ENGINEERING CO., INC., 10503 Metropolitan Ave., Kensington, Md. Model 210 coaxial attenu-

when there is no margin for error...
depend on the Lavoie non-parallax scale

for accurate voltage and time measurements. The Lavoie LA-239CR (AN/USM-50A) Oscilloscope is the only commercial scope with this feature.





Parallax can be costly when an error in reading comparative voltage causes engineering changes. The exclusive Lavoie reflecting scale superimposes the reticule on the optical plane of the cathode-ray screen. . . . Thus there is no error of parallax. The reflecting scale does not prevent the use of a camera with the Lavoie LA-239CR Oscilloscope. A camera adapter plate is available for use with the Fairchild F-284 or F-286 camera. The same instrument is also available in the conventional flush-face version (model 239CF).

OSCILLOSCOPE DATA

Wider Bandwidth: Complex waves from 5 cycles to 15 megacycles. Sine waves from 3 cycles to 20 megacycles.

Extended Sweep Frequencies: Linear from 10 cycles to 20 megacycles internally synchronized. Triggered sweep, from a single impulse to irregular pulse-intervals up to as high as 6 megacycles.

Square Wave Response: Rise time 0.022 microseconds, only 5% droop on flat-topped pulses as long as 30,000 microseconds duration.

Greater Stability: Electronically regulated power supplies throughout to maintain accuracy and constant operation under varying line conditions or line surges. Surges on the line from which Model LA-239CR is being powered can be displayed without distortion.

Higher Signal Sensitivity: Maximum sensitivity without Probe: 10.4 millivolts. With Probe: 100 millivolts. (Maximum signals, 125 V. Peak and 450 V. Peak respectively.)

Timing Markers: Interval: Markers of 0.2, 1, 5, 20, 100, 500 or 2,000 microseconds may be superimposed on the trace for the accurate measurement of the time base.

Voltage Calibration: Signal amplitude is referenced to a 1,000 cycle square wave (generated internally) the amplitude of which is controlled by a step-and-slide attenuator calibrated in peak volts. (A jack is provided to deliver 30 V. Peak for use in calibrating other instruments.)

Sweep Delay: Any portion of the sweep longer than a 5 microsecond section may be expanded by 10:1 for detailed study of that portion of the signal.

Power Source: 110 to 130 V. AC from 50 to 1,000 cycles. 295 Watts. (Fused at 4 amperes.)

Dimensions: In Bench Cabinets: 19½ in. wide, 15¼ in. high, 16¾ in. deep. In Rack Mounting (with cabinet removed to fit standard relay rack): 19½ in. wide, 14 in. high.

REPRESENTATIVES

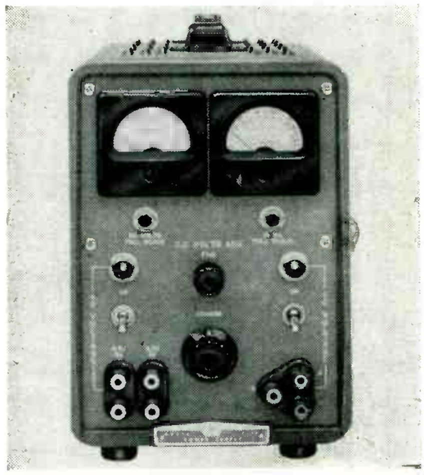
ALBANY, J. A. Reagan Co., Albany 4-7676
ATLANTA, Southeastern Industrial Instruments, Exchange 7801
BALTIMORE, Thomas L. Taylor, Belmont 5-9126
CHICAGO, R. Edward Stemm, Columbus 1-2227
DENVER, Allen I. Williams Co., Main 3-0343
FLINT, Sam Robbins, Inc., Cedar 5-7310
FORT WORTH, Mitchell Speairs Co., Webster 8811
HARTFORD, M. S. Coldwell, Jackson 2-5832
LOS ANGELES, T. Louis Snitzer, Webster 1-5566
MONTCLAIR, Louis A. Garten & Associates, Montclair 3-0257
SAN MATEO, R. L. Pflieger Co., Fireside 5-1134
ST. LOUIS, Edwin H. Murty, Evergreen 5-7728

Lavoie Laboratories, Inc.
MORGANVILLE 1, NEW JERSEY

designers and manufacturers of Electronic Equipment ator pads are used without derating with pulse power having a duty cycle of 1:2,000 and a pulse duration of 5 μsec.

▶ **Technical Highlights**—The attenuator pads (50-ohm impedance) are available in 1-db steps from 1 to 10 db. Frequency range is 1,000 to 10,000 mc. They feature high power capability (3 db is rated for an input of 5 w average with a peak power of 10 kw); high absolute accuracy (at 4,000 mc at room temperature ± 0.1 db of nominal value); temperature coefficient, $+0.00043$ per db per deg F; and small variation with frequency (average 3 db pad changes $+0.3$ db between 1,000 and 10,000 mc). The military version is not damaged by shock test of MIL-T-945-A without shock mounts.

Eleven types are available ranging in price from $37.50 to $46.50.

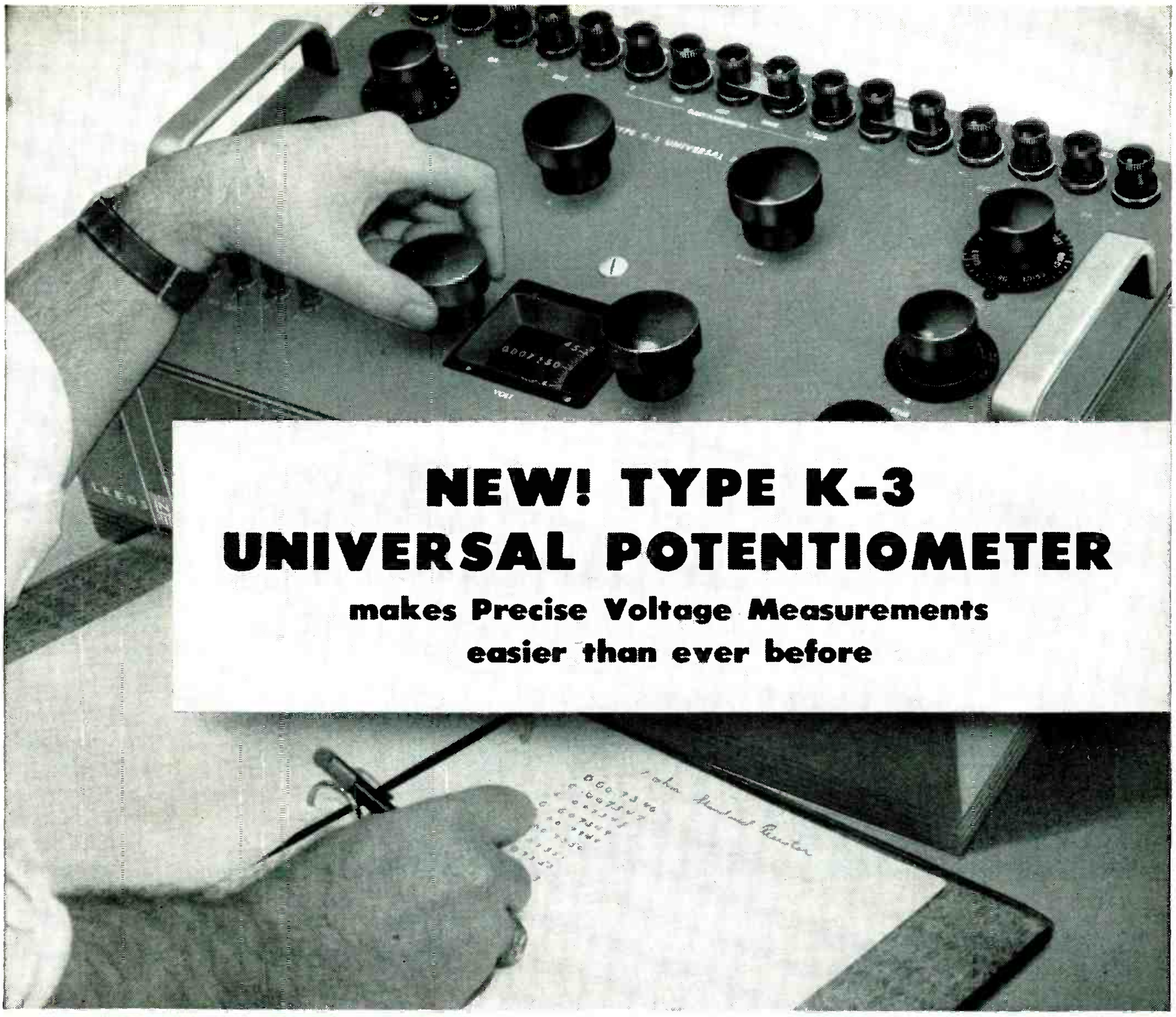


POWER SUPPLY
is a multipurpose unit

HEWLETT-PACKARD CO., 395 Page Mill Road, Palo Alto, Calif. Model 711A multipurpose power supply is designed to power all types of laboratory, field and factory electronic test setups.

The instrument offers a voltage range of 0 to 500 v and no-load to full-load regulation of better than $\pm$ 0.25 percent or 0.5 v. Ripple is less than 1 mv. There are separate current and voltage meters, with new pushbutton range switching for accurate measurement of small voltages and currents.

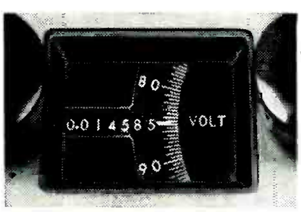
▶ **Other Advantages**—Additional features include complete overload



NEW! TYPE K-3 UNIVERSAL POTENTIOMETER

makes Precise Voltage Measurements easier than ever before

- **Scale reads directly in voltage**
- **Guarded against humidity, static, leakage of any kind**
- **"Thermal Free" circuit reduces voltage errors**



You take your readings directly from a central reading window . . . no more mental arithmetic in adding up dial settings. You can use this unique instrument in hot, humid weather . . . in cold, dry weather . . . without worrying about leakage or static.

The many new design and construction features . . . metal case for electrostatic shielding . . . guarding of battery and detector circuits . . . enclosed switches and slidewires . . . thermal free circuit construction . . . central reading window . . . make this Type K-3 Universal (Guarded) Potentiometer the most advanced general purpose instrument available today. You will find it a worthy new addition to the Type K line . . . originated some 50 years ago . . . the world's most widely used precision potentiometers.

Six pages of data are required to give you full details. Ask for Data Sheet E-51(6); write your nearest L&N Office or 4979 Stenton Avenue, Philadelphia 44, Pa.

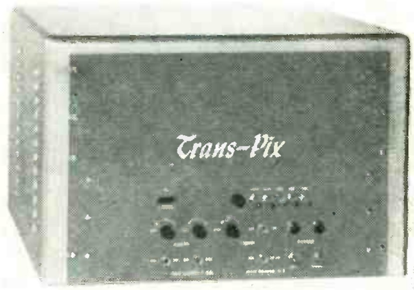
LEEDS NORTHRUP
instruments *automatic controls • furnaces*

Jrl. Ad. E-51(1)

protection and grounding of either positive or negative d-c terminals.

The instrument is small and light, weighing just 18 lb, and is enclosed in an all-metal case with carrying strap.

Model 711A is priced at $225.



COLOR TV TRANSMITTER
a low-power r-f type

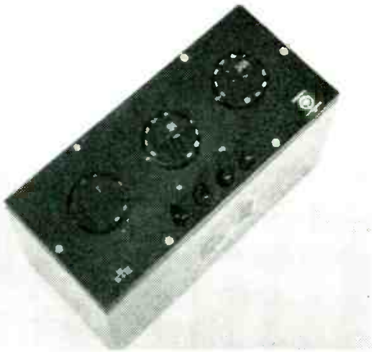
Kay Electric Co., 14 Maple Ave., Pine Brook, N. J. Designed for use with antenna or cable, the new Trans-Pix covers the l-f tv channels and fulfills the color requirements of differential phase shift and envelope delay. Two models are available—model 25 with a 25-w output, and model 2 with a 2-w output. Both units may be used for black-and-white and color tv.

▶**Some Specifications** — Video response is 4.5 mc ±1 db; picture carrier, 25 w peak power into 50 ohms; power input, approximately 600 w at 117 v 50/60 cps. There are 2 outputs, each at ½ power into 50-ohm antennas. A single 50 ohm dummy load for ½ power single antenna operation is provided.

The r-f specifications, except for the power output, apply to both models. Model 2 is priced at $2,500; and model 25, $6,950.

DECADE POT DIVIDER
gives direct ratio reading

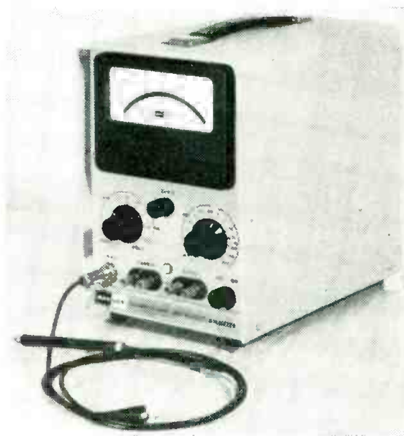
Industrial Instruments, Inc., Cedar Grove, N. J. Model DP-1 decade potentiometer contains two 10,000 ohm rheostats connected so as to maintain a total resistance of 10,000 ohms at all times. Resistance between the center and either end is variable from 0 to 10,000 ohms, while resistance between center and



opposite end makes up the difference to total 10,000 ohms.

▶ **Ratios**—Switches are in ratio steps of 0.001, 0.01 and 0.1, providing ratios of 0.000 to 1.000 in steps of 0.001. Ratios are guaranteed to ±0.1 percent at all settings above 0.01. The ratio is indicated directly on the dials of the decades at all times.

Resistors employed are bifilar wound and adjusted to ±0.05 percent. Step switches are self-cleaning with phosphor bronze spring wipers and detent mechanism for positive location of switch points.



MICROVOLT-AMMETER is chopper stabilized

KAY LAB, 5725 Kearney Villa Road, San Diego 12, Calif. Model 203 is a combination d-c microvoltmeter, microammeter and amplifier. Chopper circuitry provides high sensitivity with drift-free stability and high input impedance.

▶ **Wide Range**—Fifteen voltage ranges cover from 100 μv full scale to 1,000 v full scale and 10 current ranges cover from 100 $\mu\mu$a full scale to 100 ma full scale. The uncluttered zero-center meter face instantly indicates polarity on two

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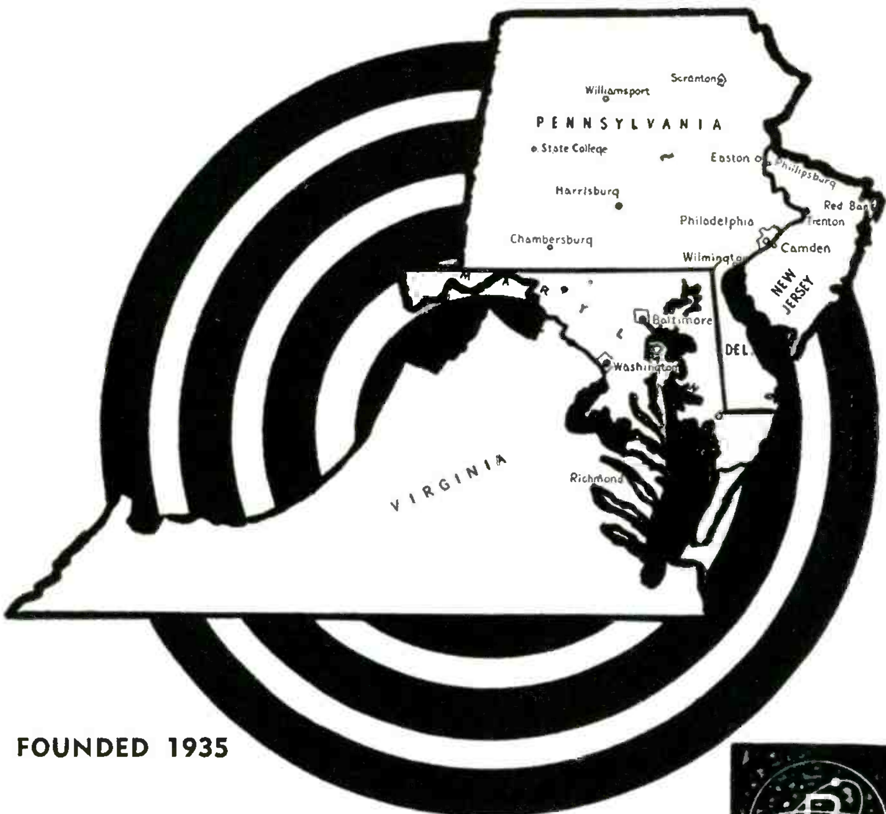

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5 Circle Drive, Margate, N. J.

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33 E. Golf View Rd., Ardmore, Pa.

for information, contact any of the above members

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mirrored scales which cover all ranges. The instrument is capable of measuring as little as 10 $\mu\mu$a full scale. The amplifier has a maximum gain of 80 db.

The unit is ideally suited for transistor circuit development, research and production. Price, complete with probe, is $550.

ZOOM LENS
for use with Vidicon tube

THE PERKIN-ELMER CORP., Norwalk, Conn. Model 16TV Auto-Zoom, a motor-driven zoom lens with a 5-1 focal length range, has been designed for use with the Vidicon tube. It can focus on any object from 6 ft to infinity, with lens speed varying from f/2.7 to f/4.7.

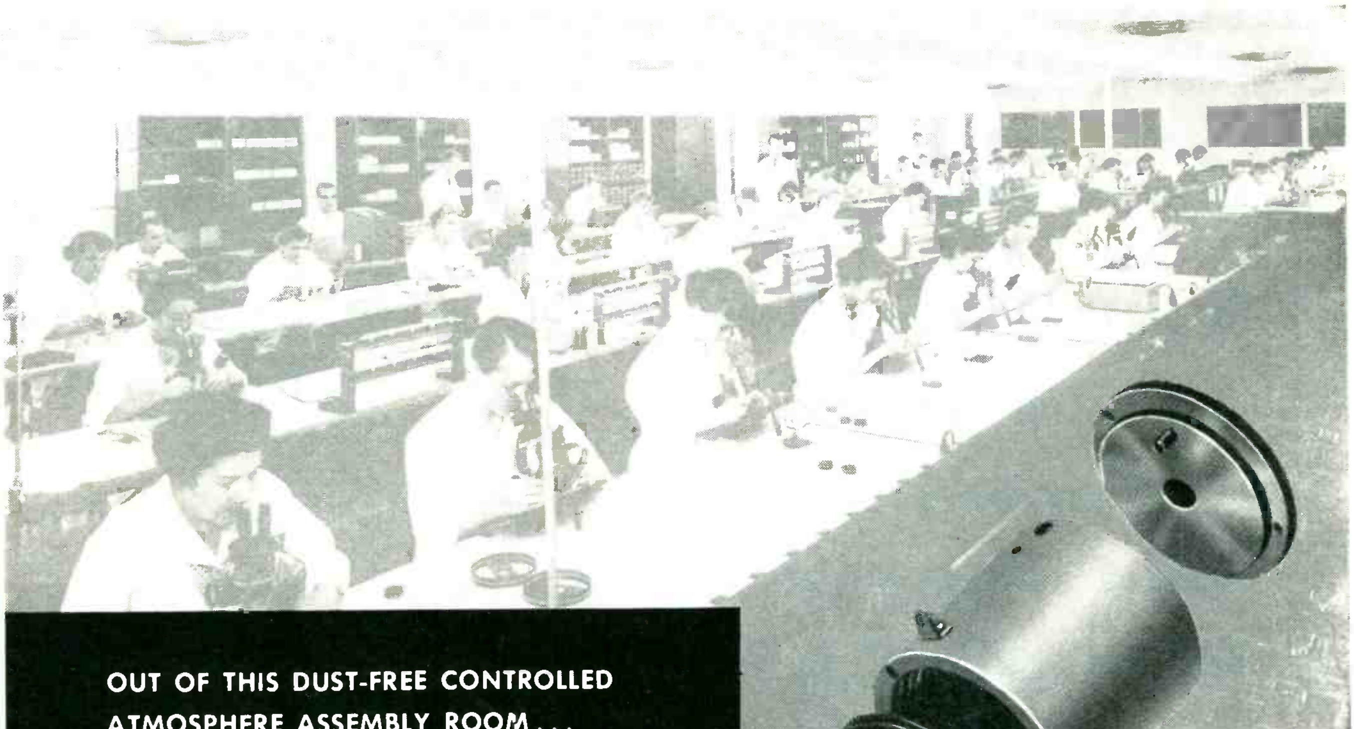
The motor-driven zoom, focus and aperture setting of the lens may be controlled at any distance from the camera.

► **Uses**—The lens will find wide use in industrial and noncommercial applications such as observation of hazardous areas, production line monitoring and educational uses. In commercial tv it is useful for sports events, news coverage, and special and remote pickups.

Overall dimensions of the lens, including motors but not control box, are 9 in. long by 5 in. in diameter. Weight is approximately 6 lb.

ALL-PURPOSE RELAY
for aircraft and mobile use

OHMITE MFG. CO., 368 Howard St., Skokie, Ill. Model D0 general-purpose relay has a maximum con-



OUT OF THIS DUST-FREE CONTROLLED ATMOSPHERE ASSEMBLY ROOM . . .

A big advance in hi-precision 10-turn potentiometers

priced far below anything of comparable quality

$12.00 in lots of 1 to 25.
Quantity discounts above 25 units.

SPECTROL Hi-Precision
Model 800

QUALITY FAR BEYOND ANYTHING OF COMPARABLE PRICE

Standard Linearity ± .3% (as close as ± .025% available)
Standard Resistance Tolerance ± 3%
Standard Resistance Range 500Ω to 400 KΩ
(Resistance Tolerance as close as ± .5% available)

Cost advantages are not made by short-cuts at Spectrol. Design and production knowhow make the cost savings. Every potentiometer is produced under the same hi-standard conditions—from precision winding to the rigid quality-controlled final assembly.

That's why the 10-turn Model 800 provides accuracy which out-classes others at comparable cost—and in addition to closer electrical tolerances—offers other quality features like machined aluminum lids, precision-ground shafts, and dimensionally stable laminated phenolic housings.

Versatile, accurate, reliable over a long life—available in volume quantities—immediate delivery from stock—the Model 800 is a great advance.

Write or call for more details about the wide variety of special features available—and about Spectrol's miniature and single turn potentiometers—today.

SPECTROL — **Electronics Division of Carrier Corporation**
1704 South Del Mar Avenue, San Gabriel, California

Write for catalog or contact your nearby Spectrol representative—

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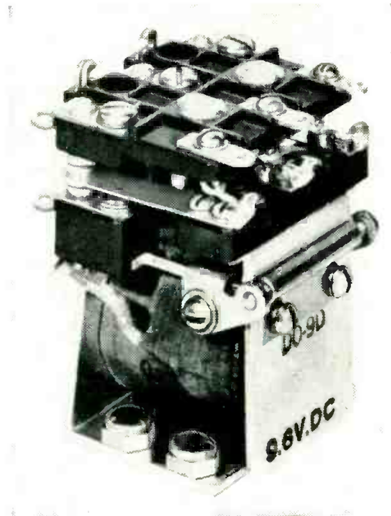
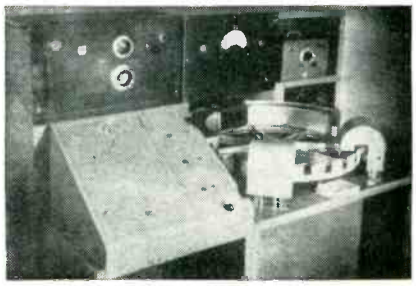


tact combination of four-pole, double-throw. It is particularly adaptable to aircraft and mobile equipment applications where severe shock and vibration are encountered.

► **Protection**—The contact and terminal insulation is of molded phenolic material. The design of the molded parts around the moving contact arms affords maximum protection against mechanical injury.

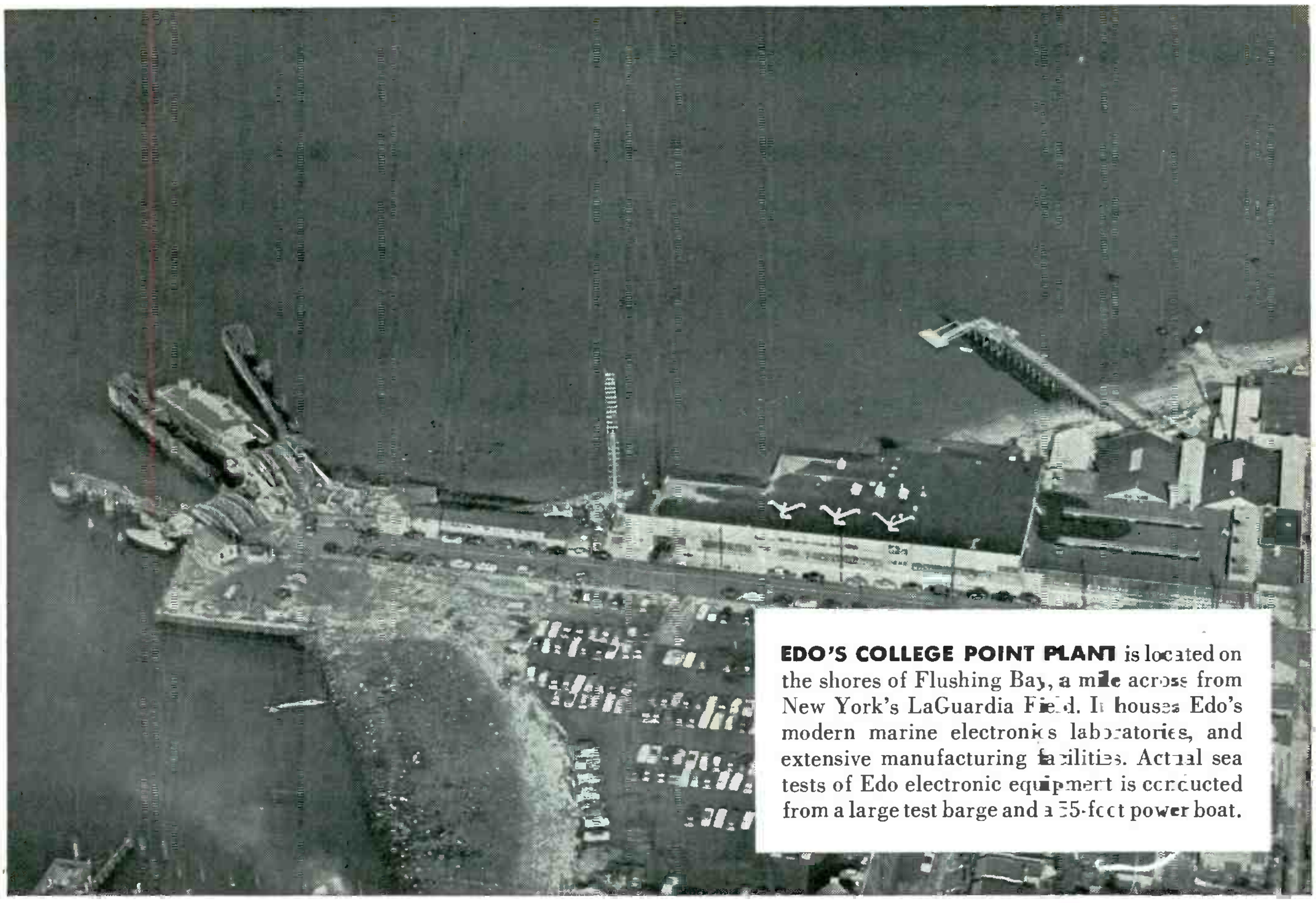
Contact rating is 10 amperes at 115 v a-c or 32 v d-c noninductive load.



PRODUCTION MACHINE tests capacitance

AMERICAN RADIO CO., 445 Park Ave., New York 22, N. Y., has announced an automatic production machine for measuring the temperature coefficient of ceramic dielectric capacitors. It features increased operating speed—a rate of 1 precision measurement every 40 seconds, extraordinary coefficient accuracy of 2 parts per million, and direct capacitance measurement exact within 0.0038 $\mu\mu$f.

► **How It Works**—Heart of the system is a compact analog computer



EDO'S COLLEGE POINT PLANT is located on the shores of Flushing Bay, a mile across from New York's LaGuardia Field. It houses Edo's modern marine electronics laboratories, and extensive manufacturing facilities. Actual sea tests of Edo electronic equipment is conducted from a large test barge and a 35-foot power boat.

Miracle(s) at College Point have made EDO Marine Electronics Headquarters

Miracles in electronics—a steady stream of them—have marked Edo's emergence as headquarters for marine electronics development.

Out of Edo's well-equipped plant at College Point have come many *firsts* in marine electronics for a wide range of uses—both naval and commercial—to name a few:

- **The first continuously indicating and recording deep depth sounder with a range of 6000 fathoms.**
- **Many new types of sonar equipment for surface ship and submarine use.**
- **The Edo Fishcope—the fish-finder that assures larger hauls in less time.**
- **Edo Loran—new, compact, direct-reading navigation equipment at moderate cost.**
- **Edo Radar—for smaller commercial boats, with patented slotted waveguide antenna.**
- **Edo Survey Depth Recorder—for accurate survey work.**

These are but a few of the wide range of equipments developed and manufactured by Edo. Through their superior performance, accuracy, range and dependability, they have proved that the Edo flying fish emblem is the symbol of quality and satisfactory operation.

Edo has developed and manufactured all types of Sonar—echo-ranging, listening, and sounding.

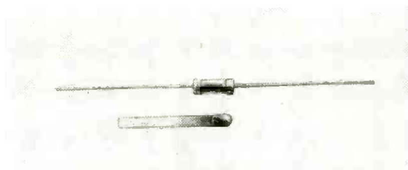
EDO CORPORATION • COLLEGE POINT, L. I., N.Y. Edo Since 1925 operating as a capacitance meter to provide direct readings. An indexing turntable holding 24 units transports the capacitors to three measuring positions automatically, where they are cycled in 10-minute steps from 25 C ambient to 90 C back to 25 C. Heating is accomplished in a closely regulated tunnel-like oven covering the periphery of the turntable.

Less than 1 second after the capacitor is connected to the instrument, the capacitance is indicated on 2 dials. Maximum capacitance to be tested is 400 $\mu\mu$f, and the maximum capacitance change during test is 10 $\mu\mu$f.

VARIABLE TRANSFORMER
includes on-off switch

CONDENSER PRODUCTS CO., 140 Hamilton St., New Haven, Conn., has introduced a new variable transformer that controls input and output voltages. It is spot welded to the power supply and eliminates the need for a separate variable input transformer to control the input and output voltages.

Control dial on the transformer is calibrated in percentages of line voltage, rather than in voltage, to simplify operation.



CARBON FILM RESISTOR
is glass-sealed unit

PYROFILM RESISTOR CO., INC., 8 Whippany St., Morristown, N. J. The PT500 glass-sealed carbon film resistor features extreme ruggedness, small size and high stability.

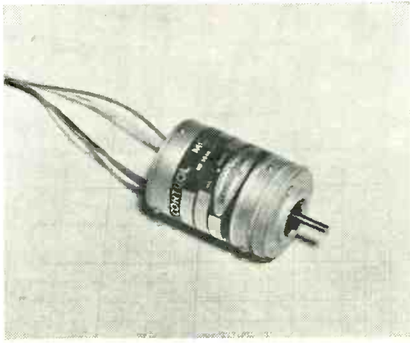
►**Features** — Stability is better than ± 0.03 percent per year at 0.25-w rating and derating to zero power at 140 C. Using 0.5-w rating, derating to zero at 160 C, stability is better than ± 0.1 percent in 1,000 hr.

►**Matched Networks**—The PT500 is particularly suited for use in

For additional information on all items on this page, use post card on last page.

matched networks. Small size and completely self-insulating features permit close spacing. Ruggedness is achieved by a hard borosilicate glass envelope that is fusion-sealed to the end caps.

The PT500 is available in sets with temperature coefficients matched to 1 ppm per deg C for high precision use over wide temperature ranges. Mounting may be done on leads capable of withstanding up to 15-lb pull. Actual size is $\frac{3}{16}$ in. diameter by $\frac{7}{16}$ in., measured the length of the resistor.



SERVO MOTOR
for high temperature use

SERVOMECHANISMS, INC., 625 Main St., Westbury, N. Y., announces the type 171 Class H 400-cycle servo motor. The 3-oz motor, which measures $1\frac{1}{16}$ in. in diameter, is capable of withstanding continuous class H operating temperatures.

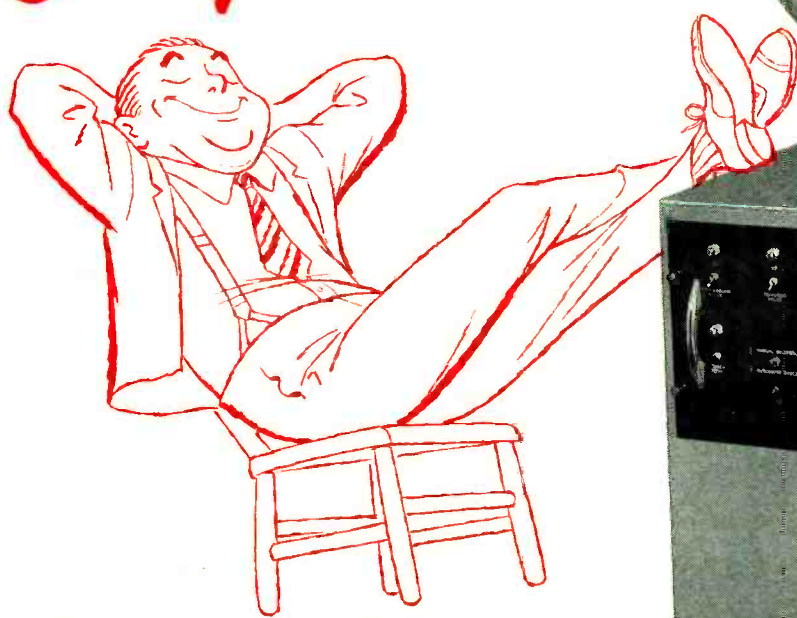
▶ **Life Expectancy**—The motor is designed for a minimum life of 1,000 hr of continuous operation at 150 C ambient temperature. Early tests indicate an expected life of 200 hr continuous operation at an ambient temperature of 180 C.

The motor is ideal for use in high-speed aircraft and missile applications.

INSULATING PARTS
made by new method

EPM CORP., 570B Van Siclen Ave., Brooklyn, N. Y., introduces a new inexpensive method of producing coil forms and insulating parts from $\frac{1}{8}$ in. to 1 in. in diameter at a fraction of the cost of standard molding methods. The technique eliminates the need for expensive

Completely Automatic!



KINNEY MODEL CRS 48

CATHODE RAY TUBE ALUMINIZER

Kinney's new compact Model CRS 48 Cathode Ray Tube Aluminizer offers completely automatic operation. This is accomplished through the use of a linear adjustment timer which can be quickly and easily readjusted to meet specific cycle requirements. The high vacuum pumps are matched to insure minimum cycle time. Other features include:

- **Simple change-over switch for manual operation when desired**
- **Regulated air admission through hollow electrode**
- **Sliding panel containing all controls**
- **Electrical operation of all components to eliminate need for compressed air**
- **Protection from glass particles and dirt of all internal parts by unique unit design**

Request complete technical data on this amazing new aluminizer. District offices in Boston, New York, Philadelphia, Cleveland, Chicago, and Los Angeles are competently staffed to discuss *all* your vacuum problems . . . and to give you full details on this new product. Call or write us today!

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THE NEW YORK AIR BRAKE COMPANY
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INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.

Our Vacuum problem involves ....

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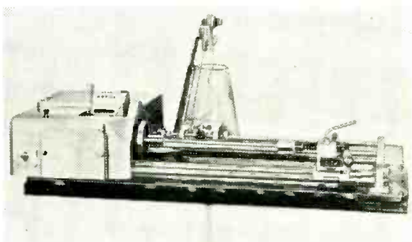
molds heretofore required. The use of polyester, epoxide, Nylon, Teflon and many other materials is made possible because of the unique design of manufacturing.

AN-TYPE CONNECTOR
in any pin configuration

HERMETIC CONNECTOR CORP., 176 Walnut St., Bloomfield, N. J., has developed a new, more rugged AN-type connector for use where glass-to-metal hermetic sealing is required. Any pin configuration desired is available, while they can be obtained in sizes ranging from 8 STD 32.

The connectors are particularly useful in higher and lower temperature applications, or where pins must be more rugged or where vibration is a factor.

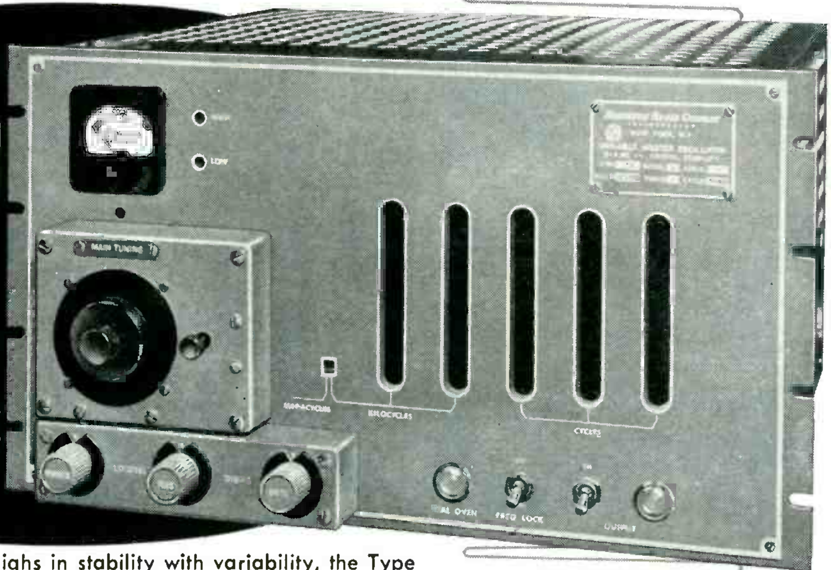


12-IN. SPACE WINDER
with instant resettability

GEO. STEVENS MFG. CO., INC., Pulaski Rd. at Peterson, Chicago 30, Ill., has available a new 12-in. space winder featuring a fingertip pressure carriage release button which permits instant resetting to identical starting point at the end of each winding cycle.

Model 431-AM has screw feed and a no-slippage driven tailstock

For increased reliability in FREQUENCY SHIFT reception specify NORTHERN RADIO . .

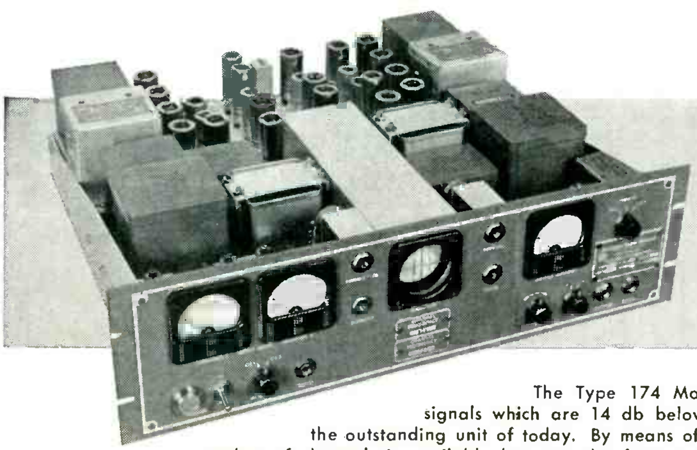


VARIABLE MASTER OSCILLATOR

- Long-time stability 1 cycle per megacycle
- Variable to ANY frequency from 2 to 4 mc within 1 part per million

In addition to accomplishing these new highs in stability with variability, the Type 173 Model 1 is so easy to operate that it can be handled by completely unskilled personnel: frequency is continuously displayed.

It is excellent as the basic control oscillator for diversity receivers, HF transmitters, and other communication devices, or as a laboratory standard. It also provides both a crystal-controlled BFO and a time base 100 kc crystal oscillator as a secondary standard; stability of the latter is 1 part in 5 million. The power supply for this model is housed in a separate panel.



NEW! FREQUENCY SHIFT DIVERSITY CONVERTER

- for use with *either* single-receiver frequency diversity systems or two-receiver space diversity systems

The Type 174 Model I provides solid copy of signals which are 14 db below white noise level—making it the outstanding unit of today. By means of plug-in units, any reasonable number of channels is available between the frequencies of 425 and 3315 cps for either frequency or space diversity operation. For standard FS operation, the plug-in networks provide shift adjustments from 100 to 1000 cps shift. Normal Input Level:—40 to +10 VU (Zero VU =1 MW into 600 ohms). Satisfactory operation on fades to —60 VU.

Pace-Setters in Quality Communication Equipment

NORTHERN RADIO COMPANY, inc.

147 WEST 22nd ST., NEW YORK 11, NEW YORK

In Canada: Northern Radio Mfg. Co., Ltd., 1950 Bank St., Billings Bridge, Ottawa, Ontario.

Write for complete information.

- Frequency Shift Keyers
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- Diversity Receivers
- Frequency Shift Converters
- Multi-Channel Tone Systems
- Tone Keyers
- Demodulators
- Monitors
- Radio Multiplex Systems
- Tone Filters
- Line Amplifiers
- Twinplex Equipment

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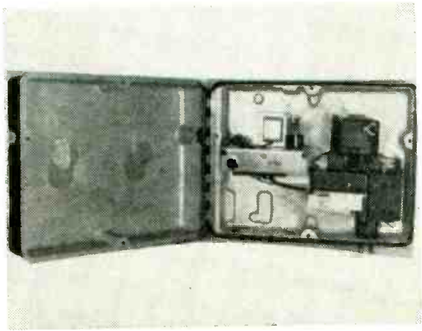
which entirely prevents strips and flexible forms from twisting during winding. The machine winds space-wound resistors, distributed-constant delay lines, heating element coils and straight wound potentiometers up to 4 in. o-d.

▶ **Specifications** — Maximum traverse for any single continuous winding is 12 in. Winding range is from 22 turns per in. to 1,520 turns per in. Winding speed is up to 6,500 rpm in the fine-wire high-speed range and up to 4,500 rpm in the low-speed high-torque range. One model T-2 tension is furnished for single winding, handling wire gages 20 to 44 on spools up to 4½ in. diameter.

Price is $1,115.



LEVEL CONTROLLER
electronic and pneumatic

FIELDEN INSTRUMENT DIVISION, Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa. The Pneutronic level control utilizes the accuracy of electronic capacitance sensing elements to detect minute changes in levels in tanks, drums, process baths, pipelines and other conveyors. Electronic signals are then converted by the Pneutronic control into proportional pneumatic output.

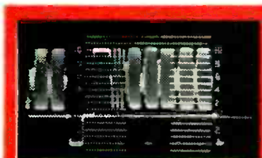
Eliminated are servo motors and other rebalance mechanisms. The closed-loop control is largely unaffected by external changes in voltage, air supply, temperature and pressure.

▶ **Uses**—The level control will find broad utilization in the petroleum, chemical, food processing and other basic industries where accurate control of level and flow are important. For use in hazardous locations, the device is available in

HE CAN CHECK VIDEO ANYWHERE

HE HAS A NEW VIDEO TRANSMISSION TEST SET

The Original Full Rack and the Portable Unit Produce the same Precise Test Signals.

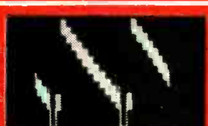


MULTI-FREQUENCY BURST

AMPLITUDE vs FREQUENCY. Check wide band coaxial cables, microwave links, individual units and complete TV systems for frequency response characteristics without point to point checking or sweep generator.

WHITE WINDOW

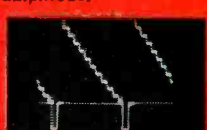
LOW & HIGH FREQUENCY CHARACTERISTICS. Determine ringing, smears, steps, low frequency tilt, phase shift, mismatched terminations, etc. in TV signals or systems.



STAIRSTEP SIGNAL modulated by crystal controlled 3.579 mc for differential amplitude and differential phase measurement. Checks amplitude linearity, differential amplitude linearity and differential phase of any unit- or system.

Model 608-A HI-LO CROSS FILTER for Signal analysis.

MODULATED STAIRSTEP signal thru high pass filter. Checks differential amplitude.



MODULATED STAIRSTEP signal thru low pass filter. Checks linearity.

TELECHROME Model 1003-A

Video Transmission Test Signal Generator

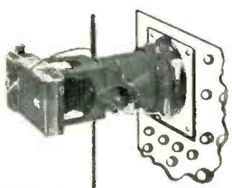
★ Completely self contained ★ Portable ★ Multi-frequency burst ★ Stairstep ★ Modulated stairstep ★ White window ★ Composite sync ★ Regulated power supply.

Now, Telechrome Video Transmission Test Equipment is available as a *completely portable* 12¼" standard rack mounting unit.

Everyday these Test Signals generated by Telechrome equipment, are transmitted Coast-to-Coast by NBC, CBS, ABC, the Bell System, Canadian Bell and leading independent TV stations throughout the U. S. and Canada. Hundreds of network affiliated TV stations and telephone TV centers thus check incoming video signals.

The compact, inexpensive, portable Model 1003-A is all that is required to generate signals for local and remote performance checking of your entire video, cable, or micro-wave facilities.

1521-A OSCILLOSCOPE CAMERA —Polaroid type for instantaneous 1 to 1 ratio photo-recording from any 5" oscilloscope.



DELIVERY 30 DAYS

Literature on these and more than 150 additional instruments for color TV by TELECHROME are available on request.

TELECHROME INCORPORATED

The Nation's Leading Supplier of Color TV Equipment
88 Merrick Road Amityville, N. Y.
AMityville 4-4446

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special dust-proof and explosion-proof cases.

The unit is priced in a standard case at $300 plus probe.

CURVE TRACER for transistors

AMERICAN ELECTRONIC LABORATORIES, INC., 641 Arch St., Philadelphia 6, Pa., announces its model 126 and 126S *pnp-npn* transistor curve tracer.

▶ Features—Extreme flexibility is offered in wide voltage and current ranges, oscilloscope switching, and availability of various outputs to any terminal of the transistor. It features calibrated sweep current to 60.0 ma standard, 3 amperes optional; seven constant current steps up to 20 ma per step; internal calibration, and Z-axis blanking available.

Model 126 is supplied less oscilloscope enclosed in desk panel rack; model 126S with oscilloscope, in open table-type relay rack.

VALVE ACTUATOR aids electronic control

ASKANIA REGULATOR CO., a subsidiary of General Precision Equipment Corp., 240 E. Ontario St., Chicago 11, Ill., has developed an electrohydraulic valve actuator for electronic controllers. It is a complete self-contained unit including control valve, hydraulic power source and proportional positioning mechanism which can be used with existing electronic controllers.

Outside connections consist of the signal wires from the controller and an electric power supply. The

need quick service on TIMERS for automatic control?

Time Delay Timers

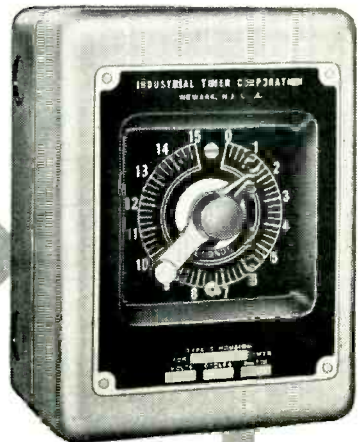
The more automatic control problems we get, the better we like it. For while it's true each automatic control job is a bit different from the rest, the record shows that our 19 years of timer experience has given us the special knowledge it takes to give you the right answers, and in near-record time.

If one of our standard timers won't do your job — or one of the 721 combinations we have thus far developed from our 17 basic units — our engineers will go right to work to develop a new combination that's the one for you. That's the way we grow — and we like it.

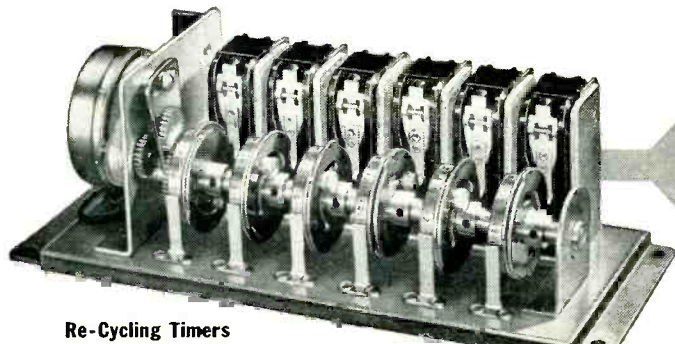
We manufacture a complete line of timers in these 4 broad classifications:

TIME DELAY TIMERS • INTERVAL TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS

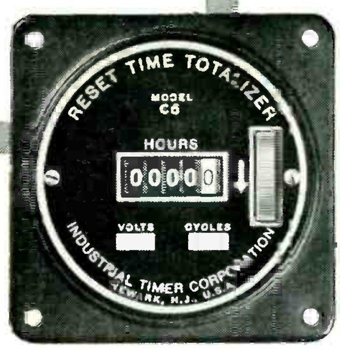
And since we maintain large stocks of our 17 basic units, we can assure you of rapid deliveries — of excellent deliveries even on special orders. So whatever your automatic control problem, you have everything to gain by submitting it to our timer specialists. They'll give you a profitable answer — almost with the speed of automatic control itself.



Interval Timers



Re-Cycling Timers



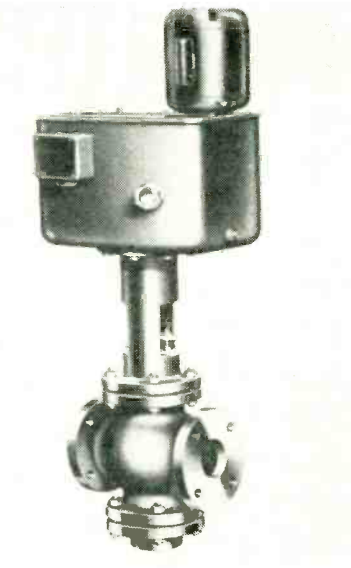
Running Time Meters

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

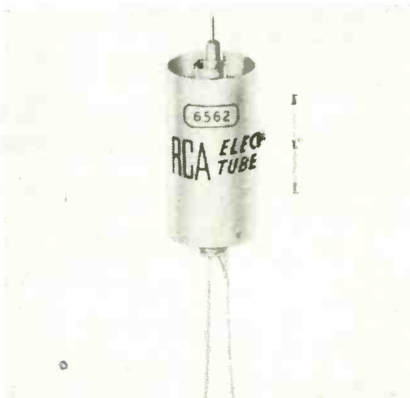
INDUSTRIAL TIMER CORPORATION
1409 McCARTER HIGHWAY, NEWARK 4, N. J.

Want more information? Use post card on last page.



signal current is applied to a high-resistance coil (3,000 ohms or more) which moves in a magnetic field.

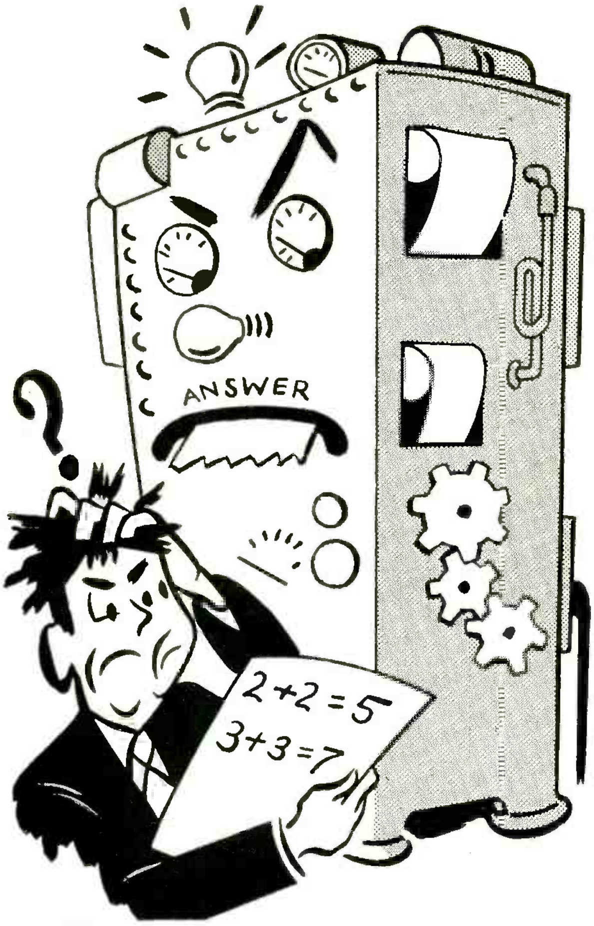
▶ **Jet Pipe**—Linked to the coil is the company's exclusive jet pipe which converts an electrical signal of less than 50 mw into the powerful stroke of a control valve. The valve moves at a speed of better than 1 ips. Thrusts of 600 lb and more can be handled, with strokes presently available up to 2 in.



OSCILLATOR TRIODE
for radiosonde service

RADIO CORP. OF AMERICA, Harrison, N. J., has introduced a fixed-tuned, uhf oscillator triode, type 6562, having a pencil-type construction and intended for transmitting service in radiosonde applications.

▶ **Design**—It incorporates two integral resonators of the cavity type. One of the resonators is fixed-tuned and connected between grid



Not Getting The Right Readings?

Install Hubbell *Interlock* Plugs To Solve Your Wiring Problems

Modern electronic equipment depends upon small component parts for accuracy of operation. The wiring of connections to sources of power, as well as between elements within the unit, must be dependable and must be designed for fast, easy rearrangement and maintenance. Hubbell *Interlock* Plugs meet all these requirements and actually provide an extra margin of dependability.

HUBBELL SELF-LOCKING CONNECTORS *Interlock*

You Can Be Sure Of A Positive Connection

Unlike other terminals, *Interlock* Plugs are designed with a locking mechanism that permits contact on *two surfaces* and provides a constant low contact resistance. *Interlock* plugs *lock automatically* in their eyelets or jacks, can be quickly disconnected when intended, yet cannot disconnect accidentally — — and they're designed to withstand unusual strain and vibration!

Tests Prove It!

By actual laboratory test, the Hubbell *Interlock* Type "A" Plug, capacity 10 amperes, withstands a 47 pound pull without disconnecting; the Type "B" Plug, capacity 5 amperes, a 16 pound pull; Type "C", capacity 1 ampere, 4.7 pounds; and the heavy duty Type "S" Plugs, capacity 15 amperes, up to 222 pounds.

For Further Information, Write Dept. A:

HARVEY HUBBELL, Inc.

Interlock Electronic Connector Dept., Bridgeport 2, Conn.

SELF-LOCKING CONNECTORS

Want more information? Use post card on last page.

and cathode. The second is connected between grid and plate and is tunable over a narrow range centering at 1,680 mc.

Features in radiosonde service include high efficiency, small frequency drift, low battery drain and small size. Associated circuitry is simplified by the external connection of the cathode to one of the heater leads.

The 6562 is approximately 2½ in. high, excluding heater leads, and 1 in. in diameter.

VARIABLE SPEED DRIVE
available from ¼ to 1½ hp

MAGNETIC AMPLIFIERS, INC., 632 Tinton Ave., New York 55, N. Y., has announced the Magne-Speed variable speed drive. The line consists of two sizes covering a range from ¼ to 1½ hp. It features stepless instant starting, compact design, and 50-to-1 speed range with good regulation. Reversibility, dynamic braking, local or remote control may be specified.

Another important feature is the unit's extreme simplicity so that it may be installed without special tools or wiring.

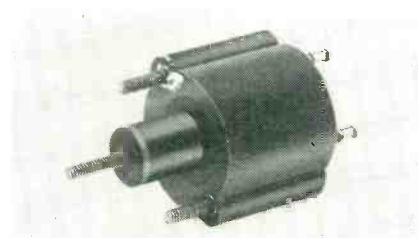
▶ **Prices**—Depending on horsepower, size and type of control specified, prices range from \$261 to \$666.50 including motor in all cases.

LOW-PASS FILTER
used in communication centers

KAAR ENGINEERING CORP., Middlefield Road, Palo Alto, Calif. Number 8314 low-pass filter unit has wide application for use between the transmitter and antenna to attenuate spurious r-f output. It is particularly useful in installations of several transmitters and receivers to reduce interference and to

improve transmitter performance to meet FCC technical requirements.

▶ **Performance Data**—Insertion loss is 0.5 db maximum from 115 mc to 160 mc; 6.0 db maximum from 160 mc to 180 mc; 65 db minimum from 225 mc to 500 mc. Standing wave ratio is 1.3 maximum from 115 mc to 160 mc.



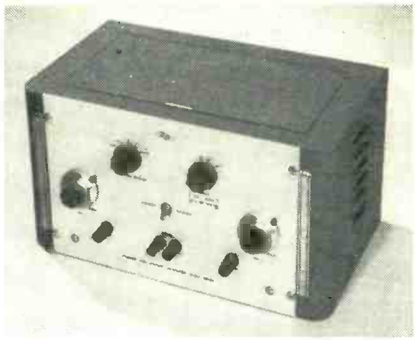
VARIABLE COIL
in one-piece design

COIL WINDERS, INC., New York Ave., Westbury, N. Y., has developed a one-piece hermetically sealed variable coil designed to replace a costly two-piece molded Bakelite assembly. The molding material is an epoxide resin which meets military specifications for stability, resistance to moisture, and high dielectric strength.

▶ **Uses**—Originally designated as a range marker coil, designed for use in military radar equipment, this unit may be incorporated into oscillator, i-f, or wave-trap circuitry. Inductances in excess of 100 mh can be obtained without difficulty.

CALIBRATOR
measures voltage, current

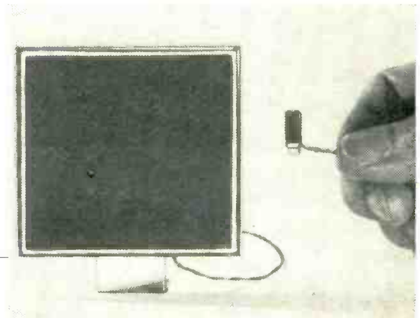
ELECTRO-PULSE, INC., 11861 Teale St., Culver City, Calif. Utilizing the most accurate technique for meas-



urement of the voltage or current of nonsinusoidal wave shapes, the model 6020A voltage and current calibrator may also be used for sine wave or d-c level measurement.

▶ **Operation**—The waveform to be measured is compared to 2 precision 1-v reference sources, variable from 0 to 1-v by 10 turn calibrated potentiometer.

To measure waveform amplitude, one of the reference levels is adjusted until the line is superimposed on top of the waveform, after which the waveform amplitude may be read directly from the reference voltage control 1,000 division dial. Two variable reference levels are provided to enable measurement of bipolar waveforms or to set up production tolerance checks.



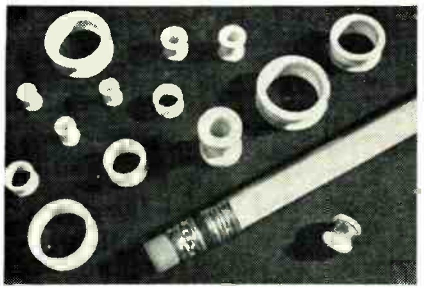
SUN BATTERY CELLS in wide range of sizes

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., has available a series of selenium sun battery cells. They are ideal components for transistor power supplies, control applications, photometric equipment, as well as experimental uses.

▶ **Production**—They are now in production in a wide range of sizes and power ratings—from 0.14 sq in. to 10.5 sq in. in photosensitive area and from 0.1 mw to 15 mw power output in direct sunlight.

High self-generated output power is featured in the cells. Short-circuit current up to 40 ma, or open-circuit voltages up to 0.5 v per cell can be generated in direct sunlight. Long life operation can be expected from these cells which are encapsulated for moisture, corrosion and scratch resistance.

For full information and specifications, ask for bulletin SR-115.



MAGNETIC CORES
speed computing

WESTINGHOUSE ELECTRIC CORP., 401 Liberty Ave., Pittsburgh 30, Pa. Several thousand magnetic cores such as these recently built by the company may be used in a single computer or data processing machine.

▶ **Winding**—The cores are wound on ceramic spools that range in size down to $\frac{1}{32}$ in. in diameter and $\frac{1}{16}$ in. high. The strip with which the cores are wound—a nickel-iron alloy—is rolled as thin as one eight-thousandth of an in.

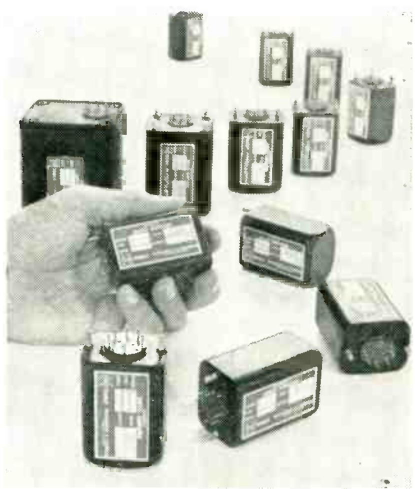
Normally a core consists of only 6 to 15 wraps of the magnetic material on the spool. These Hiperthin cores have high permeability and are more temperature stable than ferrite cores. The cores are also applicable to h-f magnetic amplifier circuits where high gain is needed.

LITTLE CONNECTORS
with one-piece inserts

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y., has added a new miniature Continental connector to its AN-type 1300 series. The connector is available with 3, 4, and 5 contacts, and features one-piece molded inserts. This construction prevents moisture traps and electrical breakdowns which often occur with conventional AN two-piece inserts.

▶ **Military Requirements**—The precision-machined aluminum shell is finished to meet military requirements for salt-spray test resistance. The inserts are permanently swaged into the shell to form a single cartridge unit. Floating contacts in the subminiature connectors assure self-alignment of each contact and reduce engagement and disengagement forces to an absolute minimum.

Inserts are interchangeable in the plug or receptacle shell. Precision-machined brass-pin contacts and spring-temper phosphor-bronze contacts are gold-plated for ease of soldering.



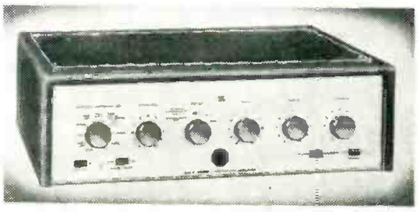
MAGNETIC AMPLIFIERS operate from −55 C to +100 C

TIMELY INSTRUMENTS & CONTROLS CORP., 1645 W. 135th St., Gardena, Calif. A new line of magnetic servo amplifiers are designed for use as power amplifier output stages for the control of 400 cycle 2 phase servo motors, including Navy BuOrd MK14, MK7, MK8 and their equivalents.

No d-c power supplies are necessary for operation of the amplifiers and their transistor or tube control circuit. Using no rectifiers, the amplifiers operate over a wide ambient temperature range of −55 C to +100 C.

▶ **Uses**—The amplifiers find wide application in aircraft fire control systems, navigational radar auto-pilots, and missile guidance systems.

Standard output ratings of 3, 6, 10, 16 and 40 w are available.

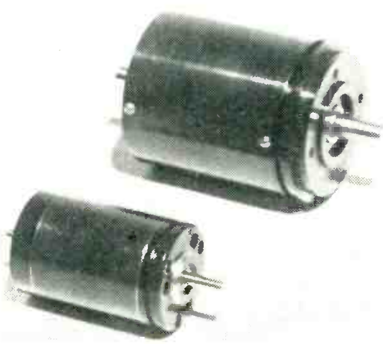


POWER AMPLIFIER
with equalizer-preamplifier

HERMON HOSMER SCOTT, INC., 385 Putnam Ave., Cambridge 39, Mass. Type 210-D laboratory amplifier is a complete 30-watt power amplifier with equalizer-preamplifier in a single compact case. It features the dynaural dynamic noise suppressor and record distortion filter.

▶ **Typical Specifications** — Hum level is 80 db below maximum output; harmonic distortion less than 0.5 percent; first-order difference tone intermodulation, less than 0.25 percent; frequency response flat from 19 cps to 35,000 cps.

Net price is $169.95.



SPEED REDUCERS
universal design

PIC DESIGN CORP., 160 Atlantic Ave., Lynbrook, L. I., N. Y. Type No. U precision speed reducers are available from stock and have been designed as a universal unit with variable ratios from 5:1 to 3,000:1 with oil-less bearing or miniature ball bearings, ABEC-5 tolerances as required. Backlash measured through the entire train is less than 30 ft. Material is stainless steel and Naval bronze.

▶**Sizes**—There are 2 unit sizes available from stock: $1\frac{1}{16}$ in. diameter which is equal to the MK-14 series, and the $1\frac{3}{4}$ in. diameter equal to the MK-8 series. Parts for all ratios are stocked and assembled per order.

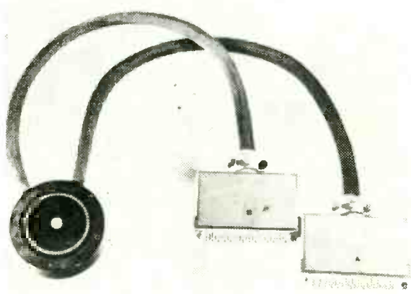
Send for the new free 64-page catalog No. 7.

RELAY
features supersensitivity

INDUSTRIAL ELECTRONICS CO., INC., Hanover, Mass. The series 3000 supersensitive electronic relay has power amplification of approximately 10 million to 1. Input power to the relay is less than 0.00011 w, while the output circuit can carry up to 1,150 w.

▶**Applications**—The relay may be used as a level control for filling containers, as a precision temperature or pressure controlling device, and in a variety of applications to measure movements of delicate devices.

The relay is of very compact design with overall dimensions of $2\frac{1}{2}$ in. by $5\frac{3}{16}$ in. and is of the plug-in type. Literature is available.



HIGH-SPEED SWITCHES
with semimolded contacts

GENERAL DEVICES, INC., P.O. Box 253, Princeton, N. J., has announced production of high-speed switches of advanced design. The line incorporates a new semi-molded contact plate construction. Each contact pin is permanently locked into precise alignment, affording maximum dimensional stability. Convenient wire leads are permanently molded into the contact plate for ease of connection. Solder type terminals can also be had on request.

► **Available Models**—Switch types include single or multiple pole, stacked, concentric opposed, raised contact, segmented, or printed circuit designs.

All units feature extended, service-free life and more predictable performance.

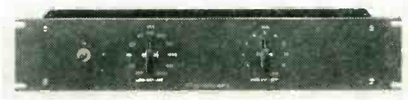
PLOTTER-FOLLOWER solves numerable problems

LOGISTICS RESEARCH INC., 141 S. Pacific Ave., Redondo Beach, Calif., has developed a graph plotter-follower that plots one variable against another in algebraic increment steps of 1/100-in. at 20 increments per sec.

Designated Logrinc, the plotter-follower is designed for use with digital differential analyzers to solve problems in trajectory analysis, cross and autocorrelation, Fourier analysis, data reduction, and conversion to digital form of functions not readily generated in a digital computer.

Logrinc follows any dark continuous curve by a photoelectric light. Since the follower seeks one edge rather than scanning the line, it can follow any change in slope for single values of X, and can follow a line of any slope up to and including infinity.

Prices range between $5,700 and $6,500.



FILTER
gives better sound effects

Pulse Techhniques, Inc., 1411 Palisade Ave., West Englewood, N. J. Twenty-two cutoff frequencies ranging from 50 cps to 12 kc make the HLF-3 high and low pass filter ideal for the reduction of rumble, hum, noise and distortion in music and program material. Better sound effects are possible because of more mid-range frequencies. Low cutoffs are OFF, 50, 80, 100, 150, 250, 500, 750, 1,000, 1,500 and 2,000 cps.

High cut offs are 1, 1.5, 2, 3, 4, 5, 6, 8, 10 and 12 kc and off. The circuit is constant K, 18 db per octave, 600 ohms. Shielded toroids minimize hum pickup. Rack mount is 3½ in. panel. Price is $232.50.

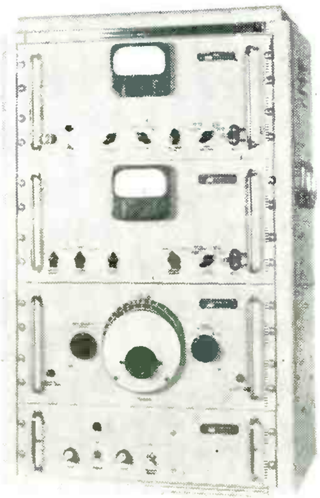
D-C POWER SUPPLY
aircraft battery eliminator

Gates Electronics Co., 611 Morris Park Ave., Bronx, N. Y. Model G101F aircraft battery eliminator provides continuous and reliable d-c power for ground operation and bench testing of airborne equipment

—motors, dynamotors, relays, inverters, activators, solenoid valves and vibrators.

Large panel meters indicate d-c output voltage and current. An ammeter protection circuit eliminates the danger of needle slam during periods of high in-rush current, permitting safe starting of rotating motors, dynamotors and inverters. Other features include a delay fuse for short circuit protection and a warning light in case of overload. Ratings are 0 to 28 v d-c, 0 to 20 amperes, with 1-percent ripple.

Price is $160.



DISTORTION ANALYZER
designed for laboratory use

RADIO FREQUENCY LABORATORIES, INC., Powerville Road, Boonton 3, N. J. Model 863 two-tone distortion analyzer is designed to measure the intermodulation of two signals in a nonlinear network. The equipment consists of an oscillator unit, an amplifier unit, a receiver unit and a power supply. The oscillator and amplifier units generate a variable two-tone signal with a minimum of spurious output frequencies. The two tones are of equal amplitude and spaced 400 cps apart. This signal may be transmitted over a communication system or through a nonlinear network and the intermodulation products measured at the receiver.

▶ Uses—Application will be found in measurements of intermodulation distortion on carrier telephone and carrier telegraph transmission systems in the frequency range of 1 to

 For additional information on all items on this page, use post card on last page.

100 kc. Another use will also be found for evaluating the quality of voice circuits and sound systems. The analyzer uses the CCIF method of determining intermodulation distortion.

The equipment is divided into 4 chassis which are mounted in a 19-in. rack cabinet 33¼ by 21¾ by 15¼ in. deep. Total weight is about 160 lb.

GEIGER COUNTER is all-transistorized

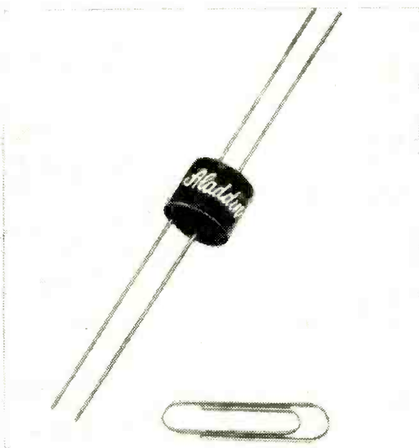
THE RADIAC CO., INC., 489 Fifth Ave., New York 17, N. Y. An all-transistorized Geiger counter features 3 methods of radioactivity indication, a continuously variable time-constant control and a meter which reads in percentage of uranium.

▶ **Advantages**—The panel meter, flashing lamp, and earphones all operate simultaneously to signal the presence of a radioactive substance, such as uranium or thorium ore. The transistorized circuitry, which includes an automatically regulated h-v power supply, greatly reduces current drain, resulting in fewer batteries and lighter weight overall.

It will give up to 350 hr of service. The percent meter calibration allows assay of ore samples in the field, and the variable time-constant may be set to correspond to the speed of the instrument over the area traversed.

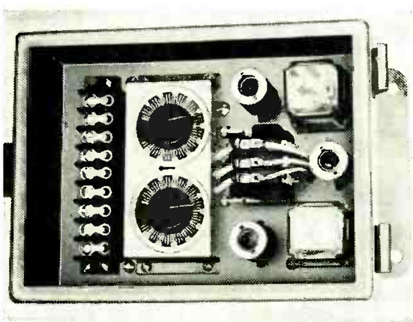
PULSE TRANSFORMERS in porcelain ferrite sleeves

ALADDIN RADIO INDUSTRIES, INC., Nashville 2, Tenn., has developed a new line of miniature pulse transformers, housed in porcelainized ferrite sleeves. The construction technique involves using a simple



equivalent of the familiar pot-core. The moisture-proof external finish on the ferrite makes it unnecessary to add to the size and weight of the unit by molding it in plastic or canning it.

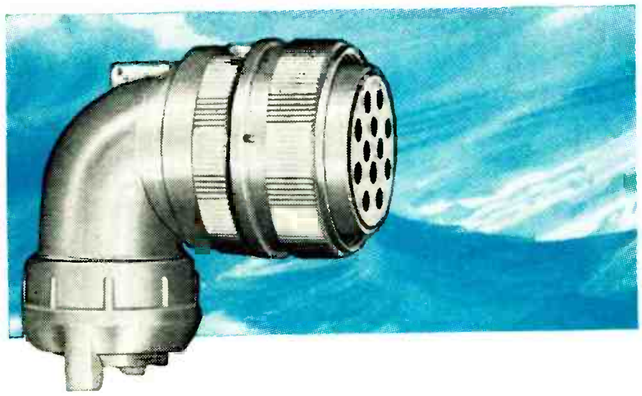
▶ **Step-Up Ratios**—Voltage step-up ratios as high as 15 to 1 have been achieved while maintaining reasonably low distributed capacitance. Several variations on the basic design, each developed to achieve the optimum combination of performance characteristics for a particular application, are available.

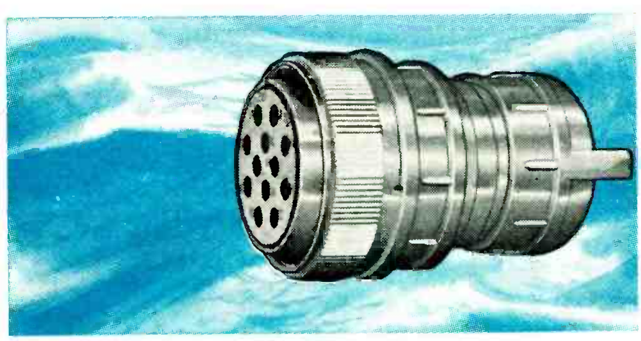


ELECTRONIC TIMER with high load capacity

FERRARA, INC., 8106 W. Nine Mile Rd., Oak Park 37, Mich. Independently adjustable on and off time ranges are featured in the model T3 electronic timer. It is designed for use on life test equipment, proportioning controls and process or machine applications requiring on-off timing cycles.

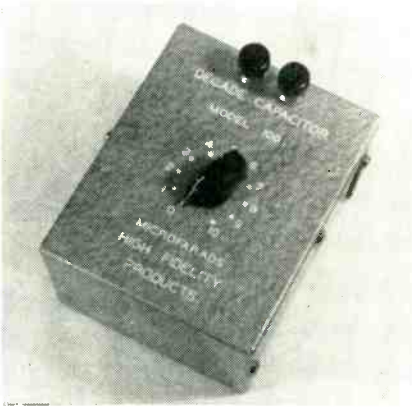
▶ **Specifications**—The timer has dpdt load contacts rated at 20 amperes, 115 v a-c, noninductive load. The circuit employs cold-cathode tubes requiring no warmup time before use. Accuracy is ±1 percent





and independent of line voltage fluctuations from 105 to 125 v.

Standard available ranges are 0.3 to 25 sec per section and 0.5 to 50 sec per section, with other combinations available. Prices are as follows: open style, $91; with NEMA XII enclosure, $105.



DECADE CAPACITOR
a laboratory-type unit

HIGH FIDELITY PRODUCTS, Box 131, Owensboro, Ky. Model 100 is a laboratory-type decade capacitor having a range of 0 to 10 μf in 1-μf steps. It is supplied in a standard tolerance of ±10 percent. Closer tolerance may be had on special order.

The unit is designed for use in wave filters, loudspeaker crossover networks, equalizers and tuned circuits. It is housed in an aluminum case which is 4 in. wide, 5 in. long, and 3 in. high.

Net price is $9.95.

TORQUE SOURCE
for lab or production use

BULOVA RESEARCH AND DEVELOPMENT LABORATORIES, INC., 62-10 Woodside Ave., Woodside 77, N. Y., announces its new all-electric calibrated torque source for testing and measuring the torque characteristics of pallet mechanisms, small gear trains, servos, springs, clutches and similar devices.

A universal chuck on the front panel, driven by a three-phase motor, supplies the torque which is read directly in oz-in. on a large easy-to-read meter.

▶ **Applications**—Useful for laboratory or production requirements as a torque source as well as calibrated dynamometer, model 40 has a range of 0.5 to 40 oz-in. with better than 5-percent overall accuracy at shaft speeds from 0 to 100 rpm.

Overall dimensions are 22 in. wide by 12 in. high by 15 in. deep. Designed for 3-phase, 208-220 v, 60-cycle operation, it is priced at $495.

PORTABLE VOLTMETER has-overvoltage protection

SHASTA DIVISION, Beckman Instruments, Inc., P. O. Box 296, Richmond, Calif. Use of the meter movement for just the top 5 to 10 percent of the range permits this portable single-range expanded-scale voltmeter to obtain high accuracy from a rugged, low-accuracy meter movement. Only the voltage range of interest is expanded full scale—by a patented circuit without electron tubes. Guaranteed accuracy is ±0.5 percent of input voltage.

▶ **Features**—The instrument offers overvoltage protection, wide frequency range (50 to 5,000 cps) and voltage expansions of ±5, ±10, or

±15 v at 115 v. It is designed for applications where exceptional ruggedness and reading ease are required. Both meter and circuit elements are hermetically sealed. The unit is true rms reading. Price is $105.

CAMERA
records cro patterns

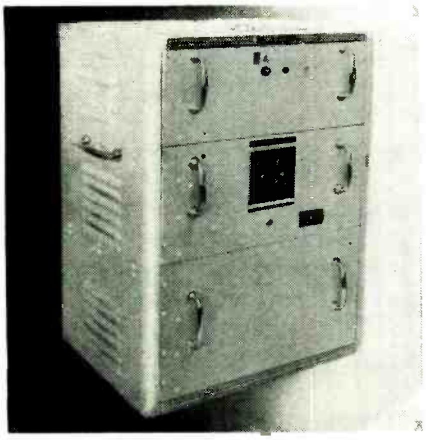
ALLEN B. DUMONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J. High-resolution film images without distortion regardless of aperture setting are featured in a new continuous-motion oscillograph record camera. The new camera for making moving-film or single-frame recordings of patterns on c-r oscillograph screens is designated as type 321-A.

▶ **Features**—The camera uses easily obtainable 35-mm film, and the film magazines accommodate either standard 100 ft spools or any film length up to 400 ft on reels. It has electrical connections which permit it to be remotely operated, and it may be quickly turned on its side to permit recordings plotted along a vertical axis.

VOLTAGE REGULATOR
is distortion-eliminating

CURTISS-WRIGHT CORP., Electronics Division, 631 Central Ave., Carlstadt, N. J. The EE100 voltage regulator is designed to eliminate disturbing harmonics and low-frequency noise in 115-v, 60-cps power sources.

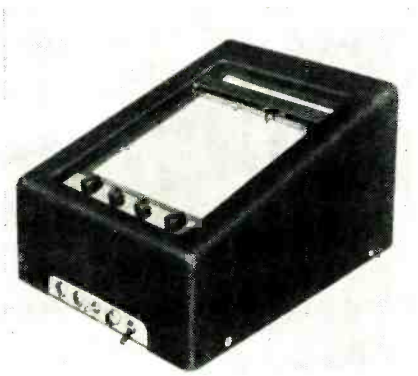
▶ **Regulated Power**—It furnishes 1.4 kva of ±1 percent electronically voltage-regulated power with line



distortion reduced to less than 0.3 percent. Simultaneously, it furnishes an additional 4 kva of ±1 percent electromechanically regulated power for those applications where normal line distortion and slower voltage regulation can be tolerated.

The instrument is also ideally suited for preventing instability and inaccuracy in a-c computer nulling operations.

Price of the unit is $1,689.



X-Y RECORDER
with flat-bed presentation

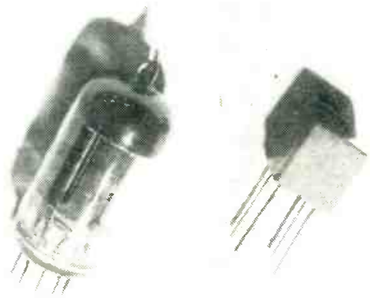
ELECTRO INSTRUMENTS, INC., 3794 Rosecrans, San Diego 10, Calif. The flat-bed presentation of the new 8½ in. by 11 in. X-Y recorder permits the plot to be visible during the entire plotting operations. This feature also permits the plot to be marked or identified in place.

The pen assembly adjusts to accommodate a full pad. To change plot paper, one simply flips the switch control, removing the pen and arm from the plotting area, and tears the plot from the pad.

► **Performance**—Pen speed is ½ sec full scale, made possible through a new servo design. Jitter is effectively eliminated through the use of new circuits which eliminate 60- and 120-cycle pickup. Performance of the recorder with noisy signals is also greatly improved.

The instrument is provided in 11 scale ranges, from 5 mv to 500 v full scale. Input impedance is 200,000 ohms per v. Potentiometer input is by switch control.

Price is $1,475 and delivery, 75 days.



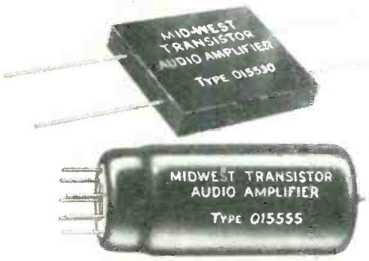
TINY MAGNET
replaces vacuum tubes

BERKELEY DIVISION, Beckman Instruments, Inc., 2200 Wright Ave., Richmond 3, Calif., has developed the Ferristor, a tiny magnetic amplifier designed to replace short-lived vacuum tubes. It will end costly downtime and production line stoppages caused by tube failure. The Ferristor, encapsulated in epoxy resin in a tiny plastic cube only ½ in. on each side, is immune to shock, moisture, prolonged overloading or vibration.

It is currently being used in the series 5840 magnetic dual preset controller which has only 2 vacuum tubes (as compared with 54 in the electronic model); and the model 7650 magnetic EPUT meter, which uses only 3 vacuum tubes (as compared with 35 in the electronic model).

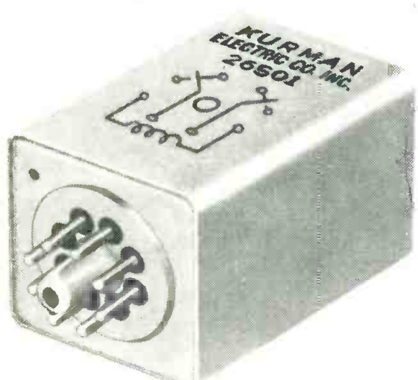
AUDIO AMPLIFIER
miniature transistor type

MID-WEST COIL & TRANSFORMER CO., 1642 N. Halsted St., Chicago 14, Ill., announces a new miniature transistor audio amplifier in 2 styles. The tube type measures 1½



in. high by $\frac{11}{16}$ in. in diameter. The flat type measures $\frac{5}{8}$ in. by $\frac{3}{4}$ in., with a thickness of $\frac{1}{8}$ in.

▶ **Advantages**—Some of the features are small size and reduced weight, high gain, battery drain of about 2 ma, hermetic sealing, low noise and hum level and low distortion.



VERSATILE RELAY
is small and fast-acting

KURMAN ELECTRIC CO., INC., 35-18 37th St., Long Island City, N. Y. The series 25S octal plug-in hermetically sealed relay is ideal for aircraft, mobile, marine and land-operated communications networks.

▶ **Technical Data**—Features include a-c or d-c operation, a life of 250,000 operations minimum with full contact load of 25 amperes 125 v a-c resistive or 1,000,000 operations minimum with reduced contact load of 5 amperes 125 v a-c resistive. It is fast-acting—4 μsec with 2-w input (d-c only) and will meet MIL-R-5757B Class A.

Minimum coil sensitivity is 0.5 w d-c and 2 v-a a-c; maximum coil dissipation is 4 w d-c and 8.5 v-a a-c; maximum d-c coil resistance is 6,800 ohms d-c and 9,800 ohms a-c. Contact arrangement is up to three pole double throw with a maximum operating voltage of 120 v d-c or 375 v a-c.

Among the special features are solder lug terminals and special mounting construction.

FREQUENCY COUNTER
with digital in-line readout

ELECTRO INSTRUMENTS, INC., 3794 Rosecrans, San Diego 10, Calif. A new events-per-unit-time meter, model 250, features true digital inline readout. This feature eliminates ambiguity and reading errors. Readings stay constant during sampling period. There are no lost readings and no hold adjustments. Sampling changes or dead-times are eliminated. Decimal coded contacts provided in the instrument give simple, direct printout.

▶ **Specifications**—Display is 5 inline digits, 1 in. high letters. Accuracy is ±1 digit; frequency response, 10 cps to 100 kc; sensitivity, 0.2 v rms; input impedance, 10 mc; time base, 1 sec crystal controlled.

Price is $875.

VOLTAGE REGULATOR
55 to 65-cps input range

SORENSEN AND CO., INC., 375 Fairfield Ave., Stamford, Conn., has announced model MA1000S tubeless a-c line voltage regulator. It uses a magnetic amplifier controller circuit with a silicone diode reference element, and is basically insensitive to frequency variations. The unit is particularly applicable to unattended installations requiring highly dependable automatic line regulation.

▶ **Other Features**—It offers very stable performance over long periods with a minimum of maintenance. Input frequency range is 55 to 65 cps. Regulation accuracy is ±0.5 percent against line or load.

POWER RECTIFIER
operates up to 200 C

HOFFMAN ELECTRONICS CORP., 3761 S. Hill St., Los Angeles 7, Calif. The NS-P1 silicon power rectifier is capable of operating at ambient temperatures up to 200 C. It is housed in a rugged, shock and vibration-proof plated case measuring approximately 1⅛ in. in diameter and 1¼ in. in height.

▶ **Specifications**—Maximum reverse working voltage is 60 v and minimum Zener (breakdown) voltage is 70 v. Forward current density at 1 v drop is in excess of 600 amperes per sq in. of junction area.

CENTRIFUGAL BLOWER
for electronic cooling

ROTRON MFG. CO., Schoonmaker Lane, Woodstock, N. Y. Model R type 3501 centrifugal blower is designed for use in applications requiring a high pressure-to-volume cooling performance. Small in size, it is particularly suitable for operation at high shaft speeds obtainable with 400 cps power supplies. Altvar motors are incorporated for

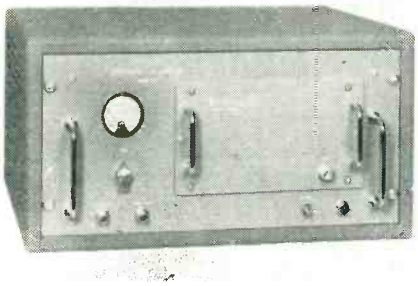
constant cooling efficiency in airborne applications.

Weighing approximately 3 lb, the unit is capable of moving 25 cfm at 7.5 in. wc at 11,000 rpm. It can operate either on single or three-phase, 60-cps and 400-cps power.

SYNCHROS
used in avionic equipment

CLIFTON PRECISION PRODUCTS CO., INC., Marple at Broadway, Clifton Heights, Pa., has announced the new, guaranteed 7 minute accuracy size 8 synchros. The units are available as transmitters, control transformers, resolvers, repeaters and differentials. They are exceptionally corrosion-resistant due to the use of nickel alloy laminations and stainless steel bearings.

In addition to the usual 11.8 or 26 v excitation, the units are also available in 115-v 400-cycle primary, 90-v secondary transmitters, control transformers and receivers.



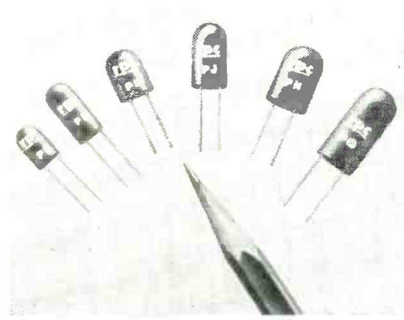
VHF-UHF CONVERTER
reads frequencies to 515 mc

BERKELEY DIVISION OF BECKMAN INSTRUMENTS, INC., 2200 Wright Ave., Richmond 3, Calif. Model 5580 vhf-uhf converter measures and reads frequencies up to 515 mc in digital form. The converter is designed for use with the model 5571 frequency meter to multiply by 12 the meter's range. Its accuracy is to 1 part in $10^7 \pm 1$ cycle.

In production with the converters are model 5581 plug-in units which cover 13 fixed bands from 42 to 515 mc to eliminate costly wide-band amplifiers.

The units consist of a mixer and multipliers for generating precise references or base frequencies from the crystal controlled frequency produced by the converter.

For this operation, the converter's multiplier circuit generates the crystal controlled frequency by taking a 1-mc pulse from the model 5571 and injecting it into the plug-in unit.

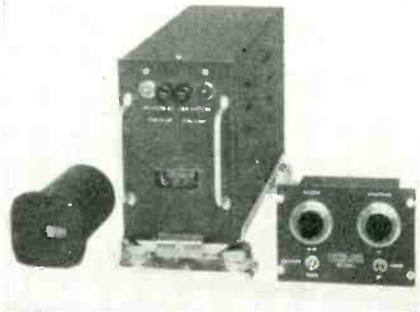


MINIATURE RESISTORS
for printed circuits

RESISTANCE PRODUCTS CO., 914 S. 13th St., Harrisburg, Pa., is now producing a line of precision wire-wound miniature resistors engineered expressly for use with printed circuits. These type P resistors are single-ended units made for easy rapid mounting on printed circuit panels with no support other than the wire leads needed.

Type P resistors can be safely operated at full rated load in ambient temperatures up to 125 C. They are made with high temperature epoxy resins and resistance wire with special high temperature insulation. Sizes are available rated at from 1/10 w up to 1 w.

► **Specifications**—The resistors are available in a complete line of 6 sizes ranging from $\frac{1}{4}$ in. diameter and $\frac{3}{8}$ in. long to $\frac{3}{8}$ in. diameter by $\frac{3}{4}$ in. long. Available resistance values range from 0.40 megohm up to 3 megohms. Tolerances range from 1 percent to 0.05 percent. The resistors will meet all applicable test requirements of MIL-R-3A, Amendment No. 3.



INDICATOR
measures strain-gage output

INDUSTRIAL CONTROL CO., Wyandanch, L. I., N. Y. The SL-1002 is a precision, servo-driven indicator designed to measure the output of conventional strain gages. It consists of an indicator, servo amplifier and control box.

An important feature is the counter presentation and small indicator size. Precision is high, with linearity of 0.2 percent. The novel gage circuit used minimizes drifts due to unbalanced thermal emf's. No additional batteries or standard cells are required as the amplifier provides the bridge excitation.

► **Applications**—The SL-1002 is especially useful where many indicators must be photographed together. Its balancing speed is adequate for multiplexing. It can be furnished with digital readout by the addition of the proper digitizer. It can be adapted to the measurement and readout of voltage, current, resistance, temperature, flow, humidity and most other process variables. It is a building block to automation.

Literature

Stationary Tachometers. Metron Instrument Co., 432 Lincoln St., Denver 3, Colorado. Bulletin No. 105 describes a complete line of stationary tachometers which have new circuits and new takeoff heads that increase the life of the company's tachometers by five times. The tachometers described have no brushes, slip rings or other parts that need regular maintenance. Hundreds of combinations are available to meet exact speed measuring requirements.

Ore Analyzer. Tracerlab Inc., 130 High St., Boston 10, Mass. Bulletin M-106 discusses a new instrument for determining the amount of uranium and thorium in ores. The equipment described consists of the P20 scintillation detector and a Geiger tube to be mounted on a shielded well which holds samples of ore bearing uranium and thorium. One detector takes beta counts while the other reads gamma only.

An SC-51R Autoscaler is connected with each detector and counts radiation pulses from the sample. The autoscalers are interconnected so as to stop counting simultaneously either after a predetermined interval chosen on the SC-42 preset timer or after a preset count has been obtained on one scaler.

Plastic Film. E. I. DuPont deNemours & Co., Inc., Wilmington 98, Del. A new booklet shows the latest commercial uses and detailed physical and chemical properties of Mylar polyester film. Included is an easy-to-read chart detailing the characteristics of Mylar which have permitted design improvements and cost reductions in many products. These properties include insensitivity to moisture, resistance to solvent and chemical attack, wide temperature operating range, plus greater tensile strength than any other plastic film.

Facilities Bulletin. Acton Laboratories, Inc., Acton, Mass. An 8-page booklet illustrates and describes the company's facilities for research and development, custom design and environmental testing of electronic measuring instruments and components for government and industry.

Counters and Meters. Spencer Mfg. Co., 3253 N. Cicero Ave., Chicago 41, Ill. A 4-page bulletin covers a line of counters and meters that add, subtract and perform many control functions. Illustrations, operating information and specifications are given for a batch counter (priced at $99.50), an elapsed time meter (priced at $15), and a magnetic impulse counter (priced at $29.50). The case for the magnetic impulse counter described is an additional $10.

Environmental Testing Services. General Testing Laboratories, Inc., 58 Washington Ave., Carlstadt, N. J. A 9-page brochure describes the environmental testing services rendered by the company. Illustrations and chief features are included.

Electrically Variable Inductors. Vari-L Co., Inc., 432 Fairfield Ave., Stamford, Conn., has available a folder containing operating principles, design information, applications and tabular data on its electrically variable inductors. Net unit price for 17 different models described ranges from $27.50 to $52.50. Quantity discounts are also shown.

Adjustable Cup Core Coils. North Hills Electric Co., Inc., 203-18 35th Ave., Bayside 61, L. I., N. Y., has available a data sheet on the series 700 standard adjustable cup core coils covering the 1.5 to 1,000 mh range completely. The units described are designed for supersonic applications, low frequency i-f amplifiers, telemetering circuits, audio applications and filters. Chief features, technical information and quantity prices are listed.

Precision Potentiometers. Borg Equipment Div. of The George W. Borg Corp., 120 S. Main St., Janesville, Wisc. Systems engineers will be particularly interested in a new brochure covering all phases of precision potentiometer design and application. Complete information, graphs and charts covering physical and electrical design characteristics are included. The brochure "A Symposium of Technical Articles" is available upon request.

Radio and Electronic Supplies. Sun Radio & Electronics Co., Inc., 650 Sixth Ave., New York 11, N. Y., has available for free distribution to industrial users, schools, laboratories, government bureaus, a-m/f-m and tv broadcasters and armed forces the first edition of catalog 56 of radio and electronic supplies. It contains 144 pages of useful information for procurement and engineering personnel engaged in electronic design and production.

▶ **Handiness** — The catalog has been designed for quick easy use. The triple index system enables a person to locate any part, by manufacturer, specific product or general category. To avoid confusion, original manufacturers' part numbers are used in nearly all cases. Numerous product illustrations are included.

Tape Recorder. Presto Recording Corp., Paramus, N. J. Volume 7, Number 10 of the *Recorder* illustrates and describes the R-11 tape recorder, a professional quality tape transport mechanism widely used in broadcasting and commerical recording.

Price of the new model H version of the mechanism is $775. The carrying case model is available at $827, while the console with the A-901 amplifier sells for $1,250.

Radar Target. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass. Technical bulletin 6-2-3A describes the Ecco reflector, which is effective as a passive target for radar energy. Suggested applications are listed. Accompanying curves give actual performance data, compared to that of a sphere and a circular corner reflector of the same dimensions.

Vibrator Converters. Cornell-Dubilier Electric Corp., 2900 Columbia Ave., Indianapolis, Ind. Engineering bulletins EB-3500 and EB-3600 cover 375 va and 200 va vibrator converters respectively. The units illustrated and described are designed for railroad and marine service. Electrical and mechanical specifications are included.

Sheet Metal Products and Electronic Components. Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio. A new catalog illustrates and describes the company's line of sheet metal products and electronic components. Special fabrication facilities are also outlined.

To insure ease of selection and ordering, complete sizing information is given on each product. Suggestions for uses and applications are also included.

Audio Wire. Alpha Wire Corp., 430 Broadway, New York 13, N. Y., has published catalog S-55 on audio wire, which contains descriptions, specifications and illustrations of the company's in-stock line of 145 audio items.

pH Meter Tester. Photovolt Corp., 95 Madison Ave., New York 16, N. Y. Bulletin No. 138 covers the electronic pH meter tester, model 25. It illustrates and describes a compact line-operated instrument without batteries, for quick and easy checking of the proper performance of pH meters by direct application of a voltage through a high resistance, requiring neither electrodes nor buffers for the checking test. A price list is included.

Electrical Tapes. Permacel Tape Corp., New Brunswick, N. J. A 4-page brochure, "From Push Buttons to Panel Boards," illustrates the use of plastic tapes as a new insulation for electrical control equipment. The 4-color brochure describes how to save time and labor by using plastic electrical tapes as an insulating agent instead of fiber board.

Also included are the latest technical data on the use of Permacel's plastic electrical tapes, Permacel 29, Permacel 30 and Permacel 302. The data include thickness, elongation, adhesion, tensile strength and dielectric strength.

Power Supplies. Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena 8, Calif. A line of power supplies (electronic and magnetic amplifier types) are illustrated and described in a 6-page folder. Constant current supplies, transistor power supplies and motor speed controls are covered. Model X series closely regulated sub-chassis mounting d-c power supplies described range in price from $33.50 to $150.

Transistors and Rectifiers. General Electric Co., Syracuse, N. Y., has published an 8-page brochure containing condensed specification and rating data on transistors and rectifiers. Critical parameters for absolute maximum ratings and design center ratings are given for the complete line of GE *npn* and *pnp* transistors currently in production.

In addition, critical specifications for the complete GE germanium rectifier line include basic rectifier units, high-temperature rectifiers, magnetic amplifier rectifiers, rectifier stacks, 5-ampere power rectifier, and medium power rectifier stacks in various applications are given.

Brochure ECG-95 is cross-referenced to individual specification sheets containing complete data on the components.

Silicone Reference Guide. Dow Corning Corp., Midland, Mich., has published a 1956 reference guide on silicone products. The new edition describes almost 150 of the most generally used silicone products, 18 of which were first introduced within the last 12 months.

The products are grouped by physical form and cross-indexed by usage enabling them to be located by what they do, as well as by what they are.

Twelve pages, printed in two colors, cover product descriptions that are condensed and devoted to essential data. The booklet is thoroughly illustrated with charts, tables, graphs and application photographs.

Small Motors. Barber-Colman Co., Rockford, Ill. A new condensed catalog describes the company's line of shaded pole a-c motors for use in industrial instruments, projection equipment, servomechanisms and communication equipment.

Unidirectional, synchronous, and reversible motors are available with ratings up to 1/20 hp. Barcol geared-head motors will handle loads up to 100 lb in.

Ask for catalog F 4271-6.

Time Delay Relays. Elastic Stop Nut Corp. of America, Elizabeth, N. J. A new illustrated bulletin, SR-6R, describing models NEL and NEH Agastat time delay relays, has been announced. Model NEL features electrical interlock. The NEH features instant-action double-throw auxiliary switch plus time delay contacts.

The operation of each Agastat model is described in detail. A wiring diagram shows a contact arrangement for a model from each line. Operating voltage and contact arrangements for other models in the NEL and NEH lines are presented in chart form.

D-C Reference Voltage Source. Avien, Inc., 58-15 Northern Blvd., Woodside 77, N. Y. Design and performance data of the k-volt standard, new tubeless, high-stability d-c reference voltage source for measurement and control circuits, are presented in a 2-page bulletin.

Data are given for 3 a-c operated and 3 d-c operated models, with graphs showing output through ambient temperatures from −55 C to +100 C, and through supply voltage variations from 20.5 v to 32.5 v d-c and 85 v to 145 v a-c.

Included also are block schematics describing typical application of the "k-volt standard" for control systems, measurement circuits and stabilizing circuits.

Clad Metals. Joseph Kinney Co., Inc., Carnegie, Pa., manufacturers of copper-clad steel and steel-clad copper products has made available a publication describing new uses for clad metals. The 30-page booklet contains much technical information about new uses of copper clad metal in radio, electronics and aircraft.

Split-Second Recorder. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Phila-

For additional information on all items on this page, use post card on last page.

delphia 44, Pa. Data sheet 10.2-21 covers a new split-second ElectroniK strip chart instrument. The instrument described has a full scale pen speed of ½ sec and facilitates recording of rapidly changing variables encountered in laboratories, research centers and experimental stations.

Stabilizing Amplifier. George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass., has released a technical bulletin describing a new stabilizing amplifier, model K2-P, recently added to the company's line of electronic analog components. General characteristics, operational details, applications, and suggested methods of applying bias are presented.

Electrical Insulating Materials. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill. A newly revised and enlarged 32-page catalog contains descriptive information, photos, prices and ordering data on electrical insulating materials. A table of contents and an alphabetical product index are quick guides to: cords and twines, woven tapes, tubings and sleevings, mica plates, slot wedges, varnishes, solvents, filling compound, Mylar-rag paper combinations, creased separator coils, paper, slot insulation, varnished fabrics, pressure-sensitive tapes and class H silicone insulating materials.

Electronic Computers. Underwood Corp., Electronic Computer Div., 35-10 36th Ave., Long Island City 1, N. Y., is now publishing the *Elecom Pulse*, a quarterly news medium for illustrating and explaining the company's electronic systems and developments.

Featured in the pilot issue is an article on the use of printed circuits in the Elecom 50 "business brain," and an operational report by an Elecom user in the petroleum industry. A new product section will appear as a standing feature.

Electronic Measuring Instruments. Marconi Instruments, 44 New St., New York 4, N. Y., publishes a quarterly bulletin, *Instrumentation*, which deals with the design of electronic measuring instruments. Volume 5 No. 3 describes development of an f-m signal generator for

the Citizen's Band, a new r-f power meter, and includes notes on L-C oscillators and distortion meters. The bulletin will be mailed regularly to engineers upon application.

Paper Capacitors. Plastic Capacitors, Inc., 2511 W. Moffat St., Chicago 47, Ill. Catalog 155 covers a complete line of paper capacitors for a-c and d-c applications. Included are data on mineral oil impregnated paper dielectric capacitors in a variety of containers; synthetic oil impregnated paper dielectric capacitors; and Aroclar a-c capacitors.

Charts, diagrams, technical data and part numbers are given.

Magnetic Shielding. Perfection Mica Co., 1322 N. Elston Ave., Chicago, Ill., has published technical studies on its Fernetic and Conetic magnetic shielding. The new material includes 8 new charts that show the increased efficiency of different thicknesses of the various shielding products manufactured by the company.

"Assist to Engineering" also includes a detailed illustration of a Gauss meter. Purpose of this diagram is to enable engineers to build their own meters so that they can make their own measurements.

Millimeter Waves. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y. Volume 4, No. 3, of the *Reports* deals with millimeter waves. The 6-page folder is well illustrated and lists many references.

Sweep Generators and Test Equipment. Telonic Industries, 73 N. Second Ave., Beech Grove, Ind., has available a complete line catalog with specifications tables. The company's basic instruments are illustrated, and all outstanding performance characteristics and features are carefully explained. Ask for catalog 5-A.

Precision Wire Wound Resistors. The Daven Co., 191 Central Ave., Newark 4, N. J., has available a new catalog on resistors that is intended as a guide to basic data for the application and design engineer.

In addition to a complete listing

of all Daven types, the catalog includes new charts and data on various types of hermetically sealed, encapsulated and subminiature resistors.

Certified test data on measurements, temperature and accuracy can be furnished. Listed are JAN, MIL and other government ratings.

Transformers and Resistors. Hycor Co., Inc., 11423 Vanowen St., North Hollywood, Calif., has available literature on the miniature 400-cycle power transformers, the series 800 precision ratio transformers, the H series hermetically sealed precision wire-wound resistors, and series E fixed noninductive wire-wound precision resistors. Illustrations and technical specifications are included.

Test Instruments. EICO, 84 Withers St., Brooklyn 11, N. Y. A new catalog describes 54 models of professional electronic test instruments in both kit and factory-wired form.

Containing 12 pages in 2 colors, the catalog describes the features, applications and specifications for each model including kit and factory-wired prices. It includes such units as oscilloscopes, vtvm's, multimeters, signal and sweep generators, tube testers, signal tracers, resistance and capacitance boxes, accessory probes and high-fidelity amplifiers.

Miniature Connectors. The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif. Miniature quick-disconnect electrical connectors that incorporate 16 industry requirements and meet the latest MIL-C-5015 AN"E" specifications for full instrument rating are described in a new bulletin. Construction and operational features are set forth.

The connectors described have a quick-disconnect that locks positively without safety wiring, is sealed automatically, and can be visually inspected for correct assembly and installation. It is moisture-sealed, vibration dampened, operative from −67 to +250 F, corrosion-resistant and unaffected by pressure variations.

It is pointed out in the bulletin that receptacle inserts are available in resilient or hermetic-sealed types. The complete unit, with all components ready for assembly and installation, is delivered in a sealed and dated package.

Transistor Power Supplies. Electronic Research Associates, Inc., Nutley, N. J., announces a 4-page, 2-color catalog describing their expanded line of tubeless and transistor supplies.

The catalog includes technical and descriptive material on models designed for transistor applications, tubeless single and dual units, and constant current converters. Several new models are described, including all-transistor semiconductor power units.

Electronic Systems. Craig Systems, Inc., Danvers, Mass. An 8-page folder illustrates and describes the company's communications and navigation systems which are mobile, transportable, and stationary.

Components for Airborne Radar. Airtron, Inc., 1103 W. Elizabeth Ave., Linden, N. J. A complete catalog series, covering the entire range of components in the double-ridge waveguide system used in commercial airborne penetration radar, is now available.

The literature provides the aircraft and radar designer with a convenient reference source covering electrical and mechanical characteristics, construction, dimensional data, installation information, materials and finishes, flange combinations and ordering data. Photos and drawings illustrate the various ridge waveguide components.

Timers. G. C. Wilson & Co., 1915 8th Ave., Huntington, West Virginia, has available a 6-page brochure with current information and specifications describing the standard line of electronic timers manufactured by the company. Included in the line discussed are delay, repeat cycle and interval timers.

Electronic Consulting Service. Thomas H. Briggs and Associates, Township Line Road, Rd. No. 1, Malvern, Pa. A 4-page folder tells of the organization's breadth and

NEW PRODUCTS (continued)

capabilities in engineering projects and products adaptable to specific needs. Informational data on development, production, systems and surveys are shown. Professional experience, and a representative listing of clients and projects served by the organization are also given.

Custom Molded Teflon. Sparta Mfg. Co., Dover, Ohio. A new brochure contains many graphic illustrations of the various applications of Teflon as cup, ball or shaft seals, washers, gaskets and diaphragms.

Teflon's unique properties make it an ideal material for use in certain applications where flexible materials cannot withstand severe service temperatures and/or corrosion.

Precision Pulse Oscilloscope. Newport Instruments Ltd., Newport Pagnell, Buckinghamshire, England. A single-sheet bulletin gives details on a new precision pulse oscilloscope. The instrument described has been designed primarily for making quantitative measurements of the characteristic features of pulsed or transient waveforms.

The information given on leaflet OSC.11 gives details of the construction and specification, and draws special attention to the high beam current crt which gives a bright, sharp trace under full daylight conditions.

Pointer Bulletin. Illinois Testing Laboratories, Inc., Chicago 10, Ill. An 8-page bulletin covers about 20 precision instruments for general industry. In it will be found a brief description of the salient features of each instrument in the company's line and the number of the bulletin which gives complete engineering data on the instrument.

Servo Motor. Servomechanisms, Inc., 625 Main St., Westbury, L. I., N. Y., has available a single-sheet bulletin illustrating and describing the class H 400-cycle servo motor, type 171. The motor discussed is designed for a minimum life of 1,000 hr of continuous operation in an ambient temperature

 For additional information on all items on this page, use post card on last page.

of 180 C. Small size of the unit described makes it ideal for use in high-speed aircraft and missile applications. Preliminary specifications are included.

Facilities Brochure. Packard-Bell Co., 12333 West Olympic Blvd., Los Angeles 64, Calif. Facilities of the company's technical products division for research, development and production of electronic equipment, both for the armed forces and private industry, are described and illustrated in a new 28-page brochure.

Temperature Cabinets. Webber Engineering Corp., P.O. Box 217, Indianapolis 6, Ind. Data on a complete line of temperature cabinets from 1 cu ft to 45 cu ft are contained in a new 4-page bulletin. The bulletin illustrates and describes cabinets which have temperature ranges available from +300 F using lifetime sealed electrical units to −200 F by mechanical refrigeration. All temperatures discussed are controlled in accuracy to ±0.2 F. Nine optional features are available in addition to 27 standard features.

Operational Equations for Computer Programming. Berkeley Div. of Beckman Instruments, Inc., 2200 Wright Ave., Richmond 3, Calif., polishes up the operational equation to short cut electronic computer programming by speedily deriving problem setups. Data file 120 describes how this direct use of the operational nature of computing elements saves time replacing complex computing circuits with symbolic equations. The equations discussed specify every number, type and interconnection of computing component required. Matching each right with a left side variable insures completeness of setup derivation.

Spray Paint Masks. By-Buk Co., 4314 W. Pico Blvd., Los Angeles 19, Calif. A 4-page brochure on spray paint masking includes a long list of Kwiky-Dot overlapping masking disk sizes and custom shapes made from many types of pressure-sensitive tape, some of which are made especially to release from anodized aluminum and magnesium surfaces without transferring adhesive.

For the task of properly masking hermetic seal electronic terminals they have developed a line of reusable Cap-Masks. For making printed circuit master drawing they make very narrow widths of black tape—down to 1/16 in. wide—in 60 yard rolls, and also many sizes of black doughnut-type disks. All are described in the bulletin.

Pressurized Connector. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A 2-page illustrated color bulletin describes special features, and electrical and mechanical specifications for the new 40-contact pressurized Continental connector. Mounting and clearance dimensions are also included. Write for bulletin GA.

Ratemeter. North American Philips Co., Inc., 750 South Fulton Ave., Mt. Vernon, N. Y. A 4-page folder gives complete data on the Norelco Eltratemeter (type 12112 frequency meter). Technical information covers operation and application of the 6-digit high-speed scaler for proportional, scintillation or Geiger counting. Specifications include maximum and minimum rates, resolving time, total capacity, zero reset, connections, controls, operating characteristics, sensitivity and dimensions.

Special data are given on the 100-kc tuning fork and mechanical register stages. The ratemeter discussed can time a predetermined count or count for a predetermined time.

Colloidal Dispersions. Acheson Colloids Co., Division of Acheson Industries, Inc., Port Huron, Mich., has issued a newly revised 4-page booklet, listing 42 colloidal and semi-colloidal dispersions for electronics and related industries.

Products discussed include dispersions of graphite, molybdenum disulfide, mica, vermiculite, zinc oxide and acetylene black. Carriers and diluents are given for each product, along with typical applications and important physical data.

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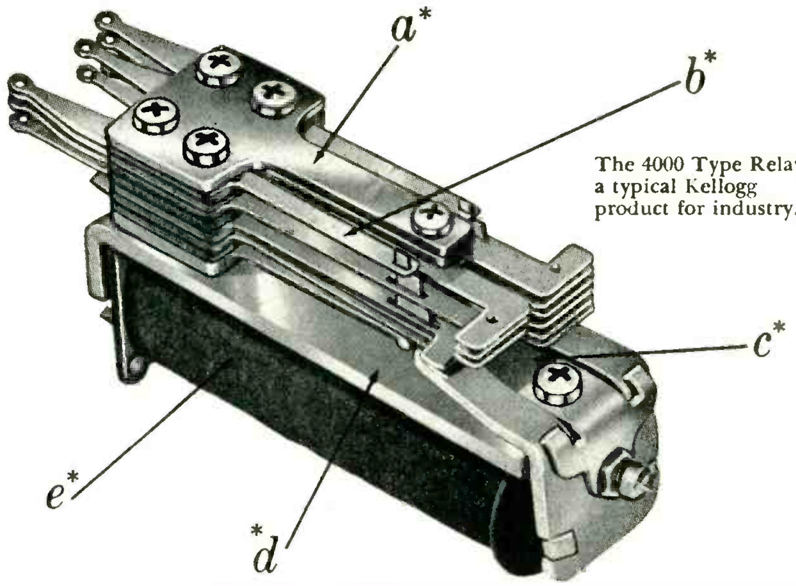

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Plants and People

Edited by WILLIAM G. ARNOLD

Electronics manufacturers continue to make plant and facility expansions and acquire other companies. Engineers and executives are promoted and move to new positions of responsibility. Industry societies elect new officers for 1956

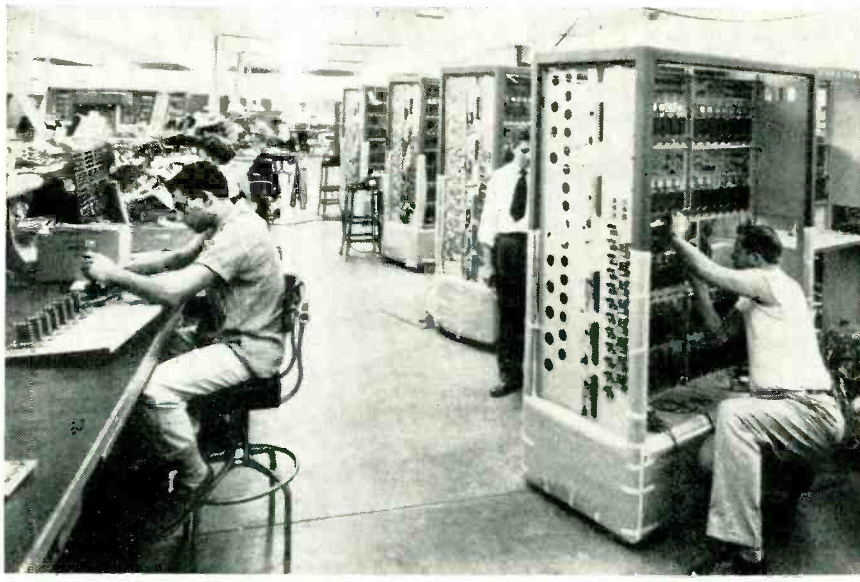
ElectroData Dedicates New Computer Plant, Plans Another

ELECTRODATA CORP. dedicated the first of two new computer plant facilities in Pasadena. The firm was established by Consolidated ElectroDynamics as an independent affiliate in 1954 to facilitate manufacture and sale of Datatron electronic data processing machines on a full scale basis. It has 400 employees and sales last year exceeded $3 million.

Datatron originally was developed in 1953 by the computer division of Consolidated, at a cost of over $1 million. Consolidated retains 36 percent of ElectroData's 910,000 shares of stock.

The new plant cost approximately $525,000, including capital equipment, and was completed on schedule last August after eight months of construction. It provides 40,000 sq ft of manufacturing and office floor space.

Ground will be broken for a new building adjoining this one, to double the plant's capacity. Most of the new space will be devoted to production facilities.



Production line at new Electro Data plant in Pasadena, Calif.

ElectroData has installed 17 systems nationwide to date—ranging in application from guided missile design and oil refinery operation to billing insurance policyholders.

Because of high starting and expansion costs and the initial deferment of income from lease contracts, the company has not expected to show a profit until 1956. The firm has a backlog of nearly two dozen system orders, averaging $200,000 each.

NBC Promotes Weaver, Robert Sarnoff, Hammerschmidt

SYLVESTER L. WEAVER, JR. has been elected chairman of the board and Robert W. Sarnoff, president of NBC. General David Sarnoff will continue as a director of NBC.

Andrew L. Hammerschmidt, associate director of technical operations for NBC, has been named vice-president and chief engineer. He succeeds the late Robert E. Shelby, who died suddenly of a heart attack on Dec. 8.

Hammerschmidt joined NBC in New York in 1941 as a television engineer. From 1942 to 1948 he served as a development engineer for NBC and, in 1948, was named tv technical operations supervisor for station WNBK, NBC-owned station in Cleveland.

A. L. Hammerschmidt

Four years later he was appointed assistant director of color tv systems development for NBC and headquartered in New York. In 1954, he was named to his present post of associate director of technical operations.

General Motors Builds Electronics Plant

AC SPARK PLUG division of General Motors will build a new plant of about 75,000 sq ft near Milwaukee, Wisconsin.

The new plant will be the first of

several buildings to be erected to accommodate AC's "expanding electronic and defense manufacturing work."

AC has 3 other plants operating in Milwaukee, producing products in the fields of military bombing and fire control systems, guided missile developments, jet engine fuel controls and specialized electronics work.

Construction of the new building will begin early in 1956 and be completed in 1957.

Texas Instruments Appoints Shepherd

MARK SHEPHERD, JR. has been promoted from assistant vice-president to vice-president in charge of the semiconductor products division of Texas Instruments.

He has been in charge of the firm's semiconductor products manufacture for three years.

As vice-president of the division, Shepherd will continue to be responsible for product development, manufacture, sales and administration. The division has grown to employ approximately 500 people and recently completed its move into a new addition on the main Dallas plant.

He served progressively in the apparatus division as project engineer, assistant chief engineer and chief engineer for semiconductor products. In 1953, when the semiconductor products division was formed, he was named asst. v-p.

Alto Scientific Opens Instrument Plant In California

F. E. TERMAN, dean of engineering and provost of Stanford University, inspects transistorized voltmeter at Alto Scientific Company's new Palo Alto, California plant. Describing the instrument's operation is Alto president, Thomas F. Turner (left) while Alto vice-president, Dr. David Cherry (far right) and Lester Libby participate. Occasion was the formal opening of expanded laboratory, manufacturing and office facilities in which Alto will conduct research and development work, fabrication in pilot and production runs and manufacture proprietary instruments.

Du Mont Elects Schultz President, Names Engineer

DAVID T. SCHULTZ has been elected president and director of Allen B. Du Mont Laboratories succeeding Dr. Allen B. Du Mont who continues as chairman of the board.

Schultz was senior vice-president and treasurer of Raytheon. He has been a vice-president, treasurer and director of Raytheon for more than 25 years.

The election of Schultz is another step taken as part of a plan, voted by stockholders in October, to separate broadcasting from manufacturing operations, to change the corporate and capital structure and to revitalize management. The Du Mont Broadcasting Corp. already has been formed and "spun-off" to stockholders.

Nicholas De Falco has been named general quality control manager for all manufactured products of Allen B. Du Mont Laboratories. He served as assistant general quality control manager prior to his new appointment. He succeeds Richard F. Rollman, who has resigned.

De Falco joined Du Mont in 1947 as manager of television receiver testing. He was subsequently made technical assistant to the vice president, quality control manager for television receivers and then assistant general quality control manager. In his new position he will supervise the operations of quality control departments in each company division.

Bogue Unveils Canadian Plant

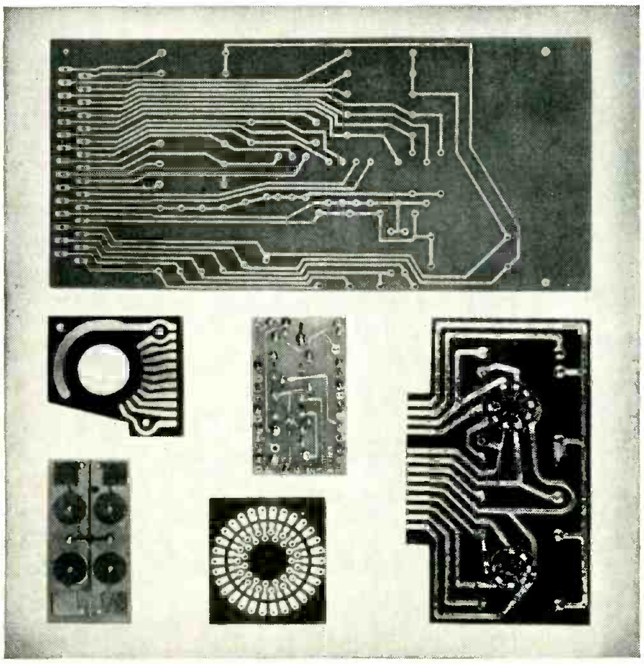
BOGUE ELECTRIC of Canada, formally opened its new plant at Gloucester, near Ottawa, Ontario.

An address by C. D. Howe, Minister of Trade and Commerce, and an open house highlighted the inauguration ceremonies.

The new plant will give the Canadian firm facilities for the production of motors and generators, power supplies, control systems and electronic components.

E. F. Schinman, president of Bogue, stated that the new plant

For the most dependable printed circuits, you need the high bond strength, workability, heat-resistance of C-D-F DILECTO® METAL-CLAD LAMINATES



Printed circuits based on C-D-F materials are being used with great success in military electronic equipment, commercial television and radio sets, telephone switchboards—even sub-miniature radiosonde equipment and hearing aids.
Photos courtesy of Photocircuits, Inc., Glen Cove, N. Y.

HIGH BOND STRENGTH—C-D-F's special adhesive for metal-clad Dilecto bonds the copper foil to the plastic without affecting the laminate's superior electrical properties. Heat-resistance, dissipation factor, dielectric constant, dielectric strength, and insulation resistance of the Dilecto base remain unaffected. The closely-bonded foil can be etched cleanly and dipped in hot solder to 220°C. (428°F.) for ten seconds with a guarantee of no blistering or separating. Metal-Clad Dilecto can be punched or machined either before or after etching.

EXCELLENT WORKABILITY—On all five Dilecto metal-clad grades, you can solder, punch, saw, and assemble components either by hand or automatically. Thanks to the inherently superior workability of the plastics laminate over that of ceramic-type materials, Dilecto can be dropped, jammed into tight chassis, and otherwise treated roughly on the assembly line and in service.

HIGH HEAT-RESISTANCE—Metal-Clad Dilecto Laminates are made of phenolic, epoxy, or Teflon* resin for various conditions of service and assembly, and have either cellulosic paper or woven glass-fabric base. All are ideally suited to printed-circuit applications in which heat-dissipation is a major problem. Continuous exposure to high ambient operating temperatures in enclosed electronic equipment has no significant effects on Dilecto's electrical and physical properties.

UNLOAD YOUR HEADACHE HERE! C-D-F, a big, reliable source of supply, can help you get the most for your printed-circuit money by reducing rejects, lowering fabrication costs, assuring dependable quality every time. Send us your print or problem, and we'll gladly supply appropriate test samples free. See our catalog in the Product Design File (Sweet's) or send for the new 20-page Dilecto catalog. Let your nearby C-D-F sales engineer (listed in Sweet's) help you right from the design stage!

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BOND STRENGTH—0.0014" foil (Lbs. reqd. to separate 1" width of foil from laminate)	5 to 8	5 to 8	8 to 12	8 to 12	5 to 8
MAXIMUM CONTINUOUS OPERATING TEMP. (Deg. C.)	120	120	150	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil.)	800	800	700	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35°C. & 90¾ RH	50,000	50,000	30,000	20,000	Over 10^6 megohms
DIELECTRIC CONSTANT 10^6 Cycles	4.20	4.20	4.90	4.95	2.85
DISSIPATION FACTOR 10^6 Cycles	0.026	0.026	0.019	0.018	0.0006
ARC-RESISTANCE (Seconds)	10	10	60	80	180
TENSILE STRENGTH (psi.)	16,000 x 13,000	14,000 x 11,000	46,000 x 42,000	48,000 x 44,000	23,000 x 21,000
FLEXURAL STRENGTH (psi.)	21,000 x 18,000	19,000 x 16,000	60,000 x 55,000	75,000 x 65,000	13,000 x 11,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.40 x 0.35	0.40 x 0.35	6.5 x 6.0	13.5 x 11.5	6.0 x 5.0
COMPRESSIVE STRENGTH flatwise (psi.)	28,000	27,000	60,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Cotton rag paper	Cotton rag paper	Fine-weave, medium-weight glass cloth	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural greenish	Natural Brown	Natural	Natural	Natural

All these standard grades are available with 0.0014", 0.0028", 0.0042", or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*duPont Trademark

CONTINENTAL DIAMOND FIBRE

CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.

NEWARK 16, DELAWARE

will help to supply Canada's growing needs for industrial power supplies and control systems as well as supply her Air Force and Navy with control and communications apparatus.

Other products to be manufactured at the new plant wlil include water conditioning equipment, magnetic amplifiers, rectifiers, servosystems, sonic tank gauging equipment and bearing temperature monitors.

The structure has approximately 80,000 sq ft under one roof. When the plant is in full production it will employ about 350 persons. Thomas Trumbour is factory manager.

RCA Selects Semiconductor Head

ALAN M. GLOVER has been appointed general manager of the newly created RCA semiconductor division.

A new $3 million plant to house semiconductor engineering and additional manufacturing facilities is being erected at Somerville, N. J., and until it is completed in 1956, Dr. Glover will make his headquarters at the RCA plant in Harrison, N. J.

He joined RCA in 1936 as an engineer on the development of phototubes. From 1941 to 1950 he acted as manager of gas tube and phototube engineering. In 1950 he was made manager of power tubes, product administration, and in 1953 he became manager of controls and

Alan M. Glover

standards in the power tube and cathode ray tube operations department. A year later he became manager of the semiconductor operations department.

General Mills Promotes Engineers

AIRCRAFT and missile systems will receive greater emphasis in a staff reorganization by the mechanical division of General Mills.

Cledo Brunetti, as director of engineering, research and development, takes over the position vacated by Frank B. Jewett, Jr., who is leaving to become a vice-president of Vitro Corporation of America.

Dr. Brunetti had been director of research and development. Now he acquires responsibility for production engineering also.

Carl L. Kober, World War II German radar and guidance expert, becomes associate director in charge of systems engineering, research and development. He had been manager of systems analysis.

John E. Barkley becomes associate director of research and development. He had been manager of physics and chemistry research and now adds administrative responsibility for mechanical and electronics research.

Sperry Rand To Build In Arizona

SPERRY RAND CORP. plans the construction in Phoenix, Ariz. of an advanced flight research center and modern plant to develop and manufacture electronic equipment for civil air industry and the military services.

Included in a three-part industrial development package will be a modern hangar and shop space at Sky Harbor Airport, utilization of a former USAF auxiliary airfield and a plant and engineering facility in the Greater Phoenix area. The firm plans initially to construct hangar and shop space on a 40-acre tract of leased land at Sky Harbor Airport.

The shop and hangar, expected to be completed within a year, will be used in connection with the company's long-range programs for developing automatic flight and engine control equipment. Initial plans for a factory and lab building are being drawn and construction is expected to begin within 12 months

A. R. Weckel, vice-president, has been named to the new post of manager, special missile system division of Sperry Gyroscope Co. He will have charge of all engineering, manufacturing and contract activities of the large-scale Sparrow I air-to-air missile program for the U. S. Navy. In addition, the new division will be assigned supervision of other large-scale missile programs.

Weckel, vice-president and general sales manager until this new assignment, is a Sperry veteran of 21 years. He has been general sales manager since 1950 and a vice-president since 1955.

IRC Elects Ehle And Marsten

INTERNATIONAL RESISTANCE CO. elected Harry A. Ehle as executive vice-president and Jesse Marsten as senior vice-president.

Ehle, formerly vice-president of sales and advertising, left Campbell Soup Co. to join the IRC organization in 1931 as foreman of its wire wound department. He became a member of the IRC sales staff in 1935 and, in 1938, was promoted to the position of assistant to the president, which he held until 1942 when he was elected to the vice-presidency. He is a member of the

Harry A. Ehle

Jesse Marsten

IRC board of directors and executive committee.

Marsten has been actively engaged in IRC expansion for the past 25 years. He joined the company in 1930 as chief engineer and was elected to vice-president of affiliates and engineering in 1939. He is a member of the IRC board of directors and executive committee. Prior to IRC, he was associated with Marconi Wireless Telegraph Co., RCA and Freed Eiseman Radio Corp.

Kaye Appointed Transdyne President

LEOPOLD M. KAY has been appointed president of the Transdyne Corp. For eight years he was with CBS-Columbia and its predecessor, Air King Products Co., as vice-president for engineering. Prior to this, he was associated with Lear, Raytheon, Airadio and Pilot Radio Corp. in engineering activities.

Transdyne recently opened a new building in Maspeth, New York City. The plant will concentrate in the fields of nuclear instrumentation, information storage and handling and nuclear research equipment.

Ramo-Wooldridge Plans Expansion

RAMO-WOOLDRIDGE Corp. of Los Angeles has secured options on 800 acres of land in the southern part of Denver, Colo. to provide for the future erection of a $5,000,000 manufacturing facility.

The acquisition of the Denver site is part of a long range expansion program and will eventually provide a plant for the quantity production of electronic systems. It will employ 300 to 500 persons. According to the firm, the work to be done at Denver, while still undetermined, is not expected to have any relation to activities known to be planned by any other companies for the Denver area.

Present Los Angeles facilities of Ramo-Wooldridge in the International Airport district consist of more than 300,000 sq ft of laboratory space devoted to research and development activities in advanced electronics and in the field of guided missiles.

The company recently announced the acquisition of an additional 41 acres of land near the Los Angeles International Airport for the expansion of its research and development facilities. A 60,000 sq ft plant is to be built on the site. Construction may begin around mid-1956.

Sylvania Selects Two Engineers

EDWIN G. SCHNEIDER has been appointed chief engineer of the electronic systems division of Sylvania Electric. Sherrerd B. Welles was named manager of the missile systems lab.

Dr. Schneider has responsibility for advanced system programs, engineering and research planning and liaison with professional and military organizations. His office is in division headquarters at the Waltham Laboratories.

Previously, he was manager of the missile systems laboratory, which is part of the new Waltham Laboratories. He joined Sylvania in 1954 as technical director of the missile systems laboratory.

Before that he was, for three years, director of the electronic research directorate of the U. S. Air Force Research Center at Cambridge, Mass. From 1947 to 1951, he was director of Project Meteor, a guided missiles project which was conducted for the U. S. Navy's Bureau of Ordnance by MIT.

Dr. Welles joined Sylvania a year ago as manager of the electronics department of the missile systems laboratory. In his new assignment, he succeeds Edwin G. Schneider.

Before coming to Sylvania, Welles was acting deputy for components and techniques of the electronics directorate at the U. S. Air Force's Research Center in Cambridge, Mass.

Anton Electronics Names Engineers

MYRON YOUDIN has been named vice-president and assistant director of research and development at Anton Electronic Laboratories of Brooklyn, N. Y. The company also announced appointment of Adolph Lovoff as general manager of the instrument division.

Myron Youdin

Youdin was formerly executive assistant to Nicholas Anton, president and director of research of the firm.

Lovoff joins the staff from the engineering division of Vitro Corporation of America, where he worked with Argonne National Laboratory personnel in evaluation of economic, nuclear and heat transfer aspects of boiling water reactors.

IBM Plans New California Plant

INTERNATIONAL Business Machines Corp. will call for bids early in 1956 for a multi-million dollar plant to be built on a 190-acre tract near San Jose, Calif. The "campus" type layout will include a card plant, manufacturing building, school, product engineering building, administration building and research laboratory. The company's existing card plant and research laboratory at San Jose will be consolidated into the new plant.

Raytheon Opens Lab, Promotes Engineers

RAYTHEON opened its new industrial electronics laboratory in Wayland, Mass.

The two-story brick structure is situated on a 73-acre site. It will be used for engineering and development of advanced electronics equipment for both government and commercial applications. Total floor space is approximately 225,000 sq ft. Approximately 1,200 employees are housed in the new building.

The Wayland laboratory was begun on November 29, 1954. It cost approximately $2,500,000. Engineering activities which were formerly carried out in seven separate localities have been consolidated in the Wayland building.

Raytheon also announced that Niles P. Gowell has been named chief engineer of its receiving tube division.

He will be responsible for all engineering functions of the division.

He joined Raytheon in 1928. During the intervening 27 years with the firm, he has held several positions of increasing responsibility, and just prior to his present appointment was head of the quality control and applications engineering departments of the division.

John M. Palmer has been appointed manager of manufacturing for the receiving tube division. He is responsible for production in the receiving tube plants at Newton and Quincy and for related functions such as process engineering, methods, scheduling and plant engineering.

He comes to Raytheon with more than 20 years' experience in tube manufacturing. He joined Sylvania Electric Company in 1933, and held various positions including that of chief industrial engineer and plant manager. In 1947 he joined Landsdale Tube Co., a subsidiary of

Philco, as plant manager, and later became general manager in charge of all phases of receiving tube, cathode ray tube and transistor operations.

In another move, Raytheon established a new division under its receiving and cathode ray tube operations, to be known as the special tube division with R. L. McCormack as manager. The new division, with headquarters in Newton, Mass., sets up separate facilities and has responsibility for all non-entertainment type tubes including industrial and special-purpose types for guided missiles, aircraft, radar and other military and commercial applications.

McCormack reports to N. B. Krim, vice-president who heads the operations. McCormack joined Raytheon in 1938 after five years as a tube engineer in Sylvania's plant in Salem, Mass.

General Electric Changes Electronics Division

GENERAL ELECTRIC has realigned its organizational structure to better meet the needs of an industrial electronics business which is expected to double in size in the next five years.

The entire electronics division, except for home radio and tv sets, has been shifted from the Appliance and Electronics Products Group to the newly-named Electronic, Atomic and Defense Systems Group. Home radio and tv have been assigned to the newly formed Consumer Products Group along with all other of the firm's major consumer products such as major appliances and housewares.

The electronics division gains six company components operating in the field of producer's and military electronics and an industrial electronics, laboratory, an industrial computer section and an electronics business study. The six new units include the specialty control department, the x-ray department, the naval ordnance department, the special defense projects department, the aircraft products department and the Schenectady aeronautic and ordnance operation.

W. R. G. Baker, vice-president of

I. J. Kaar

GE and general manager of the electronics division, said that the manufacturing facilities of the businesses assigned to the electronics division will not be affected by the organizational realignment. He said that no movement of the six new electronics division units nor of the manufacturing facilities of the radio and tv home receiver units is planned or contemplated.

GE also announced the establishment of a color system technical project to integrate the activities of its several departments involved in the color tv field. I. J. Kaar, formerly electronics division manager of engineering, was named by Dr. Baker to head the project. Kaar has been with GE for 30 years. He has served as section head in charge of high-power transmitter engineering, engineer in charge of all receiver developments, manager of the radio and tv department and manager of the engineering department of the electronic division.

GE also announced that John B. Russell has been appointed manager of the engineering analysis sub-section of its electronics laboratory in Syracuse, N. Y.

Dr. Russel joined the laboratory as a consultant in July of this year coming from Columbia University where he was head of the department of electrical engineering.

Honeywell Opens Denver Plant

A NEW $1 million manufacturing plant for the Heiland division of Minneapolis-Honeywell was recently opened. The new plant, a one-story, 45,000 sq ft structure, is located on a nine-acre plot in Arapahoe County, on the outskirts of Denver.

General Precision Promotes Reichel

W. A. REICHEL has been appointed to the newly created post of senior vice-president in charge of engineering for General Precision Equipment Corp. He is a director of General Precision and executive vice-president of GPE's subsidiary, Kearfott Co. He is also a director of several other GPE subsidiaries.

Prior to joining Kearfott in 1944, Reichel had been director of engineering of Eclipse-Pioneer, division of Bendix Aviation.

GPE also announced plans to acquire a majority of the outstanding stock of Shand and Jurs Co. of Berkeley, Calif.

S & J products, ranging from simple hatch and manhole covers to complex electronics instruments, are sold principally to the petroleum and chemical industries in the U. S. and overseas. Sales of the company for the year 1955 are estimated at $2,500,000.

General Precision is a management company with twenty-one subsidiaries whose principal activity is the design and production of instruments, components and systems for industry and defense.

WCEMA Councils Elect Officers For 1956

THOMAS P. WALKER has been named to head the Los Angeles Council of the West Coast Electronic Manu-

facturers Association for 1956. The Association includes more than two hundred member companies.

Winfield G. Wagener of Varian Associates in Palo Alto, Calif. was elected to head the San Francisco Council of the Association.

Walker is vice-president of the Triad Transformer Corp. and also senior partner in the law firm of Walker, Curry, Eilers, and Wehrle. He has been a director of the Association for two years, and chairman of its legal committee.

Named to the post of Los Angeles Council vice-chairman is Hugh P. Moore, board chairman of Lerco Electronics, Burkank electronics manufacturer. Secretary-Treasurer of 1956 is D. C. Duncan, vice-president and general manager of Helipot Corp., a division of Beckman Instruments.

The new directors of the Los Angeles association, also named for 1956 terms, include S. H. Bellue, chief of material at Hughes Aircraft Co.; Hugh F. Colvin, vice-president and general manager of Consolidated Electrodynamics Corp.; Paul R. Repath, president of Paul R. Repath Co.; and Gramer Yarbrough, sales manager of American Microphone Co.

Elected to the post of vice-chairman of the WCEMA San Francisco Council is Calvin K. Townsend, general manager of Jennings Radio Manufacturing Co. of San Jose.

New secretary-treasurer is J. A. Chartz, general manager of Dalmo Victor in San Carlos.

Directors-at-large for 1956 are: Andrew Gould of Friden Calculating Co.; G. I. Long of Ampex Corp.; H. Myrl Stearns of Varian Machine Associates and Douglas C. Strain of Electro-Measurements.

CBS-Columbia Names Engineers

A PLANNED program of expansion of the engineering department of CBS-Columbia was announced by R. T. Capodanno, vice-president in charge of engineering.

William Vassar was recently named director of engineering, the first step in the program.

Other additions to the engineering department include Ludwig

Zucker as chief mechanical engineer. He has had more than 28 years of experience in the electronics field, and has held positions as chief mechanical engineer with several other electronic manufacturers.

Walter Lukas has been named chief electrical engineer and is responsible for all television projects, components engineering and advanced development. He brings to his new post more than 14 years in electronics experience.

Martin Perry has been appointed chief radio engineer.

Harold H. Knubbe, with the company since 1952, has been promoted to the newly established post of technical assistant to the vice-president in charge of engineering. The move represents a wide extension of his present responsibilities within the department. He has been in the electronics industry for the past 24 years.

Israel J. Melman, chief television engineer, will supervise developmental black-and-white and color tv projects. He has been with the firm since 1950.

Bernard Klibanner has been named supervisory mechanical engineer for both radio and tv products under the new realignment. He has had more than fifteen years of experience in electronics mechanical engineering work.

Lockheed Promotes Louis Ridenour

LOUIS N. RIDENOUR, has been appointed director of the research laboratories of Lockheed's missile systems division in California.

He was formerly program development director at the missile division and has been associated almost a year with the entire scope of the division's work.

In taking over active direction of the division's research activities, Ridenour revealed that the research program will continue to expand substantially—both in scope and facilities.

"The division's company-sponsored program of basic research, exclusive of contract research, will be stepped up very appreciably—I might say by several hundred percent—over 1955's program." Ridenour said.

Dr. Ridenour, who was U. S. Air Force chief scientist, was chairman of the USAF Scientific Advisory Board Committee, which surveyed Air Force research and development activities. The resulting Ridenour Report led to establishment of the office of Deputy Chief of Staff, Development, and also the Air Research and Development Command. He headed development work at MIT's radiation laboratory leading to the SCR 584 radar system.

He has also served as consultant to the Office of the Secretary of War and as professor of physics and dean of the Graduate College of the University of Illinois.

Hobson, Zarem Leave Stanford Research

JESSE E. HOBSON, director of Stanford Research Institute, Menlo Park, Calif., since March 1948, has submitted his resignation, effective March 31, because of ill health.

SRI's board will start looking for a successor early this year, according to Dr. Wallace Sterling, chairman of the board and president of Stanford University.

During the nine years Hobson has been in charge of SRI, it has grown from a staff of 50 people and annual research rate of $250,000 to a staff of 1,200 and an annual rate of $10.5 million in active commercial and government contracts.

Immediately before his appointment to SRI, he was director of

Armour Research Foundation for four years.

Stanford also announced that A. M. Zarem has resigned his positions as assistant director and manager of the Southern California division of the Institute to enter the field of private consulting.

Dr. Zarem intends to establish an office in Los Angeles to engage in independent research counseling and advisory services to business and industrial management. He has been with SRI since August, 1948.

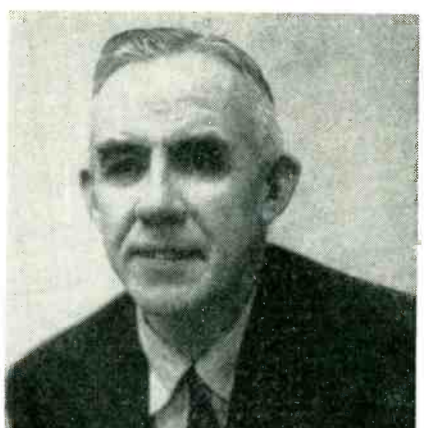
He invented an automatic electronic control system for operating high speed photographic equipment, a camera shutter capable of framing rates up to 100,000,000 per second, an electromechanical servo system and an electrical control method for monitoring power systems and indicating faults.

Marvelco Appoints Research Director

HANS E. HOLLMANN has been appointed as director of research of the Marvelco electronics division of National Aircraft Corp.

Dr. Hollmann formerly was research scientist for Hydro-Aire electronics division, recently acquired by National Aircraft Corp. From 1947 to 1954 he served as the sole research scientist at the Naval Air Missile Test Center, Point Mugu, Calif.

In Germany, Hollmann managed his private research institute and acted as research consultant to Telefunken, Siemens and other companies. After World War II he became professor of high-fre-



Hans E. Hollman

quency and electromedicine at the Friedrich Schiller University in Jena, East Germany, but left in 1947 to avoid being transferred to Russia. He came to this country under the sponsorship of the U. S. Government.

Clevite Promotes Research Head

S. J. BEGUN, vice-president and director of the Clevite Research Center, has been appointed director of marketing for Clevite Corp.

In his new position he will supervise the company's patent and market research departments as well as help coordinate the development of new products and new markets in this country and abroad. The previous director of marketing was Willard W. Brown, now president of the company's Cleveland Graphite Bronze division.

Born and educated in Europe, Dr. Begun began his career in Germany working on telephone circuits and electro acoustics. During this period he designed a new commercially practical magnetic wire recorder.

After coming to this country in 1935, he designed an endless-tape magnetic recorder for such uses as automatic weather announcements and voice training.

He joined the Brush Development company in 1938.

Electro Engineering Builds New Plant

ELECTRO ENGINEERING WORKS of Oakland, Calif. has broken ground for construction of a new building to house their development and manufacturing facilities. The firm manufactures precision transformers. The new 15,000 sq ft manufacturing facility will be located in San Leandro, Calif. Plans have been drawn for later construction of a 4,000 sq ft office building, in addition, on the two- and one-third acre plot purchased by Electro. Total cost for building and equipment is estimated at over $300,000. Electro Engineering employs about 70 people at the present time and the new construction will permit an

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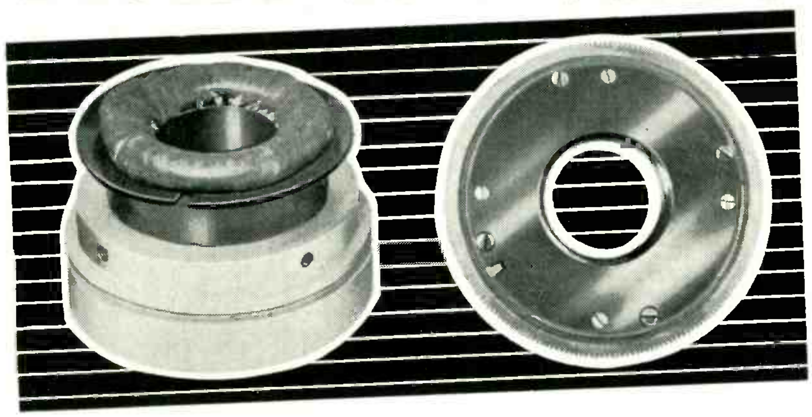

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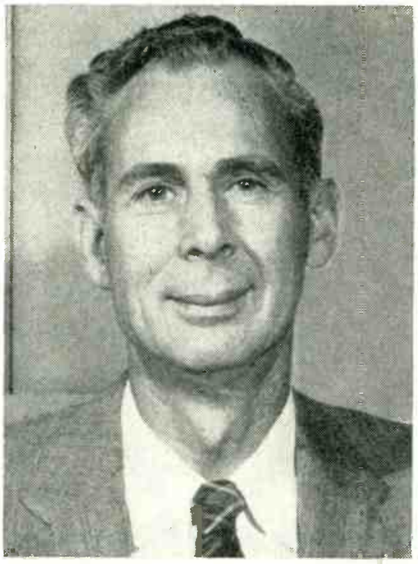
increase to over 100 employees. L. W. Wahlgren is president of the firm. Secretary-treasurer and business manager is A. W. Fry. James J. Holloran is vice-president and chief engineer.

Fairchild Camera Names Chaffee



FAIRCHILD Camera and Instrument Corp. announced the appointment of Milton A. Chaffee as director of electronics and systems research.

He was formerly deputy director of systems at the Air Force Cambridge Research Center in Cambridge, Mass. During World War II, he was a member of the research staff of the Radiation Laboratory at MIT.

From 1945 to 1950 he was associated with Airborne Instruments Laboratory as supervisor of field service. He served as development planning officer for the Deputy Chief of Staff for Development, U.S.A.F. from 1950 to 1952.

During the Korean War he acted as chief civilian scientist of the Commanding General of the Far Eastern Air Force and aided in the operational use of ground control radar in Korea.

Eitel-McCullough Selects McAulay

WILLIAM MCAULAY has been named manager of application engineering of Eitel-McCullough in San

Bruno, California.

He joined the Eimac field engineering department in 1954 as an assistant in the division he will now head. He has been active in the broadcasting and electronics fields for many years.

Automatic Electric To Build $16 Million Factory

A NEW, multimillion-dollar factory, research laboratory and general office structure will be erected by Automatic Electric Co. on the 170 acre site of the former Westward-Ho golf course in Northlake, Illinois.

The new facility is expected to cost in excess of 16-million dollars and be completed by late 1957.

The overall structure will contain approximately 1,300,000 sq ft, or 29 acres of floor space.

Facilities devoted to factory operations will be on one floor, with a straight line production flow from the receipt of supplies and raw materials to the shipment of the finished product.

Research and development laboratories together with the general, administrative, engineering and sales offices will be housed in a building of some 300,000 sq ft.

When the new factory is completed, the company will be able to consolidate into one facility all of its Chicago operations, which are now housed in fourteen different buildings.

Boyle Metalcraft Appoints Lloyd

W. C. LLOYD has been appointed vice-president of Boyle Metalcraft Corp. of Brooklyn, N. Y.

He was formerly connected with Westinghouse meter division and with General Electric Co. of Bloomfield, N. J. in engineering and testing.

Continental Can Forms Physics Group

PAUL ERLANDSON, former chairman of the physics department and assistant vice-president of Southwest Research Institute of San Antonio, Texas, has been named director of the department of physics of Continental Can Company's new central research and engineering division. The division will ultimately employ 75 professional scientists and 25 administrative personnel.

In his new position, Dr. Erlandson will head the company's experimental work on the application of the principles of physics to the high speed automatic equipment used in manufacturing and closing containers and closures, as well as to its future ionizing radiation sterilization program.

American Bosch Promotes Giba

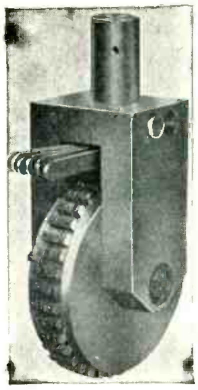
JOHN J. GIBA has been appointed vice-president in charge of the newly created contracts division of American Bosch Arma Corp. His first position was that of electrical designer at Arma, beginning in 1932. He had been assistant chief engineer since 1954.

Burns Appointed Chief Engineer Of El-Tronics

MERYL C. BURNS has been appointed chief engineer of El-Tronics

In 1947, he joined the Berkeley Scientific Corp. as a project engineer and the following year was promoted to chief engineer.

He left that company in 1952 to organize the Digital Instrument Co. in Coral Gables, Fla. Two years later he sold the business to Brush



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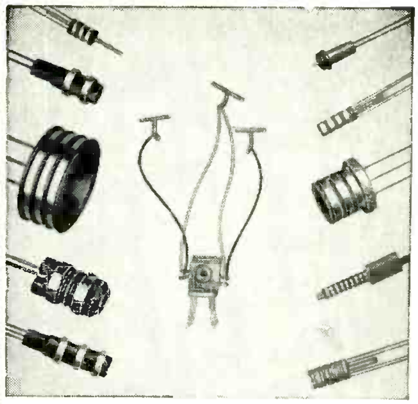

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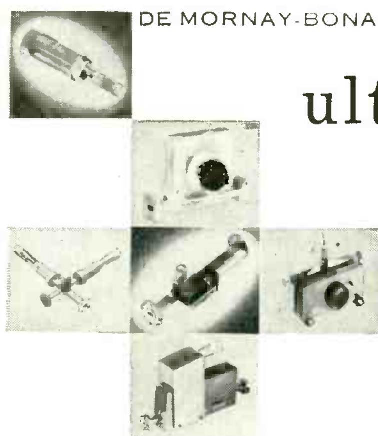

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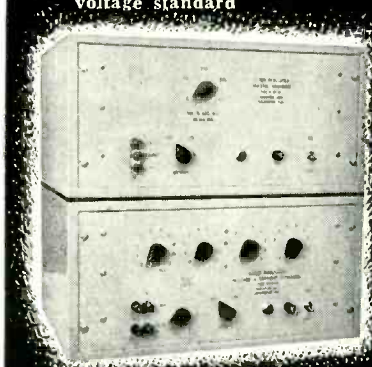

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Electronics and was in charge of development and production design of digital type equipment for that firm at the time of his new appointment.

Lambda Electronics Builds New Plant

LAMBDA ELECTRONICS CORP. is building a new plant in College Point, N. Y. The firm manufactures regulated and unregulated d-c power supplies.

The new building will be ready for occupancy in mid-summer. The company contemplates further expansion of its product line in 1956, including a possible entrance into several new fields of manufacture.

Potter & Brumfield Elevate Smith

ZEKE R. SMITH has been appointed chief engineer of applications for Potter & Brumfield of Princeton, Ind. For the past two years he has been manager of the Chicago office of Potter & Brumfield. He was formerly associated with the Kansas City division of Bendix Aviation Corp. as a components engineer. During World War II, he was a radar instructor with the U. S. Air Force and later was associated successively with the Airborne Instruments Laboratory, Philharmonic Radio Corp. and Air King Products Co. Before joining Bendix he was engaged in electronic engineering projects at Wilcox Electric Co. and the Vendo Co.

Hupp Acquires Pioneer Research

THE HUPP CORP. acquired the business and assets of the Pioneer Electric and Research Corp. of Chicago, an electronics firm engaged in manufacturing and research operations.

Pioneer Electric and Research has developed and is now manufacturing remote control equipment using new electronic techniques. The equipment, which is primarily being used in teletypewriter communication facilities, also permits central control of remotely located teletypewriters on a common circuit.

It is planned to adapt the equipment for telemetering, television program switching, power transmission control, pipe line regulation, railroad signal control and other related fields.

The business of Pioneer will be conducted as the Pioneer Electronics Division of Hupp, with J. J. McEnerney continuing as president.

Burroughs Appoints Services Manager

JOHN H. HOWARD has been appointed manager of the engineering services division of Burroughs research activity. He is presently associate director of research and will replace DuRay E. Stromback who has been named engineering manager of the Plymouth plant. In his new position he will direct the division which supplies drafting, fabrication, components engineering, testing and other technical services.

Before coming to Burroughs as a senior research engineer in 1950, Howard had served as director of development of Engineering Research Associates, Inc. and as project engineer with the Sperry Gyroscope Co. He was appointed associate director of the activity in 1953.

John H. Howard

Want more information? Use post card on last page.

New Books

Principles of Guided Missile Design—Guidance

By Arthur S. Locke. *D. Van Nostrand Company, Inc., New York*, 1955, 729 *p*, $12.50.

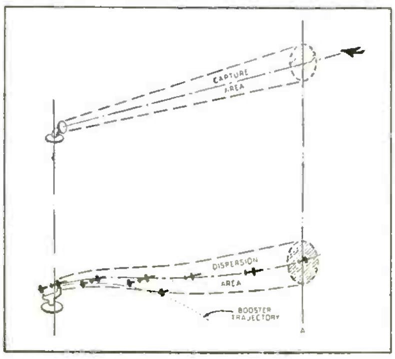
Some of the most sophisticated electronic engineering is being carried on in the field of guided missiles. Little has been published heretofore on the subject.

▶**Scope**—This book gives no aid nor comfort to potential enemies nor is it the author's intention so to do. He does, however, perform a useful service in assembling the body of scientific and engineering knowledge bearing on problems of missile guidance. This will provide the engineer entering the field with an intellectual groundwork from which he can approach classified literature that will later be made available to him.

▶**Content**—The first chapter orients the reader by discussing the tactical employment of missiles and broadly stating the guidance problems that arise.

In Chapter 2, the author deals with prior developments in the field. These include conventional autopilot systems, electronic navigation, radio control of glide bombs, preset control as used in the German A-4, and the German command guidance system which used audio tones.

The book then delves into some physical and mathematical considerations basic to design of missile guidance systems. This includes material on propagation of electromagnetic waves—radio and infrared—transform analysis and theory



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of servomechanisms. A chapter on tactical considerations introduces the reader to some statistical concepts and then proceeds to cover in greater detail much of the same ground as Chapter 1.

Chapters 9 and 10 on transducers, modulation systems and microwave components are thorough.

► **Analysis**—Chapters on target considerations and analyses of flight plans are highly mathematical.

The concluding chapters on guidance systems, bandwidth considerations and telemetry contain much interesting information.

► **Evaluation**—The book is interesting as a "first" in a vastly intriguing field and does indeed contain information that every young missile guider should know.

Captain Grayson Merrill, USN, is editor of a five-book library on guided missile design. Forthcoming volumes will treat aerodynamics, propulsion and structure; armament, launching and range testing; operations research and systems engineering; and space flight.—J.M.C.

Electrical Measurements and Measuring Instruments

BY E. W. GOLDING. *Pitman Publishing Corp., New York*, 1955, 913 *p*, $10.00.

MEASURING instruments described in this book are, for the most part, nonelectronic. Instruments discussed include ammeters and voltmeters, wattmeters and watt-hour meters and instruments for measuring power-line frequencies.

The book begins with discussion of electrostatic and electromagnetic theory and electrical circuit analysis. The author then introduces the reader to inductance and capacitance and methods for measuring these quantities. There follows a chapter on resistance measurement and use of a-c and d-c potentiometers. These latter sections contain some particularly good material on the various kinds of bridge circuits and when to use them.

► **Other Subjects**—Measuring techniques for several other physical quantities are described including: magnetism, illumination, high voltage and temperature. Material on eddy currents and their effects, waveforms and transients is particularly timely.

Electronic instruments discussed in the bulk of the book include: photometers, harmonic analyzers, the cathode-ray oscillograph, vacuum-tube voltmeters, self-balancing slide-wire potentiometers, stabilized power supplies and a photoelectric tachometer.

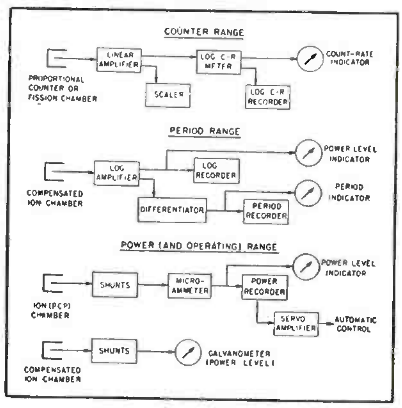
▶ **Electronics**—The last chapter of the book, 35 p, deals specifically with electronic instruments. The author leads off with a brief discussion of the properties of the vacuum tube followed by the characteristics of diodes, triodes, tetrodes, pentodes and thyratrons. Included are discussions of servomechanisms, negative feedback and velocity feedback. Specific circuits described are the pentode amplifier, cathode follower, servo amplifier, counting rate meter, Q meter and electronic counter.

Although the book contains information of interest to both the user and designer, its format tends to favor the user. —J.M.C.

Principles of Nuclear Reactor Engineering

BY SAMUEL GLASSTONE. *D. Van Nostrand Co., Inc., New York,* 1955, 861 *p,* $7.95.

WRITTEN for the practicing engineer as well as for the senior and graduate engineering student, this book is intended to present the basic scientific facts of nuclear reactor engineering in maximum breadth and in as much depth as is



Instrumentation for reactor control

permitted by the size of the book.

Of special interest to the electronics specialist will be the chapters entitled: Nuclear Reactor Instrumentation, Control of Nuclear Reactors, and Radiation Protection (section on radiation survey instruments).

These three chapters give rather complete coverage of the electronic instruments which are presently in use on and around nuclear reactors. It would, however, be unfortunate if the reader gained the impression that most of these instruments were needed in the operation of any one reactor, since there still exists, in fact, a need for simplification of such equipment.

There is a good treatment of reactor safety systems. The author delves sufficiently into the philosophy of reactor safety to intrigue the neophyte and to start arguments among the old-timers.

To summarize: a well-balanced, meaty contribution.—JOHN E. BINNS, *Reactor Operations Division, Brookhaven National Laboratory, Upton, N. Y.*

Thumbnail Reviews

Office Automation. Richard Hunt Brown Automation Consultants, Inc., New York, 283 p, $12.50 (loose-leaf). Includes six main sections: commercial, hardware, accounting, socialogical, scientific and developmental. Highly interesting hardware section provides key information on electronic and integrated processing equipment currently available. Publisher will keep material current on a service basis.

Control of Nuclear Reactors and Power Plants. M. A. Schultz. McGraw-Hill Book Company, Inc., New York, 313 p, $7.50. Discusses theory and operation of automatic reactor and nuclear power plant control mechanisms. Considers radiation detectors and operational control problems over the complete cycle of operation. Schematic diagrams illustrate appropriate electronic circuits especially those used in problem simulation.

Two Hundred Miles Up. J. Gordon Vaeth. Ronald Press Company, Inc., New York, 261 p, $5. A discursive account of upper atmosphere research, covering balloons, rocket experiments at White Sands and plans for the minimum satellite vehicle. One chapter discusses instrumentation for upper atmosphere research.

Radio-Tube Vade-Mecum. P. H. Brans, Antwerp, Netherlands, 1955, 381 p. Twelfth edition of list of all the world's radio tubes.

Backtalk

Cathode-Compensated Amplifiers

DEAR SIRS:

IN THE article by J. Millman and H. Taub on cathode-compensated amplifiers (p 156, Nov. 1955, ELECTRONICS) and in the article by H. Taub et al (p 143, same issue) it is claimed that this style of amplifier has the advantages of gain stability, linearity, and increased output with less plate current, over the uncompensated amplifier.

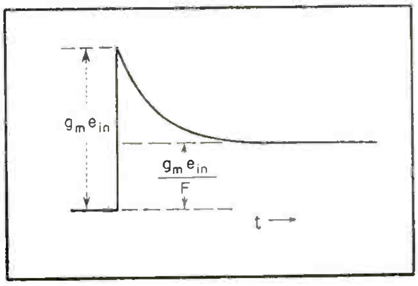
While the cathode-compensated amplifier does have certain virtues, it is important to remember that the improvements are obtained only at frequencies and for rise times for which the feedback is effective. Near the upper frequency limit of the uncompensated amplifier, the impedance of the cathode capacitor begins to reduce both the feedback and its resulting improvements.

In particular, at high frequencies, these amplifiers cannot produce an output greater than that of an uncompensated amplifier of equal plate current. This is true even though they may have full output at low frequencies and full bandwidth at low amplitudes.

For example, in Millman's output amplifier, the cathode impedance at 3.7 mc is less than 80 ohms, reducing the $1+g_mR_k$ factor to about 1.8, from a value of about 5 at mid-frequency.

The output capabilities of this style of amplifier are correctly given in Valley and Wallman's Vacuum Tube Amplifiers, p 104, in general terms. For a more explicit understanding of the action, it is instructive to calculate the plate current which flows in response to a voltage input step. It is

$$i(t) = \frac{g_m e_{in}}{F}\,[1+(F-1)\exp(-tF/T)]$$



where $F = 1+g_mR_k$, the factor by which the gain is reduced and the bandwidth extended, and $T = C_kR_k = C_LR_L$

The plate current consists of the constant amount $g_m e_{in}/F$, plus a current peak whose initial value is $\frac{F-1}{F} g_m e_{in}$. Hence, just after a voltage input step, the current must swing by $g_m e_{in}$, exactly the same as it must in the uncompensated case. If the tube cannot supply the current, the output will distort. In some cases, the output current can be supplied in response to a positive step, if the factor F is not too large, but in the usual situation, the tube will cut off on a large, sharp, negative step.

Another way of looking at it is to regard the purpose of a video voltage amplifier as generation of a video voltage across the output capacitance. This obviously requires the passage through the output capacitance of a certain a-c current, which must be generated by the tube.

While it is true that for a given tube current, the d-c output voltage may be increased by raising the load resistance, in the a-c case the voltage must be developed, not particularly across the load resistance, but across the load capacitance, which is fixed, and there is therefore no alternative but to pass this current through the tube.

W. F. SCHREIBER
Research Department
Technicolor Motion Picture Corporation
Hollywood, California

Transistor Symbol

DEAR SIRS:

IN the December edition of ELECTRONICS it was suggested by Mr. William G. Shepard in a letter in *Backtalk* to employ the symbol, XR, to designate transistors on schematic diagrams.

In the interest of reducing complex symbol notation in equipment stenciling and equipment publications, and to prevent misinterpretation, I suggest a single letter, Y, which has not been used previously by the military and industry to represent a particular electrical element in equipments or on schematic diagrams.

My objection to the symbol XR is that in the event an equipment employs a plug-in resistor (an idea not completely remote) the symbol for the plug-in resistor socket would be XR. Also, insignificant as it may seem, the hand lettering or type setting of two letters instead of one would raise the cost of equipment publications which is at present an all-time high. Furthermore, the symbol for a plug-in transistor socket would become XXR, a needlessly long symbol.

JULIAN M. SIENKIEWICZ
Project Engineer
McLaughlin Research Corp.
New York, N. Y.

EDITOR'S NOTE: The use of a single letter does seem desirable. Any other readers care to make suggestions?

Reliability Semantics

DEAR SIRS:

WHILE admiring American ingenuity in the coining of apt, succinct, and highly descriptive phrases, I feel driven to protest against the misuse of existing words of specific meaning when nothing is gained by so doing.

In American technical periodicals there has recently been a spate of articles on reliability. In these, the expression "expectation of life" (6 syllables) is rarely used. It is being replaced by a new and (to my mind) meaningless phrase "life-expectancy" (5 syllables).

"Expectancy" (in Britain, at least) means "full of expectation or anticipation" in the sense of the air of expectancy that precedes the rise of the curtain at a first night, and so indicates human emotion. While "expectation" does carry a shade of this meaning of personal anticipation, the expression "expectation of life" has long been accepted as denoting the probable length of time which will ensue before failure.

If syllables must be saved at all cost, I think that a better case could be made for "life expectance" if life must be adjectival. Personally, I would prefer to use "probable life" which has only four syllables.

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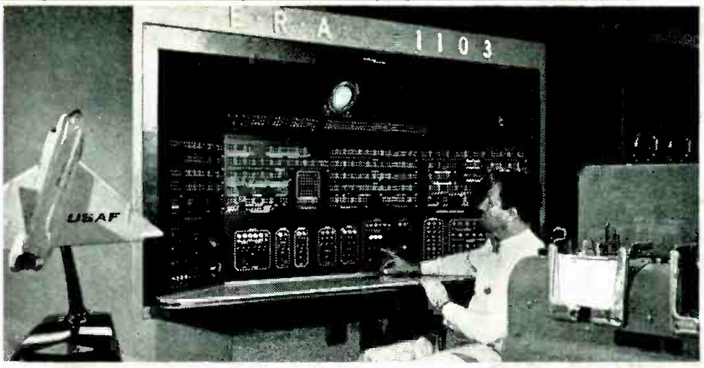

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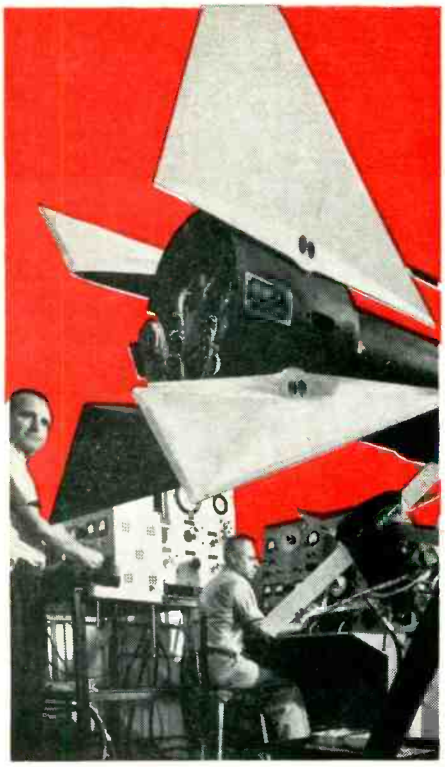

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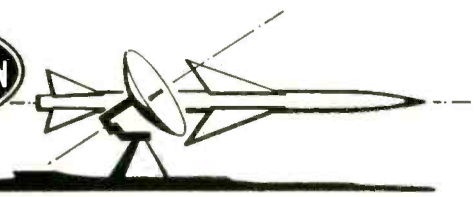

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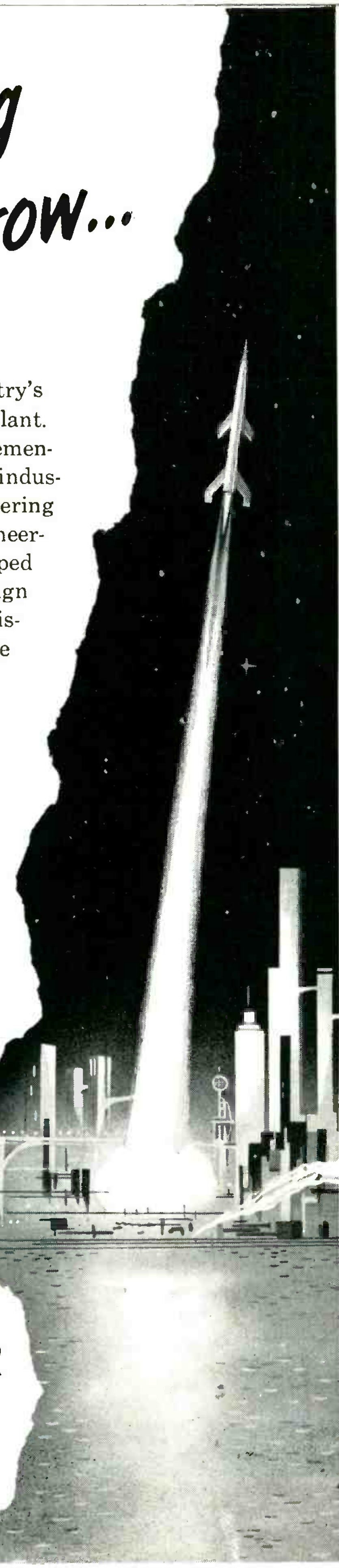

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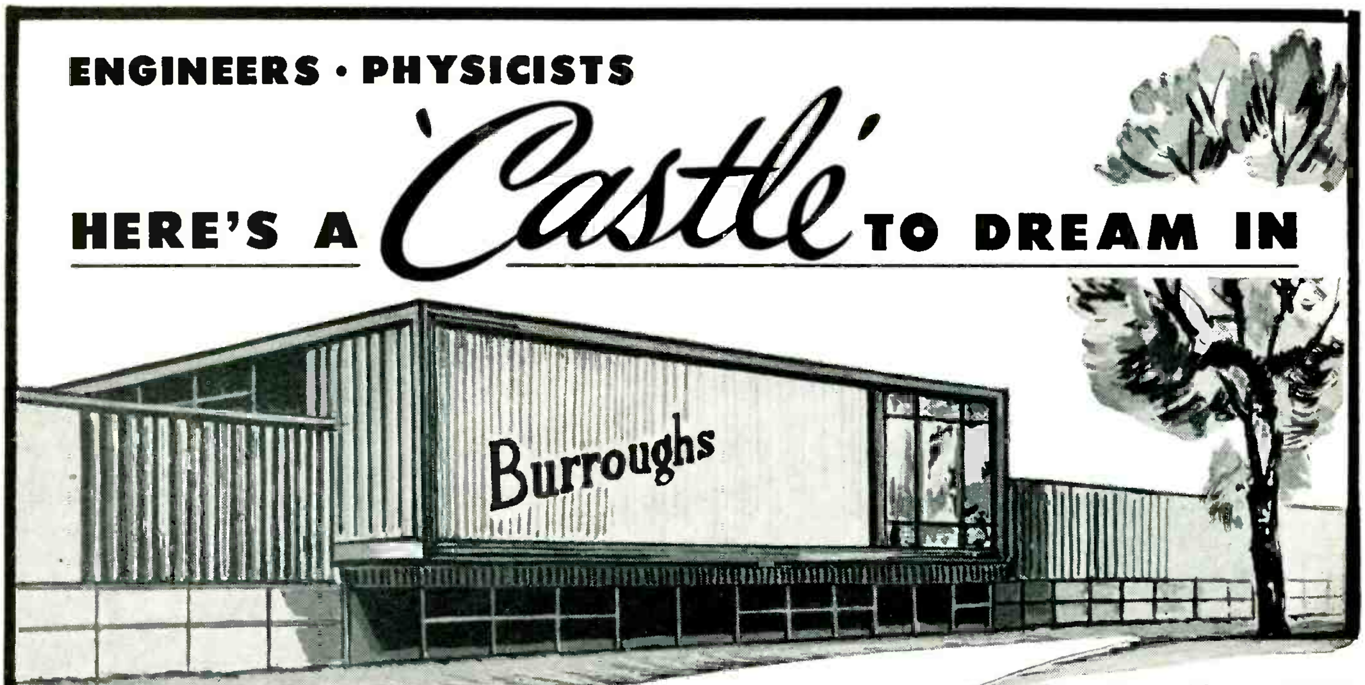

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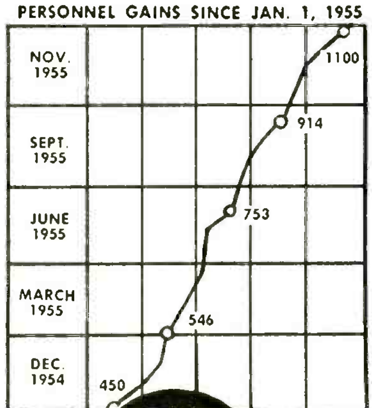

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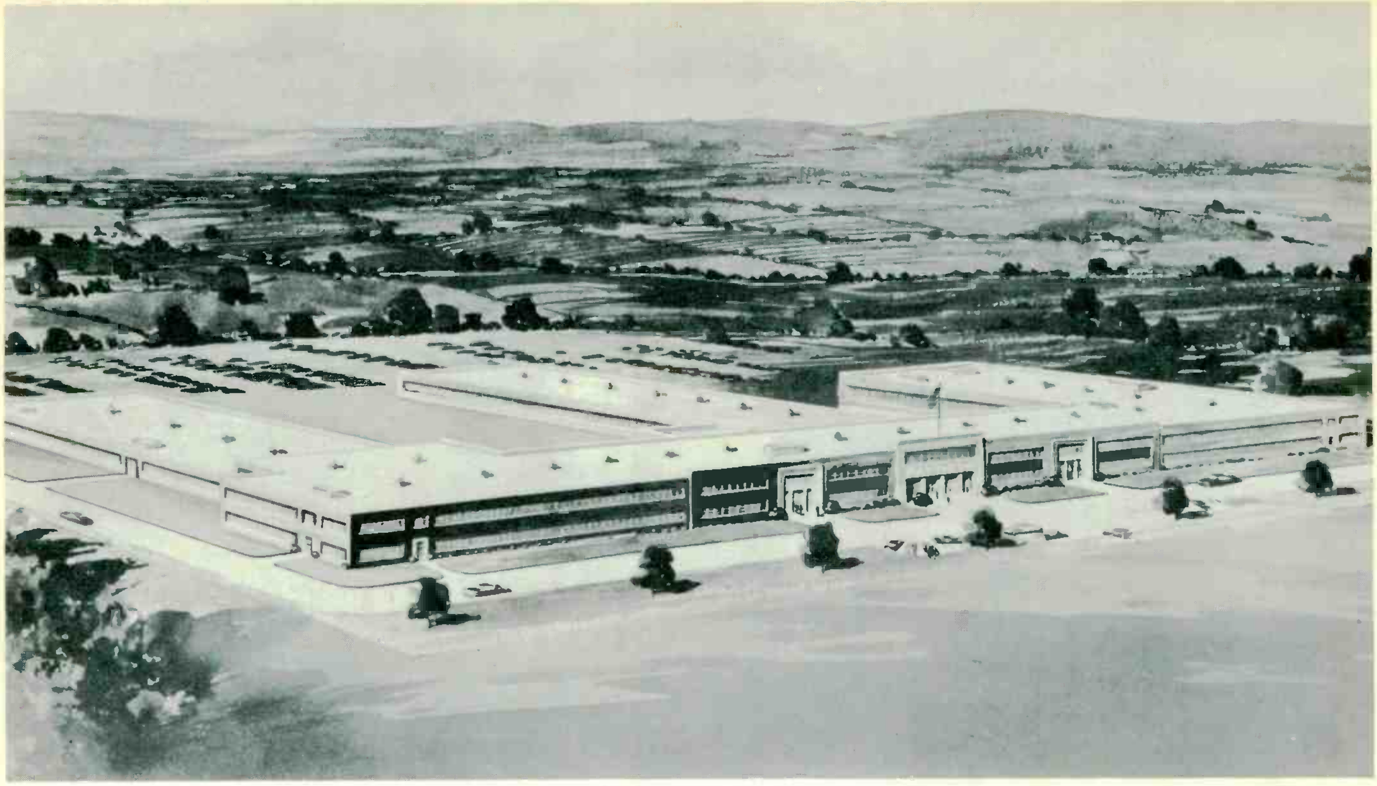

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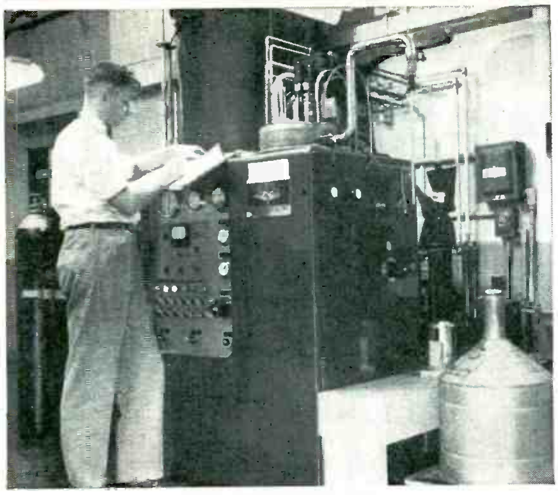

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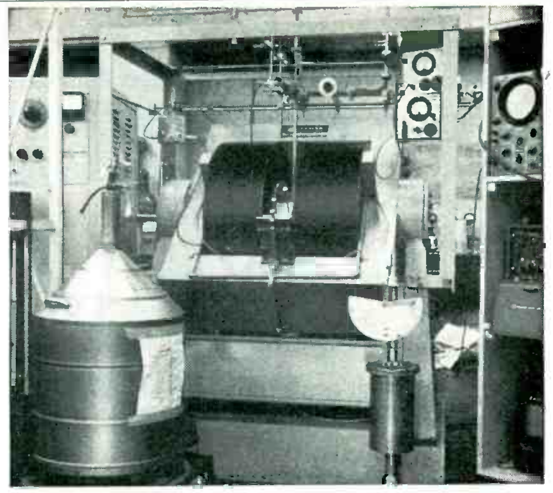

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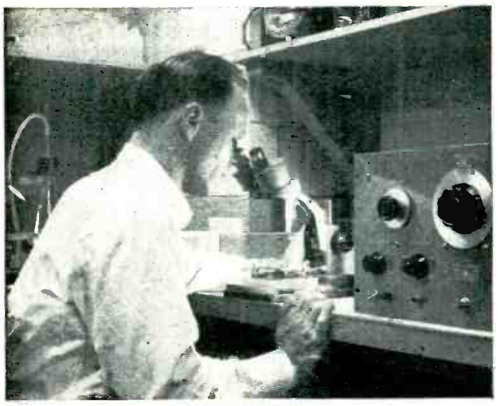

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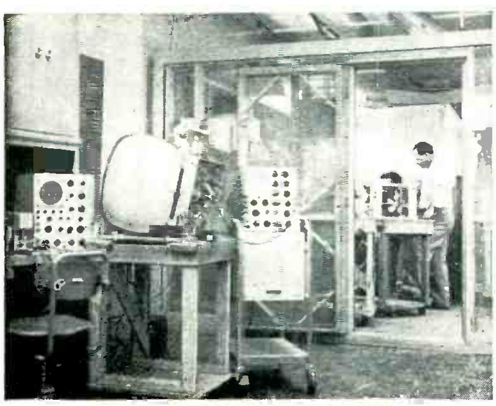

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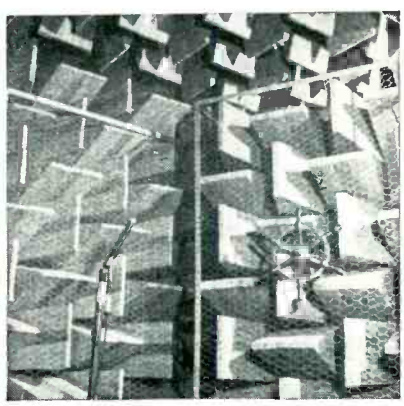

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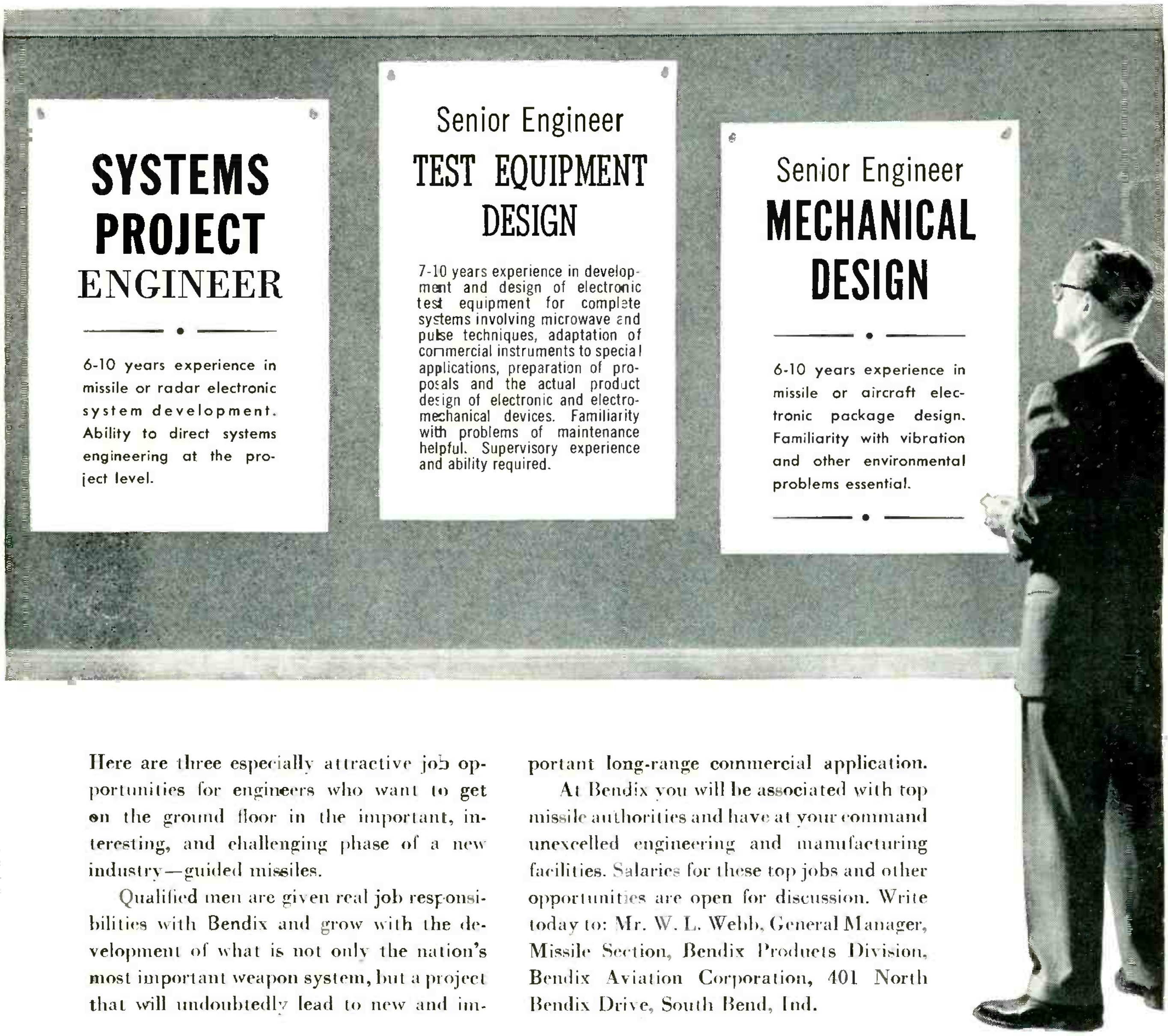

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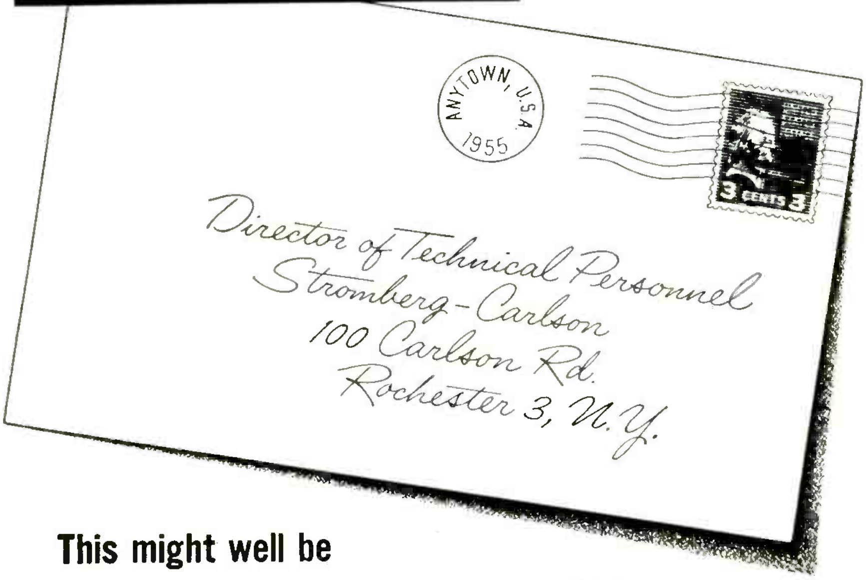

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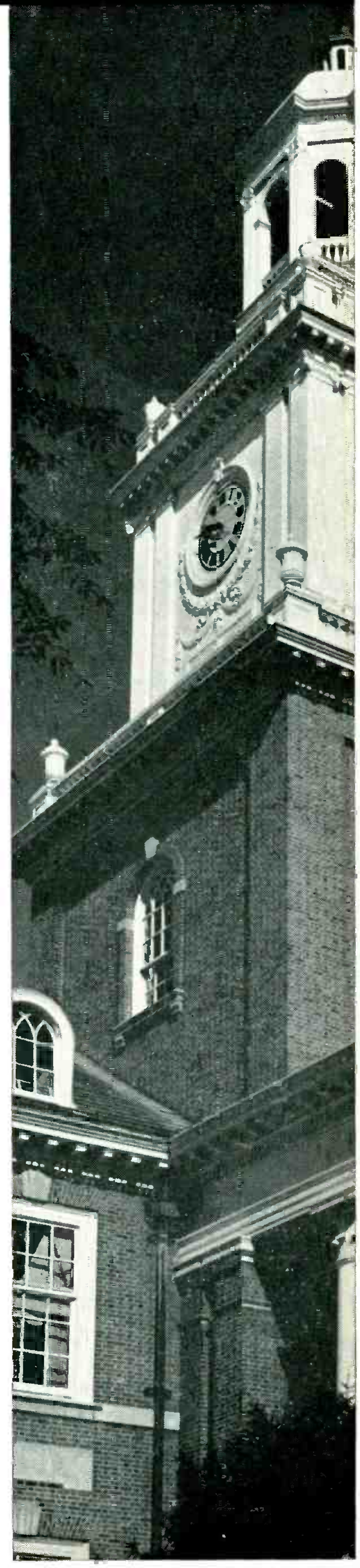

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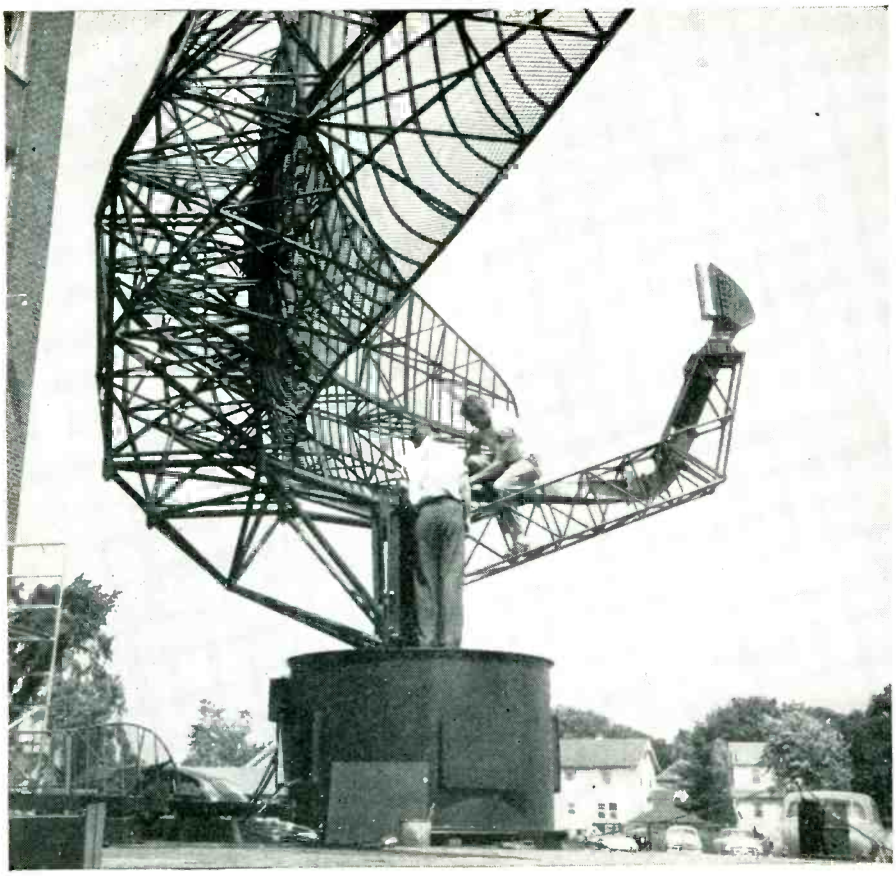

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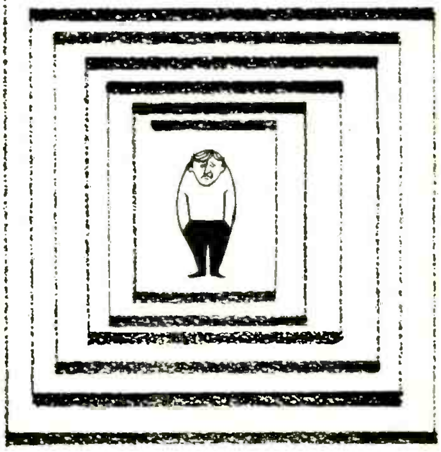

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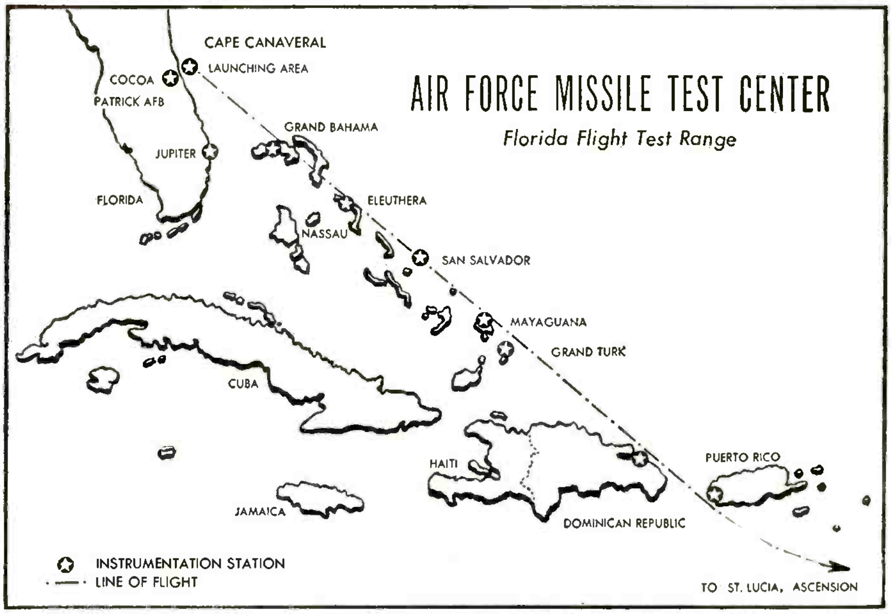

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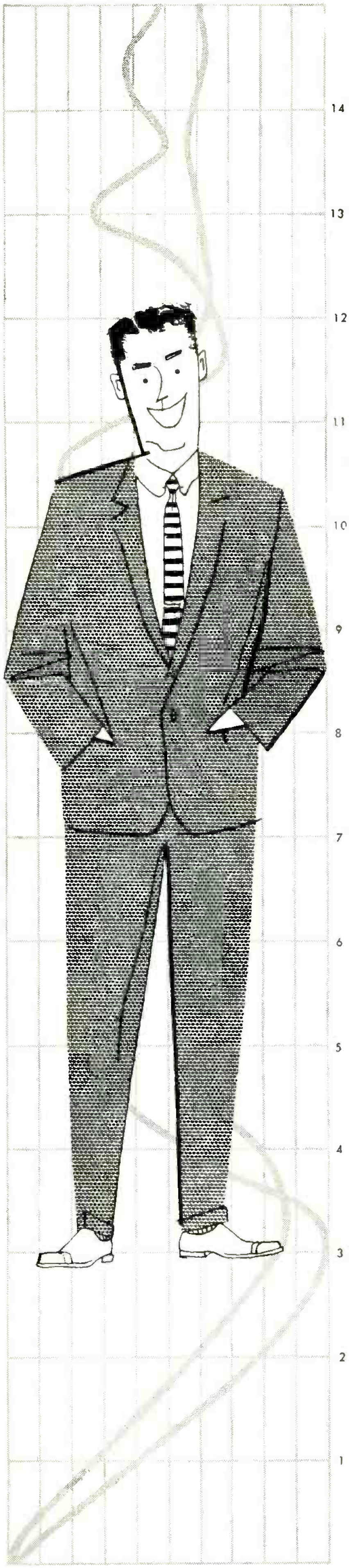

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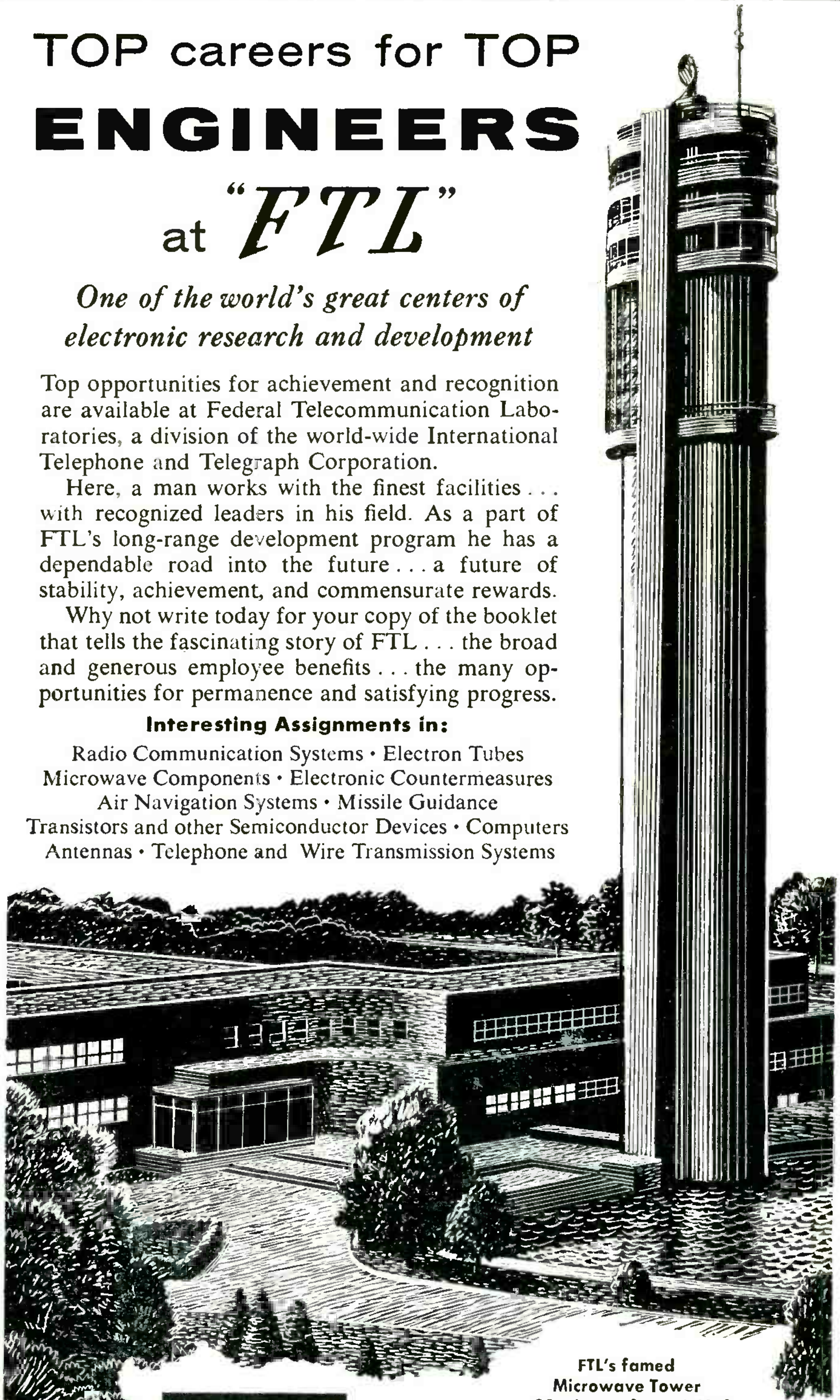

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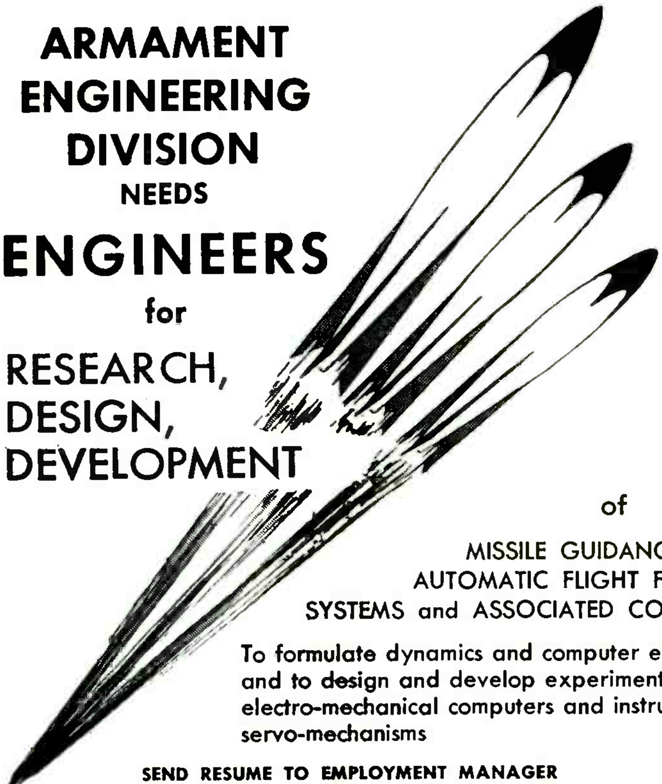

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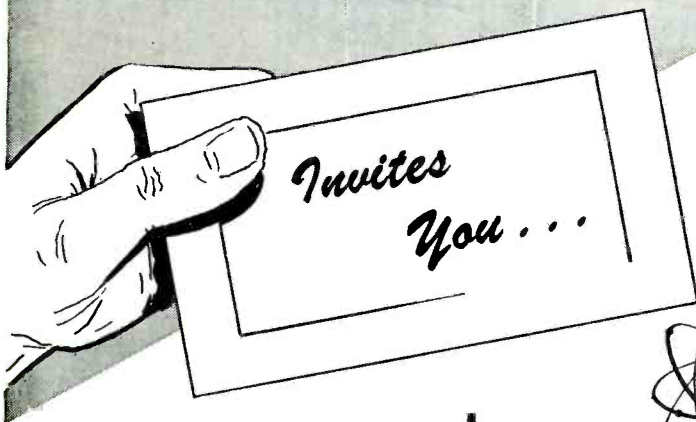

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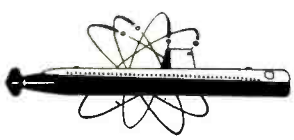

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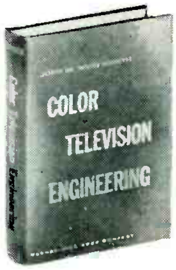

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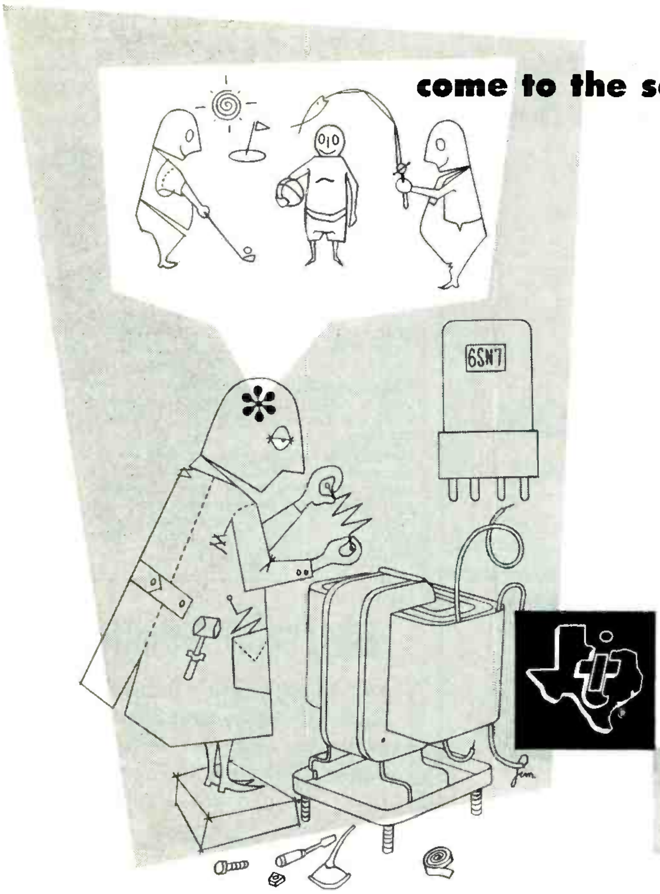

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2K25	12.50
2K28	33.00
2K30	100.00
2K33A	50.00
2K34	85.00
2K41	85.00
2K45	40.00
2K47	120.00
2K54	7.50

2K55	5.00
2P21 (image orthicon)	35.00
2V3G	1.25
2X2	.35
2X2A	.85
3A4	.50
3A5	.50
3AP1	2.00
3B21	5.00
3B23	3.50
3B24	.95
3B24W	5.00
3B25	3.00
3B26	2.85
3B27	3.00
3B28	5.00
3BP1	2.00
EL-3C	5.00
EL-3CJ	8.50
3C23	3.50
3C24	2.35
3C31	1.50
3C33	9.50
3C37	10.00
3C45	5.85
3D21A	5.00
3D22	9.75
3DP1	3.00
3E29	8.50
3EP1	2.00
3FP7	2.00
3FP7A	3.35
3GP1	2.00
3HP7	3.00
3J21	50.00
3J31	35.00
3K27	125.00
3KP1	6.00
3RP1	7.25
3X2500A3	125.00
4.400A	40.00
4AP10	3.75
4B22	6.50
4B23	5.50
4B24	5.00
4B25	8.00
4B26	3.00
4B27	2.25
4B28	3.00
4B30	.75
4B31	30.00
4B32	10.00
4C22	7.50
4C25	3.00
4C27	5.00
4C35	15.00
4E27	8.00
4J34	35.00
4J52	50.00
4X100A	18.50
EL-C5B	1.00
EL-5BHD	5.50
EL-5B2.5	6.50
5AP1	3.00
5B21	2.00
5BP1	2.00
5BP1A	7.50
5BP2A	4.75
5BP4	2.00
5C21	7.50
5C22	25.00
5C30	1.00
5CP1	2.00
5CP1A	8.50
5CP7	8.50
5D21	5.50
5D23	7.00
5FP7	1.35
5FP14	5.00
5GP1	5.00
5J29	7.50
5J30	5.00
5J32	15.00
5JP1	12.50
5JP2	6.75
5JP4	6.75
5JP5A	6.75
5JP11	9.00
5LP1	6.50
5LP1A	20.00
5NP1	2.50
5R4GY	.85
5R4WGY	2.25
5X3	3.00
5X3P1	75.00
5Z2P7	50.00
5Z4P11	100.00
EL-C6A	6.00
EL-C6J	6.25

EL-C6L	3.75
EL-6C	8.00
6AC7W	.75
6AJ5	1.15
6AJ6	2.00
WE-6AK5	1.35
6AK5W	1.20
6AL5W	.60
6AN5	2.75
6AR6	1.25
6AS6	1.25
6AS6W	1.50
6AS7G	2.35
6BM6	20.00
6C21	17.50
6G4	2.00
6J4	2.00
6J6W	1.25
6L6WGB	3.25
6SC7GTY	2.00
6SN7WGT	1.50
6SU7GTY	2.00
7BP7	5.00
7CP1	12.50
7EP4	10.00
9GP7	5.00
9LP7	3.50
9MP7	7.50
10Y	.25
CE-11V	2.25
12A6	.50
12DP7A	25.00
12GP7	17.50
12J5WGT	1.50
12K8Y	.50
12L8GT	.75
LM-15	50.00
NE-16	.30
FG-17	2.75
RK-19	.85
RK-20A	7.50
TZ-20	1.75
CE-21C	2.00
RK-21	.85
RK-22	3.50
CE-23C	1.40
PJ-23	2.00
RK-23	2.50
HK-24	2.85
HK-24G	2.00
CE-25A/B	1.50
RK-25	2.25
25E6WG	4.00
25T	2.85
25TG	2.50
CE-28D	2.50
RK-28	2.50
28D7	.75
23D7W	1.50
CE-29	1.25
CE30C	1.25
Twin 30	7.50
HY-30Z	2.65
CE-31V	2.00
FG-32	6.00
FG-33	15.00
RK-33	.50
VX-33A	2.50
RK-34	.35
35T	4.00
35TG	3.00
RK-38	6.50
RK-39	1.50
T-40	2.35
TZ-40	3.50
VX-41	2.50
CE-42C	1.50
RK-44	1.00
QK-47	50.00
RK-47	1.75
CE-48	1.75
RK-49	2.85
HY-51B	.75
FP-54	44.00
HK-54	2.00
T-55	3.50
RK-57	4.50
RK-58	.90
QK-59	25.00
QK-60	25.00
RK-60	1.35
HY-61	1.25
QK-61	25.00
RK-61	2.75
QK-62	25.00
RK-62	1.75
RK-63	18.50
HY-65	1.35
RK-65	7.00
FG-67	9.00

RK-69	2.00
RK-72	.50
RK-73	.50
HY-75	3.00
RK-75	.85
VR-75	.90
75TL	5.50
VR-78	.50
FG-81A	5.00
VR-90	.75
FG-95	17.50
VT-98BR	12.50
HF-100	7.50
100R	5.00
100TH	6.00
WE-102D	2.50
VR-105	.70
VU-111S	1.00
HY-114B	.75
WE-121A	3.50
WE-122A	1.50
F-123A	2.00
WE-123A	5.00
WE-124A	3.75
VT-127A	2.00
F-128A	10.00
HF-130	.90
VR-150	.65
FG-154	15.00
HK-154	5.00
FG-166	15.00
FG-172	20.00
QK-181	20.00
FG-190	7.50
HF-200	9.50
CE-201	2.75
CE-203	3.50
203A	2.50
203Z	5.00
204A	25.00
WE-205B	.75
207	35.00
211	.50
WE-211C	10.00
WE-211D	8.00
WE-212E	25.00
217A	1.00
217C	2.00
WL-218	15.00
CE-220	.50
CE-221	8.00
221A	2.00
CE-224	5.00
CE-225	3.00
CE-226	3.00
WE-231D	2.00
232CH	100.00
RX-233A	.70
CE-235A	5.00
WE-242A	5.00
WE-242C	8.00
WE-245A	7.50
WE-249B	2.50
WE-249C	2.50
250R	4.75
250TH	17.50
250TL	14.50
WE-251A	45.00
WE-252A	9.50
WE-253A	3.50
WE-254A	4.75
HK-257B	8.50
WE-257A	3.50
FG-258A	100.00
WE-261A	10.00
WE-262B	7.00
WE-264C	3.00
WE-267B	7.50
WE-268A	7.50
FG-271	25.00
WE-272A	5.00
WE-274A	3.00
WE-274B	.90
274B	.35
WE-275A	5.00
WE-276A	7.50
276A	2.50
WE-282A	7.00
WE-283A	4.00
WE-285A	5.00
WE-286A	5.50
287A	2.50
WE-295A	5.00
WE-296A	25.00
HF-300	15.00
WE-300B	4.50
CE-302	3.00
EL-302.5	5.00
CE-303	2.25
WE-304B	7.50

304TH	7.50
304TL	15.00
WE-305A	2.85
CE-306	7.50
307A	.85
CE-309	2.75
WE-310A	3.50
WE-311A	5.00
WE-313C	2.85
316A	.50
WE-323A	7.50
3233	4.50
WE-328A	3.50
WE-331A	7.50
WE-337A	10.00
WE-339A	10.00
WE-347A	3.00
WE-349A	6.00
WE-350A	3.00
350B	2.25
WE-352A	15.00
F-353A	2.00
WE-353A	3.50
WE-354A	14.00
WE-355A	15.00
WE-356B	7.50
WE-368A	2.00
WE-368AS	2.50
371A	1.00
371B	1.50
WE-388A	1.50
WE-393A	5.00
394A	1.85
WE-394A	2.85
WE-396A	3.00
WE-404A	10.00
410R	100.00
WE-417A	10.00
WL-417A	2.85
WE-418A	12.50
WE-421A	7.50
GL-434A	10.00
446A	.45
446B	1.75
451	5.00
WL-460	8.50
464A	2.15
WL-468	12.50
RH-507	20.00
CK-510AX	.50
WL-530	25.00
WL-531	7.50
WL-532A	1.00
GL-546	2.00
559	.45
GL-575A	10.00
WL-579B	10.00
631-P1	5.75
WL-632A	17.50
WL-655/658	100.00
WL-670A	8.00
WL-681/686	25.00
WE-701A	2.00
702A	.35
702B	.75
703A	1.50
WE-704A	.70
705A	.75
706AY/GY	12.50
707A	3.00
707B	4.35
WE-708A	.70
WE-709A	1.00
713A	.35
714A	10.00
715A	2.00
715B	3.75
715C	11.85
WE717A	1.00
717A	.35
WE-719A	9.50
720AY/EY	45.00
721A	.75
721B	7.25
722A	2.50
723A/B	9.00
WE-724A	.85
WE-724B	.85
WE-725A	3.00
WE-726A	5.00
WE-726B	25.00
WE-726C	20.00
WE-730A	7.50
WE-732A	2.00
WL-735	2.00
WL-741	1.40
WL-759	12.50
WL-786	15.00
800	1.50
801A	.35

802	2.25
GL-803	2.00
803	1.40
804	9.00
805	4.00
806	5.00
807	1.15
807W	3.00
808	1.00
809	2.25
810	10.00
811	2.65
811A	3.50
812	2.25
RCA-813	12.50
814	1.75
815	1.45
816	1.25
822	10.00
826	.65
828	9.50
829	5.85
829B	8.50
830B	.75
832	3.50
832A	5.00
833A	30.00
834	4.75
835	4.85
836	1.50
837	.95
GL-838	2.00
838	.75
842	1.85
843	.35
845	5.00
845W	8.50
849	18.50
851	9.75
860	2.85
861	25.00
865	.35
866A	1.00
866-JR	1.25
868	2.00
869B	30.00
GL-872A	2.50
CE-872A	1.50
872A	1.30
874	.50
876	.75
878	.50
879	.35
884	.95
885	.95
889RA	75.00
902P1	2.00
905	2.00
913	20.00
917	2.25
918	1.85
920	2.00
921	1.00
922	1.20
923	1.40
924	1.35
925	2.00
926	2.50
927	.95
928	2.50
929	1.25
930	1.25
931A	3.00
SN-948	7.50
954	.30
955	.35
956	.35
957	.35
958A	.35
959	1.45
972A	3.50
991	.30
1000T	100.00
CK-1005	.25
CK-1006	2.50
CK-1007	.65
CK-1009	3.50
CK-1026	3.00
R-1100	5.00
R-1130B	10.00
1500T	115.00
1603	3.00
1608	3.75
1611	1.50
1612	1.25
1613	1.00
1614	1.50
1616	.50
1619	.30
1622	1.50

1623	2.00
1624	.95
1625	.30
1630	.40
1631	1.40
1635	1.50
1636	.85
1641	1.35
1642	.40
1649	1.00
1654	3.50
1656	6.50
1661	6.00
1846	50.00
1851	1.75
1904	9.00
1960	.50
1984	10.00
2000T	175.00
2050	.95
2051	.75
2172	10.00
2183	5.00
ZB-3200	72.50
R-4100	5.75
R-4330	8.50
5528	3.75
5550	25.00
5551	35.00
5553	100.00
5556	6.75
5557	2.75
5560	17.50
5610	1.00
5632	8.50
5634	6.50
5637	5.00
5640	8.50
5644	7.50
5645	6.50
5650	85.00
5651	1.25
5654	1.20
5656	6.50
5670	1.50
5687	2.50
5691	4.50
5696	1.00
5703	1.00
5720	15.00
5725	1.50
5726	.60
5727	1.40
5728	9.00
5740	44.00
5763	1.00
5801	2.50
5803	7.50
5819	25.00
5827	2.50
5829	1.00
5842	10.00
5847	10.00
5915	1.00
5932	4.00
5933	3.00
5948	250.00
5963	1.25
5981/5650	85.00
5998	7.50
6031	4.75
6097	.65
6130	5.85
6187	1.50
6188	2.00
R-6210	15.00
UX-6653	.75
8001	8.00
8002R	15.00
8005	4.75
8008	6.00
8011	.75
8012	1.00
8012A	2.50
8013	2.75
8013A	3.50
8016	2.50
8020	1.50
8021	.75
8022	.75
8025	1.50
8025A	2.00
8026	3.50
PD-8365	50.00
9001	.85
9002	.60
9003	.90
9004	.35
9005	1.40
9006	.25

The prices quoted above are FOB shipping point

western engineers

ELK GROVE, CALIFORNIA

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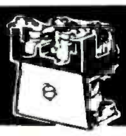
All tubes are new individually cartoned, fully guaranteed

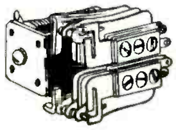
THE LARGEST STOCK OF RELAYS IN THE WORLD!

RELAYS



MINIATURE RELAYS

Automatic Electric Sales, Class S



Twin Code 0, 20 ga Contacts

Volts D. C.	Ohms	Contacts†	Stock No.	Price Each
24	300	3A	R340	1.25
24	300	4A	R342	1.25
24	300	5A, 1B	R343	1.35
24	640	1C, 1B	R640	1.25
2.5 ma	10000	1C, 1A	R1132	2.00
8 ma	5000	5A	R1133	2.00
24	600	1C	R318	1.15
24	600	2A	R319	1.15
24	600	1A, 1C	R336	1.25
24	600	1A, 1B, 1C	R337	1.35

Clare Type K

Volts D. C.	Ohms	Contacts†	Stock No.	Price Each
24	300	1A	R344	1.00
24	300	2C	R331	1.25
24	300	1C	R345	1.15
3-S	17	1A	R339	1.00
6	30	2C	R1134	1.25
48	1300	2C	R1135	1.50
24	250	1B, 2C	R1136	1.50
24	......	....	R1137	.80

Coil and Frame actuator only (No contacts).

Allied Type TSL

Volts D. C.	Ohms	Contacts†	Stock No.	Price Each
24	300	1A	R346	1.00
24	300	1C	R347	1.00
24	300	2C	R348	1.15
12	150	1A	R338	1.00

Allied Type SK

Volts D. C.	Ohms	Contacts†	Stock No.	Price Each
24	300	1C	R349	1.00
24	300	2C	R67	1.15
24	425	4C	R525	2.25

Allied Type STK

Volts D. C.	Ohms	Contacts†	Stock No.	Price Each
24	300	1A	R350	1.00
24	300	1C	R330	1.00
24	300	2A, 1C	R403	1.25

Allied Type F & Price 1150

Volts D. C.	Ohms	Contacts†	Stock No.	Price Each
6-12	120	1A	R394	1.00
12	100	2A, 1C	R395	1.25
8 ma	3000	1A	R916	1.25

Advance Type 1504 & 1604

Volts D. C.	Ohms	Contacts†	Stock No.	Price Each
24 AC	45	2A	R334	1.00
3	14.5	2C	R650	2.00
12	450	1H	R396	1.50
12	450	2A	R397	1.50

Cook & RBM

Volts D. C.	Ohms	Contacts†	Stock No.	Price Each
24	250	3A	R317	1.25
24	500	2C	R918	1.50
10 ma	6500	4A	R802	2.00

Anti-Capacity Types

Volts D. C.	Ohms	Contacts†	Stock No.	Price Each
6	40	1A	R31	1.25
12-32	500	1A	R106	.90
24	300	1C	R134	1.50
24	300	2C	R351	1.50

Price Type 1050

Volts D. C.	Ohms	Contacts†	Stock No.	Price Each
7 ma	2800	2C	R1016	2.00
5 ma	6500	2C	R1017	2.25

Automatic Electric Mfg. Co.

Volts D. C.	Ohms	Contacts†	Stock No.	Price Each
12	200	2C	R921	1.50
6	50	2C	R922	1.50

Miscellaneous Types

Mfg'r. & No.	Volts	Ohms	Contacts	Stock No.	Price Each
Kurman	24	1500	1C	R1139	1.00
Leach P3	12	325	1C	R1140	.80
Leach P3	Series	.02	1C	R1141	.80
G.E. G110F2	24	300	2C	R919	1.25
Price TB302	24	300	2A, 1C	R404	1.35

IMMEDIATE DELIVERY
PRODUCTION QUANTITIES

LATEST SUBMINIATURE TYPES

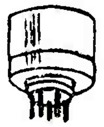
ALLIED 50G MH-12; MIL-R-5757A; 24-29 VDC; 4PDT; 300 ohm; Herm. Sealed; Solder Lug Header; 2.9 oz; Operate time 8 millisec; 1 1/16" dia. X 1 5/16" H; #R1138 5.50 ea.

STRUTHERS DUNN; Same as Allied above but 6PDT; 300 ohm; Herm. Sealed; Solder Lug Header; 4.2 oz; 1 3/16" dia. X 1 5/16" H; #R1145 .... 6.00 ea.

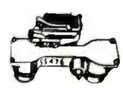
STEVENS-ARNOLD Resonant RELAYS

TYPE 182; Freq. 289 cyc; 500 ohms; SPST (1A); Sealed, Octal Plug Base; #R1146 5.00

TYPE 189; Freq. 240 cyc; 350 ohms; SPST (1A); Sealed, Octal Plug Base; #R1147 5.00



ARC 3 & ARC 5 RELAYS



55251 (K403, K405) Telechron; 24VDC; SPST; n.o. (1A); 300 ohm; #R754..1.25

55340 (K203) Price; 24VDC; SPST n.o., (1A); 300 ohm; #170 .... 1.25

55342 (K206, K213) Telechron; 24VDC; (2A's); (1C); 300 ohm; Anti-Capacity Arms; Low Loss Bakelite Insulation; #R171 .... 1.50

55476 (K101) Clare; 12-24VDC; Co-Axial Antenna Relay; SPDT (1C); 275 ohms; #R751 .... 8.50

55526 (K109, K116) Cook; 24VDC; (1A, 1C); 300 ohm; Ceramic Insulation; #R107 1.25

55528 (K107) G. E.; 12VDC; 6PST n.o., (6A's); 150 ohm; #R426 .... 2.00

55585 (K103) G. E.; 12-24VDC; Sealed Plug-in-Relay; SPDT (1C); 2500 ohm; #R419 .... 4.00

55836 (K406) G. E.; 24VDC; SPDT; 250 ohm; #R402 .... 1.50

23012-0 RBM; 24 VDC; SPDT; 250 ohms; #R172 .... 1.25

6385 ARC; 12-24VDC; SPST n.o. (1A), 10 Amp Contacts; 200 ohm; #R213 ..... 2.00

7251 ARC; 24VDC; SPDT; (1C); 300 ohm; #R406 .... 1.25

7252 ARC; 24VDC; DPST n.o. (2A); 300 ohm; #R354 .... 1.25

7735 ARC; 24VDC; Antenna Relay; SPDT (1C); 200 ohm; #R799 .... 2.50

†A=SPST, normally open; B=SPST, normally closed; C=SPDT; H=SPST, double make.

SEND FOR LATEST CIRCULAR. TERMS:—All Prices F.O.B. Our Plant. Rated Firms Net 10 Days: All Others Remittance with Order. Orders Under $10.00 Remittance with Order. Plus Approximate Shipping Charges (Overage Will Be Returned). **Cable address: UNIGENCOR, N. Y.**

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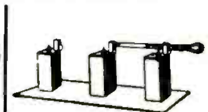
OIL FILLED CAPACITORS

VOLTS	MFD	Price	VOLTS	MFD	Price
25KV	1.0	★43.95	1000	28.0	5.50
25KV	0.5	★39.95	1000	2.0	.69
25KV	0.1	14.95	1000	0.5	.19
7.5KV	0.5	4.25	600	10.	1.29
6KV	0.25	1.09	600	8	1.19
3KV	0.5	1.59	600	4	★ .69
3KV	0.1	★1.19	600	2	★ .39
2.5KV	2.0	★2.95	600	1	★ .19
2KV	5.0	2.95	660AC	5	2.95
2KV	.25	.89	330AC	5	1.29

SPECIAL SWITCHES

SW 141 ( ) DPST normally open with or without lock-in position on push button, part of CD-318 cord set suitable for 115 V. AC SPECIAL ★.19¢



SW 224 SPDT Antenna change switch Square D Cat. No. 9320-962 SC #3ZK-9503 - 20 Bakelite Base 2x8x¼ ★.49¢

Sensitive MU-Switch 15A. 125 V. AC 15/32-32 threaded bushing. SPDT—69¢

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02	4LST	600WV	CM50B203G	★.45
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0036	A2	2500WV	CM60F362J	★.69
0068	F2	3000WV		★.99
00015	Type 59	10,000WV	3Amp @ 1MC	★5.95
0002	Type 50	10,000WV	1.6Amp @ 1NC	5.95

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Variable Transmitting Capacitor: 19 to 116mmfd 27 plates, .085" air gap. O/a dim. 4¾Lx3½x2¼ SC# 3D 9019V-1 P/o Tuning Units TU-7A a TU-79 .... ★98¢

General Electric Type IRT 3 phase induction voltage regulator. 1.64 KVA. Filled with nine gal. oil. Primary 208 volts. Brand new, limited quantity. Special $90.00

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Johnson 122-128 steatite sockets; Amphenol 49-558, steatite ring mounting; Amphenol ceramic and mica filled 1-5/16 and 1½ mounting centers.

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Autelco Jr Type 16 115V AC coil DPDT Snap Action contacts rated 15 Amp 115V, 5 Amp 230V 2.95

Cook #773 Standard Telephone Relay 900 ohm DC coil double arm 14 contacts 11A-1B-1C-1D 4"Lx1½Wx2½H .... ★1.09

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PL 259 Plug .... ★29¢
M 359 Angle Adapter .... ★23¢

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Potentiometer JLU 2000 Ohm 2w with lock nut .... ★.44¢

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2C51	3.00
2C52	3.00
2C53	10.50
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2E27	.75
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1N21	.55	2K28	35.00	4J35	150.00	RK72	1.00	WL530	23.00	829	11.00	2000T	150.00
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1N23B	1.50	2K44	195.00	4J42	190.00	211	.95	704A	1.95	836	3.95		
1N23C	7.50	2K45	80.00	4J51	190.00	217C	12.00	705A	2.75	837	2.75		
1N25	4.50	2K48	95.00	4J52	225.00	242C	10.90	706AY/		838	5.95		
1N26	6.75	2K50	295.00	4J53	225.00	244C	9.50	FY	25.00	849	35.00	5820	475.00
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1N38	1.00	2K56	72.00	5BP4	3.95	250TL	19.95	714AY	36.00	861	25.00	8012A	2.50
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21A	12.00	3C24	1.75	5J23	25.00	312A	3.50	721B	7.50	885	1.50	9003	1.25
2J22	9.00	3C31	2.95	5LP11A	25.00	323A	15.00	723A/B	18.00	902P1	6.75	9004	.35
2J26	15.00	3DP1	7.50	5SP7	96.00	327A	3.75	724A	1.95	931A	5.00	9005	2.75
2J27	15.00	3DP1A	10.00	C6A	11.00	325A	6.75	724B	2.25	954	.35	9006	.25
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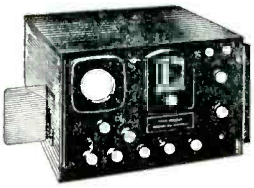
Field type X Band Spectrum Analyzer. Band 8430-9580 Megacycles.



Will Check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

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RF4/AP	1-96A	TS125/AP	TS251	APS 3 APS 4
TS12/AP	TS-45	TS126/AP	TS258	APR4
TS13/AP	TS47/APR	TS147	TS270	APR5A
TS14/AP	TS69/AP	TS174/AP	TS418	APT2-APT5
TS33/AP	TS100	TS175/AP	TF890/1	
TS34/AP	TS102A/AP	TS182	834	

You Can Reach Us on TWXNY1-3235

Large quantities of quartz crystals mounted and unmounted
Crystal Holders: FT243, FT171B others.
Quartz Crystal Comparators.
North American Philips Fluorescopes Type 80.
Large quantity of Polystyrene beaded coaxial cable.

Minimum Order 25 Dollars

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LIBERTY ELECTRONICS, INC.
119 PRINCE ST.
NEW YORK 12, N. Y.
Cables: TELSERUP

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ANY QUANTITY — NEW — SURPLUS

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AIRCRAFT — HAMS

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POLYSTYRENE CAPACITORS

1% TOLERANCE
200 VDCW 500 VDCT
Hermetically Sealed
0.5 MFD.............. $7.50 ea.
1.0 MFD.............. $12.10 ea.
Immediate Delivery

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ALL TYPES IN STOCK
Immediate Delivery

LECTRONIC RESEARCH LABS.
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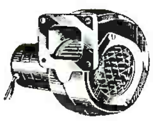
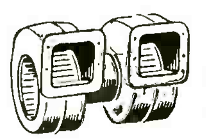
• CENTRIFUGAL BLOWERS •

Continuous Duty—110 V.—A.C.—60 Cycles

BRAND NEW • TOP QUALITY • FULLY GUARANTEED



100 C.F.M. — 3″ Diameter ROTOR Powered by shaded pole, 2 pole enclosed motor. Sturdy cast aluminum housing with attached flange on discharge. Approx. 3″ inlet, 2″x2″ outlet.
No. BL100 AI.......... $8.95
Available in DC 115 V. $16.95



TWIN BLOWER —520 C.F.M.—5¼″ DIAMETER ROTORS

Redmond shaded pole four pole motor. 5″ inlets and 3½″x3½″ outlets. Discharge flanges shipped unmounted.
No. BL520R..... $22.50

ELECTRIC TRADING CO.
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Air Equipment Experience Since 1906

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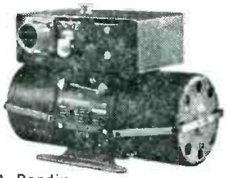
INVERTERS



10042-1-A Bendix
DC Input 14 volts; output: 115 volts; 400 cycles. 1-phase; 50 watt **$35.00**

12116-2-A Bendix
Output: 115 VAC; 400 cyc; single phase; 45 amp. Input: 24 VDC, 5 amps. **$35.00**

12117 Bendix
Output: 26 volts; 400 cycles, 6 volt amperes, 1 phase. Input: 24 VDC; 1 amp. **$15.00**

12121 Bendix
Input: 24 volt D.C. 18 amp. 12000 r.p.m. Output: 115 volts, 400 cycle, 3-phase, 250 volt amp, 7 pf. **$49.50**

12123 Bendix
Output: 115 V; 3-phase; 400 cycle; amps .5 Input: 24 VDC; 12 amp. **$49.50**

12126-2-A Bendix
Output: 26 volts; 3 phase; 400 cycle; 10 VA; .6 PF. Input: 27.5 volts DC: 1.25 amps. **$24.50**

12130-3-B Bendix
Output: 125.5 VAC; 1.5 amps. 400 cycles single phase, 141 VA. Input: 20-30 VDC. 18-12 amps. Voltage and frequency regulated. **$49.50**

12133 Bendix
Input: 26/29 volt D.C., 28 amps Output: 115 volt, 3 phase, 400 cycle, 250 volt amp., .8 pf. **$59.00**

12143-2-A Bendix
Output: 115 volts: 400 cycles; 250 VA; single phase pf. 9-1. DC Input: 26-29 VDC; 25-22 amp; voltage & frequency regulated **$49.50**

778 Bendix
Output: 115 volt, 400 cycle; 190 VA; single phase and 26 volt, 400 cycle, 60 VA, single phase. Input: 24 VDC. **$37.50**

10285 Leland
Output: 115 volts AC; 750 VA, 3 phase, 400 cycle, .90 pf and 26 volts. 50 VA, single phase, 400 cycle, .40 pf. Input: 27.5 VDC, 60 amps. cont. duty, 6000 rpm. Voltage and frequency regulated. **$59.50**

10339 Leland
Output: 115 volts; 190 VA; single phase; 400 cycle; .90 pf. and 26 volts; 60 VA; 400 cycle, .40 pf, Input: 27.5 volts DC, 18 amps cont. duty, voltage and freq. regulated. **$49.50**

10486 Leland
Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 pf. Input: 27.5 DC; 12.5 amps; cont. duty. **$70.00**

10563 Leland
Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 pf. Input: 28.5 VDC; 12 amps. **$35.00**

PE109 Leland
Output: 115 VAC, 400 cyc; single phase; 1.53 amp; 8000 rpm. Input: 13.5 VDC; 29 amp. **$50.00**

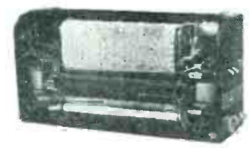
PE218 Leland
Output: 115 VAC; single phase pf 90; 380/500 cycle; 1500 VA. Input: 25-28 VDC; 92 amps; 8000 rpm; Exc. Volts 27.5 BRAND NEW. **$30.00**

MG149F Holtzer-Cabot
Output: 26 VAC @ 250 VA; 115 V. @ 500 VA; single phase; 400 cycle. Input: 24 VDC @ 36 amps. **$40.00**

MG153 Holtzer-Cabot
Input: 24 VDC; 52 amps. Output: 115 volts—400 cycles, 3-phase, 750 VA. Voltage and frequency regulated. **$95.00**

DMF2506M Continental Electric
24-30 volts input; 5.5-45 amps; cont. duty. Output: 115 volts; .44 amps; 400 cyc; 1 phase; pf 1.0; 50 watts. **$39.50**

AEROGRAPH RECORDER



ML-320/AMQ-2; Mfg. Eclipse-Pioneer
Used to record Pressure Millibars 200-1100; Temperature Centigrade —70° to 50°; Air Speed 70 to 300 MPH.; Relative Humidity 10 to 100%. CONTAINS: 4—Autosyns; 1—Servo Mtr.; 1—Vibrator Mtr.; 1—25Z6 Tube; many gears, relay, transformer, etc. Operation: 26 VAC-400 cycle; 2.5 amp. Approx. Dimensions: 20" long x 9½" H x 5" Wide. Weight 16 lbs (approx.) A real buy at **$50.00**

SELSYNS-SYNCHROS

1CT Cont. Trans. 90/55V 60 cy.	$37.50
1DG Diff. Gen. 90/90V 60 cy.	37.50
1F Syn. Mtr. 115/90V 60 cy.	37.50
1G Gen. 115V 60 cy.	37.50
1SF Syn. Mtr. 115/90V 400 cy.	$12.50
2J1F1 Gen. 115/57.5V 400 cy.	7.50
2J1F3 Gen. 115/57.5V 400 cy.	10.00
2J1FA1 Gen. 115/57.5V 400 cy.	7.50
2J1G1 Cont. Trans. 57.5/57.5V 400 cy.	5.00
2J1H1 Diff. Gen. 57.5V 400 cy.	7.50
2J5D1 Cont. Trans. 105/55V 60 cy.	17.50
2J5F1 Cont. Trans. 105/55V 60 cy.	17.50
2J5H1 Gen. 115/105V 60 cy.	17.50
2J15M1 Gen. 115/57.5V 400 cy.	17.50
5CT Cont. Trans. 90/55V 60 cy.	34.50
5D Diff. Mtr. 90/90V 60 cy.	34.50
5DG Diff. Gen. 90/90V 60 cy.	34.50
5F Syn. Mtr. 115/90VAC 60 cy.	34.50
5G Syn. Gen. 115/90VAC 60 cy.	34.50
5HCT Cont. Trans. 90/55V 60 cy.	42.50
5SDG Diff. Gen. 90/90V 400 cy.	12.50
6DG Diff. Gen. 90/90V 60 cy.	25.00
6G Syn. Gen. 115/90VAC 60 cy.	34.50
7G Syn. Gen. 115/90VAC 60 cy.	42.50
R110-2A Kearfott Cont. Mtr. 115V 400 cy.	17.50
R200-1-A Kearfott Cont. Trans. 26/11.8V 400 cy.	15.00
R210-1A Kearfott Trans. 26/11 8V 400 cy.	15.00
R235-1A Kearfott Resolver 26/11 8V 400 cy.	22.50
C56701 Type 11-4 Rep. 115V 60 cy.	20.00
C69405-2 Type I-1 Transm. 115V 60 cy.	20.00
C69406 Syn. Transm. 115V 60 cy.	20.00
C69406-1 Type II-2 Rep. 115V 60 cy.	20.00
C76166 Volt. Rec. 115V 60 cy.	10.00
C78248 Syn. Transm. 115V 60 cy.	12.50
C78249 Syn. Diff. 115V 60 cy.	5.00
C78863 Repeater 115V 60 cy.	7.50
C79331 Transm. Type 1-4 115V 60 cy.	20.00
851 Bendix Autosyn Mtr. 32V 60 cy.	7.50
403 Kollsman Autosyn Mtr. 32V 60 cy.	7.50
CK5 Bendix Mtr. 2 phase 26V 400 cy.	17.50
FPE-25-11 Diehl Servo Mtr. 75/115V 60 cy.	22.50
FPE-43-1 Resolver 400 cy.	25.00
FJE-43-9 Resolver 115V 400 cy.	25.00
999-0411 Kollsman 26V 400 cy.	15.00
1377-0410 Kollsman 26V 400 cy.	10.00
1515B-0410 Kollsman 26V 400 cy.	20.00
10047-2-A Bendix 26V 400 cy.	12.50
2900 Transicoil 115V 400 cy.	15.00

ESTERLINE-ANGUS RECORDER

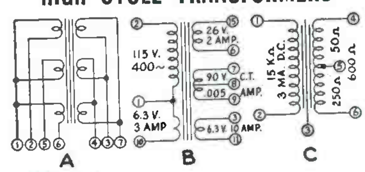
Model AW 0-1 MA

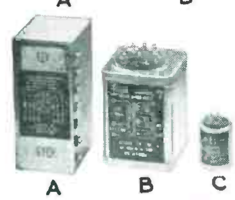
DC Milliameter permanent magnet moving coil type. Spring clock duel speed drive (hour and minute). Instructions including connection diagrams and instrument data sheet with each instrument.
Portable case **$200.00**

RATE GYRO TYPE T-2004-3C-A MFG. KEARFOTT CO.

Gyro motor excitation 115V, 400 cy. 3 ph. Take off output: 26 VAC 400 cy. single phase. Rating 20°/sec. Approximate Diameter 3¾". Height 2⅜". Weight 1¾ lbs. Hermetically sealed. Equipped with 28 VDC heater. Operates efficiently in range of —54°C to +71°C. Sensitivity .2250 volts/degree at 10K load. This is the famous Gyro used in many military units. Government cost over $1700.00. New condition.
Limited quantity @.......... **$150.00 ea.**

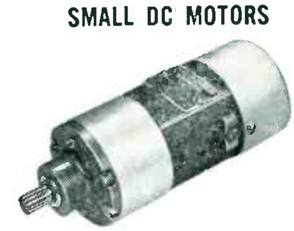
HIGH CYCLE TRANSFORMERS





A. $3.50
B. $3.00
C. $2.00

SMALL DC MOTORS



(approx. size overall 3¾" x 1¼" dia.:)

5069600 Delco PM 27.5 VDC 250 rpm	$12.50
5069230 Delco PM 27.5 VDC 145 rpm	15.00
5068750 Delco 27.5 VDC 160 rpm w/brake	6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2")	5.00
5069625 Delco 27.5 VDC 120 rpm w/governor	15.00
MM A-11 Globe PM 24 VDC	7.50
5BA10AJ18 GE 24 VDC 110 rpm	10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible	10.00
5BA10AJ52 27 VDC 145 rpm reversible	12.50
806069 Oster series reversible 1/50 h.p. 10,000 rpm 27.5 VDC 1⅝" x 3½"	5.00
C-28P-1A 27 VDC 1/100 h.p. 7,000 rpm	3.00
7100-B PM Hansen 24 VDC 160 rpm	7.50
SSFD-6-1 Diehl PM 27.5 VDC 10,000 rpm	4.00
6-volt PM Mtr. mfgd. by Hansen 5,000 rpm 1¼" in dia. 2" long overall	4.00

COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS

10 CM.—RG48/U Waveguide

POWER SPLITTER for use with type 726 or any 10 CM Shepherd Klystron. Energy is fed from Klystron antenna through dual pick-up system to 2 type "N" connectors $12.50

LHTR. LIGHTHOUSE ASSEMBLY. Parts of RT39 APG 5 & APG 15. Receiver and Trans. Cavities w/assoc. Tr. Cavity and Type N CPLG. To Recvr. Uses 2C40, 2C43, 1B27. Tunable APX 2400-2700 MCS. Silver Plated $15.00

BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. Bernard Rice, each $27.50

MAGNETRON TO WAVEGUIDE Coupler with 721-A Duplexer Cavity, gold plated $31.50

721A TR BOX complete with tube and tuning plungers $12.50

McNALLY KLYSTRON CAVITIES for 707B or 2K28, 2700-2900 MC $4.00

HOLMDELL-TO-TYPE "N" Male Adapters. W. E. #D167284 ....$2.75

BEACON ANTENNA AS31/APN-7 in Lucite Ball, Type "N" feed $22.50

ANTENNA, AT49A/APR: Broadband Conical, 300-3300 MC Type "N" Feed $12.50

"E" PLANE BENDS, 90 deg. less flanges $7.50

K-Band, X-Band Eqpt. Available ....**Send for List**

X BAND—1" x ½" Waveguide

PARABALOID DISH, 18" diam. Spun Aluminum, 8" Focus. For AN/APS-6 ....$4.95

3 CM. DIPOLE and Feed Assembly. (May be used with above dish.) 8 inches long $5.00

FLEXIBLE SECTION 9 in. long, Cover-to-Cover ..$5.50

ROTARY JOINT (APS-6) Sperry PT #658275, 180 deg. rotation, choke to choke. Has "Built-in" Di-Coupler, 20 DB., with "N" Takeoff $22.50

3CM. DIPOLE FEED, 15" L. for APS-15 ....$14.50

MITRED ELBOW, Cast aluminum, 1¼" x ⅝" W.G. W.E. Flanges. **"E" Plane** $3.50

3 CM ANTENNA ASSEMBLY: Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern: 5 deg. in both Azimuth and elevation. Sector Scan: over 160 deg. at 35 scans per minute. Elevation Scan: over 2 deg. Tilt. Over 24 deg $35.00

Cross-Guide Directional Coupler. UG-40 output flange. Main Guide is 6" Long, with 90 Deg. "E" Plane bend at one end, and is fitted with Std. UG 39/UG 40 flanges. Coupling figure: 20 db Nominal $22.50

RG52/U Waveguide in 5' lengths, fitted with UG 39 flanges to UG40. Silver plated ....**per length $5.00**

Rotating-Joints supplied either with or without deck mountings. With UG40 flanges ....**each $17.50**

Bulkhead Feed-thru Assembly $15.00

Pressure Gauge Section with 15 lb. gauge $10.00

Directional Coupler. UG-40/U Take off 20db $17.50

MAGNET AND STABILIZER CAVITY For 2J41 Magnetron $24.50

90 degree elbows. "E" or "H" Plane 2½" radius.$8.50

ADAPTER, waveguide to type "N", UG 81-U, p/o TS 12, TS-13, Etc. $7.50

ADAPTER. UG-163/U round cover to special BTL. Flange for TS-45, etc. ....$2.50 ea.

COAXIAL R.F. FILTERS

F-29/SPR-2. Hi-Pass., with 1000 mc. Cut-off. Type "N" input and output. 50 Ohms Z $9.50

F-41/SPR-1. Hi-Pass. with 300 mc cut-off. Type "N" input and output. 50 Ohms Z $10.50

AUDIO TRANSFORMERS

LVM-11. Multimatch Line Autoformer. Rated 30 watts. Will match up to 10 separate 500-ohm lines. Impedances: 500/250/167/125/100/83/71/62/50 ohms..$3.40

G-5604 Plate-to-Line 20,000 ω (with 32 MA. DC) to 600 ohms. Resp. 250/3500 cps. ± 2db. 15 mw. Level..55¢

W-15-21: Hybrid: Input Trans #1: 300 w/300 ohm. Trans. #2: 600 ohm/250,000 ohms $1.19

W-15-41: Hybrid Output. Trans. #1: 300/30 ohm. Trans. #2: 300/13,000 ohm (Plate) $1.15

● **SPECIAL:** Set of 2 Transformers: Input Trans. W-15-41 and Output Trans. W-15-21. (Above).$1.97

KS-9496: Output, 9000 ohms P-P. to 9 ohm V.C. 250 watts, 100 to 10,000 cps ± 1db $8.95

KS-9449: Driver Trans. P-P 6V6 (8000 ohms) to PP Grids CL. "B" (805's). 10 watts 1000-10,000 cps ± 1db $2.45

● **SPECIAL:** Matched Transformers KS 9449 and KS 9496 (Above) $9.95

AT 071: Interstage: 10,000 ohm pp plates to 80,000 up grids. For BC 614 Speech Amplifier $1.35

AT 199: Output: 6000 ohm plate to line (200/600 ohms) Response: 200-12 kc. For CFIA and CF 3A....$2.45

AT 037: Mike to grid: 75 ohms to 125,000 ohms...$.65

J-871: Output: Pri: 20,000/16,000 ohms P-P. Or 5,000 /4,000 ohms. Sec: 500/16/7.5/5/3.75/1.25 ohms, Silcor, hi-fi $2.75

AT SUB Subouncer, Multimatch, 200 ohms to 15 K ohm C. T. and 100 K ohm Grids ....$.69

AT501 HI-FI Special: PRI: 3000 ohms P-P/Sec: 4/16/ 12/50/200 ohms 60-10,000 CY.—1 db 50W $3.49

AT152 HI-FI Driver Pri: 10,000 ohms Sec: 40,000 ohms PP Grids 50-15 KC/1 db $1.40

AT602 Output to H. S. or line PRI: 14,200 ohms SEC: 8000/600 ohms $1.10

AT666 Intercon Input: Spkr (-4-8 ohms) to grid ($250,-000 ohms) $0.69

AT415 Plate (18,000 ohms C.T.) to line (125 ohms) 175 w.—500-600 CY $1.95

AT858 Plate (10,000 ohms C.T.) to line (125 ohms) (125130 ohms) Hi-Fi—50 W $6.95

AT-694 Hi-Fi Output: 3 Watts. 8500 Ohms P-P to V.C. (15 Ohms) 15-15KC PM 1 db $1.49

BARGAIN SPECIALS

APT-4 Jamming transmitter. Uses 5J30 or 5J31 magnetron. Power output: 130 watts, 350-760 mc. New complete with tubes $95.00

MD 30/APT-4. Modulator. For noise modulating of APT-4. Operates from 115 v. 400 cy. New $35.00

L & N RATIO BOX, #1553. Basic unit for capacitance, impedance, and conductance bridge. New, complete with instruction book $225.00

FILTER, Artificial Line: WECO D163169. 650 ohms imp. insertion loss: 5 db $32.50

Barry shock mounts: nos. 2045, C-2060, C-2070, C-2090 ....45¢ ea.

Trihedral radar reflector, MK-1, aluminum $3.50

SPLICER, for 11/16 perforator tape. WEco # X-61859 list 20 SCS #4TW 61859-20. Complete set, with number tape dispenser $8.50

MN 28Y Control box, unit of MN 26 compass. New.$3.75

Noise filters. Mallory NF1-1, 100 amp/35 vdc $1.00

Power supply unit, navy type—EL-2, Input: 115 vac, 60 cy. Output: 135 vdc/10 ma. 90 vdc/5ma; 3 vdc/360 ma. New, complete with spare parts box. To be used with model TBX radio gear $9.50

Coaxial switch, 12-position, with type "N" fittings. Type SA-14/SPR-1 ....$17.50

Amplifier, Altec A-127. 18 Watts output with response from 20-20,000 cps. Operates from 115 v. 60 cps. Std. rack panel mtg. Used, excellent $103

Pulse analyzer, type APA-6. With 3 in. scope $235

BC 602 Control box for SCR 522 (pushbutton) $3.75

24-volt Transformer. Input 115v/60 cy. Output 24v/3A $1.79

Phase-shifter. Helmholtz type: 0-360 deg $2.50

Capacitor, oil-filled, 0.25 mfd./25,000 volts dc $15

Hydrophone, MODEL MI-2. A lattice of 3 crystals in a disk-like structure: 17-37 Kc $27.50

AN/CRW-2A Remote control receiver, for operating target planes, etc. New, with soundproof mounting box $34.50

TEL. REPEATER, EE 89, complete with tubes and tech. manual $17.50

TEL. REPEATER, EE 99, with 12 vdc vibrator power supply (PE 204) $49.50

F.T.&R. 101-A. Two-wide applique, contains equalizing devices, and balancing circuits. Used for adapting 2-wire military circuits to 4-wire systems $47.50

RADAR TRAINER. Model 15-C. Brand new, complete with pulse generator, power supply, main unit, all cables and instruction book $125

MICROWAVE ANTENNAS

3 cm. Horn, 1" x ½", with twist and 180 deg. bend. With dielectric window $22.50

AT49/APR—Broadband Conical, 300-3300 MC, Type N Feed $8.95

Discone Antenna. AS 125 APR. 1000-3200 mc. Stub supported with type "N" Connector $14.50

AS14A/AP. 10 CM pick up dipole assy. complete w/ length of coax and "N" connectors $4.50

AS46A/APG-4 Yagi Antenna, 5 element array $22.50

30" Parabolic Reflector Spun Aluminum dish $4.85

AN/APA-12—Sector Scan adaptor for APS-2 radar—Complete Kit $37.50

TPS-3, 10 Ft. Dish, "Chicken Wire" Parabola. Extremely lightweight, portable $125.00

AN-154 3 vertical dipoles working against a rectangular mesh approx. 3'x4'. Freq. 140-200 mc. with lobing switch (115v, 60 cy) and portable slatted crate. Extremely rugged $27.95

LP-24 Alford loop, for use with glide-path transmitters (MRN-1, etc.) 100-108 mc $32.50

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
BDAR83	14	..	375	.150	$6.50
35X-059	19	3.8	405	.095	4.35
POSX-15	14	2.8	220	.08	8.95
DM33A	28	7	540	.250	3.95
B-19	12	9.4	275	.110	6.95
			500	.050	
DA-3A*	28	10	300	2.60	3.95
			150	.010	
			14.5	5.	
PE 73 CM	28	19	1000	.350	17.50
BD 60†	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	2.50
BDAR 93	28	3.25	375	.150	6.95

‡ Less Filter. * Replacement for PE 94.

† Used, Excellent.

PE 94-. Brand New 5.95

INVERTERS

800-1B input 24 vdc, 62 A. Output: 115 V, 800 cy. 7A. 1 phase. Used, excellent $18.75

PE-218H: Input: 25/38 vdc, 92 amp. Output 115V 300/ 500 cy. 1500 Volt-ampere. NEW $32.50

PE206: Input: 28 vdc, 36 amps. Output: 80 V 800 cy. 500 volt-amp. Dim. 13 x 5½ x 10½. New $22.50

EICOR—ML 3011-5, Input: 13.75 V; 18.4A. Output: 115 V/400∼, 3φ, 0.95 PF. 100 VA. New $59

PU 7/AP. Input: 28 vdc/160A. Output: 115 VAC, 400∼, 1φ, 500 VA., 21.6 Amp. Volt. and Freq. Reg. Used. Exc. $75

POWER TRANSFORMERS

COMBINATION—115V/60∼INPUT

CT-133	150-C-150V/65MA.6.3V/2.5A.6.3V/0.6A	$1.79
CT-127	900V/25MA PK. 5V/2A, 2V/7.5A	2.79
CT-006	350-0-350V/120MA, 5VCT/3A, 2.5VCT /12.5A, 2.5VCT/3.5A	4.39
CT-965	78V/0.6A, 6.3V/2A	1.95
CT-004	350-0-350V/90MA, 5VCT/3A, 2.5VCT/ 12.5A	4.60
CT-002	350-0350V/50MA, 5VCT/2A, 2.5VCT/ 7.5A	3.65
CT-479	7000V/.018V, 2.5V/5A/17,800 V. Test	22.50
CT-013	450-0450V @ 200MA, 10V/1.5A, 2.5, 3.5A, 5V/3A	4.35
CT-403	350VCT .026A 5V/3A	2.75
CT-931	585VCT .086A 5V/3A, 6.3V/6A	4.25

PLATE—115V/60∼INPUT

PT- 07	400VCT/4.0 AMPS For RA43	17.50
PT 034	125V/45MA (For Preamp)	1.15
PT 133	3140/1570V. 2.36KVA	85.00
PT 801	22,000V/234 MA., 5.35 KVA	115.00
PT 521	7500V/.06A. Half Wave	59.50
PT 913	2500V12 MA H'SLD	4.95
PT-38-2	37.5/40V AT 750 MA	2.15

FILAMENT—115V/60∼INPUT

FT-157	4V/16A, 2.5V/2.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25A/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 1.2V/7A, 6.4V/ 10A, 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-38A	6.3V/2.5A, 2x2.5V/7A 5KV Test	2.79
FT-650	2.5V/10A-3KV TEST LO-CAP	7.50
FT-025	2.5VCT/10A, 10KV TEST	6.95

FILTER CHOKES

Stock	Description	Price
CH-914	12HY/250 MA 2500 V. Test	$3.25
CH-CEC	117: 9-60H/.05-400 MA, 10 KV Test	14.95
CH-113	2.5H/700 MA, 2.5 KV Test 18 Ohms	5.75
CG-044	8.5H/350 MA, 3.5 KV Test 50 Ohms	6.35
CH-291	0-1H/12 A, DCR: 0.3 Ohms	12.50
CH-291	0-1H/12 A, DCR: 0.3 Ohms	12.50
CH-322	.35H/350 MA—10 Ohms DCR	2.75
CH-141	Dual 7H/75 MA, 11H/60 MA	4.69
CH-69-1	Dual 120H/17 MA	2.35
CH-776	1.28H/130 MA/75 ohms	2.25
CH-344	1.5H/145MA/1200V Test	2.35
CH-366	20H/300 MA	6.95
CH-999	15HY/15 MA—400 ohms DCR	1.95
CH-445	0.5HY/200 MA, 32.2 ohms, 3000 V.T	1.39
CH-170	2x0.5H/380 MA, 25 ohms	2.79
CH-533	13.5H, 1.0 AMP DC, 13.5 KVINS	29.95

VHF TEST SET

The signal generator is designed to serve as an aid in aligning 152-162 megacycle FM receivers. It consists primarily of a temperature controlled crystal oscillator, the plate circuit of which is tuned to the 48th harmonic of the crystal frequency. The generator provides an extremely stable output which can be varied continuously from zero to well over a hundred microvolts. Provision has been made for two-frequency output provided that a dual crystal is utilized.

New, Less Crystal $32.50

PULSE TRANSFORMERS

4P37: Primary, 50 Ohms 750V. .001 Duty. Sec. 15KV. 1000 Ohms Impedance Bifilar 12.6V/2.5A $32.50

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC. 16KV-16 AMP DUTY RATIO: 001 400 CYCLE FIL. TRANS. "BUILT-IN" $22.50

WECO: D-163247 For Modulator of SCR 720 ....$22.50

GE #K-2449A
Primary: 9.33 KV. 50 ohms Imp.
Secondary: 28 KV, 450 ohms.
Pulse length: 1.05/5 usec @ 635/120 PPS. PK Power Out: 1,740 KW.
Bifilar: 1.5 amps (as shown) $62.50

GE #K-2748-A, 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar rated at 1.3 Amp. Fitted with magnetron well $24.50

K-2745 Primary: 3.1/2.8 KV, 50 ohms Z. Secondary: 14/12.6 KV 1025 ohms Z. Pulse length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Bifilar: 1.3 Amp. Has "built-in" magnetron well $32.50

K-2461-A. Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Bifilar 1.3 Amp. Fitted with magnetron well $29.50

54J318-1—3 wdgs. Ratio: 1:1:1, 1.10 uh. /wdg., 2.5 ohms DCR $3.50

UTAH X-151T-1: Dual Transformer, 2 Wdgs. per section 1:1 Ratio per sec 13 MH inductance 30 ohms DCR $5.00

UTAH X-150T-1: Two sections, 3 Wdgs. per section, 1:1:1 Ratio, 3 MH, 6 ohms DCR per Wdg $5.00

K-904695-501: Ratio 1:1, Pri. Imp. 40 Ohm. Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise $8.95

PULSE NETWORKS

H-616 10KV, 2.2 usec., 375 PPS, 50 ohms imp..$27.50

H-615 10KV, 0.85 usec., 750 PPS, 50 ohms imp..$27.50

KS8865 CHARGING CHOKE: 115-150 H @ .02A. 32 40H @ .08A. 21 KV Test $37.50

G.E. 25E5-1-350-50 P2T, "E", CKT, 1 Microsec. Pulse @ 350 PPS. 50 Ohms Impedance $69.50

KS9623 CHARGING CHOKE: 16H @ 75 MA, 380 Ohms DCR, 9000 Vac Test $14.95

H-605: 25 KV, "E" CKT. 1.5 usec. 400 PPS. 50 Ohms Impedance, 5 sections $62.50

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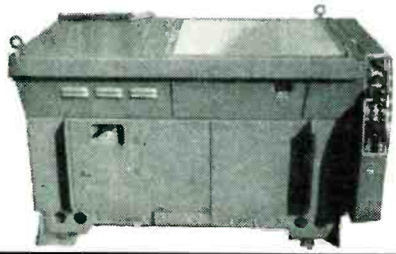
Technical Specifications:
1—Operating freq.—3000mc 10mc.
2—Power output—225kw.
3—Pulse width—1 micro second.
4—ranges—500-240,000 yds in four ranges. 10,000 yds. 40,000 yds. 160,000 yds. and 240,000 yds.
5—360 scan.
6—azimuth accuracy 1.
7—7" P.P.I. indicator.
8—7/8" coax transmission line.
9—6 antenna beam width.
10—110v 60 cyc power input.

THIS SCR-682-A IS AVAILABLE FOR INSPECTION IN OPERATION AT OUR LABORATORY BY APPOINTMENT. WRITE OR PHONE.

VG-1, 2, 3—24" P.P.I. REPEATER INDICATOR



The remote P.P.I. is a projection radar repeater using a skiatron tube to project a radar image to the top of the console, which is a transparent 24" screen used as a plotting table. This set will operate very well with the SCR-682 at an airport or weather observing station. Five ranges are provided, 4, 10, 20, 80, and 200 miles. Range marks are provided. This set operates with any radar set with a P.R.F. rate of 60-1000 CPS. Power input 110v 60 cyc. A very bright image allows use in a well lit room. Complete spares for this equipment in stock. Other repeaters in stock include: VC, VD, VE, VF, VK. WRITE.

SCR-616—BC-1269

F.M. & A.M. 145-600mc communications receiver. The BC-1269 is a UHF version of the BC-312-342 series and looks very similar. The receiver is a superhet covering the 145-600mc in 2 bands. The dial is calibrated in megacycles. F.M., C.W., or A.M. reception is offered. Power input is 110v 60 cyc using a RA-61 power supply or 12.6v AC and 250v DC 100 MA. This set is one of the nicest receivers designed. Write

TEST SETS

TS-15 Flux meter
TS-120-3 cm Beacon Test Set
TS-155 10cm Test Set
TS-173, 174, 175 Freq. meters
TS-323 Freq. meters
TS-587/U UHF noise and field strength Test Sets.
Many others up to TS-700 series. WRITE

OTHER EQUIPMENT AVAILABLE

AN/URC-4 145 and 250 mc. Air, sea rescue transceivers. All subminiaturized.
AN/ARC-12 and up
AN/APG-15 and up
36/APS-15 and up
AN/APR-4 and up
AN/TRC-7 100-156mc walkie-talkie
AN/ART-18, 23, 24 Radar relay sets
AN/APN-19 beacon
AN/APN-12 transponder
AN/CPN-6, 8, 17 radar beacons
AN/UPN-1, 2, 3, 4 S and X-band radar beacons

AN/PRC-8, 9, 10

The PRC series of radio sets are the new F.M. high freq. back pack walkie-talkies superceding the SCR-300. These sets are completely miniaturized and weigh app. 18 lbs. complete, with battery. The PRC-8 covers 20-27.9 mc. PRC-9 covers 27 to 38.9 mc. PRC-10 covers 38-54.9 mc. The set has 16 tubes. The receiver is A.F.C. controlled and has a sensitivity of .5 microvolts. The transmitter power output is app. 1 watt F.M. A crystal calibrator is provided to check and calibrate the set. The receiver is equipped with a squelch control. This set can be used with the AN-GRA-6 to provide remote operation and automatic relay. We can supply spare parts for these sets. Write for prices.

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24 VDC REVERSIBLE MOTOR — 3.7 RPM, 40 lb. Torque. Motor size: 5-½" x 4-1/32" x 3-5/16". Shaft size: 21/32" x 5/16". Also operates 24 VAC. Philco No. 441-1008 .... $5.95
27.5 VDC—6000 RPM. 1.5 oz. in Shaft Size: 1⅛" x ¼". Motor size: 2½" x 1½" No. 5069-267 .... $4.95
26 VOLT 60 CYCLE—60 RPM Synchronous Cramer Motor #1147. Shaft size: 1" x ⅛" $1.95
110 VDC 1/70 HP., 1550 RPM. Motor size: 4" x 2½". Shaft size: 1" x 3/16". Redmond #157 .... $4.95
6 VDC 1/20 HP., 4000 RPM. Motor size: 5" x 3". Shaft size: ¾" x ¼". Redmond #E-50 .... $4.95
12 VDC 1/30 HP., 4500 RPM. Motor size: 3" x 2½". Shaft size: 1" x 3/16". Delco #5047520 .... $4.95
27 VDC 1/10 HP., 3500 RPM. Shaft size: ⅝" x ¼". Motor size: 4"x3-½". Air Assoc. No. EE-763. $6.95
80 VDC 1/50 HP., 3000 RPM. Shaft size: ⅜" x ¼". Motor size: 5" x 3". G.E. #5-PN38HA10 .... $8.95
28.5 VDC 1/35 HP., 2200 RPM. Shaft size: 1½"x¼". Motor size: 4½"x3¾". Electrolux #16876 .... $5.95
27 VDC GEAR HEAD MOTOR—960 RPM; 1/75 HP; 1.75 A. Size: 5" x 3". Shaft ¼" x ⅝". Air Assoc. #EE120M1 .... Price: $7.95
27.5 VDC GEAR HEAD MOTOR—324-1 Ratio: 4050 RPM; Right Angle Drive Motor. Size 5" x 3-½". Shaft: 5/16"x¾". Bodine Type #V10R. Price $7.95
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24 VDC GEARED HEAD MOTOR—Heavy Duty, 8 Amp 2-½ lb. Torque, 100/200 RPM. Shaft Size: 5/16" x 1". Right Angle Drive $8.95
27 VDC MOTOR—1.5 A.; 1/50 HP.: 3000 RPM Shunt Motor; Motor Size: 3" x 2-¼". Shaft: 5/16" x ¾". Oster #D8-1 or WEVS-5876 .... Price: $2.95
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PM MOTORS AVAILABLE: Delco 5069625, Delco 5068571, Delco 5069370—Write for Prices.
115 Volt 60 cycle GEARED HEAD MOTOR—24 RPM. 1/100 HP. Right Angle Drive—Size: 7-½" x 4" x 4". Shaft Size: 3/16" x ¾" .... NEW: $9.95
115 VAC 60 Cycle INDUCTION MOTOR—1.9 RPM. 75 Torque oz. in.; 9 Watts—Holtzer Cabot Motor Type RWC-2505 .... $9.95

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GENERATOR: Motor 3 HP. 115/230 60 cycle single phase; Generator 115 Volt 400 cycle single Phase 1400 Watt & 28.5 VDC 400 Watt. Belt Drive. Reconditioned $195.00
AC-DC GENERATOR—Output 115 VAC 800; cycle 10.5 A. & 28.5 VDC; 60 A at 2400 RPM. ⅞" spline shaft. Bendix Eclipse No. NEA-3 .... NEW: $18.95
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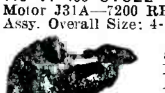
BLOWERS:

12/24 VDC—AC CAST ALUMINUM BLOWER (Pictured at left)—100 CFM: 3" intake; 2" outlet, Shunt Motor 4"x2"; 3000 RPM @ 24 VDC .. $5.95
6 VDC SINGLE—100 CFM—No. 6100. Used $4.95
6 VDC FLANGE—150 CFM—No. 6150.
24 VDC DUAL—20 CFM—Min—No. 2420 ...... $7.95
10 CFM BLOWER (Pictured—right) 27.5 VDC; 1/100 HP.; 7000 RPM; Oster Motor C2BP-1A; L-R Mfg. Co. Bakelite Blower #2. overall size: 3-½" x 4-½". Price $5.95
Same as above, 12 VDC operation: Price $5.95

115 V. 400 CYCLE—10 CFM—Eastern Air Devices Motor J31A—7200 RPM. 1/100 HP. L-R #2 Blower Assy. Overall Size: 4-½" x 3-½". No. 3110 ..... $5.95



10 CFM BLOWER (Pictured at left)—28 VDC—.6 A; 5000 RPM. Pioneer Motor SS-2345. Aluminum Blower Housing; Overall Size: 4-½" x 3-¼". Price $5.95

115 V. 60 CYCLE BLOWERS:

115-VAC 60 cycle SINGLE TYPE—100 CFM; 2-¼" intake: 2" outlet. Complete size: 5" x 6" —No. 1C939 .... **$8.95**
115 VAC 60 cycle DUAL TYPE—100 CFM; 4" intake; 2" Dis. Each side. Complete size: 8" x 6" —No. 1C880 .... **$13.95**
115 VAC 60 cycle COMPACT TYPE—108 CFM; Motor built inside squirrel cage; 4-½" intake; 3⅝" x 3" Dis. Complete size: 4-½" W x 8-⅜" H x 8-⅛" D—No. 2C067 .... **$14.95**
115 VAC 60 cycle FLANGE TYPE—140 CFM: 3-½" intake: 2-½" Dis. Complete size: 7-½" W x 7-¼" H x 6-¾" D—No. 1C807 .... **$13.95**
115 VAC 60 cycle FLANGE TWIN—275 CFM; 4-½" intake; 3-¼" x 3" Dis. Complete size: 11-¾" W x 3-⅜" H x 8-1/16" D—No. 2C069 .... **$21.95**
115 VAC 60 Cycle BLOWER—200 CFM; 4" intake; 3" x 5" outlet. Overall size: 8" x 7" x 6". Bodine Motor NSI-33. Removed from New Equipment. #BOD-200 .... **$14.95**
115—VAC 60 Cycle BLOWER—100 CFM; 3-¾" intake; 2" outlet; Rd. Flange with Flap Director. Overall size with bracket; 8" L x 6-½" W x 7" H. Removed from New Equipment. Diehl Motor FB-2106-6 No. FDBL-2106 .... **$6.95**
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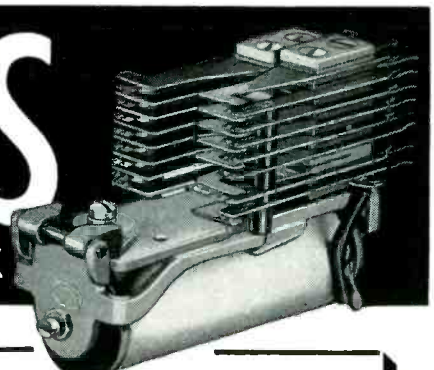

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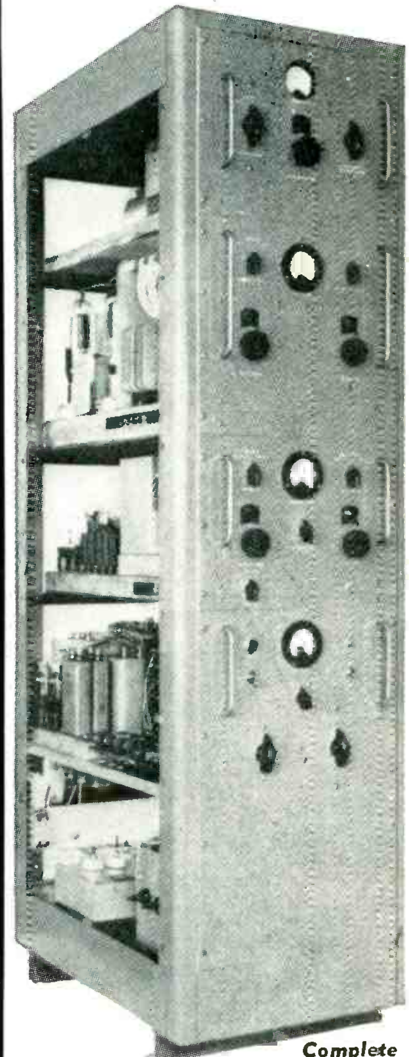

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1B26	1.19
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1B32/532A	.99
1N21	.69
1N22	.69

Type	Price
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2C43 (boxed)	14.40
2C44	.85
2C46	6.99
2C51	3.29
2C53	11.75
2D21	.79
2D21W	1.85
2E22	2.49
2E24	3.29
2E36	1.19
2G-22	1.19
2j-21	3.79
2j-22	3.59
2j-26	4.99
2j-27	6.99
2J-31	14.99
2J-32	15.99
2J-33	16.99
2J-34	16.99
2J-38	16.50
2J-39	17.99
2J-40	29.50
2J-42	69.95
2J-49	34.00
2J-61	15.99
2J-62	8.99
2K-22	18.99
2K-23	19.95
2K-25	18.99
2K-28	28.99
2K-33A	79.50
2K-39	144.00
2K-41	94.00
2K45	49.50
2K49	53.50
2K52	59.50
2K54	19.50

Type	Price
2K55	29.95
2X2/879	.59
2V3	1.29
3A5	.59
3AP1	5.99
3BP1	3.29
3B22	1.49
3B23	3.99
3B24	2.49
3B24W	4.99
3B25	3.39
3B27	6.99
3B28	4.69
3C21	.94
3C22	64.95
3C23	4.59
3C24	1.69
3C28	4.99
3C30	1.42
3C33	15.95
2C45	7.95
3D23	4.99
3E29	9.99
3EP1	2.99
3FP7	1.99
3GP1	2.89
3HP7	2.99
3J21	79.95
4A-11	.49
4AP-10	3.99
4B22	6.50
4B25/EL6C	3.95
4B28/CE225	2.99
4-125A	18.99
4B36	3.69
4C27	8.95
4C28	33.50
4C35	14.99
4D22	9.95
4D32	19.89
4E27	9.99
4J34	49.50
4J36	69.50
5AP1	4.99
5BP1	2.99
5BP1A	4.99
5BP4	2.99
5CP1	2.99
5CP1A	10.50
5CP7	8.99
5CP11A	15.50
C6J	8.49
5C22	28.99
5D21	7.99
5BP1A	6.99
5FP7	2.99
5HP4	3.99

Type	Price
5HP1	3.99
5JP1	14.50
5JP5	7.49
5RP2	16.50
5j29	9.00
5J30	16.65
5j33	5.90
5LP1	11.49
5NP1	6.99
5R4GY	1.00
5R4WGY	2.22
6-4	1.49
6AU6WA	1.21
6C4WA/6100	1.39
6C21	19.99
6J4WA	3.99
7C22	49.50
7C25	89.50
7BP1	6.99

Type	Price
304TH	10.99
304TL	10.99
307A/RK75	1.99
310A	3.60
316A	.46
327A	3.49
329A	4.69
336A	4.99
347A	3.99
350B	3.00
371B	1.00
388A	1.49
393A	4.45
394A	4.99
417A	6.99
434A	3.99
446A	1.49
446B	2.29
WL460A	9.99
WL464A	4.77

Type	Price
730A	9.99
800	.89
801A	.44
802	2.89
803	2.99
804	8.99
805	4.25
806	10.50
807	1.31
808	2.45
809	3.49
810	9.99
811	3.39
812	2.99
813	10.99
814	2.99
815	2.99
816	1.39
828	9.75
829B	10.49
830B	1.99

We Buy Your Surplus Tubes.
Send Us Your List For Highest Quotation
LARGEST BUYERS IN THE COUNTRY

Type	Price
7BP7	6.90
9LP7	5.50
10Y-	.31
12X3	1.66
15E	1.09
15R	.39
18C	.19
24R	1.99
25TG	4.44
53A	2.99
89Y	.10
100TH	6.99
100TL	8.99
203	4.99
204A	19.49
205B	.89
207	49.50
211	1.59
215A	3.49
217A	2.49
217C	5.99
221A	2.99
231D	2.39
242C	7.99
249B	2.99
249C	3.99
250R	4.99
250TH	19.50
250TL	21.50
256A	5.99
258B	4.49
259A	6.99
264C	3.44
271A	12.99
274A	1.49
2[illegible]4B2	1.99
282A/B	6.50
286A	7.46
287A	6.61

Type	Price
GL-471A	2.35
527	23.50
WL-530	19.95
WL-531	4.99
WL-532	.99
GL-559	.99
700A/B/E/D	9.99
701A	4.99
702A	1.99
703A	3.99
704A	1.59
705A	.96
706B	18.95
706C	18.95
707A	3.99
707B	4.59
708A	2.45
709A	1.19
713A	.96
714AY	27.99
715A	2.49
715B	6.99
715C	14.99
717A	.89
718AY/BY/CY/EY	21.99
719A	11.75
720AY/CY/EY/DY	29.75
721A	1.91
721B	8.10
722	1.99
723A/B	9.99
724A/B	1.29
725A	6.95
726A	14.99
726B	26.50
726C	26.50

Type	Price
832A	8.49
833A	37.49
836	2.99
837	1.99
838	1.99
841	.26
843	.49
845	7.49
849	32.50
851	12.40
860	3.99
861	14.90
864	.69
865	1.19
866A	1.19
869B	15.99
872A	1.26
874	.74
876	.96
878	1.29
884	.99
885	1.49
9-3	.69
902A	3.99
918	2.10
927	1.65
931A	2.99
954	.26
955	.49
956	.59
957	.59
958	.59
959	1.99
991	.33
1500T	84.50
CK1005	.49

Type	Price
CK1006	2.49
1608	2.99
1613	.99
1614	1.99
1616	.99
1622	1.40
1624	1.29
1625	.29
1626	.21
1629	.22
1630	.69
1632	.49
1633	.59
1639	.89
1641	2.49
1642	.29
1644	.69
1806P1	3.99
1851	1.39
1960	.99
2050	1.10
2050W	3.49
2051	.81
1A3	.69
1B3	.89
1G6GT	.69
1LC5	.94
1LD5	.94
1L4	.84
1T4	.69
1A5	.79
1H5	.69
1N5	.89
1R5	.69
1S4	.84
1S5	.69
1U4	.69
1U5	.65
1X2A	.89
1V2	.69
2A3	.99
2A4	.99
3B7	.39
3D6	.39
3V4	.73
3Q4	.83
3S4	.69
5U4	.59
5Y3	.50
5T4	.91
5V4	.89
5Z4	1.19
5W4	.89
6AC7	.89
6AC7W	1.12
6AB7	.99
6AF4	1.29
6AG5	.84
6AG7	1.19
6AH6	.89
6AL5	.59
6AJ5	1.69
6AK5	.74
6AK6	.78
6AN4	1.35
6AQ6	.59
6AR6	1.69
6AS5	.76

Type	Price
6AS7G	2.99
6AX4	.79
6B4G	.99
6BA7	.89
6B5	.99
6B8	.69
6BG6G	1.99
6BH6	.79
6BE6	.69
6BJ6	.69
6BK7A	1.21
6BL7	1.10
6BM6	35.99
6BN6	1.24
6BQ6	1.19
6BQ7A	1.19
6BX7	1.24
6CD6	1.72
6CB6	.69
6C4	.49
6C5	.49
6C6	.49
6C8G	.99
6D4	2.75
6E5	.79
6F5	.49
6F6	.99
6F6G	.69
6J4	3.29
6J6	.72
6J7	.94
6J8	.96
6K4	2.69
6K5	.79
6K6	.69
6K7	.79
6K8	1.19
6L6M	1.49
6L6G	.99
6L7	.99
6N7	1.10
6R7GT	.69
6S4	.59
6SC7	.74
6SF5	.74
6SG7	.69
6SH7	.79
6SK7	.64
6SL7	.79
6SR7	.59
6SS7	.79
6W4	.69
6W6	1.21
6V6GT	.66
6X4	.49
6X5	.49
6T4	1.44
6T8	.99
7A5	.95
7A6	.85
7A7	.79
7A8	.79
7B5	.66
7C4	.39
7C5	.79
7F7	.89
7F8	.89
7H7	.69
7N7	.89
7Q	.99

Type	Price
7Y4	.69
7Z4	.69
12A6	.59
12AT6	.49
12AU7	.79
12AT7	.99
12AV7	.94
12AX4	.83
12AX7	.79
12AY7	1.31
12BA6	.64
12BA7	.64
12C8	.69
12SC7	.89
12SQ7	.59
12SR7	.59
12SF7	.59
12SG7	.85
12H6	.65
12SH7	.69
12SJ7	.69
12K8	.69
12SK7	.69
12SN7	.79
12SL7	.89
12Z3	.49
14A7	.79
14B6	.69
12B8	.79
12N7	.99
14R7	.99
14W7	.99
19T8	.99
25L6	.64
25Z6	.61
28D7	1.21
77	.49
78	.59
80	.49
83V	.99
5651	1.39
5654	1.10
5656	8.25
5670	2.25
5686	1.79
5687	3.40
5702	1.49
5702WA	1.99
5703	1.19
5725	1.99
5744	.99
5751	2.15
5763	1.39
5796	7.99
5814	1.27
5879	1.29
5915	1.09
5963	.99
5964	1.30
5977	3.89
6030WA	3.99
6096	3.49
8002R	19.50
8005	4.90
8012	1.94
8013A	4.69
8020	2.50
8025	1.79

FAY-BILL DISTRIBUTING CO. DEPT. E1
418 Broome St., N. Y. 13, N. Y.
Telephone CAnal 6-8404

All boxed and fully guaranteed. Special quantity discount—10% on 100 or more of same type. Minimum order $10.00. Thousands of other types in stock . . . Send us your requirements F.O.B. New York 25% deposit with order or if paid in advance save C.O.D. charges. Rated firms net 10 days. Prices subject to change without notice. For fast service ask for Sy.

GLASS INFRA-RED FILTERS

Special Designed Filter When Placed In Front Of Any Light Source, Filters Out All Visible Light But Freely Passes Invisible Infra-Red Rays. Army Snooperscope Part #A-1529. 5-3/8" Dia. By 1/8" Thick. BRAND NEW. Package Of Ten Filters For ONLY $10.00

LOW-VOLTAGE TRANSFORMERS

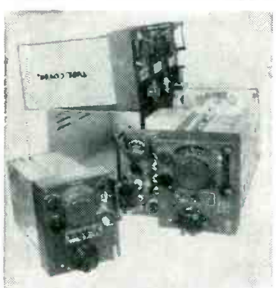
New Release of Government Surplus Material

Model #S-9527, KENYON TRANSFORMER CO. — 2.2 KVA. Input 110/220 volts 50/60 Cy. Output 11 Volts C-T (5.5-0-5.5) At 200 Amperes! Continuous Duty. Case Size 8½ x 10½ x 13".

Price BRAND NEW ONLY .... $23.95 Ea.
#S-9527-WE. — WESTINGHOUSE—Same Specs. But Single 115 V Input & Lighter Wt. NEW $22.95

Terms: Prices FOB St. Louis. Cash With Orders. Well Rated Concerns (D&B) Net 10 Days Cash.

McNEAL ELECTRIC & EQUIPMENT CO.
4736 Olive St., Dept. E-2, St. Louis 8, Mo.



AN/APR-4 LABORATORY RECEIVERS

Complete with all five Tuning Units, covering the range 38 to 4,000 Mc; wideband discone and other antennas, wavetraps, mobile accessories, 100 page technical manual, etc. Versatile, accurate, compact—the aristocrat of lab receivers in this range. Write for data sheet and quotations.

We have a large variety of other hard-to-get equipment, including microwave, aircraft, communications, radar; and laboratory electronics of all kinds. Quality standards maintained.

NEW TS-13/AP X-BAND SIGNAL GENERATORS with manual $575.00; T-47A/ART-13 Transmitters, $450.00; H-P, Boonton, G-R, Measurements, many others in stock.

ENGINEERING ASSOCIATES
434 PATTERSON ROAD — DAYTON 9, OHIO

RCA TV CAMERA

NEW Surplus
for Labs! Export! Industrials! Medicine! Closed Circuit TV!

Ideal for labs, industry, prisons, TV technicians, swim pools, medics—"mechanical eye" for closed circuit TV. 1846 Iconoscope, 6-stage video amplifier and clipper. THE REAL THING! Send for new, free, complete technical data. SOLD AT FRACTION OF REAL VALUE!

Harjo Sales Co.
Office-Warehouse: Dept. E-2. 503 N. Victory Blvd., BURBANK, CALIFORNIA

AN/APS-19 RADAR

New, complete. Fulfills following functions:

SEARCH: Aircraft, ships and land.
MAPPING: Land and water contours, coast line identification and navigational aids.
INTERROGATION: Detection and location of ships, land and airborne microwave beacon stations for homing and navigation.
INDICATIONS: Identifying challenged targets. Also, interrogating pulse.
AIM: Aim indication for firing of fixed guns.

Write or phone for complete data and prices.

V. & H. ELECTRONIC INDUSTRIES
2033 Venice Blvd. Los Angeles 6, Calif.
Phone: REpublic 5-0215
Cable Address: VIIRADELECT

Crystals

BUY NOW AND SAVE UP TO 90%

4,000,000 GOVERNMENT SURPLUS CRYSTALS

NOVICE, FT-243
FT-171, FT-241,
FT-249, DC-34/35
SHIP BAND, MISC.

SAME DAY SERVICE!
• • • •
SATISFACTION GUARANTEED!
• • • •
OVER 5,000 FREQUENCIES!

SEND FOR FREE CATALOG

"The House of Crystals"
U. S. CRYSTALS, Inc.
807 S. UNION AVE. • LOS ANGELES 17, CAL.

New "SEARCHLIGHT" Advertisements

received by February 2nd will appear in the March issue subject to limitations of space.

Classified Advertising Division
ELECTRONICS
330 West 42nd St. New York 36, N. Y.

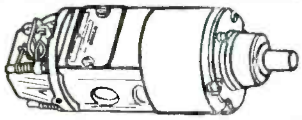
TEST EQUIPMENT

Type 160-A Q-Meter, Ser. 4268, 105-120 volts, mfgd. Boonton Radio—excellent $350.00
Type B-5, Model 798 Tube Tester, Weston .. $145.00

J & J ARMATURE WORKS, INC.
5455 Port Arthur Rd. Beaumont, Texas

KOILED KORDS 3 wires
22 inches long stretches to 9 ft. $1.26

REVERSIBLE GEARED-MOTOR
Delco-PM-Permanent Magnet Alnico Field Motor



#5071895 ¼ SHAFT or 11/16 GEAR.... $17.50
#5069600........................... $18.50
Two Types of Clamps to hold motor: $1.50 ea.

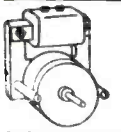
MERCURY SWITCHES
59¢ to $6.00

FILAMENT TRANSFORMER
6v—1½ amps Weighs—1 lb. 97¢

HG We Buy MERCURY HG

G.E. Switchettes
All types—75¢ ea.
10 for $6.00
100 for $50

115 v. AC RELAY
$2.90

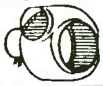


TELECHRON Motors

4 RPM on 50cy or 4¾ RPM on 60 cy. $2.85	3.6 RPM. 3.15
2 RPM ..$2.90	1 RPM .. 3.95
3 RPM .. 3.90	3 R.P. Hr 2.85
4 RPM .. 2.90	1 R.P.2Hr 2.80
	1 R.P.12Hr 3.25
	60 RPM.. 4.85

Laboratory Special 1 of Each Motor $25.

BLOWERS 115 Volts A.C. 60 cy.



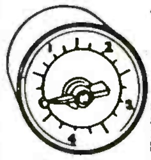
REDMOND 5" 18 watts....$8.95
DELCO 60 cfm. 40 watts.
#5062369 used in 584 RADAR $14.50

HAND WOUND 10 Sec. to 24 Min. TIMER SWITCH..$1.25

6 Watt Most POWERFUL TELECHRON MOTOR
110V 60 CY
1 RPM 6.50
6 RPM (Revers.) 10.00

3" Round Elapsed Time Meter $13.75
Square Case $14.50

MARKTIME 5 HOUR SWITCH



A 10 amp. timing device. Pointer moves back to zero after time elapses. Ideal for shutting off radios and TV sets when you go to bed. Limited supply at this SPECIAL PRICE ...$4.90
Also available in 15 min., or 30 min. or 1 hr. at....$6.50

HAYDON TIMING MOTORS
110v 60 cycle 30 RPM $2.60
110v 60 cycle 1 RPM.. 2.60
230v 60cy 1 RPM....... 1.00
2 RPM....... 1.00

please include postage

BLAN

EST. 1923

64A Dey Street
New York 7, N. Y.

SELLING

- Receivers
- Transmitters
- Radar
- Special Purpose Tubes
- Relays
- Meters
- Switches
- Connectors
- Rectifiers
- Transformers
- Motors & Generators
- Wiring Cable
- Instruments
  and
- All Electronic Components

WILL BUY ALL

New or Used

Leach Relay #5059-R
#5058
#5055
#5053-SM
#5053

Price Bros. Relay #10
Relay #5586
#5587

Antenna Switching Relay
Box # CBY 23049
BG-AN-198
BC -408

Tubes #53A
VT-127A
35T
WL-530

Highest prices paid for most all types of aircraft sparkplugs any condition

Wholesale Only

RADIO & ELECTRONIC SURPLUS
13933-9 BRUSH STREET
Detroit 3, Mich. TO 9-3403

Wholesale Only

A BARGAIN FOR YOU in a....

SOLA *Constant Voltage* TRANSFORMER

End Fluctuating Line Voltage

OVER 60% OFF . . .
the factory price of a 1-input 2,000 VA unit! And here's another bonus! This Air Forces 2,000 VA overstock, Sola Cat. No. 30768, has 4 inputs! 90-125 V., 190-250 V., 60 cy. or 50 cy. Isolated secondary is constant 115.0 V. ± 1% from no-load to full-load of 17.4 amp. So, if you choose, use it as a 220:115 V. step-down. And slash $147.50 off the factory 1-input price!

Brand new in original wood box. 4 cu. ft. Ship. wt. 254 lbs. F.O.B. Pasco, Wash. Only...................... **$97.50**

(EXPORTERS: Note choice of 50 cycles.)

THE M. R. COMPANY
P. O. Box 1220-B Beverly Hills, Calif.

LICENSE TO MANUFACTURE WANTED

Smaller British electronics firm of repute wishes to extend its field by manufacturing under license medical or industrial products of U.S.A. design.

BO-8789, Electronics
330 W. 42 St., New York 36, N. Y.

★ ***MANUFACTURERS***
Let us handle technical sales representation of your products

★ ***INVENTORS***
We will share the cost of protecting your invention if accepted for commercialization

We Specialize in Electronics, Nucleonics, Instrumentation, Servomechanisms & Cybernetics.

R. W. HODGSON CO.
Technical Sales Representation & Research & Development Engineering
3406 W. Washington Blvd. Los Angeles 18, Calif.
REpublic 2-2651

WANTED

ELECTRONIC TUBES, all types. Also want all types airborne electronic equipment: ART-13; BC-788; I-152; ARC-1; ARN/7, etc. Top dollar paid!

BOB SANETT, W6REX
1524 S. Edris Dr.
Los Angeles 35, California

WILL BUY ALL

ART-13T47A Transmitters	$200.00	BC-348 Rec'r Modified	$25.00
ART-13 T47 Transmitters	$150.00	BC-348 Rec'r Unmodified	$50.00
BC-788C Altimeters	$160.00	ARC-1 Radio Complete	$250.00
ARC-3 Complete	$185.00	BC-312 Receiver	$40.00
RS/ARN-7 Radio Compass	$175.00	BC-342 Receiver	$50.00

Ship via Express C.O.D. Subject to Inspection to
H. FINNEGAN
49 Washington Ave. Little Ferry, N. J.

WANTED

ART—13; type ATC, T-47, T-47A—transmitters
BC—348—342—312—224—receivers
EE-8 field telephones
Complete units and all component parts regardless of condition. Any quantity large or small
We Stock A Complete Inventory of ART-13 and BC-348 Parts.

RED ARROW ELECTRONIC SALES CO.
1217 Summit Ave Union City, N. J.
N.Y. Tel. Oxford 5-0984 N.J. Tel. Union 3-7916

ART-13 APR-4 BC-610-E
BC-348, BC-312, BC-342, TCS-12, BC-221, ARC-1, Dumont #241 Scope DY-17, Teletype, Boehme Keyers
ALLTRONICS, Box 19, Boston 1, Mass.
Richmond 2-0048

SURPLUS
BOUGHT & SOLD
GOULD GREEN 252 Greenwich St. WOrth 4-8044—NYC 7

"SEARCHLIGHT" RATES

DISPLAYED RATE

The advertising rate is $18.50 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page.

EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

$2.10 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

PROPOSALS, $2.10 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

"TAB" TUBES

1st Quality

TESTED — GUARANTEED

OA2	5.74	388A	1.99	GL5727	1.77
OA3	.98	394A	1.96	5732	3.94
OB2	.64	434A	3.94	5736	159.95
OB3/VR90	.84	446B	2.98	5744	2.39
OC3/VR105	.82	450TH	75.49	5749	1.72
		502AX	2.05		
OD3/VR150	.78	512AX	1.35	5750	3.10
		531DX	1.89	5751	3.09
1AD4	3.95			5764	55.99
1AG4	1.35	536AX	1.55	5765	55.99
1AX2	1.25	538DX	.98	5769	298.00
1B3	.66	539DX	2.50	CK5783	5.55
1B24	4.98	544DX	2.50	CK5787	4.95
1B46	1.88	571AX	4.45	5794	8.99
1B63A	42.50	608CX	.97	5812	2.99
1D21	3.49	701	2.95	5814	1.28
1Q23	150.00	703A	1.48		
1X2A	.62	704A	.98	5819	49.99
2C39A	16.90	705A	.98	5820	45.00
2021	.75			5823	1.29
2E22	1.89	710A	1.68	5825	11.99
2E24	2.48	715B	11.90	5828	6.70
		717A	.85	5840	5.05
2E26	3.78	721A	.98	5841	7.98
2E32	2.07	723AB	9.98	5842	12.00
2E43	1.49	724A	2.94	5944	4.48
2J30	50.50	724B	.96	5852	7.57
2J42	99.50	725A	4.49		
2K25	23.88	807	1.19	5857	59.50
2K28	29.50	307W	4.98	5863	49.94
2K29	27.59			CK5875	2.05
2K30	130.00	813	9.99	5876	12.49
2K33	219.48	814	2.48	5879	1.59
		815	3.98	5881	2.70
2K41	175.00	829B	8.49	5893	7.55
2K42	149.55	832A	5.49	5910	.74
2K43	130.00	927	1.36	5927	89.45
2K48	110.00	954	.18	5932	5.00
2K50	315.00	955	.65		
2P23	298.00	956	.30	5950	6.45
3B24W	8.48	957	.51	5959	37.25
3C22	72.50			5965	1.75
				6027	179.95
3C24	3.98	CK1005	.56	6072	3.99
3C45	7.00	1612	1.98	6080	5.99
3D21A	7.99	1613	1.27	6099	1.55
		1616	.79	6101	1.55
4-65A	19.49	1619	.34	6110	6.55
4-125A	19.09	1620	5.01	CK6111	8.95
4B23	16.98	1625	.44		
4B27	4.98	1626	.16		
4C35	16.95	1629	.22	6119	6.45
4J26	79.55	1632	.68	6121	9.00
4J30	99.55			GL6136	1.89
4J47	485.00	1633	.98	6146	4.87
4J52	649.95	1642	.62	6164	64.95
4X150A	36.00	1644	.99	6199	49.99
		1850A	99.00	6201	3.99
5C22	29.50	2050	.98	6270	199.95
5D21	9.48	2050W	2.48	6271	159.95
5U4G	.46	2051	.66	6273	199.95
6AN5	3.60	5514	4.69		
6AS6	1.60	5516	5.51	8005	4.97
6AS7G	2.98	5517	2.22	8012	1.09
6J6	.48			8013	4.91
6SN7	.56	5586	150.25	8014A	50.15
6V6GT	.56	5588	119.99	8020	2.95
6X4	.42	5634	7.50	8025A	2.99
12AU7	.54	5640	11.57	9001	.88
		5641	6.59	9002	.96
12AX7	.58	5642	.99	9003	.98
FG17	3.01	5654	1.72		
19BG6	1.38	5656	9.98	C'Ray Tubes	
24G	1.96	5663	1.06		
HK24	4.90	5670	2.24	3BP1A	6.55
35Z5	.46			3CP1S1	5.98
FZ40	4.49	5672	1.55	3DP1	4.81
50L6	.60	5676	1.55	3DP1A	6.80
71A	.74	5686	2.99	3EP1	4.71
		5687	3.59	3FP7	1.91
HY69	5.49	5692	6.48	3FP7A	6.91
QK155	699.99	5693	5.49	3GP1	1.91
QK202	99.99	CK5694	3.70	5BP1	1.98
203A	7.38	CK5697	3.70		
215	10.35	CK5702	2.50	5CP1A	14.49
233A	2.92	5704	2.25	5CP5	3.55
250R	10.95			5HP1	3.91
250TH	35.00	5713	173.50	5JP1	14.95
304TH	15.00	5718	5.99	5JP2	7.94
304TL	15.00	5719	5.99	5LP1	9.91
		5721	189.55	5SP7	100.00
416A	.48	5722	6.39	7BP7	6.50

We Wholesale to One & All
Write for complete tube listing
GET OUR PRICE B4 U BUY!!!

KLYSTRON "X" BAND

HOUSING, Latest Sealed Cast dsgn for **2K25 or 723AB.** Contains locking tube socket. variable frequency control, couples to "X" band w.g. containing geared variable attnuator. Ideal front end for Generator or Freq. Mtr. Controls at front. **SPECIAL**........$25

WAVEGUIDE TEE 106A Sperry 3.95-6 Kmc Special $10 ea........2 for $18
WAVEGUIDE TEE 107A Sperry 3.95-6 Kmc @........$12 ea
LINE ADAPTER 398 Sperry 2.6-4 Kmc Only........$10 ea; 2 for $18
LINE ADAPTER 100A Sperry 4-6 Kmc...$12

HEAVY DTY 115v/60cy SATURABLE REACTOR TRANSFORMER

4 wnds, wgt 14 lbs. will handle & control line voltage fluctuations up to 400 Watts. **WITH DATA**........**Special $9, 2 for $17, 7 for $50**

"VECTOR" PLUG-IN STANDARD TURRET

C12M CAN, OCTAL PLUG & 7 PIN TOP SOCKET, Regularly @ $1.52; "TAB" SPECIAL........@ 75c; 24 @ .50 ea; 100 @ .35 ea

NEW "TABLITE" ELECTRONIC *FLASH KIT 400 II*

Compact Camera, size case 6¾" Hgt 2¾" Dpth 5" Wdth. Uses new **LO-COST** Flash circuit ¾c per flash, 1000 to 1200 flashes per set of Batteries Color number +40. Fast Pan +200. Recycles 2 secs. Simplified Kit (Child can build) LESS BATTERIES, @ $29.95—**Set of Two 240V batteries @ $10**

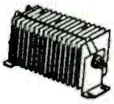
NEW PROFESSIONAL "TABLITE" *FLASH KIT 1000 II*

Includes Four 525 mfd/450V flash condensers. **operates AC & BATTERIES.** Guide number color +200; Fast Pan +500. **Less Batteries $44.98; Set BATTERIES XTRA**........$10

NEW MINIATURE METER *0-1 Milliamp*

Precision Jeweled D'Arsonval Mvt. Better than 2% accy. Readable long 1⅛" scale 20 divisions. Rugged. Well damped. Bakelite cased. Front sq. or Rear Round Face mtg. Mounts 1½; hole. 4 screws 1¼" ctrs. Not surplus.
Milliamp Shunts each.........35
"TAB" SPECIAL $3.85; 2 for $7.00; 12 for $40

NEW "TABTRON" SELENIUM RECTIFIERS



ENGINEERED *for* INDUSTRY

"Technical Apparatus Builders" mfgrs. Power Rectifiers to your specs. From one amp up to and above 1000 amps, convection or fan cooled, single or 3 phase. "NEMA" & JAN. Specs. Write for catalog.

FULL WAVE BRIDGE • DATED & ONE GTD

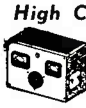
Max Amp	18VAC* 14VDC	36VAC* 28VDC	54VAC* 42VDC	72VAC* 56VDC	130VAC* 100VDC	266VAC 217VDC	Ctr Tap AC*DC 30/12	3 Phase 120VAC 150VDC	Bridge 240VAC 300VDC
1	$1.40	$2.30	$3.70	$4.45	$7.40	$25.00	$2.40	$17.10	$33.25
2	2.00	2.95	5.30	5.85	10.25	29.00	2.70	18.25	35.50
3	2.90	4.10	5.75	7.80	12.70	37.00	3.05	20.00	38.50
4	3.50	6.40	11.25	14.30	25.00	45.00	3.40	21.70	42.45
6	3.95	7.70	12.75	17.25	29.65	59.00	3.70	24.00	45.90
10	5.85	11.35	19.40	24.75	41.25	85.00	5.45	42.40	82.70
12	7.20	14.25	22.00	29.50	43.85	100.00	6.80	48.15	94.20
20	13.00	25.00	37.00	48.00	78.00	161.00	9.15	58.50	112.60
24	15.00	28.50	44.25	57.50	80.65	191.00	11.45	103.35	183.90
30	17.85	34.25	56.25	70.50	108.00	236.00	Q	135.55	259.80
36	22.35	42.00	64.75	86.50	133.65	296.00	17.20	155.10	310.40
50	29.40	54.00	105.00	115.00	173.00	405.00	27.50	206.85	413.90

JOBBERS—DISTRIBUTORS, WRITE FOR DETAILS

Heavy Duty Battery "Fast" Charger Rectifier

13-0-13V(CT) 100 Amp Fan Cooled or 34 Amp Air Cooled. Rep'mt 6V Booster Charger.
Model CR16........$12.00
16-0-16V(CT) Fan Cooled for 12V/60A and 6V/100A Booster Charges.
Model CR30........$14.00

High Current Power Supplies



ONE YEAR GTD

Variable 0-28VDC. Completely Built. Ready to Go. Full Wave Selenium Rectifier Transformer. Variac. 4" Volt & Amp Meters. Switch. Terminals & Fuse. Hvy Duty Steel Cabinet Std 115V/60 cy Input or 220V † (3 phase) to order.

Stock Number	Continuous Meters	With Meters
T28V5A *	0-28 WVDC at 5 Amp	$50
T28V5ACC	5 Amp (1% Ripple)	85
T28V5A2CC	5 Amp 0.01% Ripple	145
T28V12A	0-28 VDC at 12 Amp	125
T28V12ACC	12 Amp (1% Ripple)	160
T28V12A2CC	12 Amp 0.01% Ripple	220
T28V24A †	0-28 VDC at 24 Amp	155
T28V24ACC †	24 Amp (1% Ripple)	225
T28V24A2CC †	24 Amp 0.01% Ripple	310
T28V50A †	0-28 VDC at 50 Amp	285
T28V50ACC †	50 Amp (1% Ripple)	410
T28V100A †	0-28 VDC at 100 Amp	500
T28V100ACC †	100 Amp (1% Ripple)	700

Variable 75 to 135 VDC Completely Built. Ready to go. Includes F. W. Selenium Bridge Rectifier 4" Rectangular Volt & Ammeter.
Specify for 115 or 230 VAC 1 phase, 60 cy Input

T120V5AC	75 to 135 WVDC at 5 Amp	$190
T120V5ACC	5 Amp (1% Ripple)	240
T120V10AC	75 to 135 VDC at 10 Amp	245
T120V10ACC	10 Amp (1% Ripple)	295

*** 2" Meters: All Others 4" Meters**
POWER SUPPLIES TO YOUR SPECS
WRITE US YOUR REQUIREMENTS

New! *Quality* VOLTAGE REGULATOR ONLY $16.98

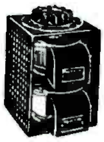
Line Voltage Stabilizer

Stabilizes line voltage within plus or minus 3% regardless of **VOLTAGE & FREQ.** Shift. Ideal for **INDUSTRIAL, LAB** or **TV & RADIO** use. Automatically operated . . . regulator turns on & off with set or Equipment. **TROUBLE FREE, QUIET.** needs no adjustment. Universal Use—from 100 to 300 Watts. Input 100-125V/Output 115V plus or minus 3% 50/60 cycles—.

230 to 115V Autoformers

For 220V/50cy Input. To 110-120V or Step up. † With Cord. Plug & Receptacle.
TPA050/50W.*........$2.55
TPA075/75W.†........3.65
TPA100/100W.†........4.00
TPA200/200W.†........5.75
TPA250/250W.†........6.75
TPA500/500W.†........8.25
TPA750/750W.†........11.79
Model TPA1000 Watts 1 KW †........16.95
TPA1500/1500W †.$22.50; TPA2000/2KW...$34
* Less Cord, Plug & Receptacle.

New Variable Voltage X-fmrs

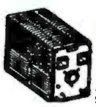


SUPERIOR-GR-STACO-UT
0-132V-1.25A*........$7.23
0-135V/3A*........10.63
Cased/0-135V/7.5A.*........19.55
Uncased/0-135V/7.5A*........15.30
Cased/0-270V/3A*........22.10
Uncased/0-270V/3A*........17.00
Cased/0-135V/15A*........39.10
Cased/0-270V/9A*........39.10
Uncased 0*27V/7.5A †........51.64
Cased 0-270V/9A*........81.60
Cased 0-270V/12A †........107.10
Cased 0-270V/15A †........124.95
Cased 0-270V/30A........154.70
GR50B/0-270V/31A/LN........115.00

BUY AS YOU NEED AT FACTORY DISCOUNTS
Large Stocks & Immediate Delivery

New Variable 0 to 6 & 12 Volt/16 Amp

DC POWER SUPPLY



Battery Eliminator Charger Model RR Plater Aircraft Marine or any DC Reg. Extra Hvy Duty Selenium Rectifier, 2 Meters V. & A. Dsgnd for Cont. Service and up to 20 Amp intermittent overload. **New Model T612V12AC SPECIAL**........$29.95

FILTER CAPACITORS

CE156M 6000MFD 15V........98c; 2/$1.50; 10/$5
CE502M 2000MFD 50V........$2.50; 10 for $20
CE603M 3000MFD 60V........$3.98; 2 fo $7

"TABTRAN" Rectifier Xfmrs

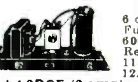
Sec'd Volts (OUAL†) 18-15-9-0:0-9-15-18V.
Series Sec'ds 36-30-18-15-9-0

TR5007 1 Amp† $5.65; 2/$10.50
TR5008 2 Amp† $6.65; 2/$12.25
TR5001 5 Amp† $8.65; 2/$15.75
TR5002 12 Amp†..$16.50; 2/$32
TR5003 24 Amp†*.$35.50; 2/$70
TR5004 50 Amp†*........$58.50; 2/$115
TR5005 100 Amp†*........$107
18 Volt 2 Amp........$1.98; 2 for $3.50
† Wndgs in Series at Ratings shown; Parallel 2X-Amps; Voltage 18-15-9-0.
*** Dual Pri 115 & 220V 60cy.**

"TABTRAN" Rectifier Chokes

CR6001/1 Amp/0.1 HY/1.4 Ohm **$4.50; 2 for $8**
CR6002/2 Amp/0.1 HY/.67 Ohm **$5.75; 2 for $11**
CR6003/5 Amp/07 HY/6 Ohm **$7.90; 2 for $15**
CR6004/12 Amp/.01 HY/.1 Ohm **$14.50; 2 for $28**
CR6005/24 Amp/.004 HY/025 Ohm **$29.50; 2/$58**
CR6006/50 Amp/.004 HY/.013 Ohm **$52; 2/$100**

DC Power Supply



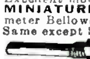
6 or 12V DC Power Supply Full Wave Rectification 6000MFD Condenser Filter Ready to operate Input 115V 60cy Output 6.3 or 12.6V.
Model 2DCF (2 amp)........$12.98
Model 5DCF (5 amp)........29.95
5DCF ACC/5 amp/1% Ripple........38.95

"TAB" NEW YORK DISTRIBUTOR — **Write for Discounts and Rectifier Catalog PR156**

"TAB" SPECIAL BARGAIN BUYS

Get Your Share of These Real Money Savers

NEW MINIATURE DIEHL PM MOTOR—Type FD6-21, RPM 10,000/27.5VDC Excellent motor for fan cooling @ **$2.50; 5/$10—motor & fan**........**$3.50: 4 for $12**
MINIATURE HI Q INDUCTOR, 0.5 Hy accy mu metal core........**$1.25; 6/$5; 12/$8; 24/$16**
meter Bellows actuating Precision Potentiometer. Temp comp cost over $200........**$20 ea: 2 for $30**
Same except Sperry #709632 only one bellows, actuated resistor........**$12; 2/$20**



FENWAL THERMOSWITCH #17111 Precision adjustable Fluid or Air control −100 to +400°F/10A/115VAC........**$4; 2 for $7**
MICRO-POSITIONER, Barber Colman AYLZ3522-S polarized DC relay. Double coil, differential current sens. for remote control........**$3.50; 2 for $6**
BOURNS MINIATURE PRECISION "TRIMPOT", 2000 Ohms........**$2.50; 5 for $10**
EDISON TIME DELAY RELAY, Octal Base. 28 or 128 Volts........**@ $1.25; 10 for $10**
PLANETARY DRIVE, 5:1 & 1 to 1 Ratio $5.29 Reg........**Special $2; 3 for $5; 10 for $10**
Bendix-Pioneer Autosyn AY-201-2A, Rotor 1 Phase 26V Stator 3 Phase 11.8V/400~...**$10; 3/$25**
Bendix-Pioneer Autosyn AY-106-A1, Rotor 1 Phase 115V Stator 3 Phase 18.2V/400~..**$10; 3/$25**

WRITE FOR OUR NEW $ BONUS CATALOGS $

FAIRCHILD Precision Potentiometer, Type 736—Five gang. 3 units. 10,000 Ohm. one 25,000 Ohm. one with 2 taps accy ±0.5% 3.5 Watts Servo mtg. $100 Reg........**$8; 4/$25**
TYPE 746—Three gang, two 9.5K Ohm, one 12K Ohm. accy ±0.5 & 1%/2.5 Watt........**$15**
TYPE 746—Dual 40,000 Ohms, accy ±0.5 & 1%/2.5 Watt........**$5; 5 for $20**
TYPE 746—Dual 20,000 Ohms, accy ±0.5%/2.5 Watt........**$7**
TYPE 746—Dual 5000 Ohms, accy ±0.5%/2.5 Watt........**$7**

RELAY, VACUUM SEALED, CLARE SK5010/DPDT/18-28VDC/3 Amp CTS Octal Base........**Special Buy @ $2.98; 3 for $7.50**
DELAY LINE—ESC #2200/0.4 mu sec'ds........**@ $2; 6 for $10**
FILTER FL-5. Range or Voice. Filters 1020 cycle audio excellent for CW..**Only 59c; 2/$1**
SINE-COSINE LINEAR SAWTOOTH DC Precision Line Potentiometer #KS15138, 100 Ohm—$100 Reg........**Buy @ 89c; 6 for $5**
FULL WAVE SELENIUM RECTIFIER, 35 ma/115VDC rated........**@ 39c; 10/$3.49**

New Radio-TV 130V/65MA Rectifiers, 6/.50¢, 25/.45¢, 100/.41¢

THAT'S A BUY **"TAB"** THAT'S A BUY
Dept 2E6 111 Liberty St., New York 6, N. Y., U.S.A. PH RECTOR 2-6245 CABLE "TABPARTS"

HI-FI HDQTS

COMPLETE LINE OF HI-FI
GET OUR PRICE B-4-U-BUY

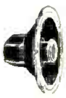
NEW G.E. PHONO CARTRIDGES

RPX050A .001 & .003........$6.98
RPX052A Gold Treasure........19.98
RPX053A Gold Treasure........28.98
RPX040A Single (S) .003........5.25
RPX041A Single (S) .001........5.25

Replc'ment Needles "TETRAD" diamond†

RPJ010A Dual (S) .001 & .003 **GE**........$1.98
RPJ012A Dual (D) .001 & .003 **Tetrad†**...18.99
RPJ013A Dual (DS) .001 & .003 **Tetrad†**..10.99
Replc'mts for New A Cartridge Only
RPJ01D or **RPJ03D** Single (D) **Tetrad†**... 9.99
RPJ01S or **RPJ03S** Single (S)........1.35
Replc'mnt Styli for RPX040 & 041 Only
RPJ001 or **RPJ005** Single (S) **GE**........1.35
RPJ003 or **RPJ004** Single (D)†........9.99
Complete Stock of Replc'mnt Needles
Send Cartridge Name and Number

NEW 15" HI-FI SPEAKERS



SOLD ON MONEY BACK GUARANTEE. Latest Design, Biggest & Best Ticonal 5DG Magnet Assembly wgt 18 lbs. 8 Ohms V.C. Rated 25 to 50 W.
TRI-AXIAL 15" (20-20000 cyc).$89
DUAL-CONE 15" (20-14000 cyc).$69
WOOFER 15" (20-4000 cyc)....$59

NEW HI-FI TWEETER

Electrostatic New 3D Tone Range. Linear Response range 7000-20000 cyc. **THB70**—Round 2¾" dia. dpth .55"........$5.25; 2/$8.50
TH516—Rectangular 2" x 6¼" dpth **"TAB" @ $6.95;**........2 for $12
Includes Circuit Data & Network Parts "TAB" ELECTROSTATIC DATA SHEET........50c

"TAB" HI-FI SPEAKERS

Inbuilt network 2 wires needed for HF & LF Response. **Famous HI-FI mfg. 15" Coaxial** PM & 5" Tweeter. 25W/20-17500 cy Model **P25CO.$19.50**
12" Coaxial PM & 3½" Tweeter. 12W/4"-15000 cy........$12.75
8" Coaxial PM & 2½; TW. 8 Watts/70-15 KC **Model P8CO**........$7.75

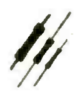
New Collaro RC-54 Changer with Hi-Fi Crystal Pickup $39.75

HI-FI RECORDING TAPE

Finest, $, $, $, Back Gtd

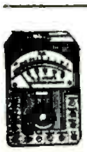
PRECISION COATED & SLIT Gtd Splice free. Quality Controlled. Plastic Base. Gtd. Constant Output. Freq. 7½ IPS 40-15KC Oxide Wnd. In 7½" reel; 1200 ft. per reel.
"TAB" @ $1.68 ea; 3/@ $1.62 ea; 12 @ $1.55 ea: 24 @ $1.45 ea; 72 @ $1.35 ea.

NEW LO PRICES!



PRECISION RESISTORS
1% Accuracy Gtd
No Mfg Choice . . .
We Ship Types in Stk
"TAB" Special
10 of One Value........ea 10¢
100 of One Value........$8.00
10 Assorted Values........$1.50
Write for Complete Listing

POCKET AC-DC *Multitester*



"TAB" 27C $7.75 ea.

Hi-accuracy precision VOM 1000 Ohms per V. Reads AC & DC Volts 0. 5. 25. 250. 1000V. DCMA; 0. 1. 10. 100MA. Ohms 0. 10. 100K Size 1¼D. 4⅝L 3½ W. Test Leads **(Plus 40c ship in U. S. A.)**

PHOTOFLASH & STROBE LAMPS

"TAB" No.	Replaces	W-Sec Max	Each
TWL	FA 104/FT118	150	$5.98
THI	Amglo 5804X	100	10.98
23ST	GE FT 210	200	9.98
THVA	SYLV. 4330	200	9.98
V4X4	X400	200	10.98
TLX	DX & FA100	150	9.00
TDX	DXC/250-350	150	10.00
353GTQ	FT 503	2000	49.98

TRIGGER COIL LO VOLT FLASH....$1.47
OIL COND-525 MFD/450VDC/53 Watt sec'ds
NEW low leakage famous mfgr..**$8; 2/$15; 6/$39**
FIVE-90 Volt (N60) Batteries........$12.50
Send 50c for "TAB" Photoflash Data

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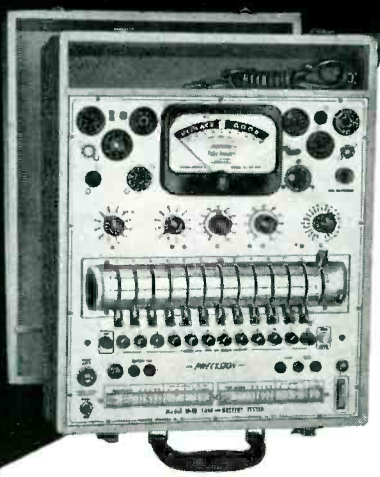

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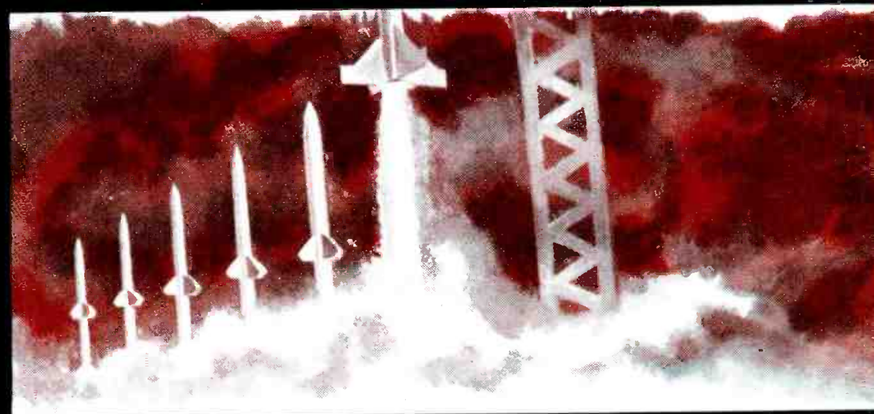

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Action	Type	Maximum Number of Positions Per Pole	Number of Poles/Deck	Size
Shorting	11-BM	24	one	$1\frac{3}{8}$ Dia. x $1\frac{11}{16}$ Depth
Shorting	12-CM	32	one	$1\frac{3}{4}$ Dia. x $1\frac{11}{16}$ Depth
Shorting	25-EM	48	two	$2\frac{3}{4}$ Dia. x $1\frac{15}{16}$ Depth
Non-shorting	85-EB	6	eight	$2\frac{3}{4}$ Dia. x $1\frac{15}{16}$ Depth
Shorting	45-DM	23	four	$2\frac{1}{4}$ Dia. x $1\frac{15}{16}$ Depth

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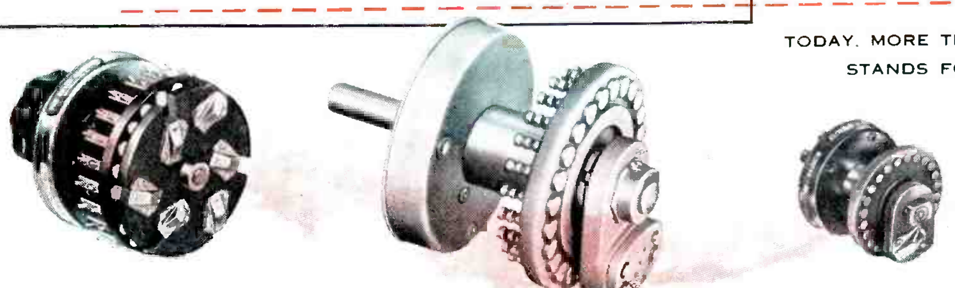

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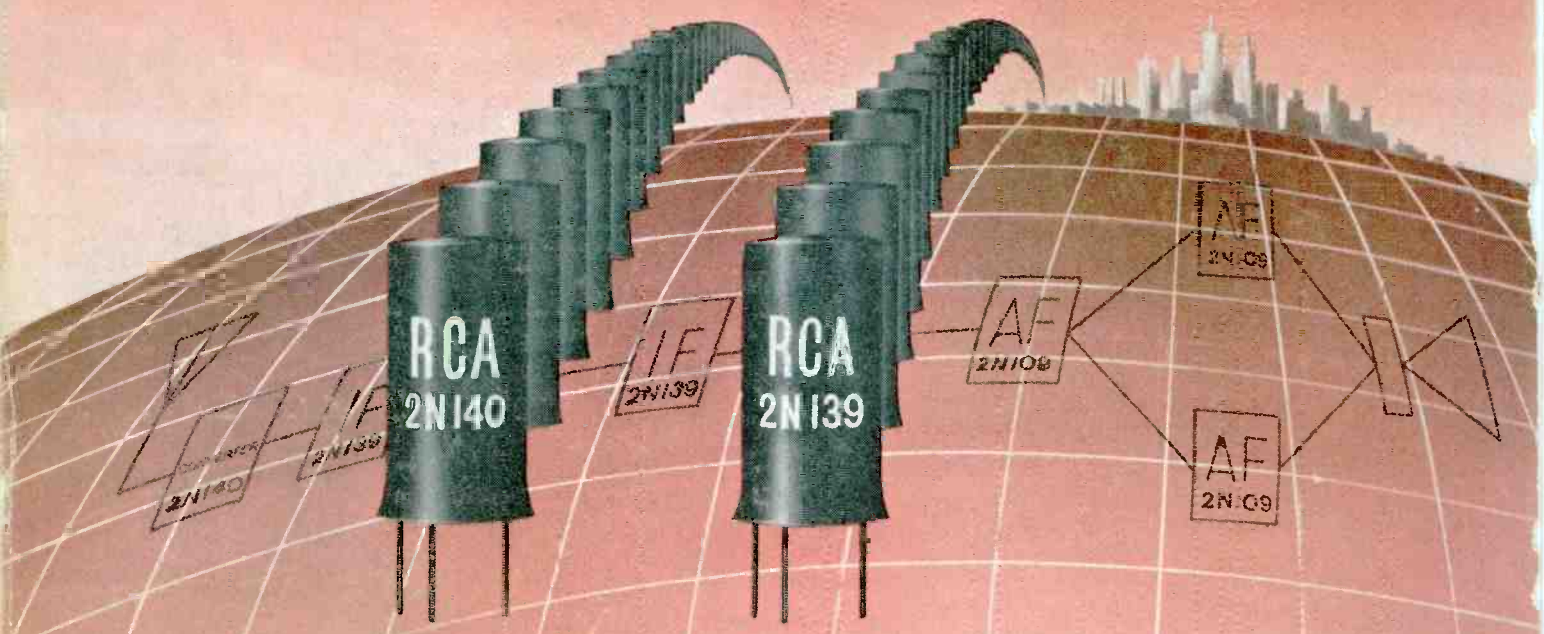

...with uniformity of characteristics from unit to unit!

RCA-2N139 and RCA-2N140 are produced under exacting manufacturing controls to enable complete interchangeability of these types within their respective circuits of suitable design *without circuit adjustments!* Both are hermetically sealed germanium-alloy p-n-p junction types and feature *excellent stability throughout long-life.*

RCA-2N139 . . . for 455-Kc if-amplifier applications . . . is capable of providing a power gain of 30 db at 455 Kc when used in suitable common-emitter circuits of quantity-produced receivers.

RCA-2N140 . . . for converter and mixer-oscillator applications in the Standard AM Broadcast band . . . features a conversion power gain of 27 db at the center of this band when used in suitable common-emitter circuits. Moreover, satisfactory converter operation will be obtained from batteries approaching the end of life.

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New, miniature RCA speaker—generic design XS-7834—for compact portable radios . . . measures approximately 5/8" deep, 2 1/8" diameter! **Three new types of long-life RCA batteries**—VS300, VS301, and VS400—for all-transistor and "hybrid" radios.

CONTACT YOUR RCA FIELD ENGINEER FOR COMPLETE DATA, DETAILS, AND SPECIFICATIONS—AT THE DISTRICT OFFICE NEAREST YOU.

TRANSISTOR DATA	RCA-2N109	RCA-2N139	RCA-2N140
MAXIMUM RATINGS (Absolute Values):			
Collector Volts	—25	—16	—16
Collector Ma	—70	—15	—15
Collector Dissip. (mw)	50	35	35
Operating Temperature (°C)	50	70	70
Typical Operation†:	**Class B Amp.**	**455-Kc IF Amp.**	**Converter**
DC Collector Volts	—9	—9	—9
DC Emitter Ma	—2††	1	0.4
Useful Power Gain (Approx. db)	33	30	—
Useful Conversion Power Gain (Approx. db)	—	—	27
Typical Noise Factor (Approx. db)	—	4.5	—
Power Output (mw)	160*	—	—
Parameters and Characteristics:			
Feedback Capacitance (uuf)‡	—	9.5	9.5
Feedback Conductance (umhos)‡	—	0.25	0.2
Base Resistance (ohms)‡	—	75	90
Current Amplification Ratio†	70**	48	45
Figure of Merit for High-Frequency Performance (Mc)‡	—	14	16
Cutoff Frequency (Mc)	—	4.7	7

†In common-emitter circuit at ambient temperature of 25°C.
*For 2 transistors in class B af circuit, and maximum distortion at 10%.
‡Based on one-generator, small-signal, hybrid-π equivalent circuit for the common-emitter connection.
††Zero-signal condition. **For large signal.

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