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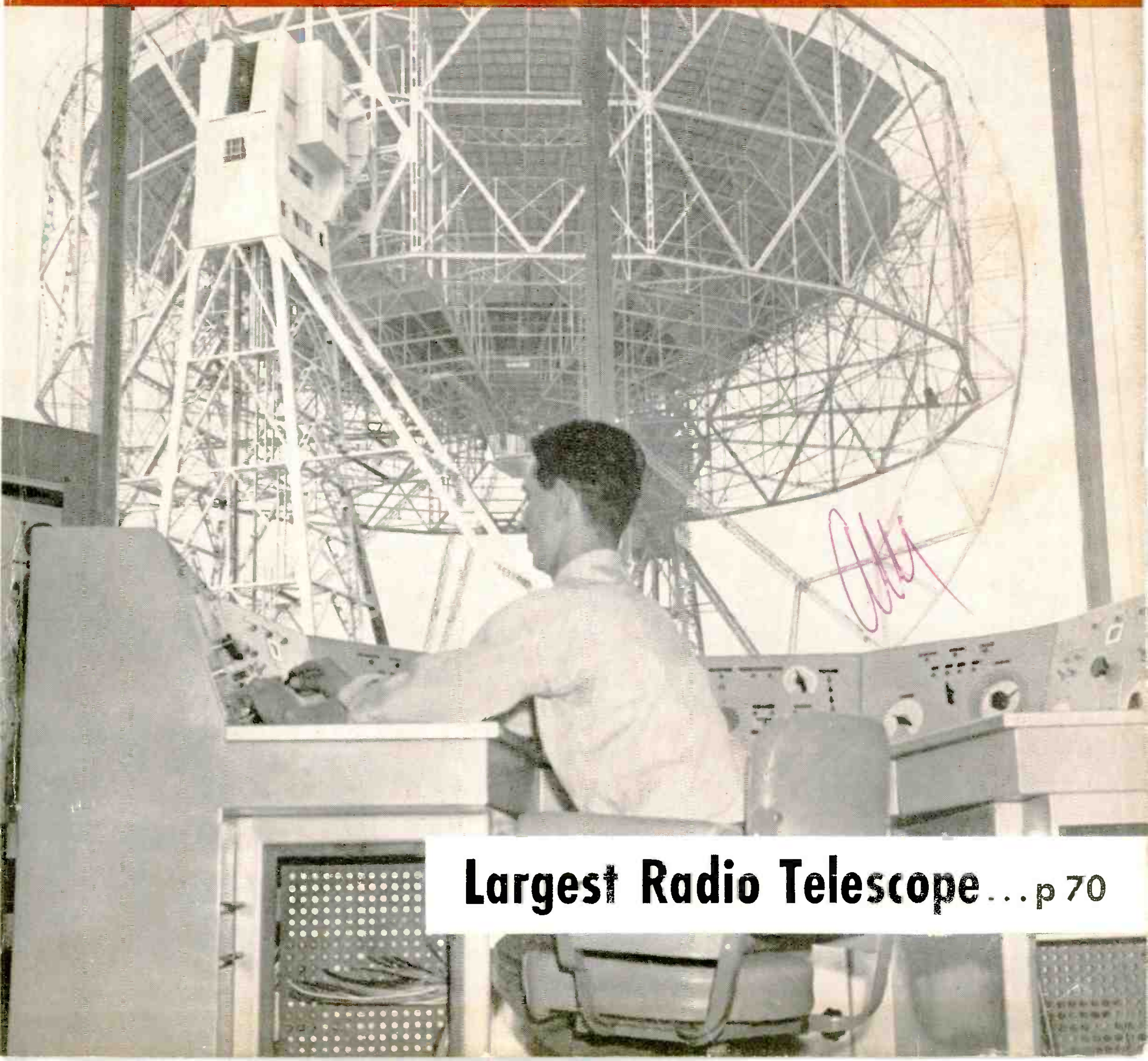
JUNE 6, 1958

electronics

engineering edition

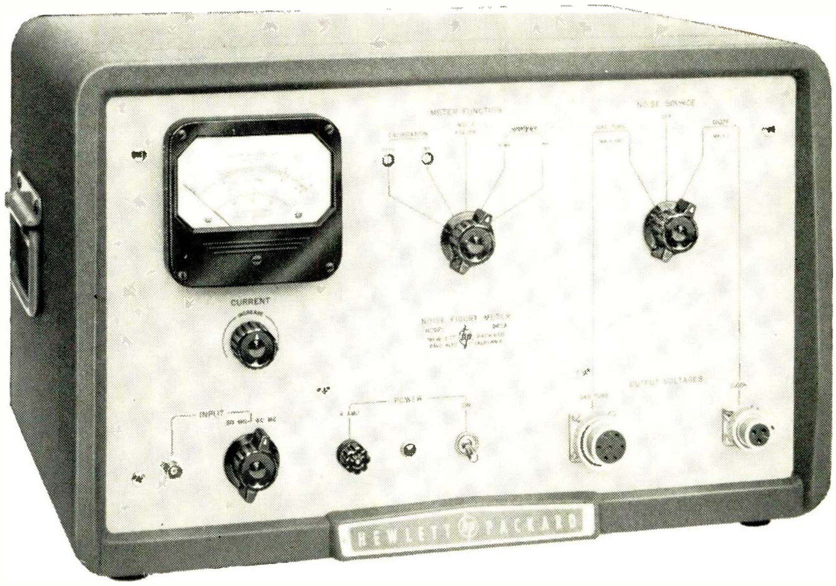
Compatible Stereo Disk ...p 65

Simulating Radar Targets ...p 82



Largest Radio Telescope ...p 70

in 5 minutes



-hp- 340A NOISE FIGURE METER

optimize receiver performance, measure noise figure directly, record all measurements

Now the new *-hp-* 340A Noise Meter, reading direct in db and requiring no periodic recalibration, does receiver and component alignment jobs in 5 minutes that previously required hours. Operation is so simple unskilled workers can easily use the instrument. Receiver performance can often be improved up to 3 db over the best adjustment previously possible. Improvement frequently equals doubling transmitter output. Accurate alignment is easy, equipment is better maintained and peak performance enjoyed regularly. Fast response is ideal for recorder operation.

External noise source

New *-hp-* 340A operates at any frequency for which there is a noise source, and uses either a gas discharge tube or temperature limited diode source. (*-hp-* has recently marketed *-hp-* 347A Waveguide Noise Source, an Argon gas discharge tube, and *-hp-* 345A IF Noise Source, a 30 or 60 MC diode source. Details on request.)

In addition to its convenience in optimizing receivers and components, *-hp-* 340A is useful in designing circuit components such as IF amplifiers, crystal mixing circuits and tubes such as wide band traveling wave tubes.

Complete details from your -hp- representative, or write direct

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SPECIFICATIONS -hp- 340A NOISE FIGURE METER

Frequency Range: Depends on noise source used.

Noise Figure Range: 3 to 30 db indication to ∞ with Waveguide Noise Source.
0 to 15 db indication to ∞ with IF Noise Source.

Accuracy: ±0.5 db, 10 to 25 db; ±1 db, 3 to 30 db with Waveguide Noise Source.
±0.5 db, 0 to 15 db with IF Noise Source.

Required Receiver or rf Amplifier Gain: Approx. 40 db (Waveguide Noise Source), approx. 50 db (IF Noise Source).

Input Frequency: 30 or 60 MC, selected by switch.

Bandwidth: 1 MC minimum.

Input Impedance: 50 ohms.

Power Input: 115/230 volts ±10%, 50/60 cps, 320 watts.

Power Output: Sufficient to operate -hp- 347A Waveguide Noise Source or -hp- 345A IF Noise Source.

Weight: Cabinet Mount: Net 40 lbs., Shipping 63 lbs.
Rack Mount: Net 35 lbs., Shipping 74 lbs.

Dimensions: Cabinet Mount: 20½" wide, 12½" high, 14¼" deep.
Rack Mount: 19" wide, 10½" high, 13½" deep behind panel.

Price: (Cabinet Mount) $715.00. (Rack Mount) $700.00.

Data subject to change without notice.

Prices f.o.b. factory.

hp® has a new 200 KC, $435 oscilloscope. Seen it?

electronics engineering edition

A McGRAW-HILL PUBLICATION • VOL. 31, NO. 23 • JUNE 6, 1958

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Issue at a Glance

DIGEST CONTINUED ON NEXT PAGE

DIGEST continued

electronics

June 6, 1958 Vol. 31, No. 23

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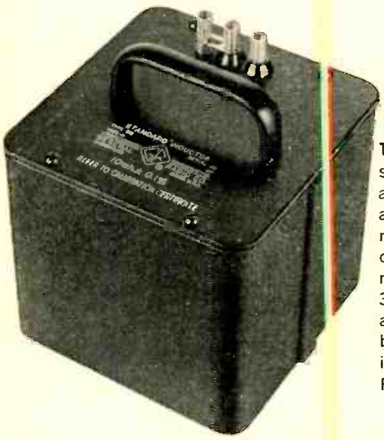
★ HIGH STABILITY OF INDUCTANCE ★ HIGH Q AT OPERATING FREQUENCY

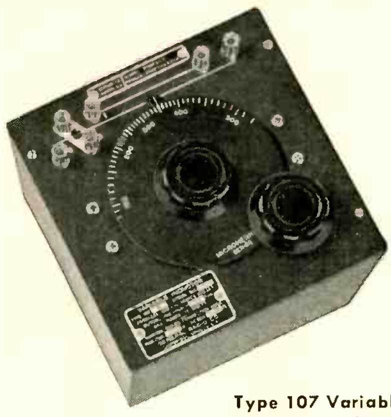
★ SMALL INDUCTANCE VARIATION WITH CHANGES IN FREQUENCY and CURRENT

★ LOW TEMPERATURE COEFFICIENT

General Radio manufactures a variety of fixed and variable standard inductors in different price ranges. Fixed inductors are toroidally wound to minimize effects of external magnetic fields. Toroidal air-core inductors like the Type 1482 approach the ideal — they offer higher stability, lower temperature coefficient, and much smaller inductance variation with current changes than is produced by solenoid or iron-core inductor types.



Type 1482 Standard Inductor — a primary standard for precise measurements at audio frequencies. All units are thermally aged to equalize winding strains. Sixteen models from 100 μh to 10 h in 1-2-5 sequence. May be used for 2- or 3-terminal measurements. Temperature coefficient, 30 parts in 10^6 per degree C. Adjustment accuracy for most units is ±0.1%. Calibration certificates furnished with each inductor give actual value to ±0.03%. Prices range from $105 to $210.



Type 107 Variable Inductor — two concentrically-mounted coils are used as rotor and stator, and may be connected in series or parallel. Calibration accuracy is ±1%. Five models available with following series-connected values: 9-50μh, 90-500μh, 0.9-5 mh, 9-50 mh, 90-500 mh. When parallel connected, inductance is one-fourth of series-connected value. Prices range from $85 to $95.

Greater economy in coil construction is obtained by using "iron" cores. By proper design and use of materials such as powdered molybdenum permalloy, excellent secondary standards can be produced and sold at relatively low cost.

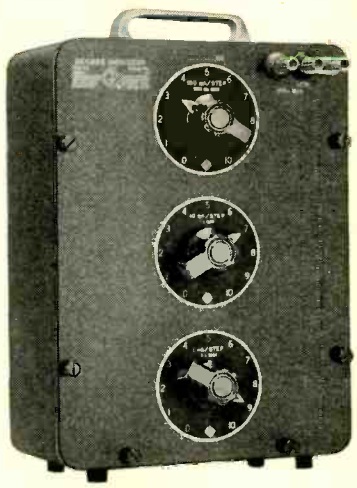
Type 1481 Standard Inductor — has higher Q at low frequencies than does Type 1482 Standard Inductor, although accuracy is not as high. Twelve models are available, from 1 mh to 5 h in 1-2-5 sequence (for 2-terminal measurements only). Temperature coefficient of inductance is about 25 parts in 10^6 per degree C, between 16° and 32°C. Accuracy is ±0.25% for large values, ±1% for smaller values. Prices from $32.50 to $40.00.

NEW Type 940 Decade-Inductor Unit — an assembly of four toroids series connected by a rotary switch to produce eleven successive values from 0 to 10. These units are ideal elements for use in filters, equalizers, and tuned circuits throughout the audio and low r-f ranges.

Type	Inductance	Accuracy	Price
940-E	1 mh/step	±2%	$100
940-F	10 mh/step	±1%	100
940-G	100 mh/step	±0.5%	100
940-H	1 h/step	±0.25%	110

NEW Type 1490 Decade Inductor

— is an assembly of three or four Type 940 Decade-Inductor Units in a metal cabinet for 2- or 3-terminal measurements.



Type	Inductance	Price
1490-C	1.11 h max. in 1 mh steps	$330
1490-D	11.11 h max. in 1 mh steps	440

GENERAL RADIO Company

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WE SELL DIRECT. Our District Sales Offices are staffed by engineers especially trained to help you in the selection of instruments and measuring systems best suited to your needs. We welcome your inquiries — will help solve your problems.

CIRCLE 1 READERS SERVICE CARD

Knee high to a grasshopper

but Fenwal's New Miniature,

Here are acute temperature sensitivity, instant response, and the strength to withstand the most demanding conditions — all in *one unit only knee high to a grasshopper!*

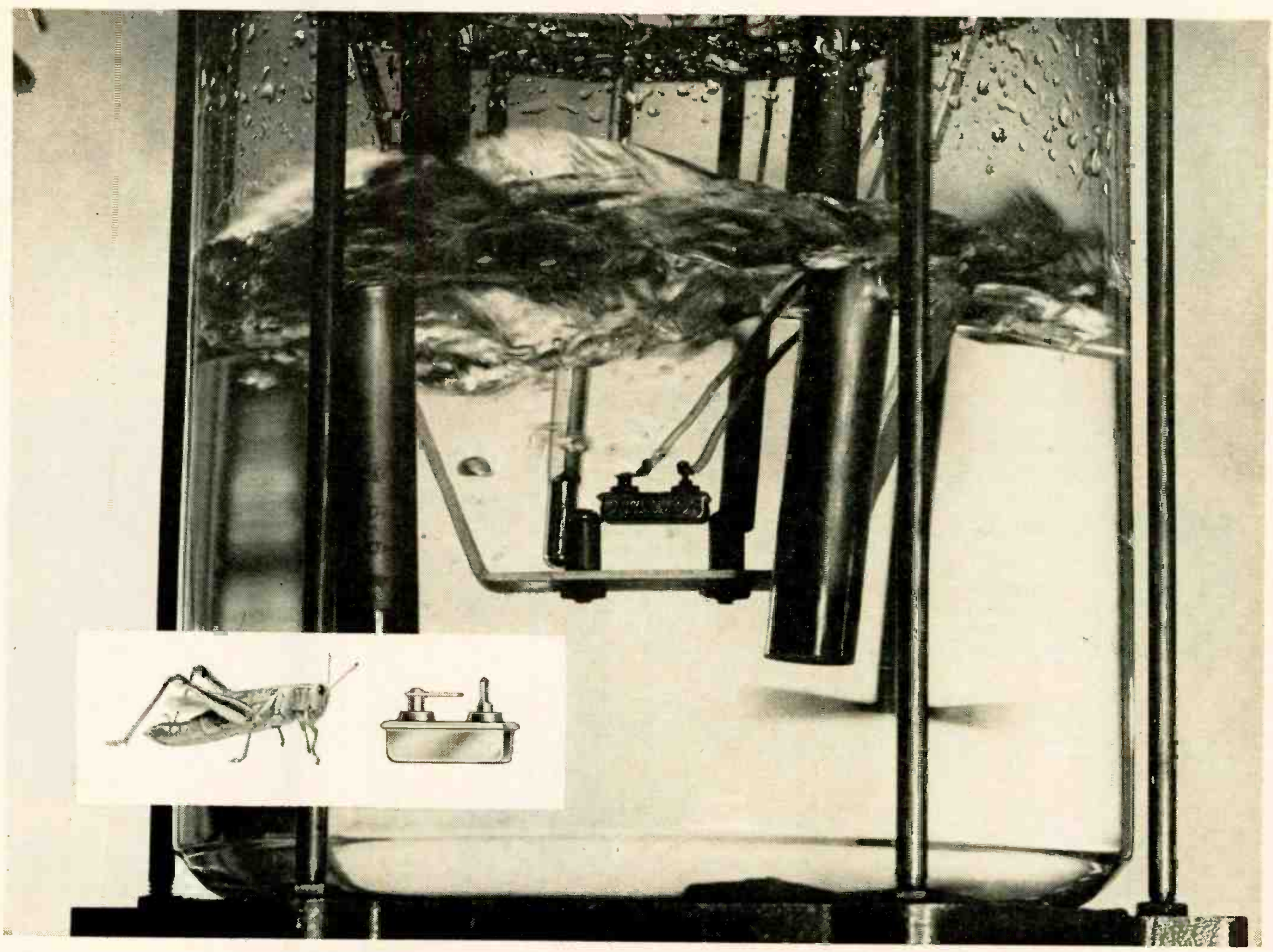
It's hermetically sealed, yet field adjustable. Maintains control characteristics even with vibrations of 500 cps with 10G acceleration — *it's rugged!*

You get wide range and sensitivity, too. The new THERMOSWITCH unit controls temperatures from −20° to +200°F within 1°. Thin wall corrosion-resistant, drawn stainless steel case insures instant response to temperature changes — *you get precision control.*

You'll want to find out more about this tiny, tough, sensitive control. For more information on the new miniature hermetically sealed THERMOSWITCH unit, and other Fenwal miniaturized controls, write for our catalog or a sales engineer. Fenwal Incorporated, 206 Pleasant Street, Ashland, Massachusetts.

Hermetically Sealed THERMOSWITCH® Unit is Strong as an Ox

New Fenwal miniature THERMOSWITCH unit being agitated in liquid bath while maintaining temperature of liquid at 140°F ±1°. THERMOSWITCH unit weighs less than ⅛ oz., can withstand 10G acceleration at 500 cps vibration. Current capacity is 2.5 amps, 115 VAC, 2.0 amps, 28 VDC.



Fenwal CONTROLS TEMPERATURE . . . PRECISELY

CIRCLE 2 READERS SERVICE CARD

new Transistorized Power Supplies

Model Q28-1

Model Q28-1
Output: 18 to 36 (28 nominal) VDC, 0 to 1 amp.
Regulation: ±0.25% for line and load change **combined**
Ripple: 0.01% maximum
Response time: 50 microseconds
$195 in cabinet
$400 in dual rack mount (illustrated)

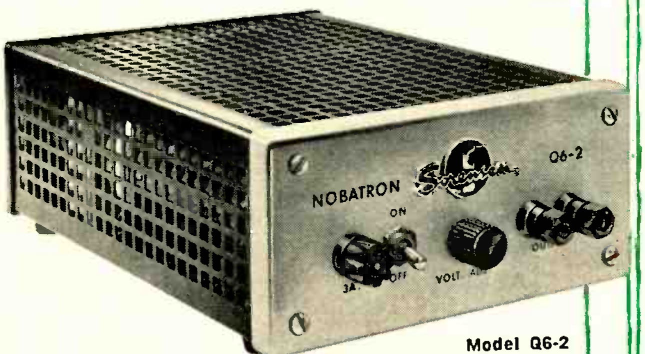
Model Q6-2
Output: 4.5 to 8 (6 nominal) VDC, 0 to 2 amps.
Regulation: ±0.25% for line and load change **combined**
Ripple: 0.02% maximum
Response time: 50 microseconds
$165 in cabinet

LOW-VOLTAGE HIGH-CURRENT DC POWER SUPPLIES

with the PERFORMANCE of ALL-TRANSISTOR CIRCUITRY

DC sources of utmost reliability, minimum ripple, and very fast response —with nominal voltages of 6, 12, 28 volts at 0 to 4 amp output—all in lighter, *smaller* packages. And these new, compact power packs are fitted with the Zener diode reference circuit that assures the ±0.25% regulation accuracy and high stability. The 2 to 1 output voltage range gives these supplies an application range that is unsurpassed. The all-transistor design provides the excellent ripple and response properties that rule out line and load transients. An exclusive protective circuit prevents short-circuit damage to the transistors. All models are low in cost, coming in single or dual rack mount, or in cabinets.

Full information on this important advance in low voltage, high current technology is now in print. Ask your Sorensen representative for full data, or let us mail it to you directly.



Model Q6-2

Sorensen

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CONTROLLED POWER FOR RESEARCH AND INDUSTRY

CIRCLE 3 READERS SERVICE CARD

Your Design is better Your Product performs better

with this full line of RAYTHEON **DEPENDABLE DIODES RELIABLE RECTIFIERS**

Germanium GLASS DIODES

TYPE	Working Voltage (max.) v	Forward Current at +1 volt mA	Reverse Current μA at v
1N55B	150	5	500 at −150
1N66A	60	5	50 at −10
1N67A	80	4	50 at −50
1N68A	100	3	625 at −100
1N95	60	10	800 at −50
1N126	60	5	50 at −10
1N127	100	3	25 at −10

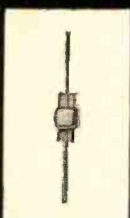
Type	Working Voltage (max.) v	Forward Current at +1 volt mA	Reverse Current μA at v
1N128	40	3	10 at −10
1N191	90	5	25 at −10
1N198	80	5†	75† at −10
1N294A	60	5	10 at −10
1N297A	80	3.5	100 at −50
1N298A	70	30*	250 at −40

*at +2 v †at 75°C

Germanium VIDEO DETECTOR Diodes

for TV video and portable radio application;
low capacity video detection; efficiency controlled at 50 Mc

Silicon DIFFUSED JUNCTION GLASS RECTIFIERS



TYPE	Peak Operating Voltage −65°C to +150°C Volts	Ave. Rectified Current 25°C mA	150°C mA	Reverse Current (Max.) in μA at Specified Voltage Volts	25°C	100°C
1N645	225	400	150	225	0.2	15
1N646	300	400	150	300	0.2	15
1N647	400	400	150	400	0.2	20
1N648	500	400	150	500	0.2	20

Silicon DIFFUSED JUNCTION RECTIFIERS

WIRE IN TYPES

TYPE	Peak Operating Voltage −65°C to +165°C Volts	Ave. Rectified Current 25°C mA	150°C mA	Reverse Current (Max.) at Specified PIV, 150°C mA
1N536	50	750	250	0.40
1N537	100	750	250	0.40
1N538	200	750	250	0.30
1N539	300	750	250	0.30
1N540	400	750	250	0.30
1N1095	500	750	250	0.30
1N547†	600	750	250	0.35

† Same as 1N1096 *to +135°C

STUD TYPES

TYPE	Peak Operating Voltage −65°C to +165°C Volts	Ave. Rectified Current 25°C Amps.	150°C Amps.	Reverse Current (Max.) at Specified PIV, 25°C μA
1N253	95*	3.0	1.0*	10
1N254	190*	1.5	0.4*	10
1N255	380*	1.5	0.4*	10
1N256	570*	0.95	0.2*	20
CK846	100	3.5	1.0	2
CK847	200	3.5	1.0	2
CK848	300	3.5	1.0	2
CK849	400	3.5	1.0	2
CK850	500	3.5	1.0	2
CK851	600	3.5	1.0	2

Ratings at 25°C unless otherwise indicated. All illustrations actual size.

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Los Angeles: 5236 Santa Monica Blvd., NOrmandy 5-4221

CIRCLE 4 READERS SERVICE CARD

ELECTRONICS NEWSLETTER

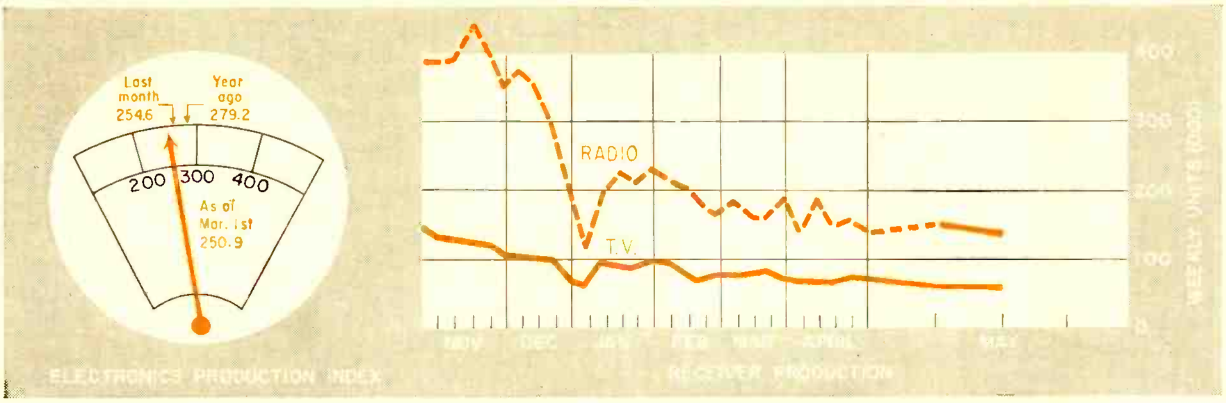
SOME DETAILS OF ELECTRONIC SPYING on Russian activities are being heard in secret sessions of a London trial. Two Oxford University students are charged with breaching Britain's Official Secrets Act. The two had charged in an undergraduate magazine that frontier incidents had been deliberately provoked to gain information about the Soviets, and that monitor stations were "avidly recording the least squeak from Russian transmitters" along the entire East-West frontier in Europe. Prosecutor said "some of the matter" in the article was true, and was "highly secret information" which the pair obtained during their service in the Royal Navy between 1953-55.

PHOTOMULTIPLIER TUBES now being developed for use in nuclear research should make it possible to measure time with an accuracy between one ten-billionth and one billionth of a second. Reason: nuclear research often requires measurement of low-energy gamma radiation emitted by radioactive nuclei, and also the time of arrival of the gamma quanta at the detector. MIT scientists L. E. Beghian, G. H. R. Kegel and R. P. Scharenberg have just reported the development of a detector with an accuracy within one-billionth of a second. Accuracy of time measurement is largely limited, they say, by the design of photomultiplier tubes now available. But, they add, new tubes promise to break through present limitations.

TV SETMAKERS will sell more sets this year than the 5.5 million predicted early this year, say Sylvania executives. Senior v-p Marion E. Pettegrew thinks sales will reach 6 million sets. And general marketing manager Robert L. Shaw says consumers are buying fewer middle-price range sets, more high-priced ones. This, he says, indicates dollar volume will hold up fairly well despite portable volume.

COMPLICATED ELECTRONIC GEAR in a large earth satellite is cheaper than providing for the survival needs of man in a space chamber, and has design advantages too. That's the conclusion of Jack Myers, University of Texas scientist, who recently reported on fundamental research with mice and oxygen-producing algae. He told a symposium on possible uses of earth satellites for life science experiments that a man in a spaceship would need 600 quarts of oxygen a day to survive; tremendous weight of oxygen tanks makes them impractical. Myers said his experiments for the Air Force indicated a photosynthetic gas-recycling system might be an alternative; man would breathe oxygen produced by algae which would grow on carbon dioxide exhaled by man. However, "no use of this procedure is reasonably foreseen in the immediate future . . ."

RADIO FIRST? Bonn University has received a 108 mc signal bounced off the moon from Ft. Monmouth as part of U.S. space research.



FIGURES OF THE WEEK

RECEIVER PRODUCTION

(Source: EIA)	May 16, '58	May 9, '58	May 17, '57
Television sets, total	67,949	68,125	80,436
Radio sets, total	149,659	159,967	243,270
Auto sets	45,582	46,215	97,750

STOCK PRICE AVERAGES

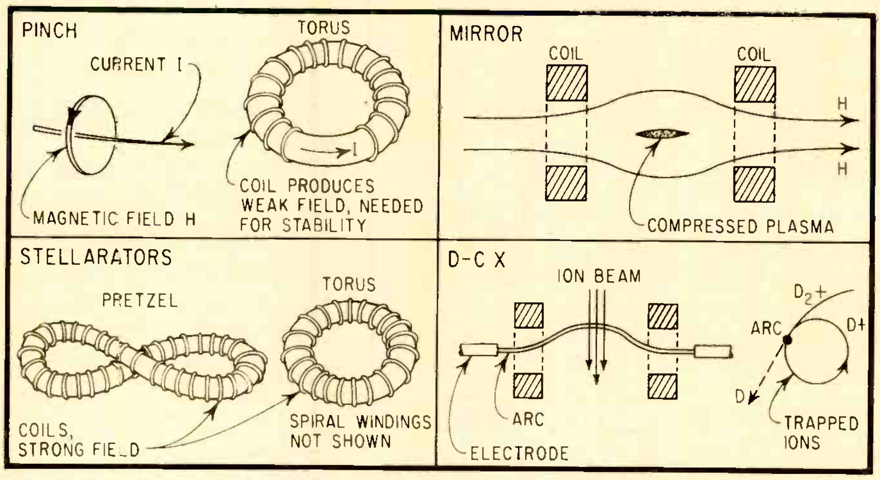
(Source: Standard & Poor's)	May 21, '58	May 14, '58	May 22, '57
Radio-tv & electronics	46.22	45.70	52.28
Radio broadcasters	62.56	60.11	69.44

FIGURES OF THE YEAR

Totals for first three months

	1958	1957	Percent Change
Receiving tube sales	84,990,000	125,041,000	—32.0
Transistor production	9,038,798	5,125,000	+76.4
Cathode-ray tube sales	1,812,825	2,322,480	—21.9
Television set production	1,221,299	1,474,729	—17.2
Radio set production	2,834,759	3,959,367	—28.4
TV set sales	1,446,969	1,682,911	—14.0
Radio set sales (excl. auto)	1,493,668	1,818,976	—17.9

MORE FIGURES NEXT PAGE



Basic designs of experimental apparatus used in controlled thermonuclear power research are shown as . . .

AEC Reveals Fusion Plans

Researchers are working on four ways of control hydrogen fusion magnetically

PRINCIPLES of four alternative routes in the Atomic Energy Commission's quest for controlled atomic fusion power were outlined last month.

Only one method, the magnetic pinch, has been revealed in detail publicity (ELECTRONICS, September 10, 1957; February 7, 1958; March 28, 1958).

All four methods attempt to obtain power from the radiation resulting from fusion reactions in hot, ionized hydrogen isotopes. The basic idea is to squeeze the gas magnetically until it reaches an "ignition" temperature. At that temperature, nuclear reactions are vigorous enough to keep the gas at fusion temperature despite the energy loss resulting from the radiation of energy. There is general belief in U. S. laboratories that the ignition temperature will be reached in a few years.

In addition to the pinch method there are three alternatives. Hybrid methods also may be used if these fail.

(1) Mirror: Energetic ions are injected into a strong magnetic field provided by two coils. The ions at first spiral at right angles to the field. As coil current is increased, the hot gas is squeezed.

(2) Stellarators: A cold gas is confined in a magnetic field. Coil current is increased until the gas temperature reaches more than a million deg C, by which time the gas is highly conductive. Then, the gas is shaken by strong alternating magnetic fields to heat it further. The stellarator's pretzel shape counteracts the drift of the gas toward the walls of the surrounding tube.

(3) D-C X: Mirror coils are fed with direct current. A confinement space is filled with super-hot ions, which heat cooler ions added after the hot plasma is formed. Molecular ions are introduced, each breaking up into a deuteron and an atom of deuterium. The atoms escape, but the hot ions are caught and circulated in the confining magnetic field.

Meanwhile, a British fusion team discovered that neutrons produced by their Zeta torus were not thermonuclear, as originally believed. The probable source, transient electrical conditions, however, may become a trigger mechanism.

Zeta is being modified to raise its temperature to 20 million C. Reportedly, a Zeta II will be built for $14 million, to attain 100 million C. Theoretically, deuterium that hot will yield net power.

Airlines to Test Infrared Warning

AIRCRAFT ANTI-COLLISION devices this month are getting renewed attention from airlines, government authorities and electronics engineers. Interest is heightened by the recent midair collision in Maryland of an Air National Guard jet and a Capital Airlines plane which killed 12 people.

The Air Transport Association indicates that the airlines right now lean towards an infrared proximity warning indicator for all passenger and cargo lines. They want a "self-contained system," one which will operate effectively as a warning device for an airliner regardless of equipment carried by other aircraft.

The ATA, an organization of 49 scheduled airlines, is keeping close watchfulness on development by electronics manufacturers of infrared anticollision devices. One such device, said to be getting close scrutiny by ATA, is Aerowarn, developed by Aerojet-General Corp., Azusa, Calif. Flight tests so far

TRANSISTOR AND TUBE SALES, MONTHLY

(Source: EIA)	Mar. '58	Feb. '58	Mar. '57
Transistors, units	2,976,843	3,106,708	1,904,000
Transistors, value	$6,795,427	$6,806,562	$5,321,000
Receiving tubes, units	28,524,000	29,661,000	43,010,000
Receiving tubes, value	$25,697,000	$25,650,000	$37,007,000
Picture tubes, units	634,779	556,136	833,257
Picture tubes, value	$12,643,404	$11,210,527	$14,850,847

EMPLOYMENT AND EARNINGS, MONTHLY

(Source: Bur. Labor Statistics)	Mar. '58	Feb. '58	Mar. '57
Prod. workers, comm. equip.	343,500	350,800	393,300
Av. wkly. earnings, comm.	$80.16	$79.95	$80.19
Av. wkly. earnings, radio	$79.39	$78.98	$76.80
Av. wkly. hours, comm.	39.1	39.0	40.5
Av. wkly. hours, radio	39.3	39.1	40.0

5-Year Guarantee

GUARANTEED FOR FIVE YEARS

New LAMBDA L-T TRANSISTORIZED POWER SUPPLIES

CONVECTION COOLED

No internal blowers • No moving parts

0-32 VDC 0-2 AMP

Introduced at the 1958 I.R.E. Show

Model LT 2095	**$365**
Model LT 2095M (metered)	**$395**

- **Ambient 50° C at full rating.**
- **High efficiency radiator heat sinks.**
- Silicon rectifier.
- 50-400 cycles input.
- Special, high-purity foil, long-life electrolytics.
- **Compact. Only 3½" panel height.**
- **Short-circuit proof.**
- Protected by magnetic circuit breakers.
- Hermetically-sealed transformer. Designed to MIL-T27A.
- **All transistor. No tubes.**
- **Transient free.**
- Excess ambient thermal protection.
- Excellent regulation. Low output impedance. Low ripple.
- Remote DC vernier.

CONDENSED DATA*

Voltage Bands	0-8, 8-16, 16-24, 24-32 VDC
Line Regulation	Better than 0.15 per cent or 20 millivolts (whichever is greater). For input variations from 105-125 VAC.
Load Regulation	Better than 0.15 per cent or 20 millivolts (whichever is greater). For load variations from 0 to full load.
AC Input	105-125 VAC, 50-400 CPS
Electrical Overload Protection	Magnetic circuit breaker, front panel mounted. Unit cannot be injured by short circuit or overload.
Thermal Overload Protection	Thermostat, manual reset, rear of chassis. Thermal overload indicator light, front panel.
Size	3½" H x 19" W x 14⅜" D.

* Preliminary and tentative specifications

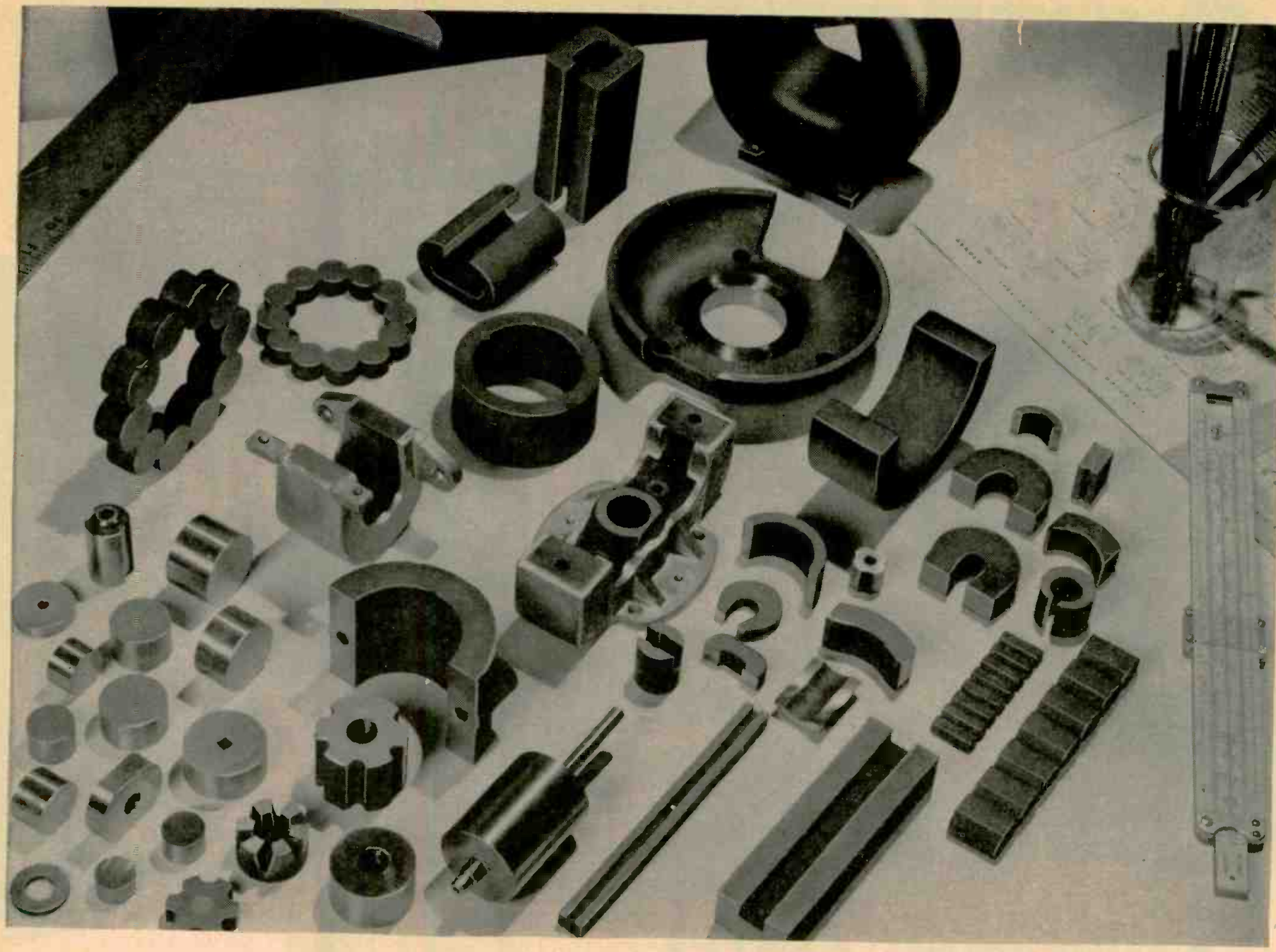
Send for complete LAMBDA L-T data.

LAMBDA Electronics Corp.

11-11 131 STREET • COLLEGE POINT 56, NEW YORK

INDEPENDENCE 1-8500 Cable Address: Lambdatron, New York

CIRCLE 5 READERS SERVICE CARD



For Alnico Magnets—Stock or Special

Specify "ARNOLD"

Materials

Cast Alnico Magnets are most commonly made in Alnico V and VI. Sintered Alnico Magnets usually are made in Alnico II, V or VI. Special permanent magnet materials include Vicalloy, Cunife, and Arnox.

Engineering Data

Write for your copy of *Bulletin GC-106C,* a general catalog of all Arnold products. It contains useful data on the physical and magnetic properties of Alnico Magnets. Lists stock items and standard tolerances for cast and sintered magnets—also stock sizes and pertinent data on tape cores, powder cores, C & E cut cores, etc.

ADDRESS DEPT. E-86

YOUR best bet when looking for a source of Alnico magnets and assemblies is Arnold—producer of the most complete line of magnetic materials in the industry.

Arnold can supply your need for any size or shape of Alnico magnet. Weights range from a few ounces to 75 pounds or more. Die-cast or sand-cast aluminum jackets, Celastic covers, etc., can be supplied as required. Complete assemblies are available with Permendur, steel or aluminum bases, inserts and keepers as specified—magnetized and stabilized according to the requirements of the application.

A wide range of the more popular shapes and sizes of cast and sintered magnets are carried in stock at Arnold. Unsurpassed plant facilities make possible quick delivery of all special orders. ● *Let us handle your permanent magnet requirements, or any other magnetic material specification you may have.*

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THE ARNOLD ENGINEERING COMPANY

ARNOLD

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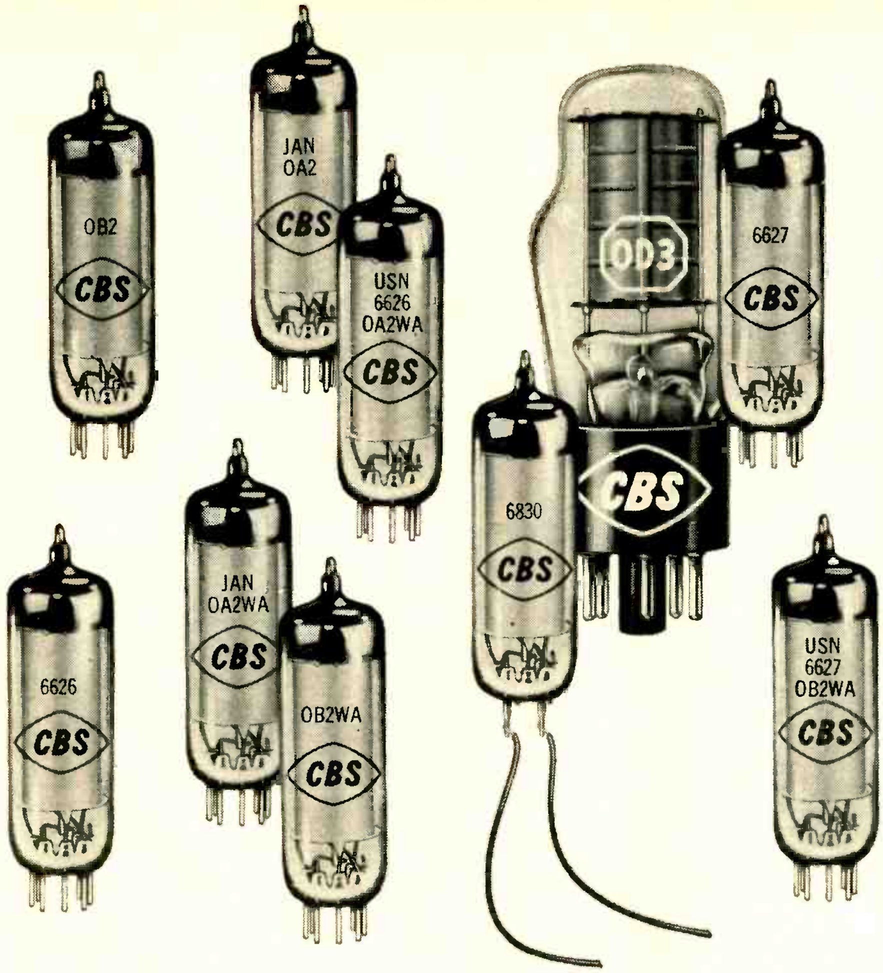


5 REASONS WHY CBS VR TUBES ARE YOUR BEST CHOICE

1. **A SPECIALIST** — There's a special reason why CBS VR tubes are more stable and dependable. CBS-Hytron specializes in VR tubes . . . has made over 20 millions of them.

2. **ADVANCED-ENGINEERING** — Within their voltage and current ranges, the reliabilized CBS 6626 and 6627, for example, provide an absolute minimum of discrete voltage shifts in voltage reference circuits.

3. **RESEARCH AND DEVELOPMENT** — CBS-Hytron has originated many VR types: OB2, USN-OA2WA, USN-OB2WA, 6830, 6831 as well as the 6626 and 6627.

4. **WIDEST LINE** — Commercial and military, miniature and GT, 105-volt and 150-volt . . . CBS-Hytron offers the most complete line of VR tubes for voltage regulation and reference.

5. **SPECIALIZED TYPES** — CBS-Hytron solicits inquiries for production quantities of specialized VR types, like the flying-lead 6830 and 6831.

These five reasons explain why most leading manufacturers specify CBS VR tubes. You, too, can have the best simply by asking for CBS. And for complete technical data, write for free 8-page CBS VR Tube Manual, Bulletin E-267.

Reliable products through
Advanced-Engineering

CBS tubes

CBS-HYTRON, Danvers, Massachusetts
A Division of Columbia Broadcasting System, Inc.

CIRCLE 7 READERS SERVICE CARD

have shown promise for the device, according to ATA.

Night radiation pattern tests are now being made from an Aerojet DC-3 over Catalina Island. Three airlines flying Convair 330's and 440's, and Constellation DC-6's and DC-7's are cooperating. When bugs in the first model are worked out, five airlines will get units to test on routine scheduled flights. In addition, one airline plans more extensive tests for all possible collision angles and amount of advance warning.

Right now, plans call for about 20 seconds warning for the average possible collision situation. One Aerojet official says that in a case like the Grand Canyon disaster where the planes converged at an acute angle, Aerowarn could have given three-and-one-half minutes of warning.

Main technical problem now is increasing discrimination between objects. Some bright-edged clouds and snow-capped peaks reflecting sun show up as possible collision hazards. Engineers are working to suppress background interference.

Unit weighs just under 30 pounds. Breadboard model tested so far uses a scanning device mounted on top of the plane's empennage which rotates at 30 rpm; it scans a 15 degree sector—7½ degrees above and 7½ degrees below the horizontal.

A "cooperative" radio warning system partly based on missile guidance principles has also been proposed. Such a system requires coding and transmitting equipment to be carried by each of two planes that might collide.

Thor Gets Moon Task 'In Months'

CHICAGO—"A modified Thor IRBM will be the first moon vehicle through which the U.S. can investigate and appraise many phenomena of space travel," Maj. Gen. Bernard A. Schriever, USAF missile head, told the Illinois wing of the Air Force Association here last week.

"Within a matter of months,"

WASHINGTON OUTLOOK

THE PENTAGON is pushing plans for standardization of electronic and other types of ground-support equipment for missile projects. A project is under way to compile a special catalog of standard military and commercial components and end-items already in the Defense Dept.'s inventory of missile ground support equipment.

The project is expected (1) to curb duplicate development of electronic and other kinds of missile ground-support gear common to two or more weapon systems; and (2) to achieve the widest possible use of ground-support apparatus now in service.

The catalog project is an outgrowth of a special conference recently held by the Air Materiel Command in Dayton to discuss the Air Force's burgeoning costs for missile ground-support equipment. About 100 service and industry experts—including representatives of the Electronic Industries Assn.—attended.

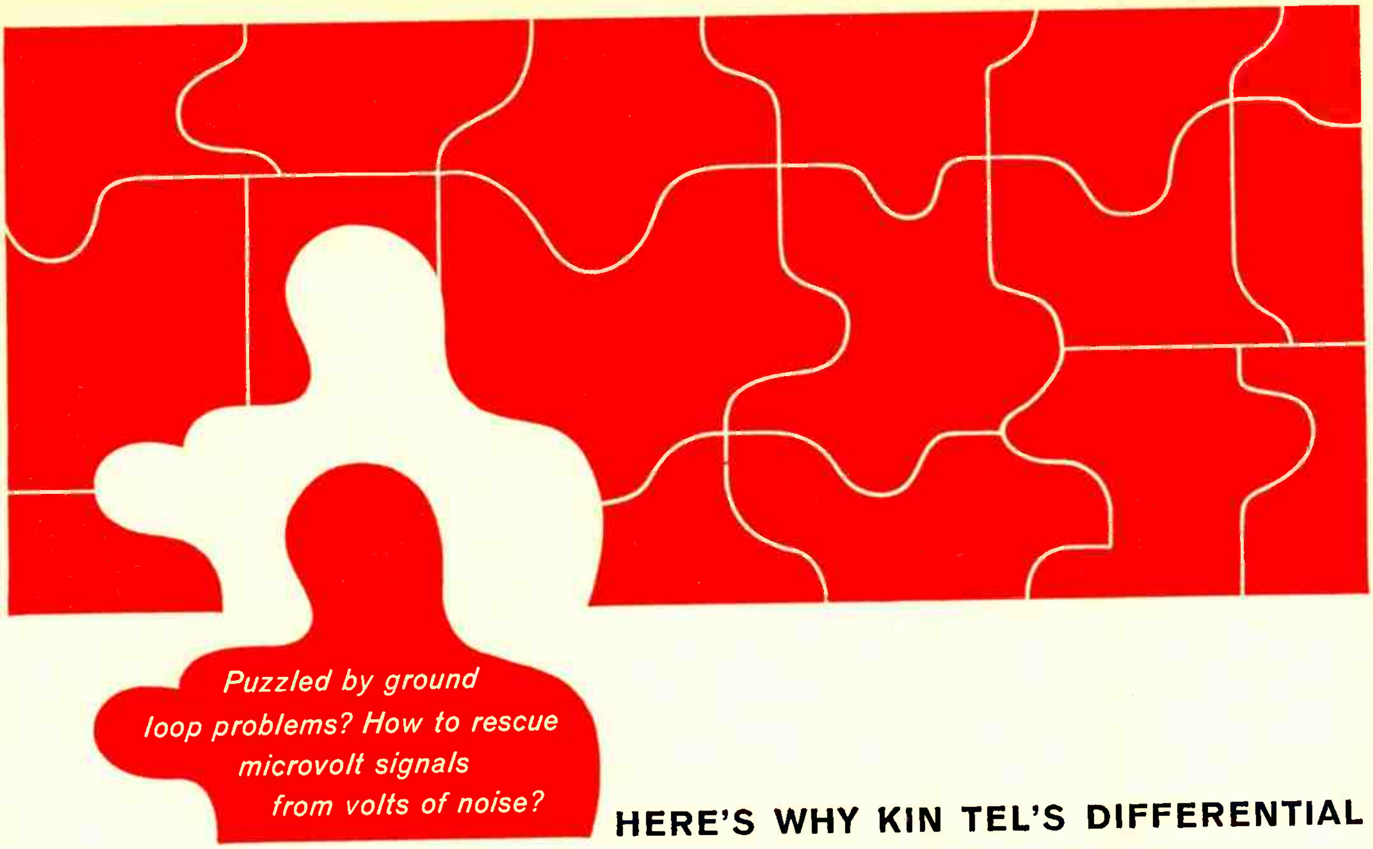
Although the conference was called by the Air Force, the Pentagon is bringing the Army and Navy into the missile ground-support standardization picture.

- **Increasing cost** of missile ground-support gear was the keynote sounded by Brig. Gen. George E. Keeler, Jr., AMC's Deputy Director of Supply at the Dayton Conference. "We have now come to the crossroads where it is essential that industry and Air Force reach agreement on how to further preserve the national economy through the elimination of gold plating, elimination of duplicate development and assurance of maximum utilization of in-service inventory," he said.

  Air Force expenditures for ground-support gear—with electronic equipment making up a big chunk—have ballooned from $962 million in 1956 to $1.6 billion this year. In more than two years, spending is expected to hit $2.8 billion. At least 12,000 new items of ground-support gear are put into the Air Force's inventory each month.

  The industry representatives have set up steering committees by commodity which will work with military officials on the catalog project. Design engineers will then be pressed to use cataloged equipment before spending funds for new missile support components or end-items.

- **Behind all the fussing** over mushrooming costs for missile ground-support equipment, many Defense Dept. officials are having some second thoughts about the highly-touted "weapon system management" scheme. They believe that one big reason for the increased costs is the fact that weapon system primes are under too little control by the services, that they are being allowed to duplicate development in many instances. The outcome may be some new limits on the responsibilities of weapon system primes.



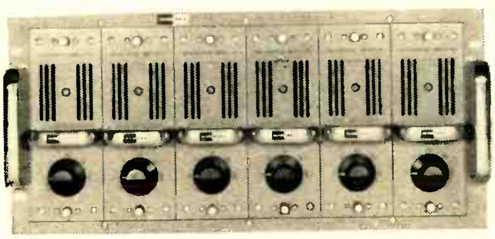
HERE'S WHY KIN TEL'S DIFFERENTIAL DC AMPLIFIERS FIT IN INSTRUMENTATION SYSTEMS

160 db DC, 120 db 60 cycle common mode rejection with balanced or unbalanced input ■ Input completely isolated from output ■ Input and output differential and floating ■ 5 microvolt stability for thousands of hours ■ .05% linearity, 0.1% gain stability ■ Gain of 10 to 1000 in five steps ■ >5 megohms input, <2 ohms output impedance ■ 120 cycle bandwidth ■ Integral power supply

These are just a few of the many outstanding features of the Model 114A differential DC amplifier . . . features that make this amplifier *really work* in instrumentation systems...features that will help solve *your* instrumentation problems today.

Ideal for thermocouple amplification, the 114A eliminates ground loop problems; allows the use of a common transducer power supply; permits longer cable runs; drives grounded, ungrounded or balanced loads, and can be used inverting or non-inverting.

For additional information and technical literature on this exceptional instrument, write or call KIN TEL – the world's largest manufacturer of precision, chopper-stabilized DC instruments.



KIN TEL 114A differential DC amplifiers ...convenient, interchangeable plug-in mounting in either 6-amplifier 19″ rack mount modules or single-amplifier cabinets.

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A Division of Cohu Electronics Inc.

Schriever said, "the Air Force plans to explore the moon as a military base." USAF will work with the Army and launch three electronics-laden moon probe rockets (ELECTRONICS, p 26, Apr. 18).

USAF will be seeking information on cosmic ray intensity, atmospheric pressures, gravitational, magnetic and electric fields. Space exploration of this type could possibly provide telescopic and tv studies of planets and the sun unblurred by the atmosphere. Space spectrographs of the sun might provide evidence of heavy element thermonuclear reactions on its surface.

"With a modified Thor as the first stage and Navy's Vanguard engine as the second, it would be possible to put several thousand pounds of satellite and electronic equipment in orbit or send several hundred pounds of working load to the moon," Schriever said. Information sent back to earth might be in pictorial form.

Only the first 500 mi of the 240,000 mi trip would be under power. Then the rocket would coast for two days, finally slowing down from a velocity of 15,000 mph to 500 mph. Increased speed would later be needed to avoid contact with the moon and circle behind it.

Electronic Desk

Communication equipment is featured in new desk being made by Odabashian & Sons, San Francisco, for about $3,500. Gear includes intercom, dictating and recording units. Radio and tv broadcast receivers in drawers use built-in amplifiers. Closed-circuit tv is optional

MILITARY ELECTRONICS

• **Navy's ship-to-air** guided missile, Talos, became operational last week when the *USS Galveston*, first of the light cruisers to be converted to Talos guided missile ships, was commissioned in Philadelphia. Next two light cruisers to be commissioned for Talos are the *USS Little Rock* and *USS Oklahoma City*. *USS Long Beach*, first nuclear-powered cruiser, will also be equipped with Talos.

Bendix Aviation is prime contractor and Bendix Radio supplies the control system. Sperry and Federal Telecommunications Labs produce the beam rider/passive homing guidance system, with Farnsworth Electric a principal subcontractor.

• **The Electronic Material Sciences Laboratory**, AF Cambridge Research Center, has begun field tests of three distinct antijamming techniques. Special General Electric equipment will be used in the field tests which will be compared and correlated with bench tests of techniques made over the past year. The new GE equipment will be used in connection with the frequency diversity radar at Maynard.

• **CAA** plans procurement of new electronic communications, air traffic control and air navigation equipment amounting to $1.027 billion over the next five fiscal years.

New edition of the plan calls for: 60 additional long range radar installations including those that will be used jointly with the military, making a total of 100 in the system; 76 new airport surveillance radar units to supplement the 62 already financed; 30 surface detection equipment units for radar control of aircraft on the ground.

Other requirements cited: 289 air traffic control radar beacons; 677 omnidirectional radio ranges (VOR), of which 634 are already financed; 573 complete new units of VORTAC; 337 more TACAN (Tactical Air Navigation) units to backfit a total of 636 existing VOR's to make VORTAC; 235 instrument landing systems (ILS), an increase of 40 over those now authorized; 225 units of the distance feature of TACAN with which to backfit 225 ILS's; and 20 ILS's in which TACAN is an integral part.

CAA will install computers in Washington and New York air route traffic control centers early this summer with funds already authorized. Also, the memory capacity of the computer at Indianapolis will be increased.

By late fiscal year 1959, other centers at Boston, Pittsburgh, Cleveland, Chicago and Detroit will be equipped with computers. More centers, it is anticipated, will become computer equipped at the rate of six per year through fiscal 1963 with the cooperation of the Airways Modernization Board.

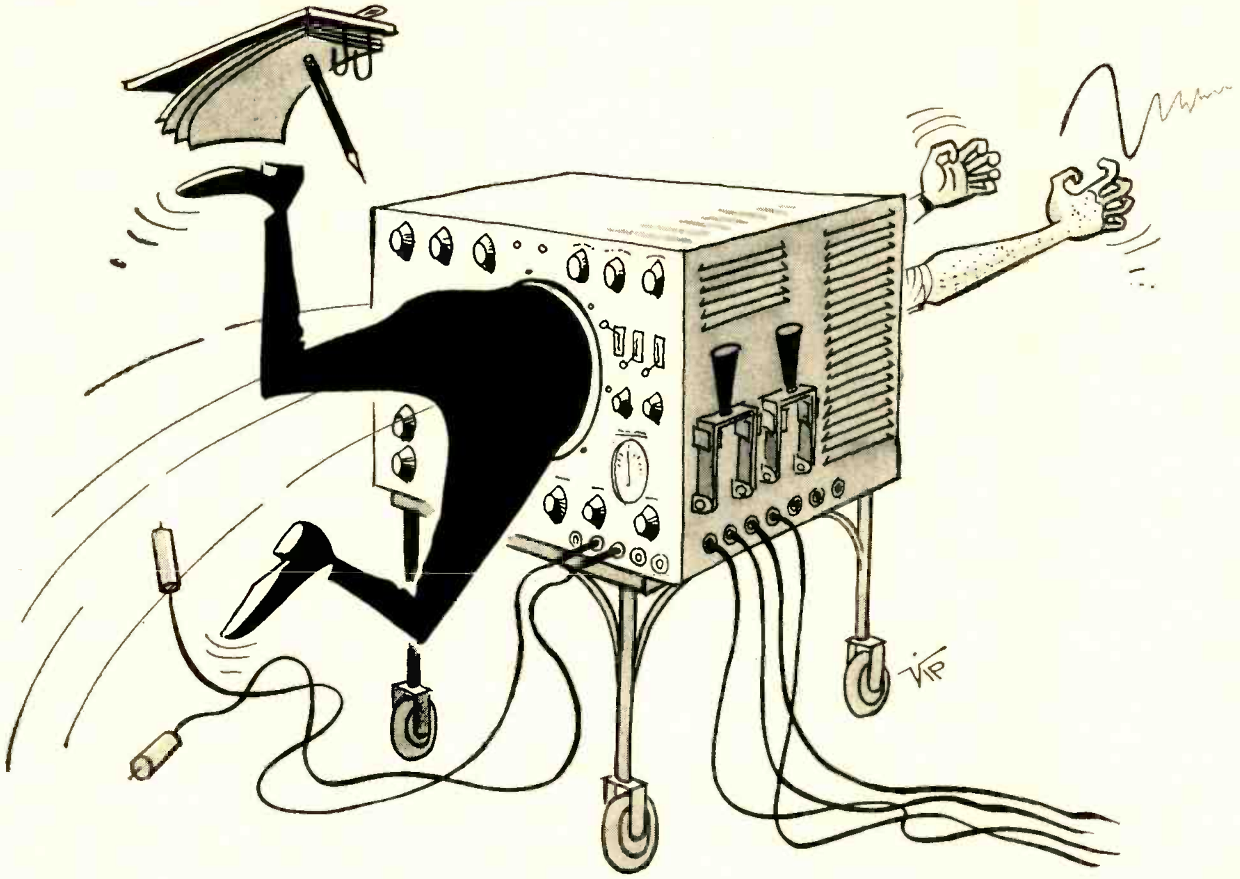
Discuss Color Tv World Standards

INTERNATIONAL STANDARDS for color tv broadcasting and testing are now the subject of a meeting of the International Radio Consultative Committee (CCIR) Study Group XI (color tv) in Moscow. The meeting ends June 10.

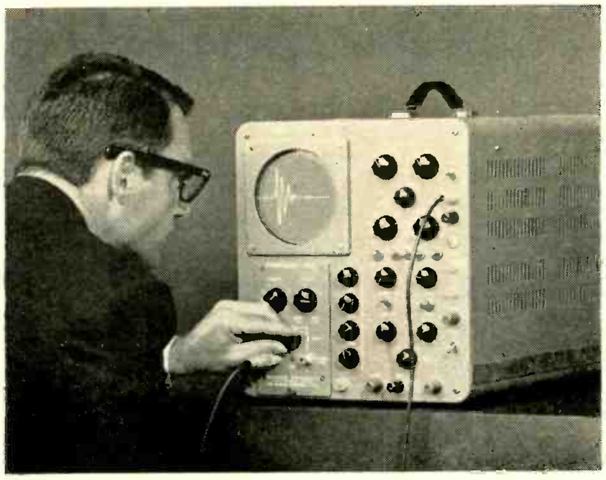
The committee makes technical recommendations to the International Telecommunications Union. J. R. Popkin-Clurman, president of Telechrome Manufacturing Corp. and a delegate to the meeting, says that in 1959 the XI Plenary Assembly of the CCIR will be held in the U.S.

USSR Plans More Industrial Gear

SOVIET ELECTRONICS production, which increased nearly 18 times from 1948 to 1957, will be kept at a high rate of output and electronic industrial controls will be introduced on a large scale, under a pro-



PROBLEM: How to Capture Elusive Transients



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International Airport Station, Los Angeles 45, California

Attempting to analyze elusive non-recurring transients has sent the best of engineers "to the showers." Conventional practices for monitoring or examining spurious signals or noise factors do not permit accurate investigations. The result is a wasteful expense of your time, your nerves, and your company's money.

SOLUTION: The Hughes MEMO-SCOPE® oscilloscope freezes wave forms until intentionally erased. Selected transient information may be triggered externally or internally and retained for viewing. Successive wave forms may be written above, below or directly upon the original information.

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SWEEP SPEED FOR STORAGE:
10 microseconds to 10 seconds per division (0.33").

FREQUENCY RESPONSE: DC to 250 KC down 3 db.

SENSITIVITY:
10 millivolts to 50 volts per division or with optional high sensitivity preamplifier 1 millivolt to 50 volts per division.

APPLICATIONS:
Trouble shooting data reduction equipment...switch and relay contact study...ballistics and explosives research...ultrasonic flaw detection...physical testing—shock—stress—strain.

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

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gram mapped out by the Communist Party.

Reports just in from Moscow reveal that on Radio Day (May 7) and the All-Union Conference on Mechanization and Automation (May 12) special emphasis was placed by Soviet leaders on radio and electronics progress.

Valery Kalmykov, chairman of the state committee on radio-electronics, USSR Council of Ministers, made these points: (1) By 1965 the USSR will have more than 300 tv studios and sets for almost 100 million viewers. (2) Research and design plans are underway to integrate telephone communications into a single automatic exchange system with major cities being linked by waveguides.

USSR Gosplan chairman Kuzmin, also deputy chairman of the Council of Ministers, made these points to industry and government leaders:

Output of industrial control instruments and other means of automation must be 10 times greater in 1959 than in 1955; by 1965, output should be five times that of 1958. Design of many new instruments to regulate processes is planned.

By this year, 150 "machine tool lines" had been produced for machine-building works, plus about 200 "automatic lines" using existing machine tools. Many of these are quality control instruments, others are regulators such as those used in metal processing. Just announced by the Physics Institute in Kiev: an infrared spectrometer that registers temperature changes of one-millionth of a degree. It will be used, says Tass, to determine content of oil or paraffin in oil products.

Kuzmin also gave these examples of electronic control already achieved: (1) Testing of the first automatically controlled locomotive is nearing completion. (2) An automatic machine to determine optimum oil drilling spots has been developed (ELECTRONICS, p 49, Nov. 10, '57. (3) Machine based on use of isotopes and optical and acoustical principles is being used to regulate composition of materials in one manufacturing process.

FINANCIAL ROUNDUP

• **Hagan Chemical & Controls Corp.** (formerly Hagan Corp.) of Pittsburgh, Pa., purchases **Kybernetes Corp.** of New York City, manufacturer of automatic data logging and temperature monitoring equipment, for an undisclosed cash sum. Hagan manufacturers automatic controls, instruments and chemicals for removing boiler scale. Hagan, orginally a manufacturer of hydraulic and pneumatic controls, has in recent years added electronic controls to its line.

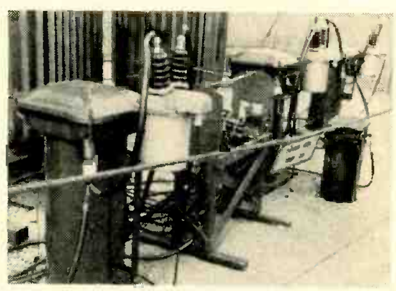
• **Shure Brothers** of Evanston, Ill., announces it seeks to acquire an additional electronics firm engaged in making components for electronic industrial automation and hi-fi sound reproduction. Shure manufactures microphones, hi-fi tone arms and cartridges, home recorders and recording heads for industrial laboratory applications.

• **Dynamic Electronics Corp.,** Forest Hills, N. Y., sells a substantial minority interest to Edward L. Elliott of Elliott & Company, New York investment firm, for $200,000. New investment plus increased bank credit will be used to finance development of several proprietary items in the military electronic and high fidelity stereo fields, areas in which Dynamic is presently active.

• **Elsin Electronics,** Brooklyn, N. Y., manufacturer of telemetering equipment and microwave components, plans to issue 265,266 shares of common stock at $1.12½ cents per share through Lee & Co. of New York City. New money will be used to repay bank loans, purchase new equipment and for working capital.

• **Chesapeake Instrument Corp.,** ultrasonics manufacturers of Sunnyside, Maryland, plans to issue $275,000 of convertible subordinated five percent debentures due 1968, through Drexel & Co. of Philadelphia. Proceeds will be used for general corporate purposes.

• **Missiles-Jets & Automation Fund** files plan with SEC to issue 500,000 shares of capital stock at $10 per share. Investments will be concentrated in securities of firms engaged in missile, jet and automation fields. Ira Haupt & Co. of New York City will manage the underwriting group which is expected to offer fund shares this month.



Wave analyzer is plugged into electric power line (left) carrying signals generated by transformers set up at power station as . . .

Civil Defense Tests Alarm

BATTLE CREEK, MICH.—An electronic device, intended to warn people in their homes when an enemy attack or natural disaster is imminent, is being field tested here over the power lines of Consumers Power Co.

National Emergency Alarm Repeater system (NEAR) is being developed by Midwest Research Institute, Kansas City, Mo., under contract with Federal Civil Defense Agency. FCDA headquarters are here.

NEAR picks up 1-volt, 240-cycle signals superimposed on normal

MADE TO MEET ALL MIL-R-10509B REQUIREMENTS

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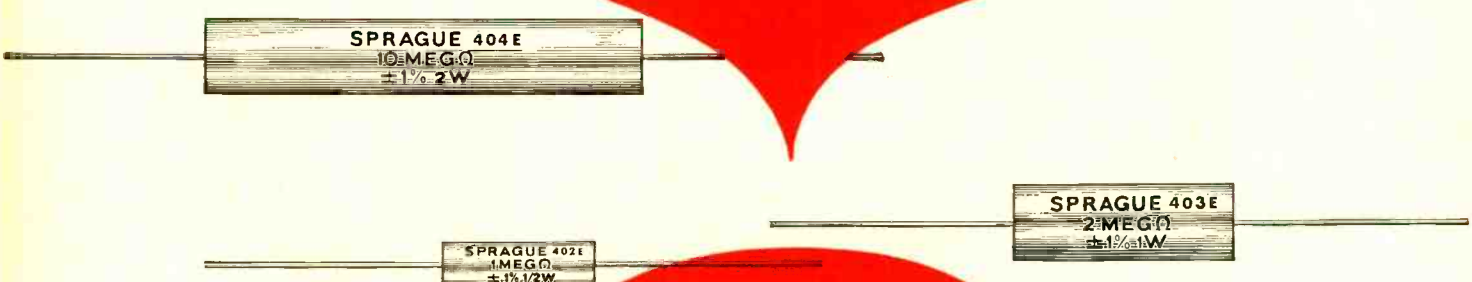

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110-v, 60-cycle house current. It plugs into any outlet and is not much bigger than a night light. When it receives a signal, it sounds a buzzer, telling residents to turn on their radio for a civil defense announcement.

The signals are provided by equipment installed at power distribution stations. Signal generator consists of three transformers which are connected in a broken delta circuit with a direct current power supply.

In testing, the signal generator equipment is located at a substation and outlets are on utility poles. Test equipment is moved from pole to pole in a station wagon. FCDA says that if field tests prove the system feasible, it will be developed for public home use.

The home receiver could consist of an inductance-capacitance or electromechanical filter to pick up the signal, a relay, a gas tube or semiconductor switch and a noisemaker. A brief delay would be required to prevent transients in the line power from causing false alarms. It has been learned that the receiver could be built into an electric clock or other appliance.

Rack-mounted unit automatically adjusts power level as . . .

Control Cuts Cochannel Noise

A POWER-CONTROL device currently in field test promises to help relieve cochannel interference problems of mobile radio users.

The control automatically adjusts transmitted power at the base station to match incoming power from a mobile unit in the field, making broadcast power inversely proportional to the received signal.

Initial tests made by GE, developers of the device, used a 250-watt transmitter.

Before installation of the power control unit, the station replied to all incoming messages with the same signal strength regardless of incoming signal power, or distance of mobile units from base station.

Transistors Run Pipeline Webs

TRANSISTORIZED remote control system that will enable a dispatcher to control flow of natural gas and petroleum from as many as 100 widely scattered points will soon be offered to pipeline operators.

At a recent meeting of the Petroleum Industries Electrical Association, an RCA spokesman said field trials of the new system are due shortly.

Central dispatchers using the system will originate instruction signals on punched tape. Signals will be relayed by microwave to the remote point or points desired.

Transistorized receiver controls at the remote point will activate mechanical equipment to start pumps, open valves or perform any of several operations now handled by resident operators contacted verbally.

MEETINGS AHEAD

June 9-13: Automation Seminar, Fourth Annual, Penn State Univ., Pa.

June 12-13: Annual Pacific Northwest Instrument Show, ISA, Portland Public Auditorium, Portland, Oregon.

June 16-18: Electrical Contact Seminar Div., Penn State Univ., Pa.

June 16-18: Military Electronics Second National Convention, Sheraton Park Hotel, Washington, D. C.

June 17-27: Two-Week Special Summer Program in Switching Circuits, MIT, Cambridge, Mass.

June 18-20: Radio Wave Propagation Statistical Methods, Univ. of Calif. Engineering Extension, Los Angeles, California.

June 22-27: Air Transport Conf., and AIEE Summer General Meeting, Statler Hilton, Buffalo, New York.

June 23-27: Vacuum Metallurgy, Summer Seminar, New York Univ. Coll. of Engineering, N. Y. C.

July 6-18: Underwater Missile Engineering, Graduate Course, Penn State Univ., Pa.

July 8-17: International Electrotechnical Commission, ASA, Stockholm, Sweden.

July 16-18: Forestry, Conservation Communications Assoc. (FCCA), Ninth Annual Conf., Parker House, Boston, Mass.

Aug. 6-8: Special Tech. Conf. on Nonlinear Magnetics and Magnetic Amplifiers, AIEE, Hotel Statler, Los Angeles.

Aug. 13-15: Conf. on Electronics Standards and Measurements, AIEE, IEE, NBC, National Bureau of Standards Labs., Boulder, Colorado.

Aug. 13-15: Seventh Annual Conf. on Industrial Applications of X-ray Analysis, Denver, Colo.

Aug. 19-22: Western Electronic Show and Convention, Los Angeles, Calif., WESCON, IRE, WCEMA, Pan Pacific Auditorium, Ambassador Hotel, L. A.

Aug. 26-Sept. 6: British National Radio Show, Radio Industry Council, Earls Court, London.

Sept. 1-9: Second International Days of Analog Calculation, Strasburg, France, contact, F. D. Raymond, 138 Boulevard de Verdon, Courbevoie (Seine) France.

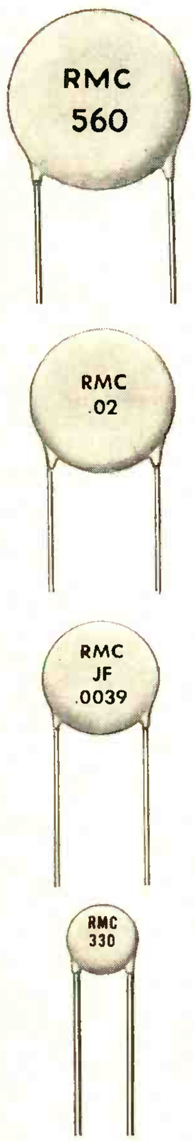
Sept. 3-5: Application of Electrical Insulation, First National Conf., AIEE NEMA, Cleveland, Ohio.

Sept. 15-19: Thirteenth Annual Instrument-Automation Conf. and Exhibit, ISA, Philadelphia Convention Hall, Pa.

rmc

High Performance Ceramic Capacitors

DISCAPS



TYPE C

Type C DISCAPS meet or exceed the specifications RS-198 of the E.I.A. Small size and lower self-inductance make them ideal for many applications. Rated at 1000 working volts, Type C DISCAPS have a higher safety factor than other standard ceramic or mica capacitors.

TYPE B

These DISCAPS are designed for by-passing, coupling or filtering applications and meet all specifications of the E.I.A. for type Z5U capacitors. Rated at 1000 V.D.C.W., Type B DISCAPS are available in capacities from .00015 to .04 M.F.D.

TYPE JF

Type JF DISCAPS have a frequency stability characteristic superior to similar types. These capacitors extend the available capacity range of the E.I.A. Z5F type between +10° and +85° C and meet Y5S specifications between —30° and +85° C.

TYPE JL

For exceptional stability over an extended temperature range, Type JF DISCAPS should be specified. They provide a minimum capacity change as temperature varies between —55° and +110° C. Standard working voltage is 1000 V.D.C.

Write for information on the complete DISCAP line.

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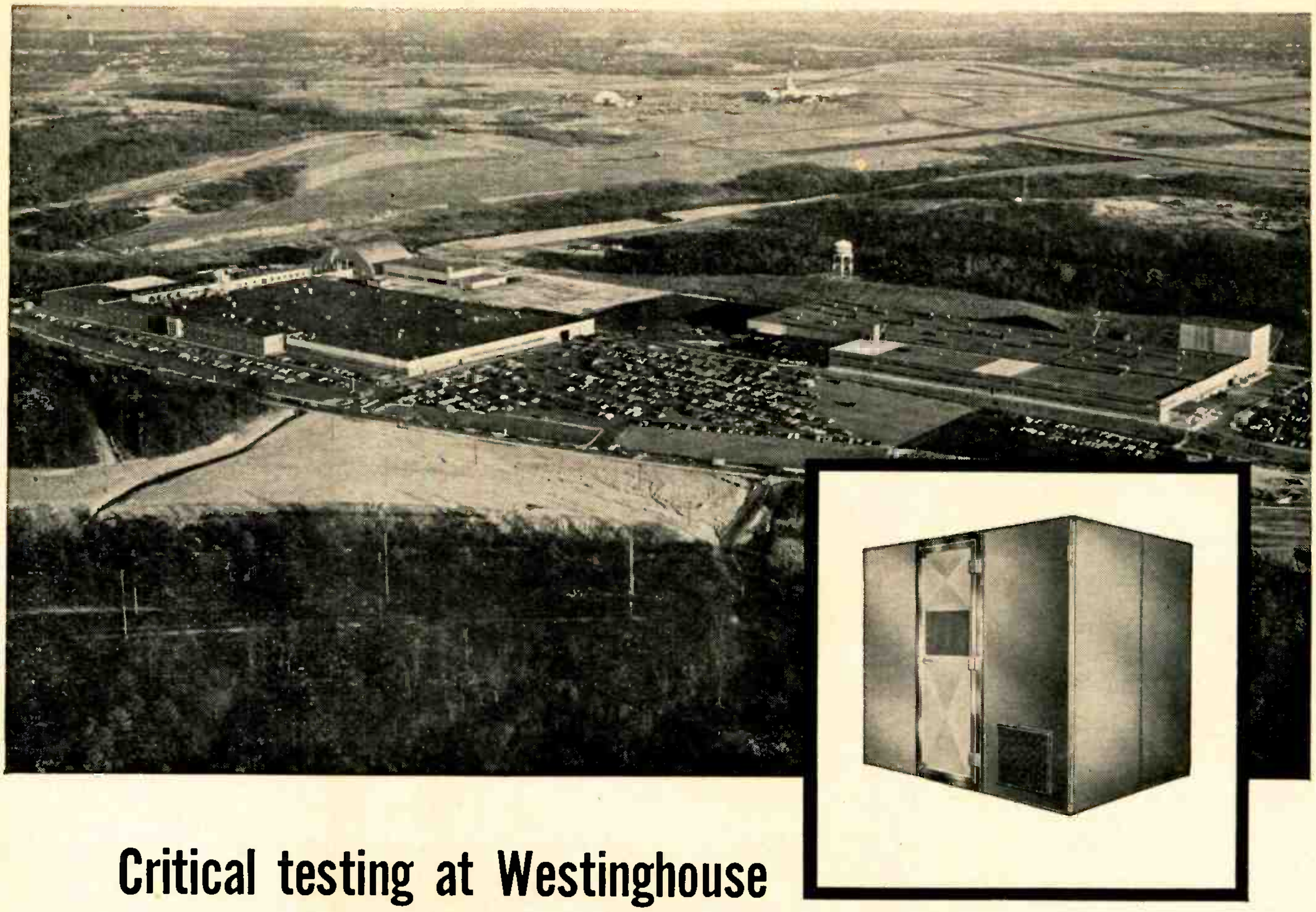

Critical testing at Westinghouse conducted in 49 Ace shielded enclosures

The Westinghouse Electronics and Air Arm Divisions, Friendship Airport, Baltimore, Md. plants, have almost unbelievably high r-f interference ambient caused by radar transmitters, missiles, military planes, spot welders, motors, powerful transmitters, and other types of electric/electronic equipment. Testing critical electronic equipment under these adverse interference conditions is extremely difficult. The slightest outside interference would distort readings.

Westinghouse takes no chances. The flight control fighter armament systems, missile guidance systems, radar, and ship-board transmitters under design and development at the plant are completely shielded from outside interference and from each other by 49 Ace shielded enclosures.

The Ace patented RFI and Cell-Type Designs* provide the high attenuation required for satisfactory results at all frequencies. All enclosures are designed and constructed to insure permanent r-f leak-proof performance. Size-flexibility is another feature. The modular construction of the panels and doors permits rapid alteration of the size of the enclosure. Small rooms can be joined to make larger units or large enclosures can be converted into smaller ones.

If you have a shielding problem—big or small—in your plant, you'll want to talk to an Ace Engineer about an effective yet economical solution. Be sure to write for free catalog on standard Ace enclosures.

*Lindsay Structure

ACE

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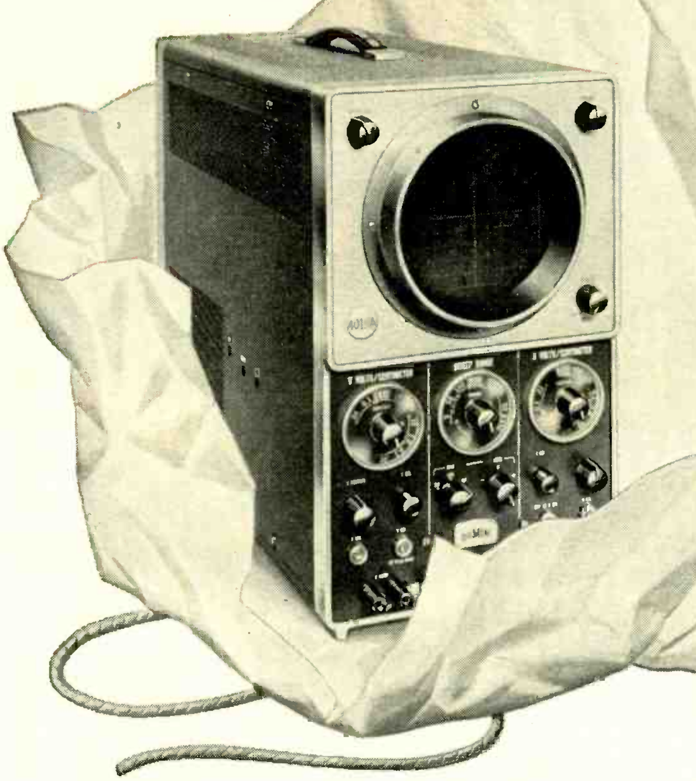


A general-purpose, 5″ oscilloscope of superb design and construction, destined to become the new standard of the industry. This Du Mont scope offers a new high degree of reliability and performance, and incorporates the following features . . .

- X-Y plotting with **identical, calibrated, high-gain** amplifiers.
- Time function plotting on calibrated linear time base.
- Continuous use of X or Y amplifier controls without disturbing calibration. Re-calibration from front panel.
- Diddle-free sync. Automatic or driven sweep selection on front panel.
- **Exclusive:** externally or internally triggered beam brightening during X-Y plots.
- High brightness provides excellent photographic writing rate.
- Sweep speeds available from .25 sec/cm to 5 usec/cm.
- Centimeter calibration.
- Choice of electronic power regulation or Sola voltage-regulating transformer.
- Hand-crafted wiring and high-reliability components for dependability and performance.

What would you expect to pay for this DUMONT scope?

Turn Page →

CIRCLE 13 READERS SERVICE CARD

See preceding page for features...

DUMONT®

401-A

OSCILLOSCOPE

SPECIFICATIONS

IDENTICAL X- AND Y-AMPLIFIERS: Sensitivity, 10 mv/cm. Sinewave response, extends flat from dc to 3 db down at 100 kc; useful to 500 kc.

SWEEPS: 17 calibrated sweeps available from 250 millisecond/cm to 5 usec/cm. Additional sweep time available, 250 msec/cm for each microfarad of external capacitance. Sweep expansion, up to 30 cm — any 10 cm segment can be positioned on screen.

RELATIVE PHASE SHIFT BETWEEN AMPLIFIERS: With X- and Y-controls at maximum, phase shift will not exceed 3° below 100 kc; at discreet higher frequencies, phase difference can be adjusted to less. Will not exceed 1° below 5 kc with any control setting.

SYNCHRONIZATION: Selection of driven or automatic sweep on front panel. Selection of internal, external or line, both positive and negative polarity, on front panel. Beam brightening gate may be triggered by sync signals during X-Y plotting and for controlled photographic exposure.

CATHODE-RAY TUBE: 5ADP — operated at 3000 volts.

POWER SUPPLY: Three regulated power supplies available for following sources: 115 V, 60 cps, 110 watts; 115 V or 230 V, 50 cps, 110 watts; 115 V, 50 to 400 cps, 140 watts. Regulated r-f high voltage for CRT.

MECHANICAL: 401-A (Bench model), 15½" x 8¾" x 21". Front or rear tilting foot. **401-AR** (Rack mounted), standard 19" rack-mounting, 8¾" high, 18¾" depth behind panel, width behind panel 14⅝", maximum protrusion (handles) in front of panel is 1½". Weight of either unit approximately 45 lbs.

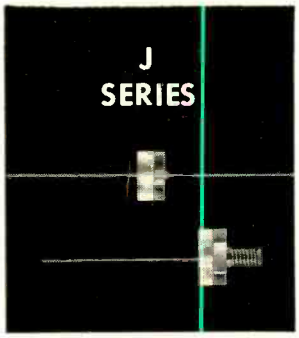
for complete details, write...

INSTRUMENT DIVISION, ALLEN B. **DU MONT** LABORATORIES, INC., CLIFTON, N. J., U. S. A.

A Wide Range of Ratings . . . Choice of Mounting
High Efficiency . . . Low Cost . . . Prompt Delivery

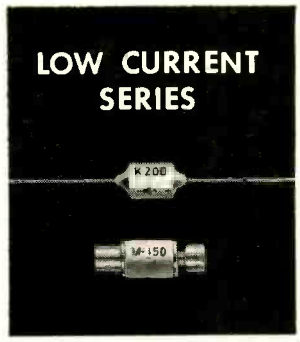
Tarzian SILICON RECTIFIERS

Offer These Advantages — and Many More!



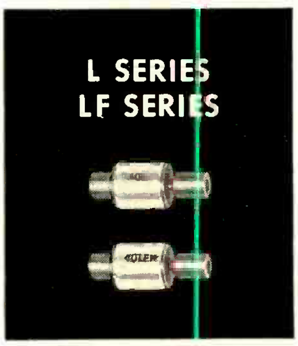
SPECIFICATIONS

D. C. Current
Range . . 1.5A(J-1)—10A(J-2)
Peak Inverse
Voltage Range 100V to 400V
Approx. Rectifier
Voltage Drop 1.25V
Approx. Weight
(Ounces) . . . . .2 oz.



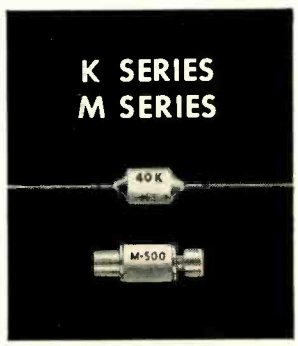
SPECIFICATIONS

D. C. Current
Range . . . . . .15A(M)—.2A(K)
Peak Inverse
Voltage Range 360V
Approx. Rectifier
Voltage Drop 1.5V
Approx. Weight
(Ounces) . . . . .2 oz.



SPECIFICATIONS

D. C. Current
Range . . . . . 1.5A(L)—5A(LF)
Peak Inverse
Voltage Range 100V to 400V
Approx. Rectifier
Voltage Drop 1.5V
Approx. Weight
(Ounces) . . . . .35 oz.

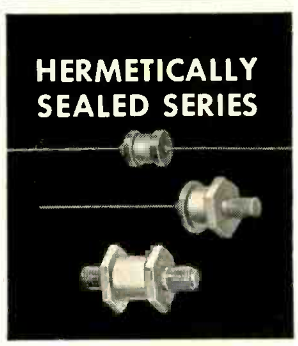


SPECIFICATIONS

D. C. Current
Range . . . . . .5A(M)—.75A(K)
Peak Inverse
Voltage Range 100V to 600V
Approx. Rectifier
Voltage Drop 1.5V
Approx. Weight
(Ounces) . . . . .2 oz.

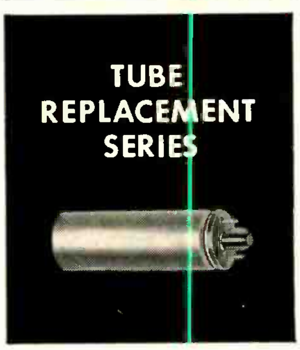
SPECIFICATIONS

D. C. Current
Range . . . . 20A to 200A
Peak Inverse
Voltage Range 50V to 400V
Approx. Rectifier
Voltage Drop 1.25V
Approx. Weight
(Ounces) . . 1.3 oz. to 7.0 oz.



SPECIFICATIONS

D. C. Current
Range . . . . .5A to 15A
Peak Inverse
Voltage Range . . 50V to 600V
Approx. Rectifier
Voltage Drop 1.5V
Approx. Weight
(Ounces) . . .15 oz. to 1.5 oz.



SPECIFICATIONS

D. C. Current
Range . . .25A(HW)—.75A(FW)
Peak Inverse
Voltage Range 1600V to 4500V
Approx. Rectifier
Voltage Drop . . . . . 8V to 10V
Approx. Weight
(Ounces) . . . . . 4 oz. to 8 oz.

SPECIFICATIONS

D. C. Current
Range . . . . . . .325A to .45A
Peak Inverse
Voltage Range 800V to 2800V
Approx. Rectifier
Voltage Drop . . . . 2V to 15V
Approx. Weight
(Ounces) . . . . .3 oz. to .9 oz.

Write, wire or phone for complete information

SARKES TARZIAN, INC., RECTIFIER DIV., Dept. D-2, 415 N. College, Bloomington, Ind.

In Canada: 700 Weston Rd., Toronto 9, Tel. Rogers 2-7535 • Export: Ad Auriema, Inc., New York City

CIRCLE 15 READERS SERVICE CARD

Look at this new, compact, $145

...and check these features

- **150 ma output 0 to 30 v dc, continuously variable**
- **High regulation; less than 0.3% or 30 mv change no-load to full-load**
- **Ripple less than 150 µv rms**
- **Metered output and current limiter prevent damage to transistors under test**
- **Compact transistorized construction**

New -*hp*- 721A Transistor Power Supply

Specifically designed to provide precision dc test voltages for transistor investigations, the new -*hp*- 721A Power Supply produces 0 to 30 volts at 150 milliamperes—sufficient for almost every type of transistor in use today.

Model 721A has a convenient 3-terminal output so that either positive or negative terminals may be grounded. Or, the supply may be "stacked" on another voltage for still greater usefulness. Need for additional metering and control equipment is eliminated since the 721A's front panel meter monitors either output voltage or current.

New *hp* 200 KC oscilloscope, $435.00.

TRANSISTOR POWER SUPPLY

that prevents overload damage to transistors

An outstanding feature is a special circuit limiting output current to a nominal value (selected on the front panel in 4 steps—25, 50, 100 and 225 ma.) This unique feature prevents accidental overloads which otherwise cause costly damage to transistors under test.

Convenience of the new 721A is further increased by its compact size, low power consumption, simple controls and extreme dependability resulting from ultra-conservative circuit ratings. Model 721A, $145.

Other *-hp-* regulated and klystron power supplies

Simple operation, widest usefulness, high regulation, broad voltage range, rugged dependability—these characteristics have made *-hp-* Power Supplies basic experimental, testing and production tools in America's laboratories and factories. The many jobs these precision instruments perform daily include powering low level amplifiers, constant frequency oscillators, pulse circuits with heavy instantaneous current demands, oscillators, small transmitters, klystrons and "bread board" arrangements from the most simple to the most complex. Brief data on *-hp-* power supplies appear in the table at right. For complete details on *-hp-* supplies meeting your power needs, call your *-hp-* representative for demonstration on your bench. Or, write direct.

-hp- 712B Regulated Power Supply
-hp- 715A Klystron Power Supply ▶

Model	Characteristics	Regulation	Current	Voltage Range	Hum & Noise Level	Price
710B	General purpose dc/ac supply	±1%, 0 to 75 ma	100 ma	100 to 360 v dc; 6.3 v ac	Less than 0.0005 v	$110.00†
711A	Similar to 710B wider voltage range	Less than ±0.5% or 0.1 v, no load to full load	100 ma	0 to 500 v dc; 6.3 v ac	Ripple less than 0.1 mv	225.00†
712B	Heavy duty, 4 outputs, 0-1 msec response	Less than 50 mv no load to full load	200 ma (pos. dc)	0 to 500 v dc; -300 v dc fixed bias; 0 to -150 v dc variable bias; 6.3 v ac	Ripple less than 500 uv	365.00†
715A	Klystron supply; square wave, external modulation	Less than 1%, no load to full load	50 ma (at 400 v)	250 to 400 v dc beam; 0 to 900 v dc reflector; 6.3 v ac	Ripple less than 7 mv	300.00

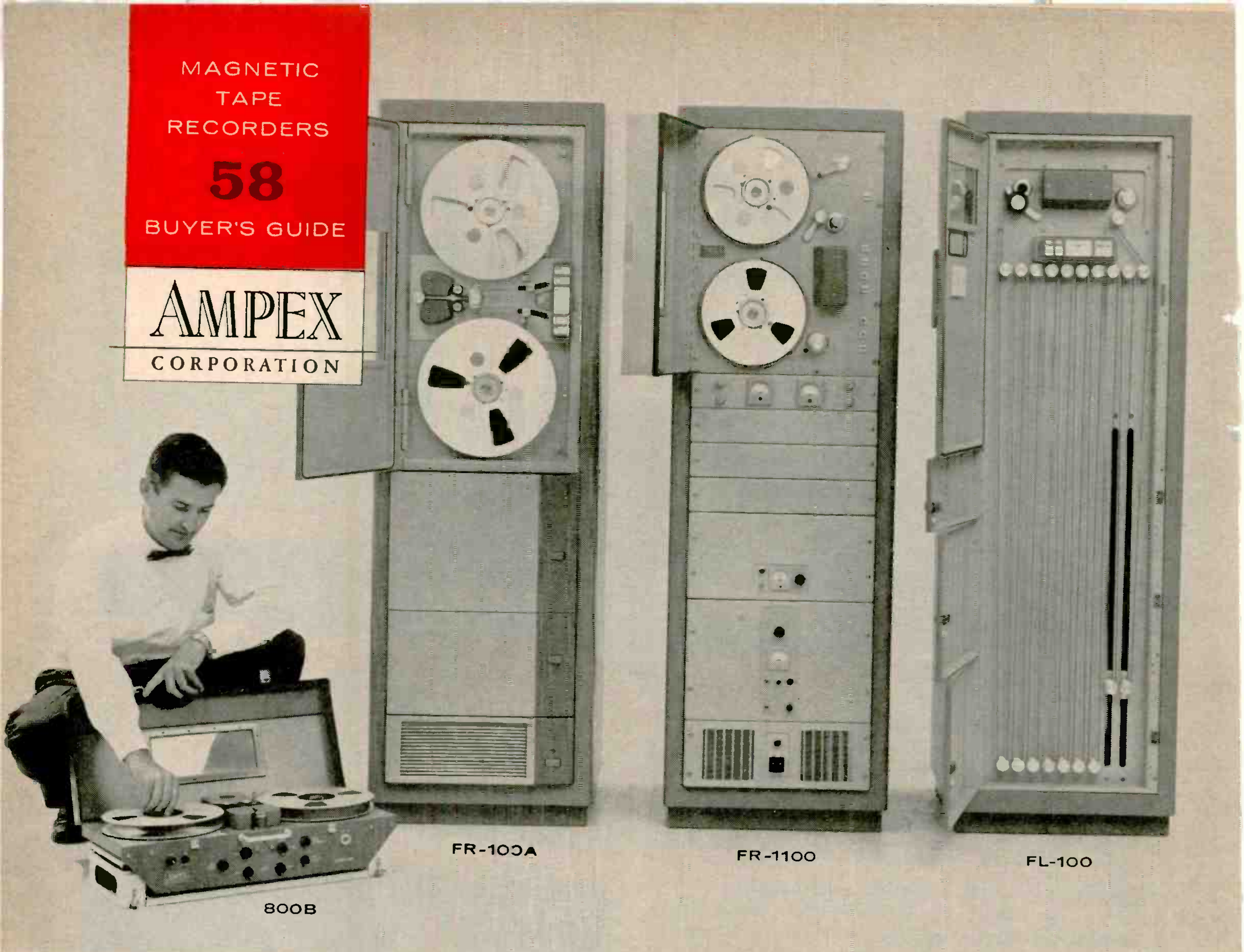
† Rack mount available at slight additional charge.

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

HEWLETT-PACKARD COMPANY
4818A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U. S. A.
CABLE "HEWPACK" • DAVENPORT 5-4451
FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

Ask your *-hp-* rep for a demonstration

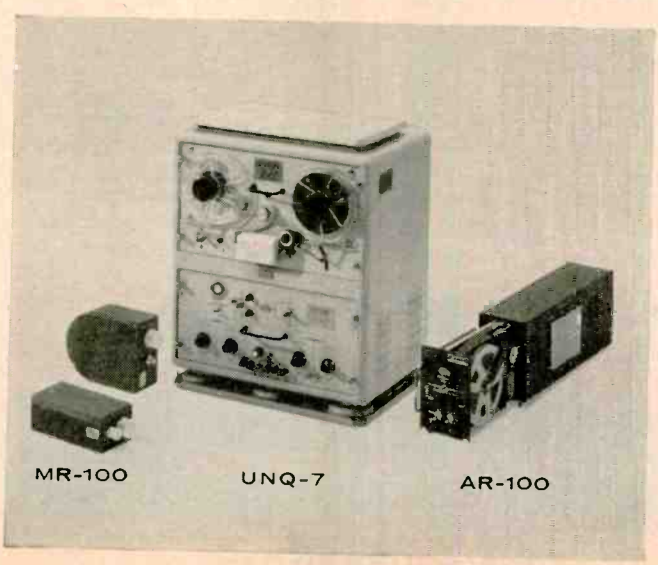
CIRCLE 17 READERS SERVICE CARD



Magnetic tape recorders for instrumentation and control . .

You get the widest choice, most performance and assured compatibility

Over 95% of all missile prime and subcontractors who are using magnetic tape have chosen Ampex equipment. In today's most rapidly moving technological race, nothing short of the best will do. Missile development pushes at every frontier of engineering knowledge, hence it needs a broad selection of highly adaptable recorders. Tapes must be interchanged among widely separated facilities. So compatibility is imperative. And of vital importance to every user: Ampex offers application engineering and nationwide field service that draw on unparalleled magnetic-tape-recorder experience.



AR-100 — AERIAL "LISTENING"

A two-track airborne recorder for data acquisition in the audio-frequency range. Recorder meets the essential requirements of MIL-E-5400 in respect to temperature, vibration, shock and high-altitude conditions. The AR-100 is an example of Ampex's special design work to fill particular military and industrial needs.

Brief physical specifications: 7½ ips tape speed; 7-inch reels; remote and local control; record only, tapes reproduced on other Ampex recorders; 23 pounds total weight including shock mountings.

MR-100 — MISSILE RECORDER

A recorder that rides in a missile, recording performance data and playing back in reverse upon reentering range of radio receivers. Playback is automatic or in response to command. The MR-100 withstands shocks up to 75g. Complete two-piece unit occupies less than 1/5th cubic foot. This recorder is applicable to other uses where its ruggedness, compactness and operational sequence are needed.

Brief physical specifications: 60 ips tape speed; precision 5¼-inch reels; ¼-inch tape; two tracks; 4 minutes recording time; tape transport and two-track electronics in cable-connected housings.

UNQ-7 — SHIPBOARD RECORDER

A two-track special-purpose recorder handling 7-inch reels with two tracks on quarter-inch tape. It has two speeds, 3¾ and 7½ inches per second. This recorder is shown as another example of Ampex's developments for military purposes.

CIRCLE 18 READERS SERVICE CARD

FR-100A—MOST PRECISE AND VERSATILE

The best recorder for critical data acquisition and processing where low flutter, wide dynamic range and precise amplitudes are required. Typical applications are data telemetry, dynamic tests on engines, components and vehicle structures, and continuous-path machine-tool control. The Ampex FR-100A has superior performance in respect to flutter, low D-C drift, wide frequency response and precise time-base accuracy (with Servo Speed Control). Construction is modular and interchangeable. Numerous standard accessories are available.

Brief physical specifications: Six tape speeds 1⅞ to 60 ips (32-to-1 overall ratio); 10½ or 14-inch maximum reel size; ¼, ½ or 1-inch tape; 2 to 14 tracks; plug-in amplifiers for Direct, FM-carrier, PDM, and NRZ-digital record and reproduce; recorder fits one or more 19-inch rack cabinets.

FR-1100—ADAPTABLE AND ECONOMICAL

A high-accuracy instrumentation recorder recommended for general-purpose laboratory use, spectrum analysis, vibration testing and other comparable applications. The FR-1100's tape mechanism is of a simple open-loop design. Accessibility of components for replacement or service is extremely good. Modular construction makes it readily adaptable to new or special problems. Very wide speed ratios are available in a multirange version.

Brief physical specifications: Four speeds in 2-to-1 steps; eight-speed multirange option provides speed ratios as high as 100 to 1; 10½-inch reels; ¼ or ½-inch tape; 2 to 7 tracks; same plug-in amplifiers as FR-100A; fits 19-inch rack cabinet.

FL-100—CONTINUOUS LOOP

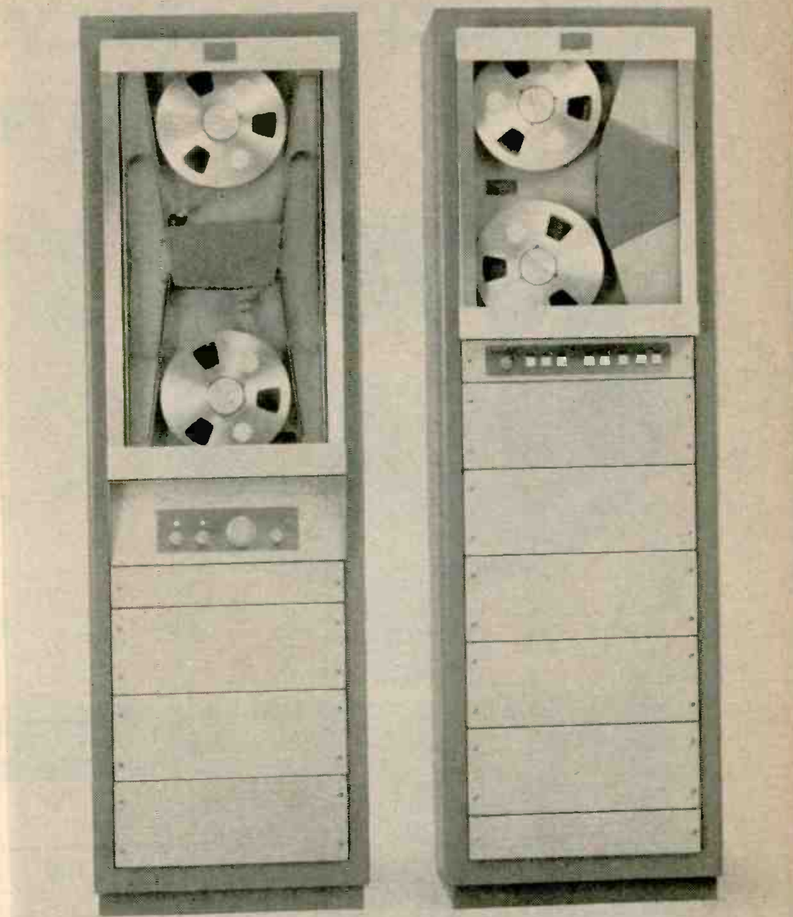
The FL-100 loop recorder provides three different capabilities: 1) cyclic repetition of short tape sections for analysis, 2) continuous time delay of a stream of information and 3) endless monitoring for calamity anticipation. Length of loop is continuously variable between minimum and maximum values, giving cycling times ranging from 0.733 seconds to 8 minutes on various speed and loop-length options.

Brief physical specifications: Four speeds in 2-to-1 steps or eight-speed multirange drive with same options as FR-1100; loop lengths from 3′ 8″ minimum to 25, 50 or 75-foot maximums; ¼, ½ or 1-inch tape; 2 to 14 tracks; same plug-in amplifiers.

800B—MOBILE AND AIRBORNE

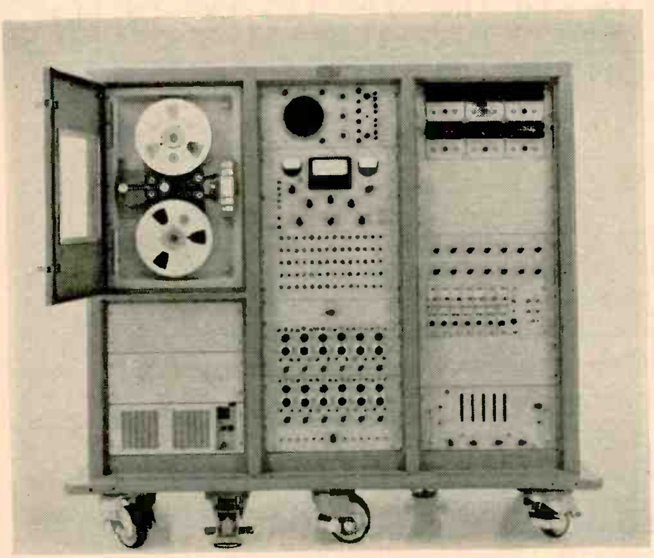
Newly improved version of the world's most widely used mobile instrumentation tape recorder. The 800B records flight-test data and information acquired in "aerial observation" and also does mobile service on the ground. In compact packaging, the Ampex 800B provides virtually the same recording capabilities as Ampex's larger laboratory-type recorders. In addition, it withstands shock, vibration, high and low ambient temperatures and high-altitude air pressures.

Brief physical specifications: Record only; any of four speeds available; plug-in amplifiers for Direct, FM-carrier or PDM recording; 10½-inch reels; ¼, ½ or 1-inch tape; 2 to 14 tracks; compact cable-connected assemblies fit small available spaces.



FR-300 FR-400

.. the Ampex specialty



MODIFIED RECORDERS AND SPECIAL SYSTEMS

Many regular Ampex models can be furnished with special tape speeds, larger reel sizes, front-access mountings, head switching systems, special performance, system buildups, etc. Ampex has a large modification engineering section thoroughly experienced in this work. The jet-engine test dolly pictured is an example of an Ampex-developed system. It includes an FR-100 recorder, preamplifiers, monitoring scopes and calibration equipment mounted ruggedly for rolling or trucking anywhere in a widespread facility.

FR-300—HIGH-SPEED DIGITAL

For reading or writing of digital magnetic tapes, the FR-300 offers transfer rates as high as 90,000 alpha-numeric characters per second. It is the first digital tape handler to match the majority of big electronic computers both in speed and in reliability of bit reproduction. Start and stop times are less than 1.5 milliseconds greatly reducing buffer requirements. Ampex furnishes complete digital tape systems including tape handler, magnetic heads, amplifiers and special Ampex Computer Tape.

Brief physical specifications: 150 ips tape speed; 10½-inch reels; ½ or 1-inch tape; 7 to 16 tracks; control of all functions by computer command, also optional local control; read and write electronics will accept and read out digital information in any of a variety of forms; complete equipment fits one 19-inch rack cabinet.

FR-400 and FR-200A—AUXILIARY DIGITAL

For lesser computers and such auxiliary digital equipment as converters, printers, etc., these Ampex digital tape handlers provide a wide range of transfer rates to match any particular need. The Ampex FR-400 uses many of the high-performance components developed for the sensational FR-300, hence is a very heavy-duty tape handler with tape speeds up to 75 inches per second.

Brief physical specifications: Tape speeds up to 75 ips; 10½″ reels; ½ or 1-inch tapes; 7 to 16 tracks; remote and local controls.

Ampex can send you comprehensive literature and specifications on the various models shown and also a 16-page brochure on principles and applications of magnetic-tape instrumentation. For any of these items, write Dept. E-58BG.

AMPEX INSTRUMENTATION DIVISION
860 CHARTER STREET · REDWOOD CITY, CALIFORNIA
Phone your Ampex data specialist for personal attention to your recording needs. Offices serve U. S. A. and Canada. Engineering representatives cover the free world.

DELCO'S FAMILY OF HIGH POWER TRANSISTORS

Typical Characteristics at 25°C

	DT100	DT80	**2N174A	2N174	2N173	2N443	2N278	2N442	2N277	2N441
Maximum Collector Current	13	13	13	13	13	13	13	13	13	13 amps
Maximum Collector Voltage (Emitter Open)	100	80	80	80	60	60	50	50	40	40 volts
Saturation Resistance (13 amp.)	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02 ohms
Max. Square Wave Power Output at 400~P-P*	400	310	310	310	225	225	180	180	135	135 watts
Max. Sine Wave Power Output at 400~P-P*	180	140	140	140	100	100	80	80	60	60 watts
Power Dissipation (Stud Temperature 25°C)	70	70	70	70	70	55	55	55	55	55 watts
Thermal Gradient from Junction to Mounting Base	1.0°	1.0°	1.0°	1.0°	1.0°	1.2°	1.2°	1.2°	1.2°	1.2° °C/watt
Nominal Base Current I_B (V_{EC} = —2 volts, I_C = —1.2 amp.)	-19	-13	-19	-19	-13	-24	-13	-24	-13	-27 ma

*Adequate Heat Sink

**Designed to meet MIL-T-19500/13 (USAF) 18 JUNE 1957

Performance characteristics to meet your switching, regulation or power supply requirements

These ten Delco Radio alloy junction germanium PNP power transistors are now in volume production. They are characterized by high output power, high gain, and low distortion. And all are normalized to retain superior performance characteristics regardless of age.

Check the data chart above—see how they fit your particular requirements in current switching, regulation or power supply. Write for detailed information and engineering data. Delco Radio maintains offices in Newark, N. J. and Santa Monica, Calif. for your convenience.

BRANCH OFFICES

Newark, New Jersey
1180 Raymond Boulevard
Tel: Mitchell 2-6165

Santa Monica, California
726 Santa Monica Boulevard
Tel: Exbrook 3-1465

DELCO RADIO
Division of General Motors
Kokomo, Indiana

RELIABILITY or

The Wonderful One-Hoss Shay

A Logical Story

Have you heard of the wonderful one-hoss shay,
That was built in such a logical way
It ran a hundred years to a day?

"For," said the Deacon, "It's mighty plain
That the weakest place must stand the strain;
And the way to build it is only jest
To make that place as strong as the rest."

The Deacon followed the two cardinal principles for reliability.

1. Know the stresses your component will be subject to (in other words know the environment).

2. Build faithfully to the specifications that <u>cope</u> with this environment.

At CPPC we feel one of our great assets is careful manufacture by a skilled and conscientious crew.

Reprints of the complete, original poem— The Deacon's Masterpiece or The Wonderful One-Hoss Shay by Oliver Wendell Holmes sent upon request.

LOOK TO CPPC FOR SYNCHRO PROGRESS

CLIFTON PRECISION PRODUCTS COMPANY, INC.
Clifton Heights Pennsylvania

CIRCLE 21 READERS SERVICE CARD

for
HEARING
AIDS

or
RECORDING
HEADS

or *ANY* MAGNETIC MATERIALS JOB . . .

Write for your Copy

"MAGNETIC MATERIALS"

This 32-page book contains valuable data on all Allegheny Ludlum magnetic materials, silicon steels and special electrical alloys. Illustrated in full color, includes essential information on properties, characteristics, applications, etc. Your copy gladly sent free.

ADDRESS DEPT. E-6

You can *rely* on core materials like the Allegheny 4750 components illustrated above, in your receivers, recording heads or microphone assemblies.

In fact, whether your equipment is small or large, the extra-broad line of A-L magnetic materials will solve your magnetic core problems. It includes all grades of silicon steel sheets or coil strip, as well as Allegheny Silectron (grain-oriented silicon steel), and a wide selection of high-permeability alloys such as 4750, Mumetal, Permendur, etc.

Our service on these materials also includes complete facilities for the fabrication and heat treatment of laminations. (For users of electrical sheets and strip, our lamination know-how is a real bonus value!) Either way, we'll welcome the chance to serve you. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

STEELMAKERS to the Electrical Industry

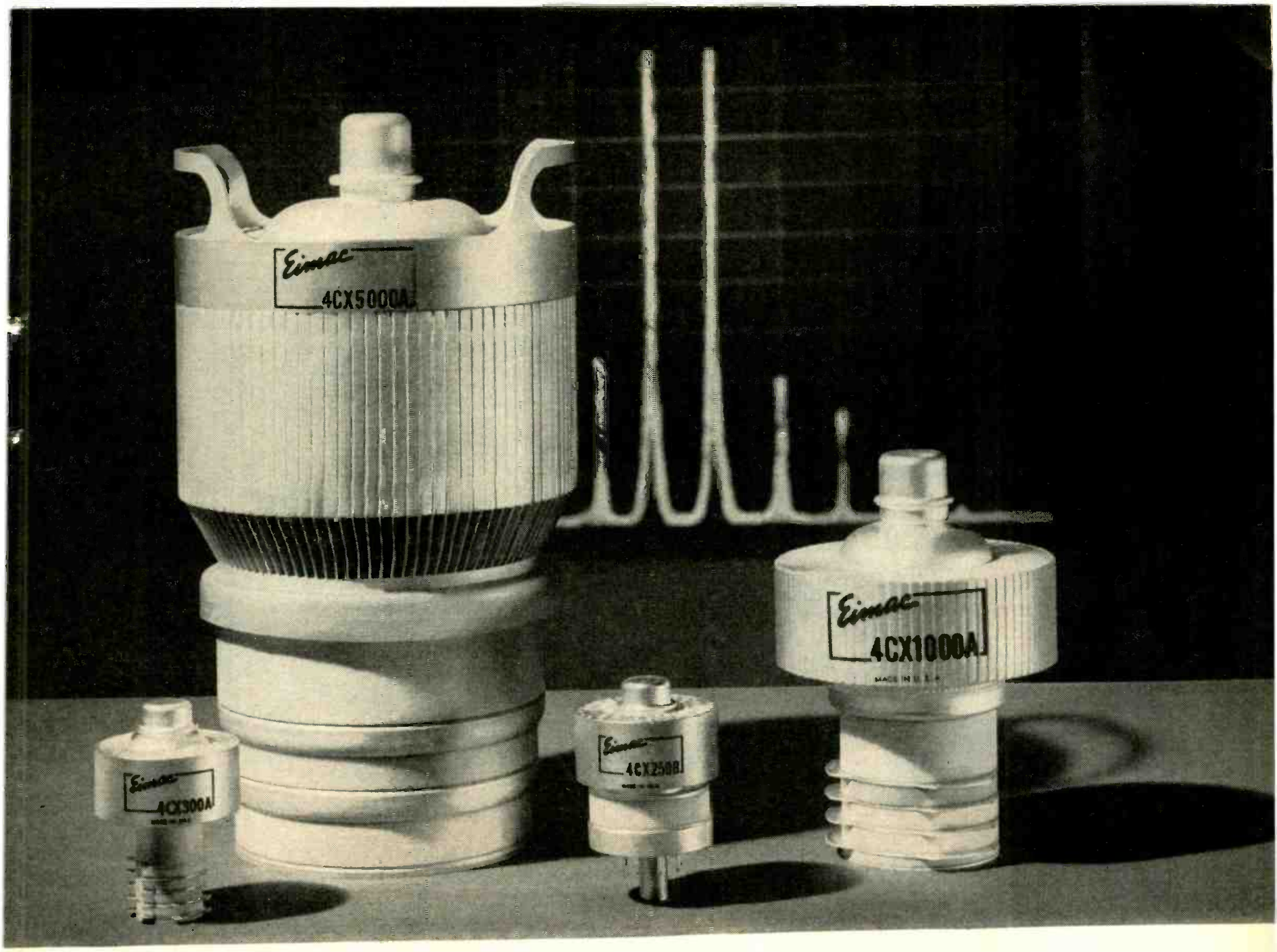
Allegheny Ludlum

AL ® STEELS FOR THE ELECTRONIC AGE

W&D 5335

CIRCLE 22 READERS SERVICE CARD

CIRCLE 23 READERS SERVICE CARD →



The Ideal Approach to SSB...

Eimac Ceramic Tetrodes from 325 to 11,000 watts

Generating a clean SSB signal is one thing . . . amplifying it to the desired power level with stability and no distortion is another. A modern Class AB_1 final amplifier designed around an Eimac ceramic-metal tetrode is the ideal answer to the problem. The Eimac ceramic linear amplifier tubes shown above – the 4CX250B, the 4CX300A, the 4CX1000A and the 4CX5000A – offer the high power gain, low distortion and high stability that is needed for Class AB_1 operation. Each has performance-proved reserve ability to handle the high peak powers encountered in SSB operation. Efficient integral-finned anode cooler and Eimac Air System Sockets keep blower requirements at a minimum and allow compact equipment design. And, all four incorporate the many advantages of Eimac ceramic-metal design, which assures compact, rugged, high performance tubes.

The high performance and reliability of Eimac ceramic tetrodes make them the logical starting point in the design of compact, efficient single sideband equipment.

Write our Application Engineering Department for a copy of the technical bulletin "Single Sideband"

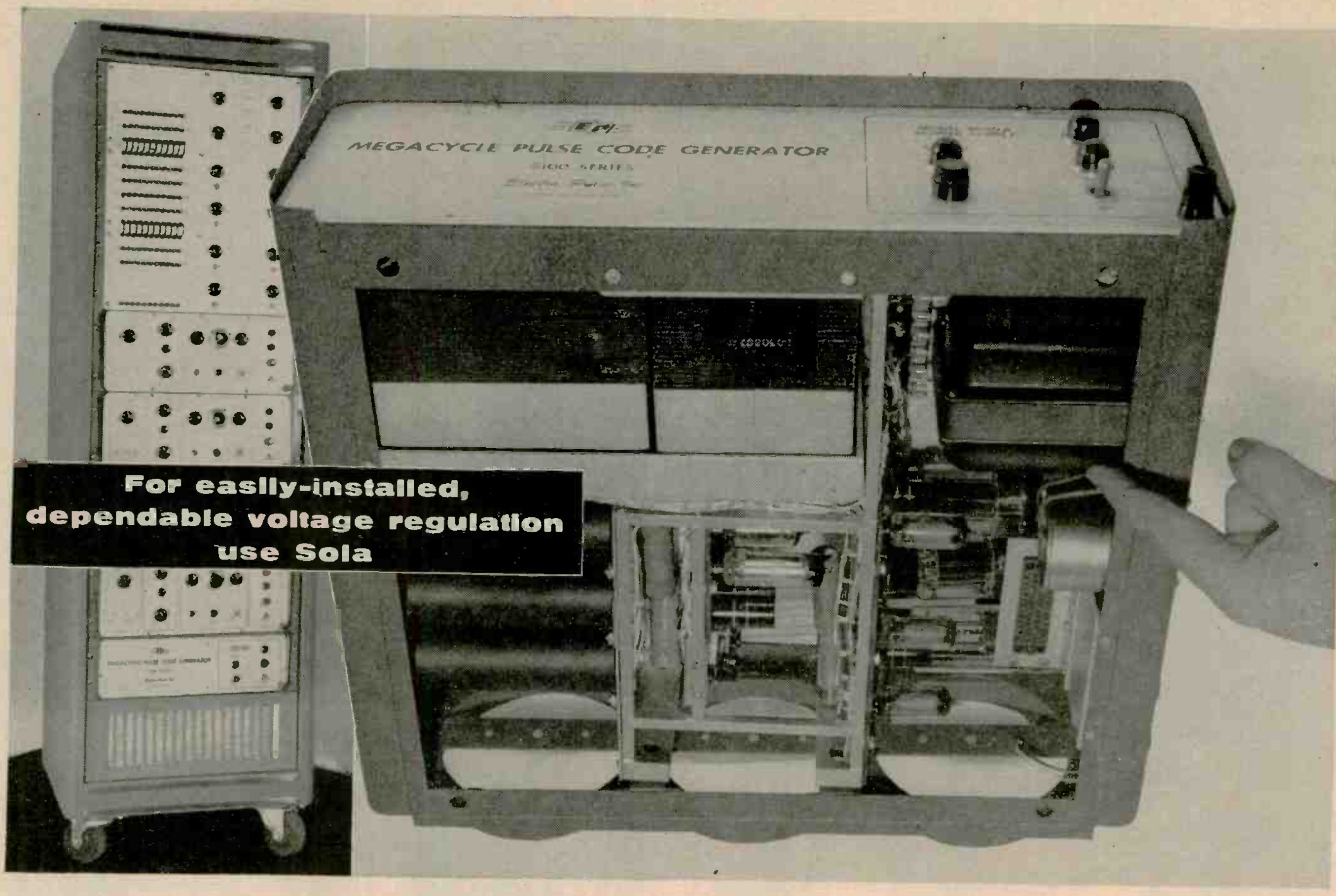
EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA

Eimac First **with ceramic tubes that can take it**

Eimac®

CLASS AB_1 SSB OPERATION

	4CX250B	4CX300A	4CX1000A	4CX5000A
Plate Voltage	2000 v	2500 v	3000 v	7500 v
Driving Power	0 w	0 w	0 w	0 w
Peak Envelope Power . .	325 w	400 w	1680 w	11,000 w



FIVE constant voltage transformer types answer most stabilizing needs

1 **Constant Voltage Filament Transformers*** are widely used by manufacturers of electronic equipment who know that inrush current and fluctuating voltage to electron filaments are costly in shortened tube life . . . in substandard performance and unnecessary failures. That's why Electro-Pulse, Inc., manufacturers of the Megacycle Pulse Code Generator (shown left), builds in a Sola Constant Voltage Filament Transformer as a component of the power supply (shown right).

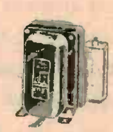
The Sola's current-limiting characteristic protects filaments from cold inrush current upon starting. It regulates filament voltages to within ±1% with line voltage variations as great as ±15%; response is within 1.5 cycles.

Stock units are available from 2.37 to 25 amp ratings. Custom designs can be manufactured in production quantities for specialized applications.

2 **Standard***: Constant Voltage Transformers for electrical and electronic equipment . . . regulation ±1% . . . response within 1.5 cycles . . . no tubes, moving parts or manual adjustments . . . static-magnetic regulation...limits current on load faults.

3 **Harmonic-Free***: Output voltage wave has less than 3% total rms harmonic content . . . other features identical with standard type . . . automatic, continuous regulation . . . for rectifiers and other loads sensitive to harmonics . . . low external field.

4 **Plate-Filament***: Regulation is ±3% with line input between 100-130v . . . plate and filament windings are combined on a single, compact core for chassis mounting . . . good isolation of input and output circuits . . automatic, static-magnetic regulation.



5 **Adjustable, Harmonic-Free:** Provides output adjustable from 0-130 volts ac, also fixed 115 volts ac . . . regulates within ±1% with less than 3% total rms harmonic content...portable for lab or shop bench use, or mounts on 19" relay rack.

**Stock or custom units*

Send for Circular 7F-CVF-269

Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill., Bishop 2-1414 • Offices in Principal cities • In Canada, Sola Electric (Canada) Ltd., 24 Canmotor Ave., Toronto 14, Ont.

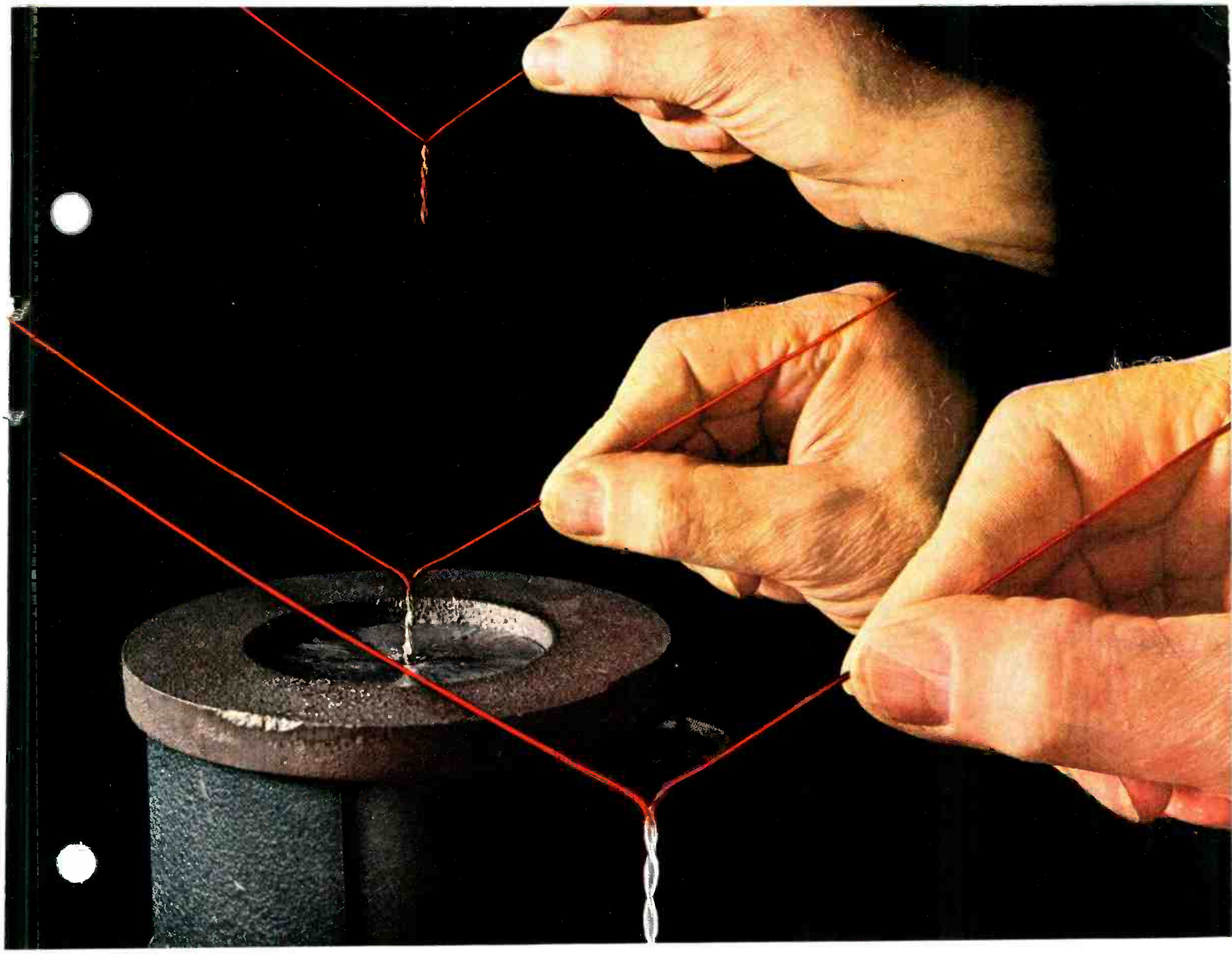
SOLA


CONSTANT VOLTAGE TRANSFORMERS


REGULATED DC POWER SUPPLIES


MERCURY LAMP TRANSFORMERS


FLUORESCENT LAMP BALLASTS



ANALAC is a true production-line wire. This film-insulated solderable magnet wire does away with pre-stripping before soldering, lends itself to gang soldering, to iron, gun and dip soldering.

Now, just one step! Analac lets you solder without pre-stripping!

Anaconda's Analac* magnet wire saves time and money on the production line. This film-insulated, solderable magnet wire can be used just as you use Formvar or Plain Enamel—with this plus advantage . . . it is solderable without pre-stripping the insulation.

Analac cuts down labor-time where many solderable connections are to be made. It's ideal, too, where removal of the insulation is a hazard to the wire. Soldering Analac by dipping, iron or gun produces a perfect joint.

It performs well in high-speed winding! Analac has the excellent abrasion-resistance and other mechanical advantages of the enamel wire you're now using.

Distinctive red color simplifies identification . . . is highly visible, helping operators turn out higher quality work.

Analac, 105°C (AIEE Class A) wire, is available in sizes from 15 Awg to 46 Awg.

The Man from Anaconda will be glad to give you more information. See "Anaconda" in your phone book—in most principal cities—or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.

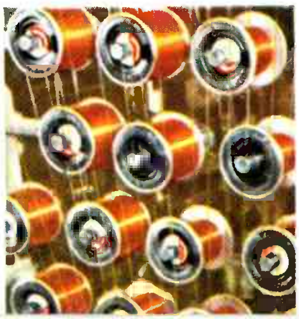
*Reg. U. S. Pat. Off. 58362

SEE THE MAN FROM ANACONDA®
FOR **READY-TO SOLDER ANALAC MAGNET WIRE**

For details on how you can save with Analac, and for engineering data—please turn the page!

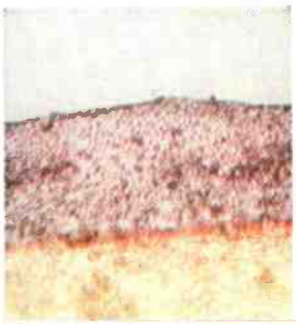
ANATHERM 155°C (AIEE Class F)
high temperature resistance

PLAIN ENAMEL 105°C (AIEE Class A)
low-cost enameled magnet wire

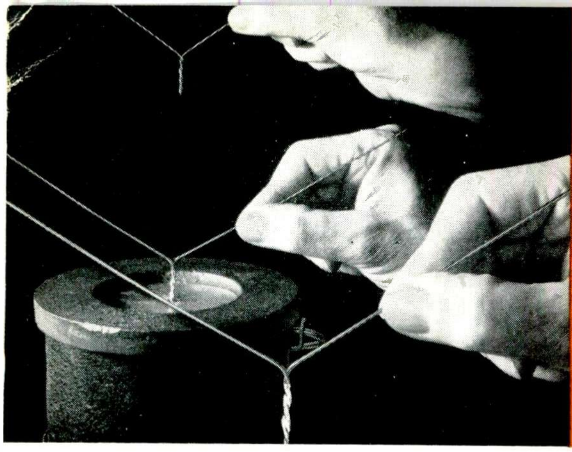


FORMVAR 105°C (AIEE Class A)
established dependability

VITROTEX 130°C (AIEE Class B)
glass-insulated, high heat resistance



EPOXY 130°C (AIEE Class B)
general compatibility



MAGNET WIRE DATA SHEET

from

Anaconda Wire & Cable Co.

IMPORTANT FACTS FOR YOUR WORK...

about Analac 105°C (AIEE Class A) Magnet Wire

SOLDERABILITY. Anaconda's Analac can be used to overcome high cost of insulation stripping by adapting your present system to automatic soldering techniques. Your Anaconda sales representative can arrange for cooperation from Anaconda's Research Laboratories to help you take full advantage of Analac's cost-saving possibilities.

Analac is versatile; lends itself to gang soldering, to iron, gun and dip soldering. Anaconda's Analac Booklet contains full information on soldering methods, fluxes, temperature control. Use the coupon below for your copy.

WINDABILITY. Analac is abrasion-resistant . . . has excellent lubricity and surface characteristics which make it readily adaptable to automatic high-speed winding operations. Can be used on your present equipment—no retooling is necessary to adapt solderable Analac.

COMPATIBILITY. Analac is compatible with most insulation varnishes presently being used.

TECHNICAL PROPERTIES

MECHANICAL PROPERTIES

Analac has excellent mechanical properties. The film possesses superior abrasion-resistance and flexibility under a number of varied conditions—such as heat, cold and moisture. The wire shows no cracks when elongated rapidly to the breaking point. It will also withstand 3 times diameter wrap after 20 percent elongation.

MOISTURE-RESISTANCE

Analac's moisture-resistance is excellent, particularly in size range 25 and heavier. It offers moisture-resistance superior to most other film-type insulations.

New Analac Booklet—yours for the asking!
Latest information . . . full technical data.
Mail coupon for your copy.

ANACONDA WIRE & CABLE COMPANY
25 BROADWAY, NEW YORK 4, NEW YORK

Please send copy of your Analac Magnet Wire Booklet. I am interested in heavy or intermediate size (15 Awg to 30 Awg)—; fine sizes (31 Awg or finer)—.

NAME & TITLE...

COMPANY...

ADDRESS...

CITY, ZONE, STATE.. .....

ELECTRICAL PROPERTIES

Analac has superior dielectric strength both in a dry condition and after exposure to high humidity. Meets NEMA twist test requirements. Analac has unusually low dielectric losses at high frequencies, which are only slightly affected by high humidity. Thus Analac is particularly suited for electronic uses.

ELECTRICAL PROPERTIES

		Number of Tests Averaged	Volts per Mil at Breakdown
Dielectric strength.	NEMA twist test, room conditions.	145	3500
	NEMA twist test, dry.	30	4050
	NEMA twist test after 6 hours exposure at 100F and 100% relative humidity.	30	4000
	Layer test—double layer wind on 1-inch diameter mandrel, apply voltage between layers.	30	2840

		Frequency			Dissipation Factor—Cotangent of Angle of Lag			
					Temperature—Deg C			
		cps	kc	mc	Room	85	125	155
Dielectric loss.	Dissipation factor at room temperature.	100			1.00	—	—	—
		1000			0.92	—	—	—
			10		1.38	—	—	—
			100		1.90	—	—	—
			1000		1.97	—	—	—
				10	1.93	—	—	—
				40	2.79	—	—	—
	Dissipation factor at elevated temperature.	100			—	1.08	1.73	15.7
		1000			—	1.32	1.48	11.9
			10		—	1.72	1.62	6.4
			100		—	1.40	1.40	5.0
					Dielectric Constant K			
Dielectric constant.	As measured by bridge and Q meter at room temperature.	100			3.00	—	—	—
		1000			2.96	—	—	—
			10		2.93	—	—	—
			100		2.85	—	—	—
			1000		2.54	—	—	—
				10	2.52	—	—	—
				40	2.90	—	—	—
	As measured by bridge and Q meter at elevated temperature.	100			—	3.63	3.85	3.66
		1000			—	3.57	3.80	2.93
			10		—	3.51	3.69	2.49
			100		—	3.40	3.63	2.33

CHEMICAL PROPERTIES

Analac has good resistance to the action of solvents, water, and dilute acids and bases. Analac will withstand 24 hours' immersion at room temperature in most varnish solvents including naphtha, toluol, xylol, and ethyl alcohol. Shows excellent resistance to 5% sulfuric acid and 5% potassium hydroxide.

THERMAL PROPERTIES

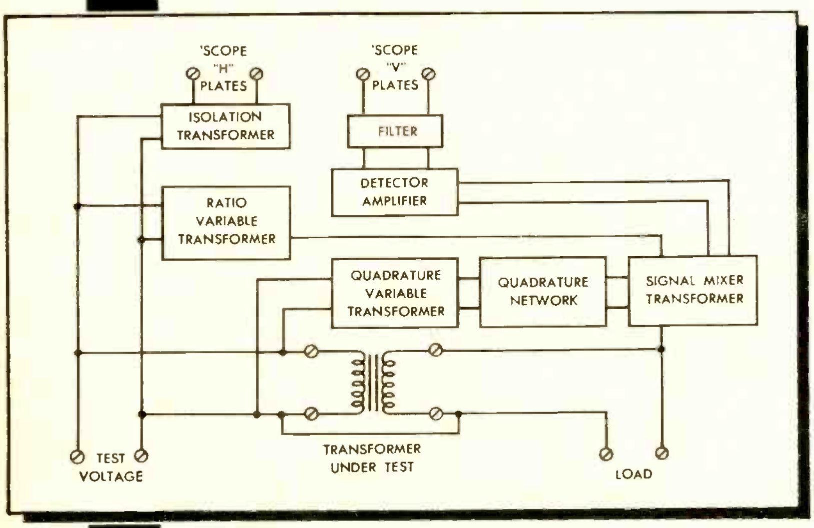
Analac is offered as 105°C (AIEE Class A) magnet wire, although its thermal stability shows it is capable of performance at much higher temperatures. Analac's thermoplastic flow cut-through data, obtained on basis of MIL-W-583A methods, has been above 200°C.

A.C. Ratiometer

...accurate to five parts per million!

The Transformers, Inc. Model 214 A. C. Ratiometer is a precision instrument to measure any voltage ratio from 0.000001 to 1.111111. Transformer ratios can be accurately measured at "no load" or under any required load.

The Model 214 Ratiometer is designed for use between 25 cps and 2,500 cps. It is supplied with plug-in filter and quadrature units for 400 cps operation. Plug-in units for any other frequency are supplied to order.



The Ratiometer consists of two precision variable transformers, a calibrated quadrature injector, a filter, and a pre-amplifier. Block diagram indicates connections of the various components within the instrument.

ACCURACY

$\pm(0.0005\% + \frac{0.0001\%}{\text{ratio}})$

FREQUENCY RANGE

25 cps to 2,500 cps

MAXIMUM VOLTAGE

Twice the frequency in cps, or 250V, whichever is lower.

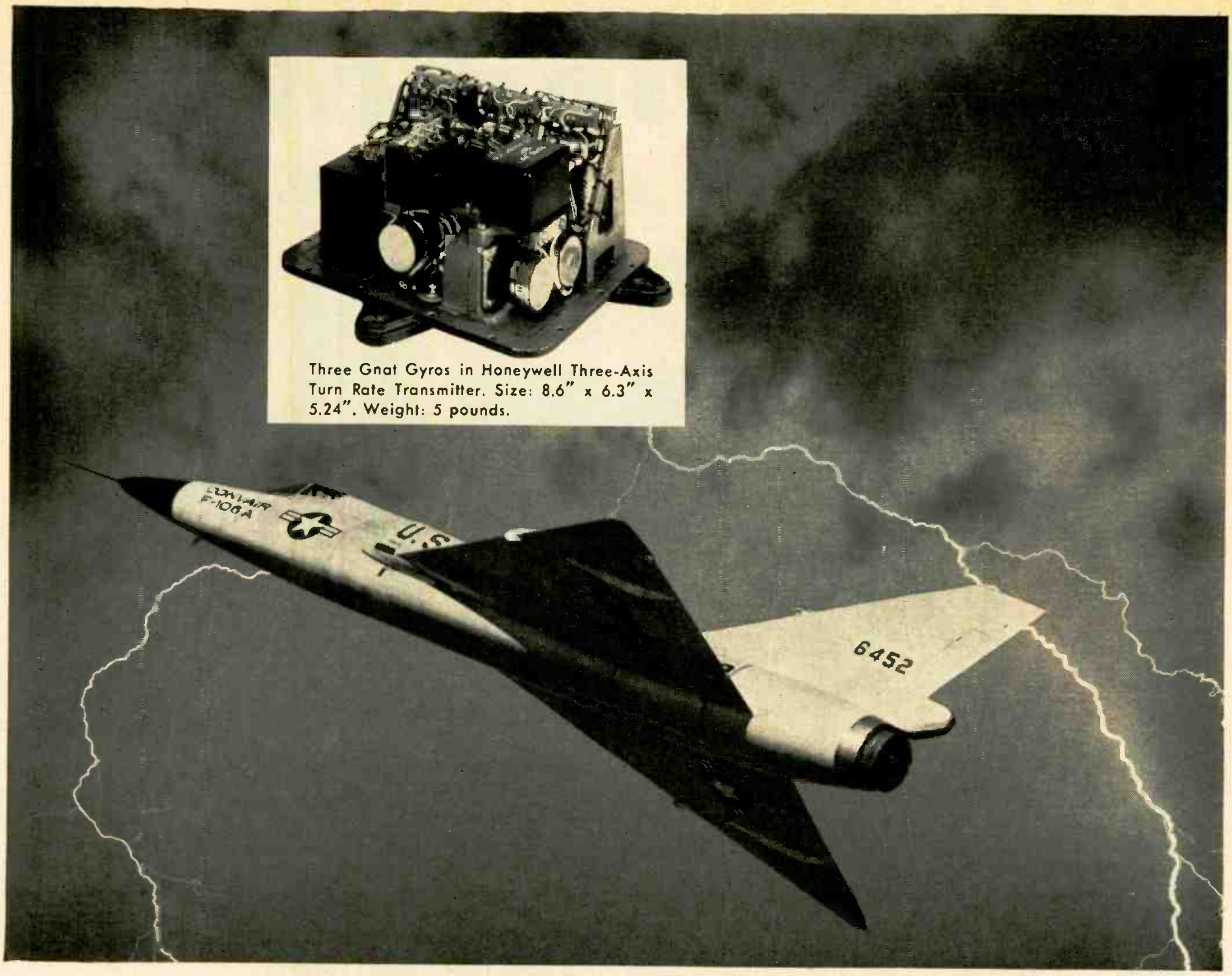
PRICE

Model 214 Ratiometer, complete with 400 cps plug-in filter and quadrature units **$1235**

For additional information, ask for Bulletin #205

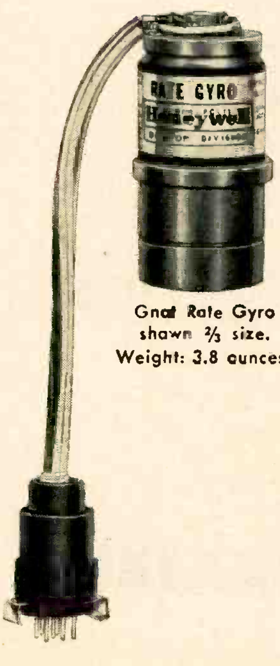
TRANSFORMERS, INCORPORATED

200 Stage Road, Vestal, N.Y.



Convair F-106 all-weather jet interceptor incorporates Honeywell Three-Axis Turn Rate Transmitter in flight control damper system

Three-axis control at <u>all</u> speeds and altitudes



Gnat Rate Gyro shown ⅔ size. Weight: 3.8 ounces.

The Honeywell Three-Axis Turn Rate Transmitter, featuring three Gnat miniaturized gyros, was selected for the new Convair F-106 "Delta Dart" all-weather jet interceptor. Built into the stability augmentation sub-system of the jet's flight control system, the Transmitter detects rate of turn about the yaw, pitch and roll axes and responds with an output signal whose voltage is proportional to these input rates of turn.

This system is designed to operate under the most severe environmental conditions to which a combat aircraft might be subjected. The Honeywell Gnat Rate Gyros are easily capable of withstanding the severe shock, vibration and temperature requirements of this application and as such are mounted directly upon the base casting without shock mounts to optimize dynamic characteristics of the system.

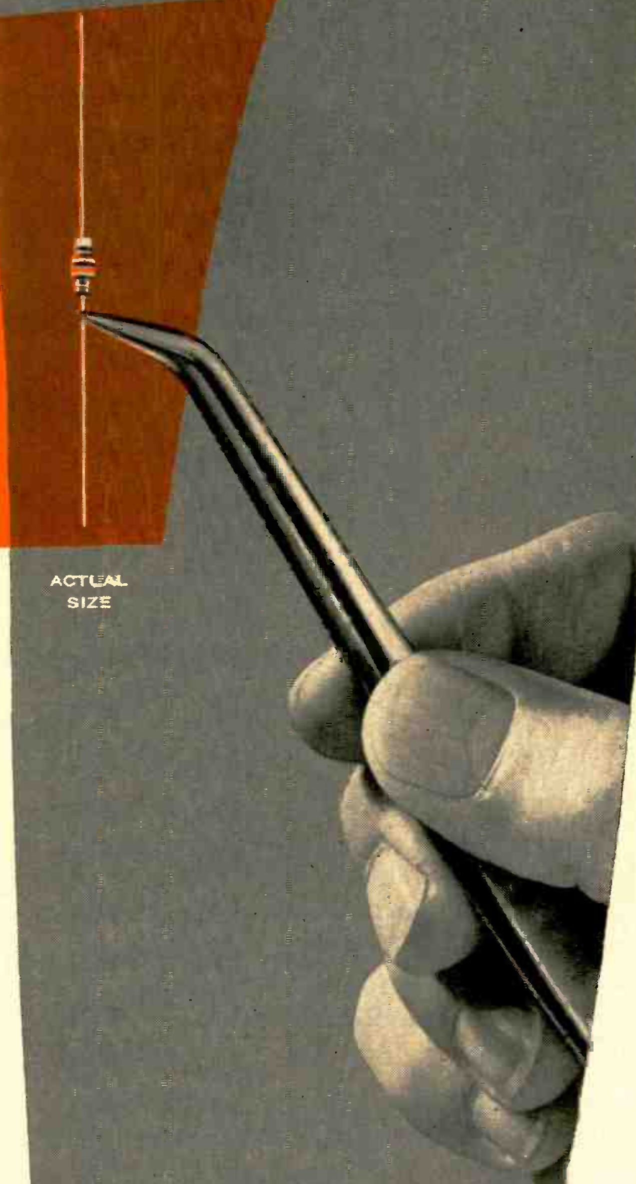
The electronic portion of the Turn Rate Transmitter amplifies and demodulates the Gyro output signals to provide polarity reversing d-c outputs proportional to the corresponding input rate to each Gyro.

Investigate Honeywell's ability to develop, engineer and produce flight control systems for today's most advanced aircraft and missiles. Write for Bulletin GN to Minneapolis-Honeywell, Boston Division, Dept. 7, 40 Life Street, Boston 35, Mass.

Honeywell

H Military Products Group

400mA 600v silicon rectifiers in a subminiature package!



One of 35 PSI rectifiers representing the *broadest range of miniature and subminiature silicon rectifiers* in the industry.

Progress in silicon rectifier manufacture in the past six months has significantly outmoded recent design concepts. Notable advances have been made in miniaturization . . . improved types have been introduced . . . the relationship between power, size and price has been drastically changed.

PACIFIC SEMICONDUCTORS, INC. has added numerous types ranging from 50v to 600v . . . 200 to 500mA. PSI is now delivering the *highest voltage, highest current silicon rectifiers ever offered in a subminiature package.*

If your problem involves further miniaturization, it will pay you to look at the new PSI line of silicon rectifiers. Compare these husky subminiatures with the bulkier types you have been specifying. It's quite possible you'll find substantial performance, size and cost advantages.

Production quantity delivery is being made on *all* PSI rectifier types. Detailed specifications available on request.

Distributors:

ALLIED RADIO, Chicago • ALMO RADIO COMPANY, Philadelphia • CRAMER ELECTRONICS, INC., Boston • ELECTRONIC SUPPLY CORP., Pasadena • ELECTRONICS WHOLESALERS, INC., Washington, D.C. • PEERLESS RADIO DISTRIBUTORS, INC., Jamaica, N.Y. • PENINSULA TV & RADIO SUPPLY, San Jose • WHOLESALE RADIO PARTS COMPANY, Baltimore

PSI also offers a broad line of Silicon and Germanium Diodes, Very High Voltage Silicon Cartridge Rectifiers, Varicaps (voltage-variable capacitors) and Diode Test Equipment.

PSI

T.M.

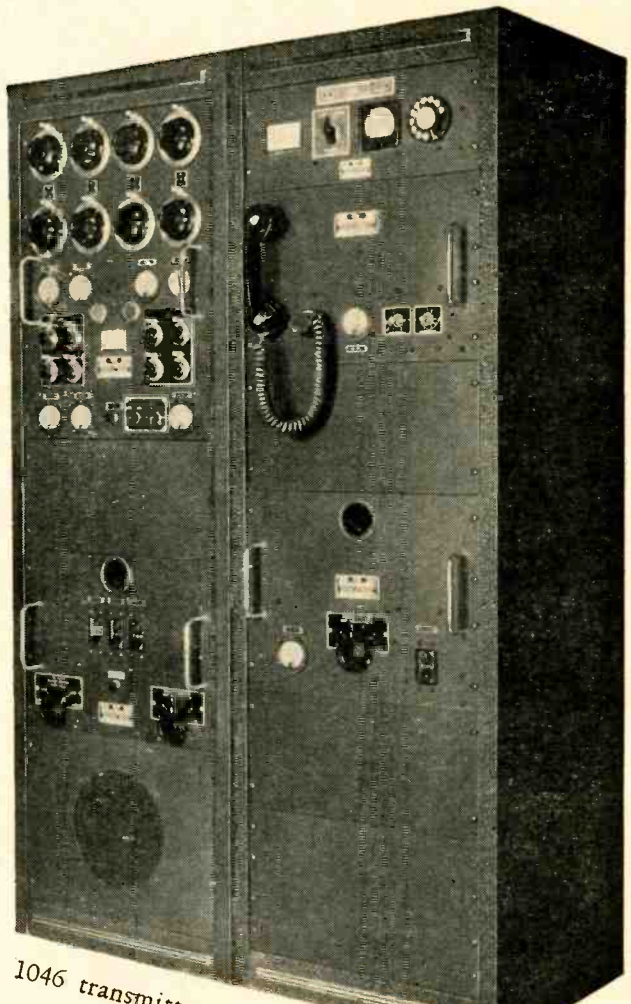
Pacific Semiconductors, Inc

10451 West Jefferson Boulevard, Culver City, California

AEROCOM'S 1046 H. F. TRANSMITTER

POWER + STABILITY

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

Now! Complete-package, 192 channel, H. F., 75 pound airborne communications equipment by Aer-O-Com! Write us today for details!

AER -O- COM

109

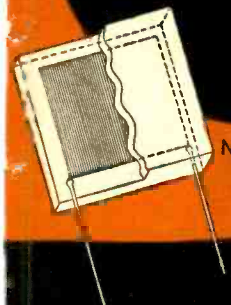
3090 S.W. 37th AVENUE MIAMI 33, FLORIDA

CIRCLE 30 READERS SERVICE CARD

CIRCLE 31 READERS SERVICE CARD→

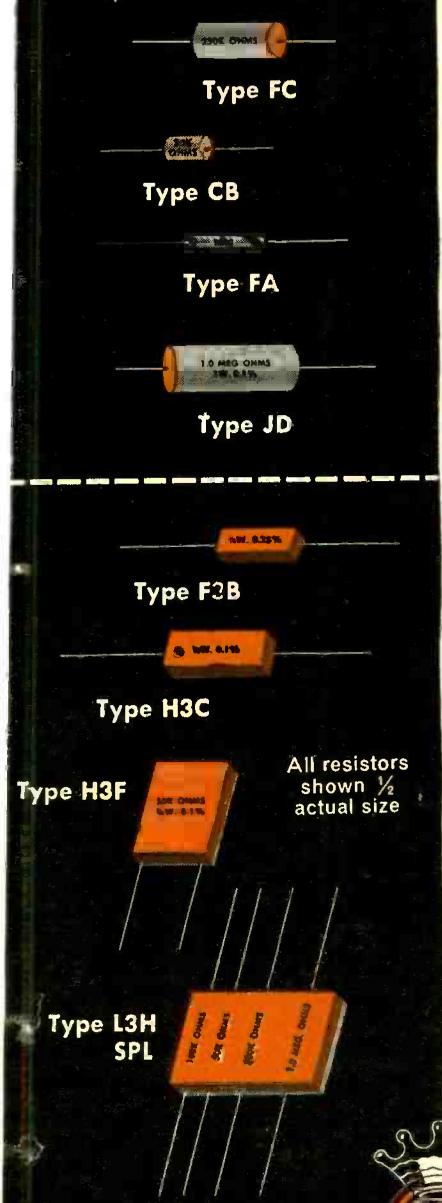
CTS

PERMANENTLY STABLE • 100% TESTED Resistors PRECISION WIRE FIXED Bobbinless



FAR EXCEED PROPOSED MIL-R-93B*

Burton Browne Advertising



COMPARATIVE DATA REPORT

Note Exceptional Stability. Note extent that MIL-R-93B is exceeded.

MIL-R-93B (proposed) Tests	MIL Requirement	CTS Maximum	CTS Average
Short Time Overload	0.5%	.05%	.02%
Temperature Cycling	0.2%	.05%	.02%
Moisture Resistance	100 megs 1.0%	1000 megs (min) .1%	—— .05%
Salt Water Immersion Cycling	0.5%	.03%	.015%
Load Life at 125°C or 85°C (500 hours)	0.5%	.15%	.05%
Temperature Coefficient Less than 2000 ohms 2000 ohms and over	Up to 75 PPM/°C 30 PPM/°C	30 PPM/°C 20 PPM/°C	—— ——
Low Temperature Storage	1.0%	.01%	.005%
Low Temperature Operation	1.0%	.05%	.02%
High Temperature Exposure (145°C)	1.0%	.05%	.02%
Acceleration	0.1%	.02%	.008%
Shock	0.1%	.02%	.008%
Vibration	0.1%	.02%	.008%

- No Wire Strain. Unique CTS "floating element" needs no bobbin or winding form . . . permits resistance elements and contacts to be firmly embedded in epoxy resin . . . forming a monolithic mass with a smaller space factor.
- Permanent Stability—Less than .05% average change under most environmental conditions and shelf life.
- 5PPM/°C Temperature Coefficient available.
- 100% Tested—High temperature exposure and short time overload tests are run on all resistors before shipment.
- Guaranteed Close Tolerance — Resistors guaranteed to be in tolerance under normal conditions of measurement. Tolerances down to ±0.05% available in standard sizes depending upon resistance value. Closer tolerances and/or matched multiples available.
- Low Inductance and Low Capacitance Characteristics with reproducible uniform frequency response.
- Withstands extreme vibration and shock due to unique construction and encapsulation method.
- Modular—Design flexibility permits grouping many resistors in a single unit.

Available in a wide variety of tubular, rectangular or square shapes. Special dimensions, tolerances, wattage ratings, resistances, etc. can be made to your precise requirement. Either axial or radial leads available.

For help in solving your fixed resistor problems, phone or write your nearest CTS office today.

*MIL-R-93B (proposed) soon to be issued, superseding MIL-R-93A.

FOUNDED CTS 1896

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Are You Preparing *Now* For The Next Boom?

America's leading companies are not sitting on their hands waiting for the recession to end. They are planning ahead *now* for higher sales and near-capacity rates of operation.

These facts stand out clearly from the eleventh annual survey of Business' Plans for New Plants and Equipment just completed by the McGraw-Hill Department of Economics:

- **Manufacturing companies expect their sales to increase 20%, on the average, from 1958 to 1961.** Growth industries, such as chemicals and electrical machinery, expect gains of 25% to 34%.
- **If these sales gains are achieved, the average rate of operations in manufacturing will rise from 78% at the end of 1957 to almost 85% by 1961.** This is the point at which pressure on costs begins to mount, as less efficient facilities are pressed into service.
- **Industry is not waiting for this point to begin getting its plants and equipment in shape for the next boom.** Despite record expansion in the past several years, many manufacturing companies plan to add new capacity in each of the next four years. But, more important, they are going ahead with the vital job of modernization and cost-cutting.

In the years immediately ahead almost two-thirds of capital investment will go for modernization and replacement of present plants and equipment. In this way manufacturing companies can avoid the higher costs and the squeeze on profits that occur when producing facilities are not in shape to handle an increase in sales volume.

These are the plans, as reported to McGraw-Hill, of a wide sample of manufacturing companies—for the most part, large firms and leaders in their respective industries. Altogether, these firms account for almost 40% of all employment in manufacturing industries.

Now Is The Time

How do your plans measure up? Are you planning ahead now for a 20% sales increase in the next three years? Is your company planning to modernize its buildings and equipment more rapidly than at any time in the recent past? If not, here are some of the inducements that McGraw-Hill editors report from their continuous checking on the state of business.

(1) **There are plenty of opportunities for increasing efficiency by the installation of new equipment and the improvement of layouts in plants, warehouses and offices.** Despite the installation of tremendous volumes of metalworking equipment in recent years, according to AMERICAN MACHINIST over half of the machine tools now in U. S. factories are over 10 years old. Replacement of worn-out and obsolete equipment will mean material savings in operating and maintenance costs.

(2) **Machinery, parts, materials and labor are much more readily available now than they are when the economy is running at full steam.** You can be more particular about quality and about specification to meet your own requirements.

(3) **With lower interest rates and less competition for loans, it is both easier and cheaper to borrow money to finance equipment and construction.** To wait for another boom is to run the risk of having to pay higher interest rates and look harder for money.

(4) **Although there is an adequate supply of most types of labor available now, the prospect is that the supply of factory labor over the years ahead will be tight.** In 1965, there will actually be fewer men and women between the ages of 25 and 44 than there are now. Good factory workers will be either hard to get, or wage rates will rise sharply or—more likely—both. The best answer is to anticipate the rise in labor costs by installing more efficient equipment to increase labor productivity.

(5) **Finally, the costs of investing in new buildings and improved equipment *now* are almost surely less than they will be later.**

These are some of the reasons why many leading firms find ***now*** the best time in years to start on a program of plant modernization. There are other good reasons in the many new products and processes coming from the boom in research and development. This year industry will spend over $8 billion on R & D—$1 billion more than in 1957. And a heavy share of the new product development will consist of better machines and processes to be made available during the next few years. Already the pace of technical advance is so rapid as to call for modernization of plants built only a few years ago.

Years of Opportunity

It has been said that the years between now and 1961 are the "middle years" between two booms. This does not mean a long period of recession, but a period of slower growth—a transition from the postwar boom based on deferred demand, to a new boom in the 1960s based on dynamic population growth and a revolution in technology.

If so, these are the years of opportunity for business—opportunity to prepare for the growth that lies ahead with the most efficient equipment, the most modern plant and the best production organization that can be devised. This is the way to fight higher costs and avert a resumption of inflation. This is also the way to ensure that your company will be ready for its new markets in the 1960s.

Are you planning ahead ***now*** to be among the leaders?

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C McGraw
PRESIDENT

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NUCLEAR ENERGY
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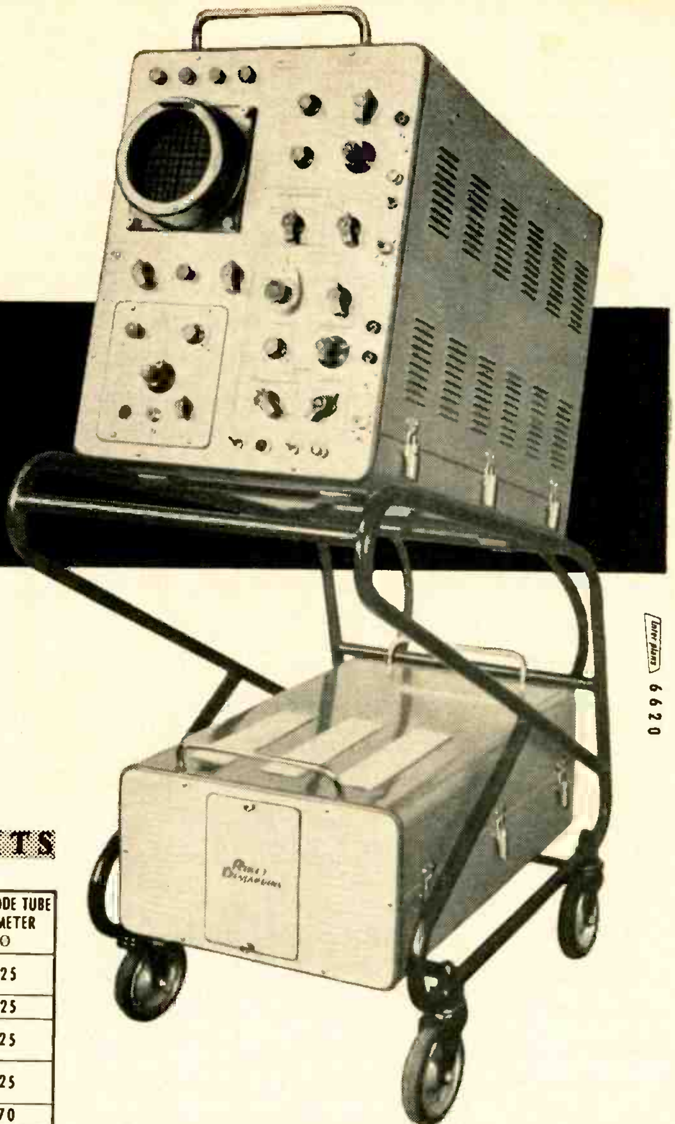
RIBET DESJARDINS

SYNCHROSCOPE 204 A



The synchroscope 204 A, an apparatus of very high performance, is unique in making it possible to record ultra-rapid phenomena reaching several thousand kilometers-second. It offers the same characteristics of precision and safe operation that have secured the universal reputation of the Electronic Department of the Ribet-Desjardins Company.

MEASURE AND CONTROL UNITS

I - OSCILLOSCOPES AND SYNCHROSCOPES

MODELS	CHANNELS	RANGE	AMPLI V: Passing Band cps - mc	AMPLI V: Sensitivity mV/p to p/cm	RESPONSE LAG µs	MARKER	CATHODE TUBE DIAMETER O
204 A	1	0.01µs/cm-4s/cm	0 - 50	50	0.007	Calibrated + 100µs	125
251 A	2	0.02µs/cm-10 s/cm	0 - 30	50	0.02	Calibrated	125
252 BL	1	0.1µs/cm-4 ms/cm	0 - 10 10 - 10	80 50	0.04	0.05µs-1000µs	125
254 A	2 1	0.1µs/cm-1 s/cm 0.1µs/cm-1 s/cm	0 - 4 0 - 10	20 50	0.12 0.045	Calibrated	125
255 A	1	0.3µs/cm-0.01s/cm	0 - 4	150	0.12	0.4µs-4 ms	70
256 A	1 2	1µs/cm-1 s/cm 1µs/cm-1 s/cm	0 - 1 0 - 0.8	15 50	—	Calibrated	90
258 A	1	2µs/cm-20 ms/cm	50 - 1	50	—	—	70
264 B	2	1µs cm-0.05s/cm	10 - 2	6	—	—	90
267 B	1	1µs/cm-0.1 s/cm	0 - 1 20 - 0.8	250 8	—	—	90
268 A	1	10 cps - 30 kc	50 - 1	45	—	—	70

II - GENERATORS AND WOBBLERS

MODELS	FREQUENCY RANGE	SIGNAL	PRECISION	MODULATION	VOLTAGE	PRECISION
406 B	20 cps - 200 kc		+/— 1,5 %	—	20 or 2x10 V	3 %
409 A	10 - 300 mcs		>0.1 % min. quartz marker	FM	0.1 V	—
410 A	0 - 250 mcs		>0.1 % min. quartz marker	FM	0.1 V	—
411 A	0 - 320 mcs		>0.1 % min. quartz marker	FM	0.2 V and 0.1 V	—
428 A	100 kcs - 30 mc		>1 % min.	AM	0.1 V constant level	—
476 A	100 kcs - 26 mc		>1 % min. and >2 % min.	FM	0.1 V	—
457 B	5 cps - 50 kc K = A/a : 2-20	a A	2 %	—	10Vz int. 100Vz ext.	+/— 5%
458 A	5 cps - 50 kc (repeat) 0.5µs - 10.000µs	0.05	5 %	—	2 x 50V z int.	+/— 5%

III - SUPPLY - MEGOHMMETERS - SUNDRY UNITS

MODELS	DESCRIPTION AND GENERAL FEATURES
111 C	100' - 400' : 200 mA 108' - 15 mA. Heating 1'.3 - 25 V up to 6 amps.
114 A	100' - 250' : 150 mA 150' - 10 mA. Heating 6.3 V, 3 amps.
674 B	5 Mohm - 100 kMohm in 4 measuring ranges at 280 V. cont. controlled
803 B	Pressure and Vibration Detector for fluids and solids.
804 B	Static and Dynamic Extensometric Units
805 A	Magnetic detection of faults in composition and treatment in large components
806 A	Magnetic detection of faults in composition and treatment in small parts
713 A	Cathodic Oscilloscope with 5 or 6 curves for all industrial investigations

Ribet-Desjardins are, among others, suppliers for :

The French Atomic Energy Authority, National French Center for Scientific Research, the Marcel Dassault Aircraft Works, the Bretigny Flight Test Center, the French National Defence, SNCF (the French Railways), Oerlikon (Switzerland), Transmission Services for the Belgian and Netherlands Armies, the Universities of Liege and Brussels, Polish and Yugoslav Central Purchasing Authorities, Brandt Company, French Public Health (neuro-biologic services for hospitals).

In order to receive technical particulars on the equipment of interest to you please write to

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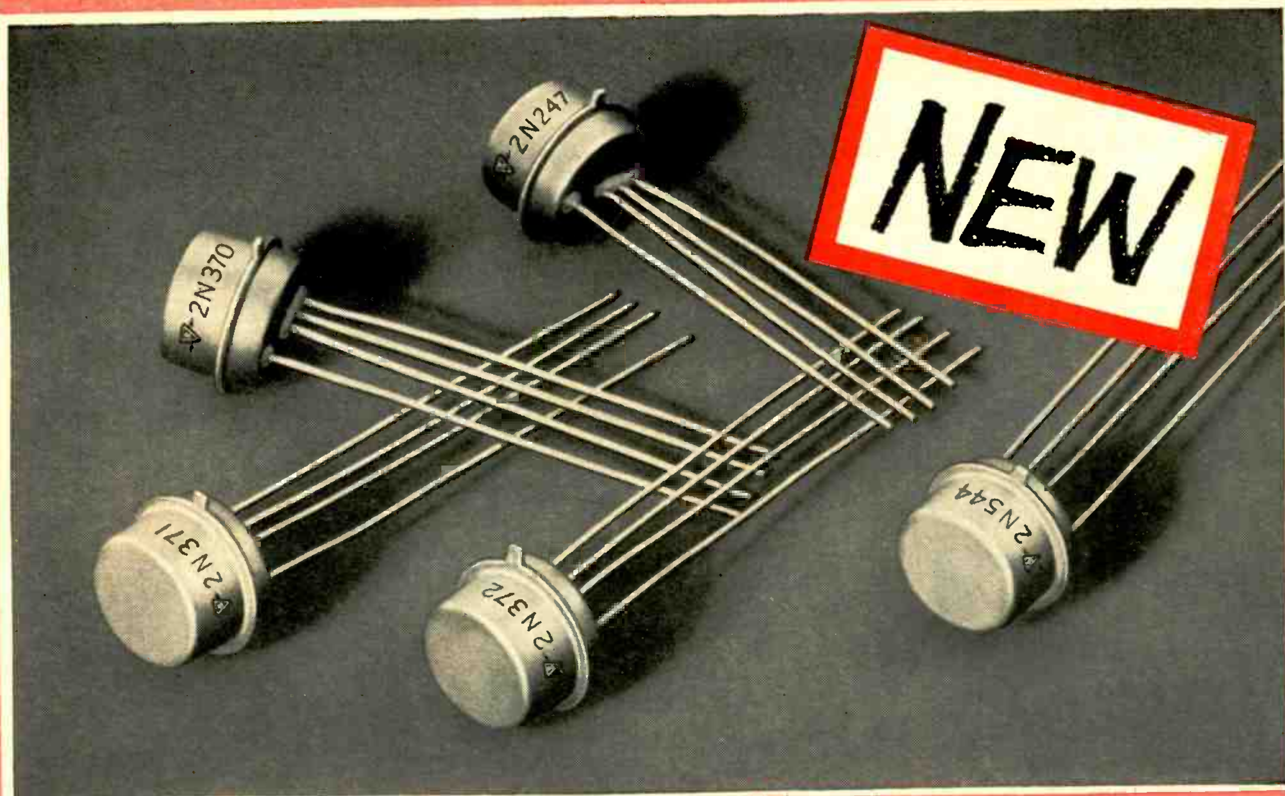


Sylvania RF-IF Transistors

Five new PNP Drift transistors, types 2N247, 2N370, 2N371, 2N372 and 2N544, for radio frequency amplifier service

Sylvania's new PNP Germanium Drift transistors feature high output resistance for increased gain at 1.5 mc to 20 mc, low feedback capacitance and high alpha cutoff frequency.

Designed for RF-IF circuits, they open the door to more transistorized electronic equipment operating from the broadcast band to the higher frequencies.

The new Sylvania drift transistors incorporate a diffused base on an intrinsic germanium layer for improved control over base thickness, more uniform base region, lower base resistance and reduced collector capacitance. The end result is superior performance at higher frequencies.

The new PNP drift transistors feature Sylvania welded hermetic seal construction for maximum protection in rugged environments. They are encased in a modified JETEC class 30 case with four flexible in-line leads. The additional center lead is connected to the metal case providing a complete unit shield and interlead shield. Coupling to adjacent circuit components is reduced to a minimum.

Call your Sylvania Sales Representative or write direct for information on new Sylvania PNP drift transistors, types 2N247, 2N370, 2N371, 2N372 and 2N544.

ELECTRICAL CHARACTERISTICS (25°C)

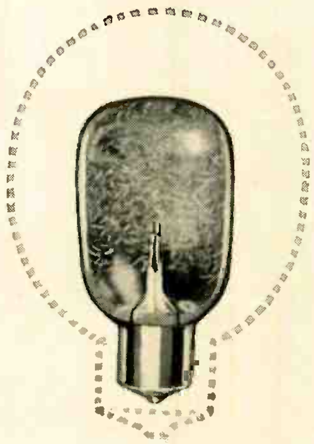
	2N247	2N370	2N371	2N372	2N544	Unit
Power Gain, Pg						db
V_{CE}= -8, I_E=1 ma, Freq.=20.0 mc						
Minimum	24	10	12	10	30.5	
Typical	27	—	—	—	—	
Maximum	31.5 (V_{CE}= -9 Freq.= 1.5 mc)	17	17	17	37.5 (V_{cc}= -9) (Freq.= 1.5 mc) (R_L =750 ohms) (Neutralized)	
Reverse Biased Collector Voltage, V_{CB}						V
V_{EB}= -0.5, I_c=50 ua						
Minimum	-40	-20	-20	-20	-20	
Typical	—	—	—	—	—	
Maximum	—	—	— (I_c =.050 ma)	—	—	
Collector Base Capacitance, Cob						uuf
V_{CB}= -12, I_E =0, Freq. =1.5 mc						
Minimum	—	—	—	—	—	
Typical	1.5	—	—	—	—	
Maximum	2.5 (V_{CB}= -9)	2.5	2.5	2.5	2.5	

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
Shell Tower Bldg., Montreal

LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY

SYLVANIA'S
miniature flashbulbs give greatly increased picture-taking light.



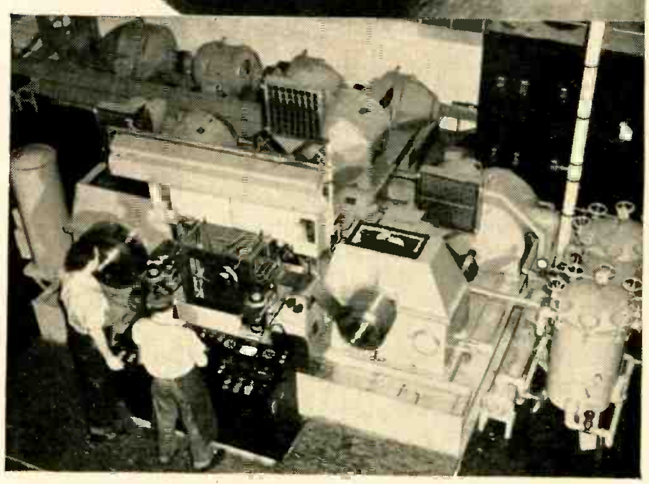
General Plate
ZIRCONIUM FOIL
Boosts Brilliance of Picture Lighting in
SYLVANIA'S
New Miniature Flashbulbs

In developing its new M-25 and M-5 miniature flashbulbs — bulbs that give picture-taking light equivalent to ordinary bulbs four times as large — Sylvania Electric Products Inc. chose General Plate as a dependable source for zirconium foil. And G.P. Zirconium foil plays an important part in the success of the new Sylvania bulbs, because it burns more efficiently than previously used materials, producing an ultra brilliant light burst with less internal pressure.

G.P. Zirconium foil is available in widths up to 8 inches and thicknesses down to 0.00075 inch. G. P. Zirconium sheet, rolled down to 0.014 inch thickness, can be supplied sheared or slit in widths from 14 inches to 0.030 inch.

Sylvania is another of the many hundreds of progressive firms who use General Plate's specially rolled strip and mill products — today you can get flat stock, rod, wire and many profile rolled shapes at General Plate in clad and single metals, including reactive materials such as Zirconium Zircalloy, Hafnium, Tantalum, etc.

For details on G.P. Zirconium write for bulletin IND-16 — to get acquainted with the G.P. Metal product line, write for catalog G.P. 1.



A Sendzimer Mill at General Plate rolls Zirconium foil to 0.00075 inch

METALS & CONTROLS CORPORATION
General Plate Division 1306 Forest Street, Attleboro, Mass.
FIELD OFFICES: NEW YORK • CHICAGO • DETROIT • INDIANAPOLIS • MILWAUKEE • PASADENA

You can profit by using General Plate clad metals

CIRCLE 36 READERS SERVICE CARD

CIRCLE 37 READERS SERVICE CARD →

SILICON RECTIFIERS

designed and manufactured to meet

THE NEW JAN SPECIFICATIONS

For AXIAL LEAD TYPES

JAN 1N538 (MIL-E-1/1084A)	JAN 1N540 (MIL-E-1/1085A)	JAN 1N547 (MIL-E-1/1083A)

now from AUTOMATIC

Maximum Values for AUTOMATIC Military Type Silicon Rectifiers designed to meet the new JAN MIL-E-1 Specification

Type No.	Peak Reverse Voltage (VDC)	DC Output Current @ 25° C. Ambient (MA)	DC Output Current @ 150° C. Ambient (MA)	Maximum Reverse Current* (MA)	Mounting	MIL-E-1 Technical Spec. Sheet No.
JAN 1N538	200	750	250	0.350	Axial lead	1084A
JAN 1N540	400	750	250	0.350	Axial lead	1085A
JAN 1N547	600	750	250	0.350	Axial lead	1083A

*Averaged over 1 cycle for inductive or resistive load with rectifier operating at full rated current at 150° C. ambients.

PRODUCTION QUANTITIES OF ALL TYPES AVAILABLE FOR FAST DELIVERY

Naturally, you can get these new axial lead JAN types direct from AUTOMATIC, and from authorized distributors throughout the country — and at prices that reflect General Instrument's years of volume production experience.

Together with the earlier JAN type stud mount group, AUTOMATIC now covers the entire medium power silicon rectifier field for the requirements of every military application.

More information? A complete set of data sheets is yours for the asking. Please write us today.

GENERAL INSTRUMENT SEMICONDUCTORS

General Instrument Corporation also includes F. W. Sickles Division, Radio Receptor Co., Inc., and Micamold Electronics Manufacturing Corporation (Subsidiaries)

AUTOMATIC MANUFACTURING

MASS PRODUCERS OF ELECTRONIC COMPONENTS

AUTOMATIC MANUFACTURING DIVISION OF GENERAL INSTRUMENT CORPORATION
65 GOUVERNEUR STREET, NEWARK 4, N. J.

Communications keyed to the jet age

At U. S. Air Force bases of operation, Kleinschmidt page printers and reperforator teletypewriters receive and transmit printed messages at speeds up to 100 words per minute.

Instant and precise communications between Air Force bases is a prime requisite in this era of supersonic speeds. To meet this essential need, Kleinschmidt teletypewriters and related equipment, developed in cooperation with the U. S. Army Signal Corps, provide fast transmission and receipt of printed communications. There is no time-lag for interpretation, no chance of misunderstanding, since both sender and recipient have identical printed originals . . . instantly.

Research and development of equipment for transmitting and receiving printed communications has been a continuing project at Kleinschmidt for almost 60 years. This unparalleled store of experience, now joined with that of Smith-Corona Inc, holds promise of immeasurable new advances in electronic communications.

Model 150 Page Teleprinter
Transmits and receives teleprinted messages at pre-set speeds of 60, 66, 75 or 100 words per minute. Uses roll or fanfold paper. "Semi-rev" operation, whereby shafts rotate only a half-revolution, reduces maintenance, prolongs life of unit.

Model 120 Typing Reperforator—Tape Transmitter
This versatile unit receives and transmits messages in perforated tape form and permits reproduction, editing and preparation of tape, as well as manual keyboard transmission.

KLEINSCHMIDT

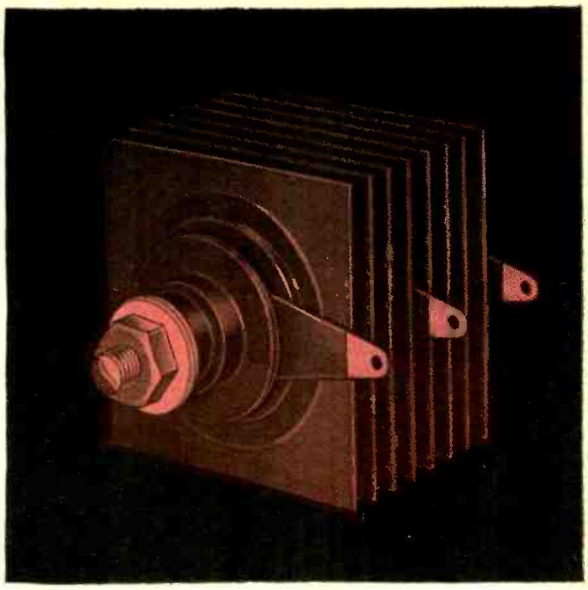
KLEINSCHMIDT LABORATORIES, INC., DEERFIELD, ILLINOIS

Pioneer in teleprinted communications equipment • A subsidiary of Smith-Corona Inc.

CIRCLE 38 READERS SERVICE CARD

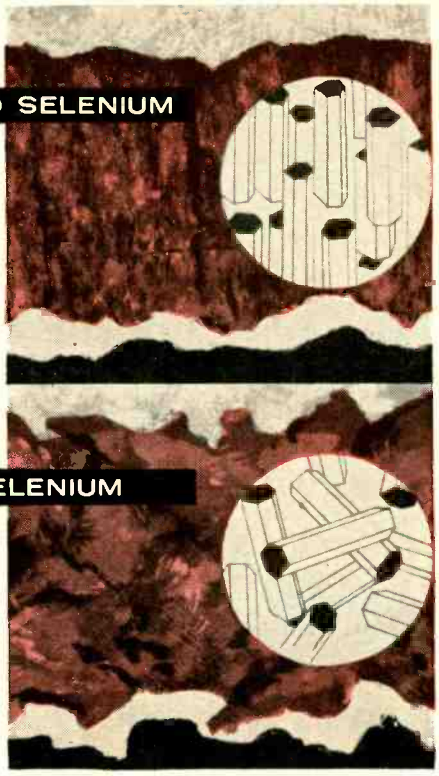
VICKERS®

Grain-Oriented (T.M.) RECTIFIERS



GRAIN-ORIENTED SELENIUM

ORDINARY SELENIUM



a new type of selenium for . . .

Higher Current Ratings
without overloading

Lower Cost per Watt Output

These new rectifiers by Vickers represent a major "break-through" in selenium rectifier development. Using special equipment and quality control processes, Vickers engineers have developed a polycrystalline selenium layer with grains oriented, rather than the random pattern found in conventional selenium layers.

The result: more *working* crystals, greater uniformity and better rectifying performance per square inch of cell area.

This improved rectifier provides increase in current ratings without increase in cell size, gives more watts of output per dollar invested. You save both on initial cost and operating cost with the new Vickers Grain-Oriented selenium rectifiers— available in cell ratings of 18 to 36 volts.

New 48-page Bulletin 3116-1 gives complete information on new Vickers Grain-Oriented selenium rectifiers. Includes construction details, charts, photographs, performance characteristics, dimensions, suggested applications and other helpful data. Please send your request on letterhead.

EPA 3110-1

ELECTRIC PRODUCTS DIVISION VICKERS

VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION

ELECTRIC PRODUCTS DIVISION

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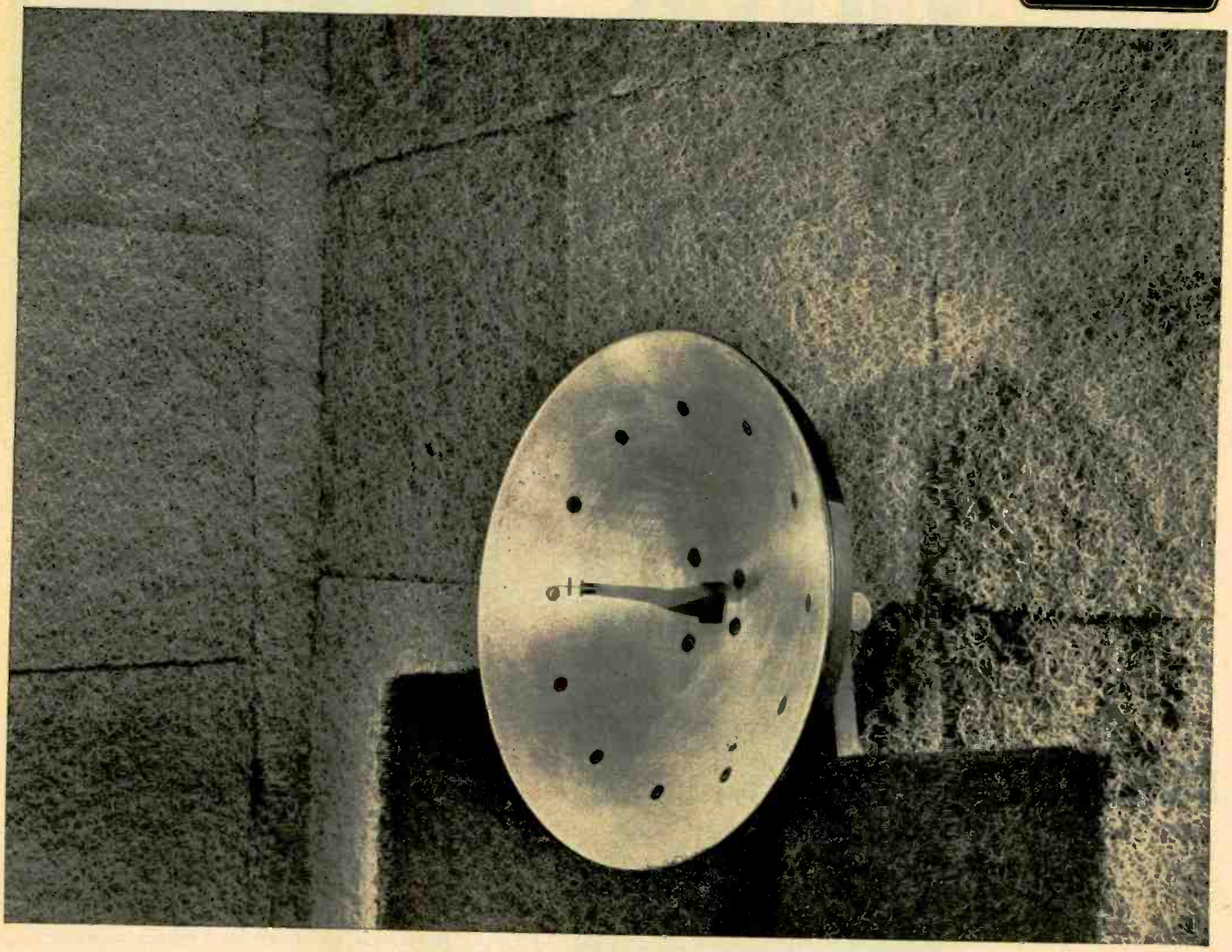
B.F.Goodrich



Best long range investment for indoor antenna testing and free space chambers

Manufactured to Military Specifications ... B. F. Goodrich Microwave Absorbents provide the most accurate reflection-free rooms for the measurement of microwave antenna patterns. As a result of thorough quality control and factory testing, B. F. Goodrich Microwave Absorbents consistently duplicate free space conditions indoors better than any other product.

In addition to outstanding electrical qualities, our absorber is light-weight, fire-retardant, easy to install. It will not deteriorate in performance when walked upon and has excellent water and weather resistant properties.

The material is currently being produced in a number of thicknesses providing broadband operation as low as 50 megacycles. Material can be furnished having less than 0.1% reflection at specific frequencies. For darkroom use, a special white compound can be applied to the surface of the pads to increase light reflectance.

When you're investing thousands, start right—specify B. F. Goodrich—the company with the *longest* experience and record for *consistently* high quality microwave material.

For new booklet on these absorbers write The B. F. Goodrich Company, 486 Derby Place, Shelton, Connecticut.

List of B. F. Goodrich Broadband Absorbers

Designation	Lowest Frequency*	Thickness	Maximum Reflection
12 CM	2500 mc	1½"-2"	2%
12 CM — 1%	2500 mc	1½"-2"	1%
12 CM — 30db	2500 mc	1½"-2"	0.1% at X-band. 2% elsewhere.
6 CM	5000 mc	1"	2%
30 CM	1000 mc	3½"-4"	2%
30 CM — 1%	1000 mc	3½"-4"	1%
60 CM	500 mc	7"-8"	2%
60 CM — 1%	500 mc	7"-8"	1%
100 CM	300 mc	10"-11"	2%
200 CM	150 mc	26"	2%
600 CM	50 mc	69"	2%
8 CM—glass fiber	3600 mc	1"-1½"	2%
4 CM—glass fiber	7500 mc	¾"	2%

Most of the above absorbers can be furnished with 0.1% maximum reflection at selected points in the frequency band.

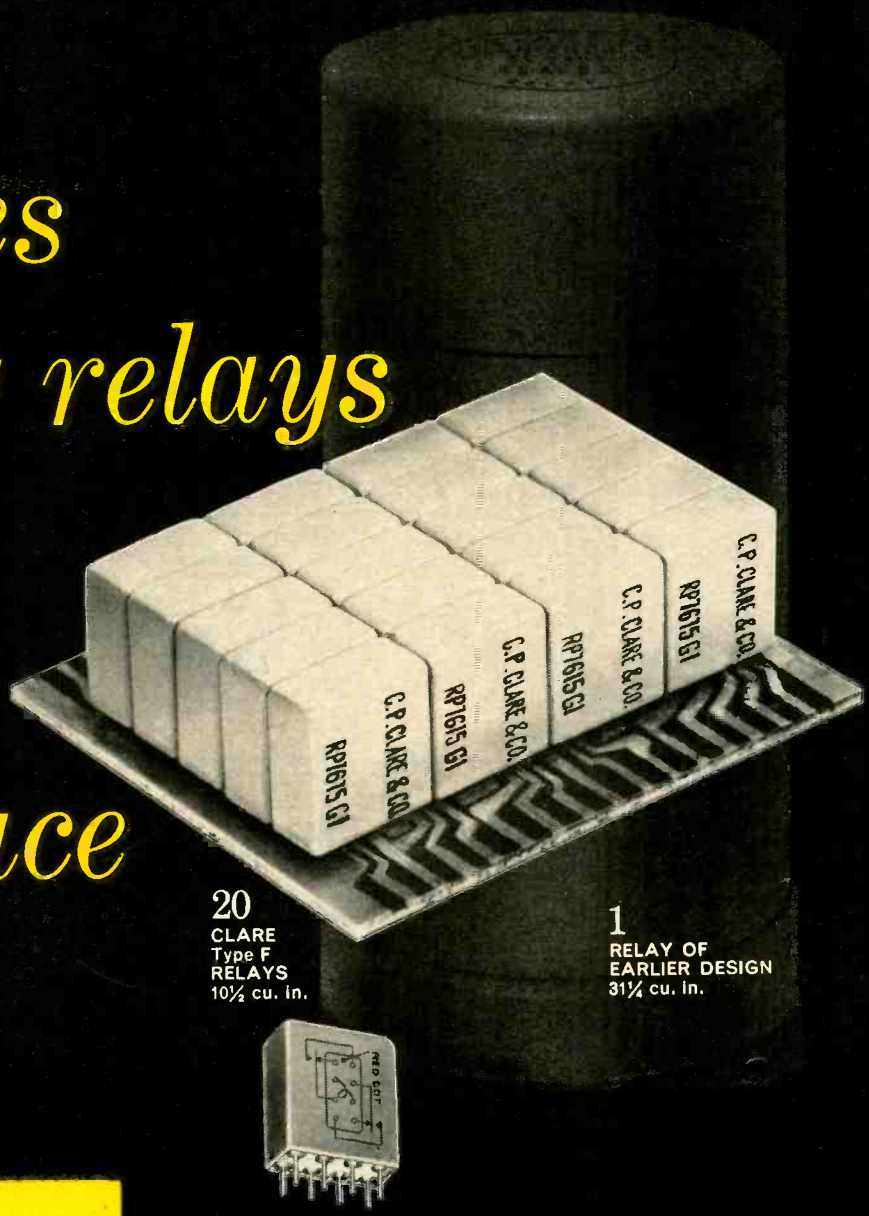
*All perform up to 30,000 mc

B.F.Goodrich
microwave absorbents

CIRCLE 40 READERS SERVICE CARD

CIRCLE 41 READERS SERVICE CARD→

20 times as many relays in 1/3 the space



CLARE Type F RELAY

SPECIFICATIONS:

Ambient Temperature	—65° C to +125° C.
Shock	50 Gs for 11 milliseconds.
Vibration	5-75 cps at maximum excursion of ¼-inch, 75-2000 cps at 20 Gs acceleration.
Dielectric Strength	Sea level—1000 volts rms between terminals and frame, and between adjacent circuits; 750 volts rms between contacts of a set. At 80,000 ft., 350 volts rms.
Insulation Resistance	1000 megohms minimum at 125° C.
Coils	Coils up to 10,000 ohms available for a wide range of voltages or currents.
Nominal Operating Power	250 milliwatts.
Pickup Time	3.5 milliseconds nominal.
Dropout Time	1.5 milliseconds nominal.
Contact Arrangement	2 pdt (2 form C).
Contact Rating	3 amps resistive at 28 volts d-c or 115 volts a-c; also for low-level applications.
Contact Resistance	0.050 ohm maximum.
Contact Life	500,000 operations minimum at 2 amps; 100,000 operations minimum at 3 amps.
Enclosure	Hermetically sealed, filled with dry nitrogen at 1 atmosphere pressure.
Mounting	All popular mounting arrangements available.
Terminals	Printed circuit; solder; plug-in (matching socket available). Variations of printed-circuit terminal length on 1/10-inch grid spacing available.
Weight	17 grams.
Military Specifications	MIL-R-25018; MIL-R-5757C, except as to contact overload.

These twenty Clare Type F Modular Relays, mounted on a printed-circuit board, take less than a third of the space occupied by a hermetically sealed relay of earlier design—a relay in wide use a few short years ago.

Clare Type F Modular Relays can be mounted in a closely restricted space—wherever the user desires—on a board punched at 2/10 inch intervals in a grid pattern.

This new hermetically sealed relay—no bigger than a postage stamp—is fast and more than moderately sensitive, yet stalwart enough to withstand extremes of temperature, heavy shock, and severe vibration.

Send for Bulletin 124 today. Write: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field

FOR SALE

This is the Magnet Wire with the extras.....

SX ®

21 different basic insulations

84 different insulation constructions

100,000+ different types and sizes

(in round, square and rectangular fabric and film coated magnet wires)

Add them up! EXTRA care in drawing and annealing—EXTRA care in insulating techniques! EXTRA rigorous "in-process" testing of wire from every machine each day plus 100% final inspection! EXTRA quick identification of size and type on easy-to-read, color coded labels ... and EXTRA attention to packaging (spool, reel, and Magna-Pak®) at each of the four plants.

MAGNET WIRE DIVISION, Essex Wire Corp., Fort Wayne 6, Indiana

Manufacturing Plants: Birmingham, Alabama; Anaheim, California; Fort Wayne, Indiana; Hillsdale, Michigan

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NATIONAL NETWORK OF WAREHOUSES AND SALES OFFICES ... CALL YOUR LOCAL "ESSEX MAN"

CIRCLE 42 READERS SERVICE CARD

CIRCLE 43 READERS SERVICE CARD →

Engineers: Tear out for your notebook

NEW MICROWAVE ANALYZERS 10 to 44,000 mc

SAVE ENGINEERING MANHOURS

A complete line of spectrum analyzers with full frequency coverage — up to Q Band

POLARAD PROVEN RELIABILITY

Model TSA

TO TEST:

MISSILES
RADARS
MICROWAVE COMPONENTS
TELEMETERING
MULTI-PULSE TRANSMISSIONS

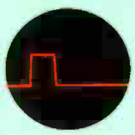
FEATURES:

- Direct reading, UNI-DIAL control
- High accuracy, resolution and sensitivity
- Stable and accurate frequency marker
- Five interchangeable plug-in units

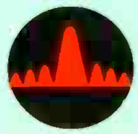
NEW APPLICATIONS

TSA-S COMBINATION SYNCHROSCOPE SPECTRUM ANALYZER

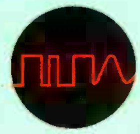
Model TSA-S



Pulsed signal as seen in synchroscope operation.



Spectrum of same pulsed signal displayed in spectrum analyzer operation.



Time display of complex video signal

MEASUREMENT OF PULSE MODULATION IN FREQUENCY AND TIME

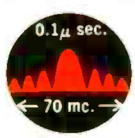
This single instrument (Model TSA-S) Synchroscope-Spectrum Analyzer provides a direct method of observing a pulsed signal and its frequency spectrum. As a sensitive synchroscope receiver, it displays a wide range of pulse widths and repetition rates. As a spectrum analyzer, it shows complete frequency spectrum. Selector switch determines function instantly.

ANALYSIS OF COMPLEX SIGNALS

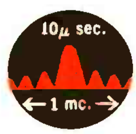
Displays the envelope of complex pulsed signals, such as used in radar systems and some telemetry applications.

TSA-W VERY WIDE DISPERSION SPECTRUM ANALYZER

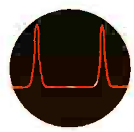
Model TSA-W



0.1 microsecond pulse using 70 mc dispersion.



10 microsecond pulse using 1 mc dispersion.



Two cw signals 60 mc apart using 70 mc dispersion.

NARROW PULSE ANALYSIS

Model TSA-W, by virtue of its wide frequency dispersion (up to 70 mc), will display the spectrum of very narrow pulses.

WIDE PULSE ANALYSIS

By changing selector switch to a narrower bandwidth, spectra of wide pulses can be displayed accurately on the TSA-W because of its high resolution (7 kc narrow bandwidth, 50 kc wide bandwidth).

SIGNAL COMPARISON

Two or more signals may be compared against a standard or each other as to frequency spacing. Wide dispersion provides simultaneous observation of signals separated by large frequency differences.

Additional applications for spectrum analyzers are available on request. Write for free handbook on spectrum analyzer techniques.

Interchangeable Plug-in Tuning Units

Tuning Unit	Frequency Range
STU-1	10 — 1,000 mc
STU-2	910 — 4,560 mc
STU-3	4,370 — 22,000 mc
STU-4	21,000 — 33,000 mc
STU-5	33,000 — 44,000 mc

POLARAD ELECTRONICS CORPORATION

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Representatives in principal cities. See your Yellow Pages.

FREE LIFETIME SERVICE ON ALL POLARAD INSTRUMENTS

Engineers: Tear out for your notebook

MULTI-BAND MICROWAVE RECEIVER

400-46,700 mc

A sensitive microwave receiver is a basic tool in microwave testing operations. A few of the many and diverse applications of this versatile instrument are illustrated below, using a Polarad Model R Receiver, 400 to 46,700 mc. Operation is simplified by UNI-DIAL control and direct reading frequency dial.

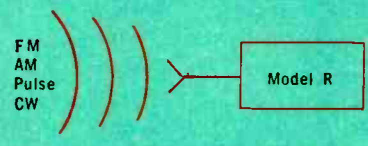
Frequency Range

Tuning Unit Model RR-T	400 — 1,000 mc
Tuning Unit Model RL-T	950 — 2,040 mc
Tuning Unit Model RS-T	1,900 — 4,340 mc
Tuning Unit Model RM-T	4,200 — 7,740 mc
Tuning Unit Model RX-T	7,300 — 11,260 mc
Tuning Unit Model RKS-T	9,500 — 15,600 mc
Tuning Unit Model RKU-T	14,700 — 22,000 mc
Tuning Unit Model RQ-T	20,300 — 46,700 mc

POLARAD
PROVEN RELIABILITY

Model R

RECEPTION of MICROWAVE ENERGY



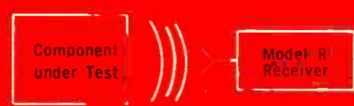
A multi-purpose broadband microwave receiver is indispensable for quantitative analysis of microwave signals and monitoring of all types of radio and radar communications. With a test antenna connected to the r-f input, power and frequency comparisons of virtually any type of signal encountered in microwave work (AM, FM, cw and pulse) may be read directly on the front panel meter. Trigger output reproduces pulse width and repetition rate, at the same time eliminating noise that may be present.

SOME TYPICAL APPLICATIONS:

ANTENNA PATTERN MEASUREMENTS

Connect a synchronized antenna drive and pattern recorder (Polarad Models AD-1 and PR-1 or equivalent) into microwave system as shown in block diagram. As receiver antenna is rotated, pattern variations may be observed directly in db, or as a proportional voltage function on the receiver meter, and are recorded on the moving chart of the recorder. Besides permitting complete investigation of minor lobes the high sensitivity of the Model R receiver allows ample separation of transmission and receiver antennas to avoid phase errors, without high powered source. Tuned, narrow band preselector eliminates spurious and interfering signals which might cause error. Dynamic range permits establishing nulls as much as 60 db down from energy in the direction of maximum directivity.

LEAKAGE and INTERFERENCE MEASUREMENTS

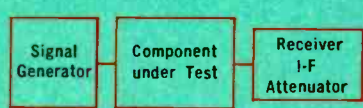


Use a dipole or horn antenna, connected to receiver input, to search around connectors, screw joints or any other suspected source of leakage. Any r-f energy present is indicated on the front panel meter. By calibrating the microwave receiver, absolute leakage level may be accurately determined. The Polarad Model R receiver is ideally suited to leakage detection because of its extremely high sensitivity, its broad frequency coverage and its use of a preselector below 11,000 mc to eliminate spurious responses.

MEASUREMENT of RELATIVE POWER of HARMONICS

With the receiver tuned to the harmonic in question, set an arbitrary gain level on the meter. Then, normalize the receiver gain with the receiver tuned to the fundamental and repeat the measurement. Subtract the db power level of the harmonic from the db level of the fundamental to determine the relative power level between the signals. Important receiver requirements for this measurement are broadband coverage and wide dynamic range as featured in Polarad Model R.

CALIBRATION of COMPONENT ATTENUATION



With the component under test placed between the signal source and the receiver, set an arbitrary gain level on the receiver meter. Then remove the component and connect the source directly to the receiver. Increase the attenuation of the calibrated i-f attenuator on the front panel of the receiver until the same reference meter reading is reached. Attenuation of the component under test is then equal to the amount by which the i-f attenuator was increased.

OTHER APPLICATIONS:

- Measurement of bandwidth of microwave cavities
- Frequency meter
- Field intensity meter
- Pulse, pulse time or pulse position demodulator
- Sensitive microwave power meter
- General communications

Complete specifications and prices on request.

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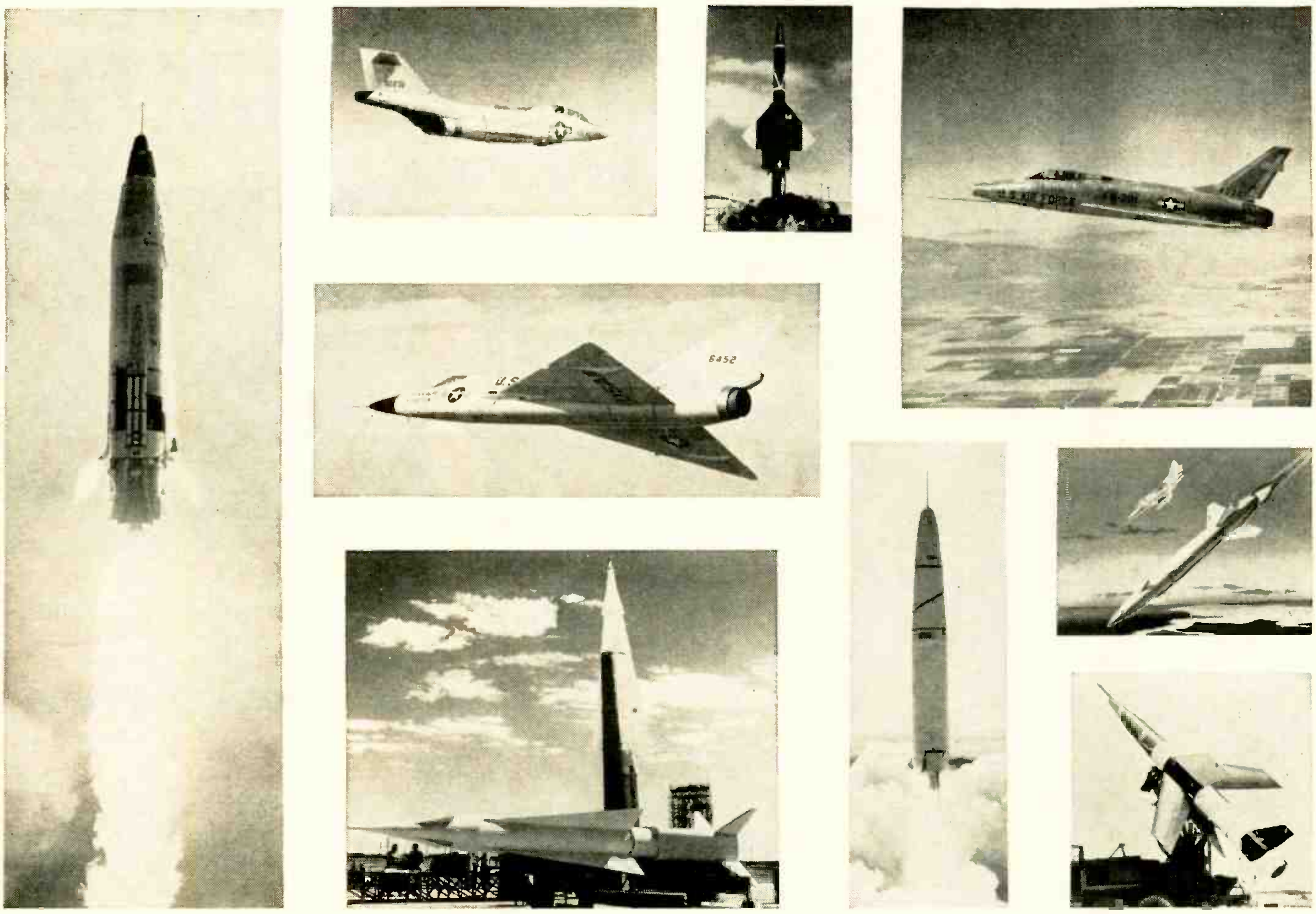

What do these latest aircraft and missiles have in common?

All are equipped with Genisco flight control or instrumentation accelerometers. What better proof of reliability?

With component reliability getting increased attention from missile and aircraft designers, it is significant to note the number of supersonic weapon systems equipped with Genisco accelerometers.

A complete list reads like a roll call of tactical and strategic missiles and aircraft now in the nation's arsenal. Included are such weapons as the *Atlas, Thor, Nike Ajax, Nike Hercules, Bomarc, LaCrosse, Bull Pup, Talos, Dart, Matador, Corporal* and *Terrior* missiles; and the F100D *Super Sabre,* F101 *Voodoo,* F106A, and Canada's CF105 aircraft. What better proof of the reliability of Genisco instruments than this acceptance by designers of these weapons?

Combining product reliability with guaranteed delivery schedules and competitive pricing has made Genisco the free world's largest producer of potentiometer-type flight and fire control accelerometers. More than 40,000 have been delivered to date.

Send for technical data sheets on all Genisco Accelerometers.

MODEL GLH

MODEL DDL

MODEL GMO

MODEL GAH

Genisco INCORPORATED

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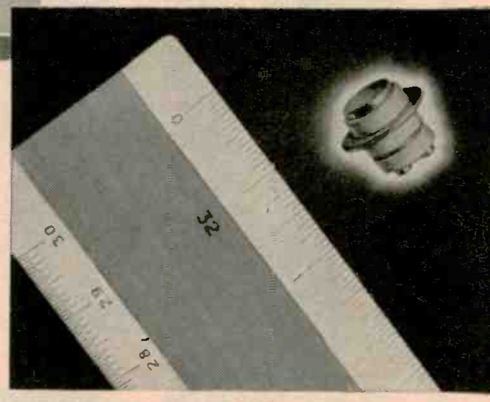
NEW G-E MILITARY

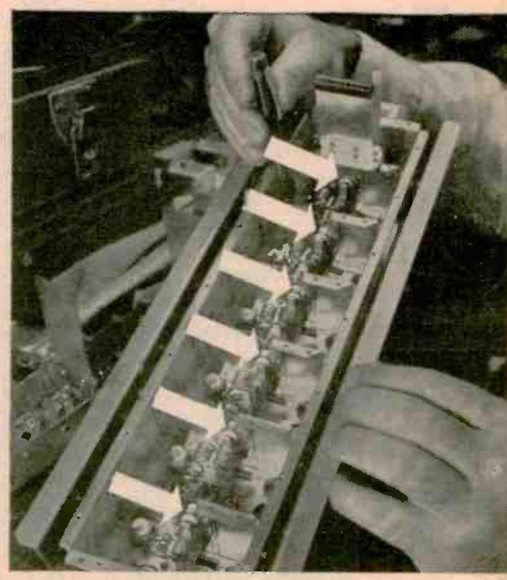


SHOWN ACTUAL SIZE. The 7077 is so small (only .44" long and .48" wide) that the tube can be used in compact circuitry or miniaturized equipment.

◀ Advanced UHF systems had critical need for this tube in radar, communications, navigation. General Electric designed and built it.

CERAMIC TUBES MEAN GENERAL ELECTRIC! A G-E technician is weighing the ceramic spacers of the 7077 triode before firing, to check their density—one of a whole series of special methods developed by General Electric to make practical the use . . . in tubes . . . of tough, heat-resistant ceramics.

CATHODE ASSEMBLY BY MICROSCOPE! The G-E production worker above is welding the nickel cap on a tantalum cathode sleeve only 1/10 inch in diameter. Note the white Dacron lint-free dress and rubber finger cots! These help protect 7077's from dust and lint—the most common causes of short-circuits.



ONLY ITS COUNTERPARTS CAN NOISE-TEST A 7077! Evidence of Type 7077's low-noise, high-gain performance, is the use of five more of these General Electric triodes in a specially-developed multi-stage test amplifier that provides 90 db total gain. *Every 7077 built* receives this noise test!

CIRCLE 46 READERS SERVICE CARD

7077 TRIODE TOPS ALL TUBES IN UHF-AMPLIFIER ADVANTAGES!

- High gain: 14.5 db
- Low noise: 5.5 db
- Low capacitance
- Low inductance
- Low power input
- Light weight
- Small size
- Ceramic ruggedness

This low-price tube is in regular production *now*. Compare the 7077 with other tubes A and B, which you can obtain for efficient high-gain, low-noise amplifier service at 450 megacycles! (See chart at right)

	7077	Tube "A"	Tube "B"
PRICE	$$	$$$$$	$$$$$$
RELATIVE SIZE			
WEIGHT	1.6 grams	4.5 grams	23 grams
POWER INPUT	2.5 watts	4.2 watts	13.4 watts

No tube like this existed. The industry asked for a UHF amplifier tube for new and critical military applications in radar, communication, and navigation systems. General Electric creative design took it from there. Working with a list of "musts"—such as small size, light weight, top performance, and initial and operating economy—General Electric tube engineers developed new materials and processes that made possible new design approaches.

Now the 7077 is ready—electrically, mechanically and life-tested—coming from a factory in volume production. It meets full design specifications for performance. The 7077 is built for rugged operation up to 100,000 feet altitude, and up to 300 C envelope temperature. No forced-air cooling is required.

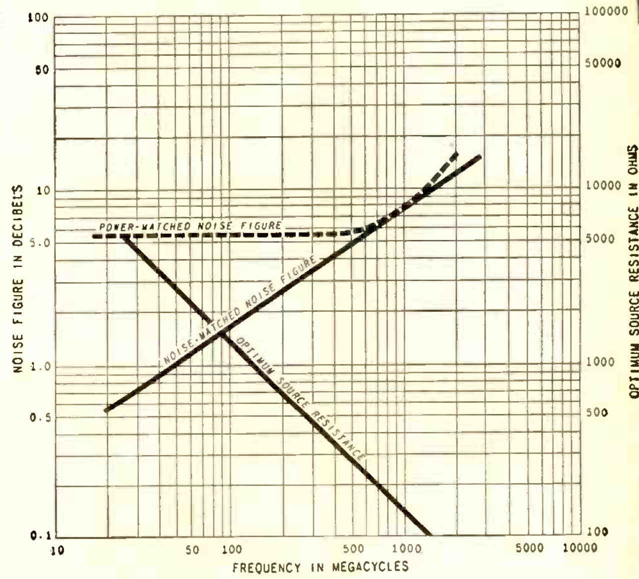
Phone your nearest General Electric Receiving Tube Department office listed below for further information about this newest, smallest, best-performing UHF triode... including the low price.

EASTERN REGION	CENTRAL REGION	WESTERN REGION
200 Main Ave., Clifton, N.J. Phones: (Clifton) GRegory 3-6387 (N.Y.C.) WI. 7-4065, 6, 7, 8	3800 N. Milwaukee Ave. Chicago 41, Illinois Phone: SPring 7-1600	11840 W. Olympic Blvd. Los Angeles 64, Cal. Phones: GRanite 9-7765 BRadshaw 2-8566

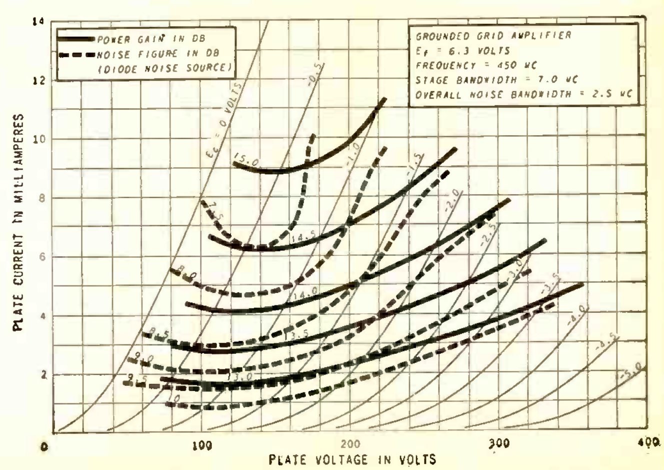
Progress Is Our Most Important Product

GENERAL ELECTRIC

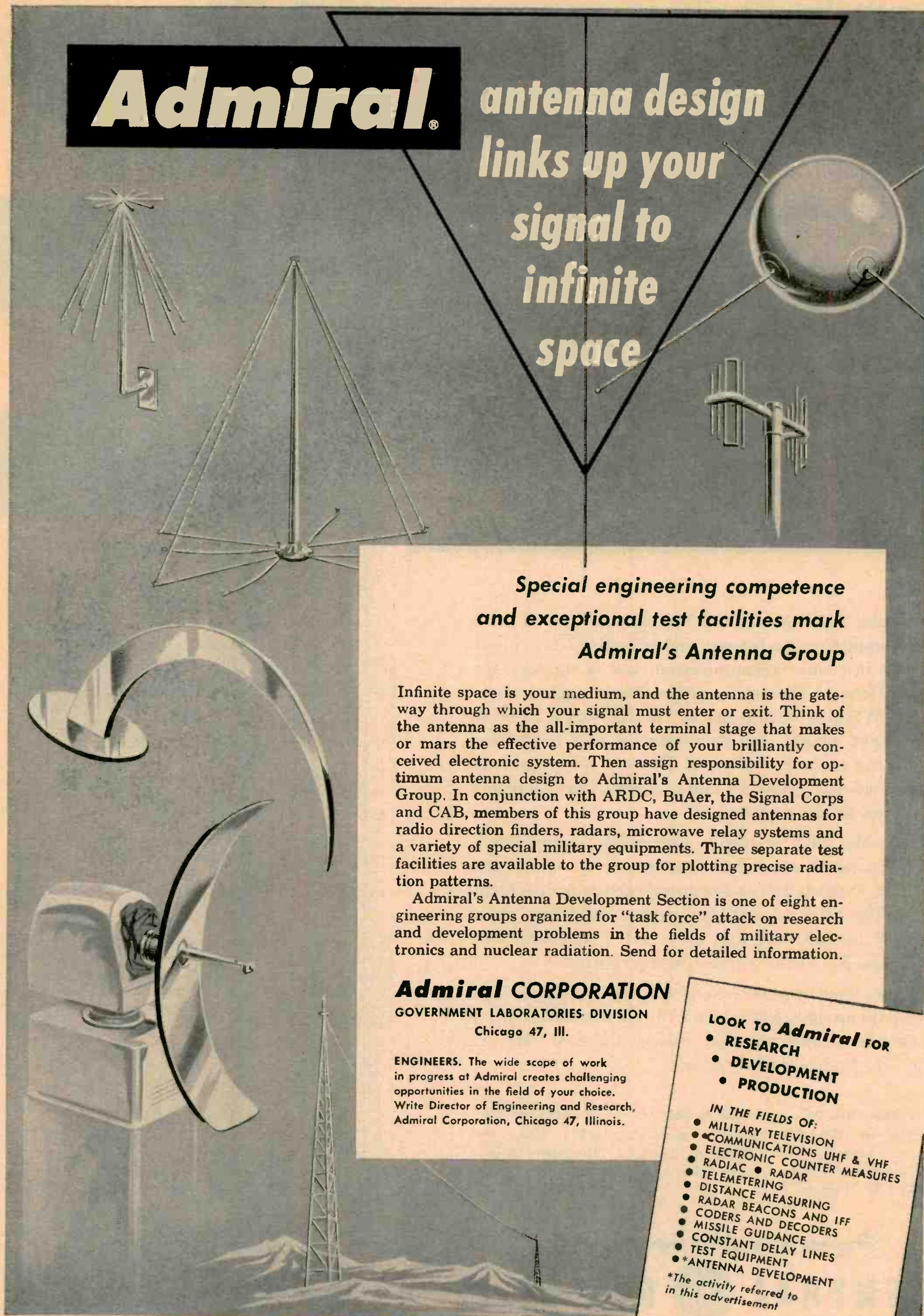
12-11-203



Wide range of 7077 performance, 30 to 1,000 mc, is shown by the noise figures above, under power-matched and noise-matched conditions, using an argon noise source. Noise contours are similar to those below with a diode noise source. Contours below plot noise figure and gain for 450 megacycles at various tube operating points.



CIRCLE 47 READERS SERVICE CARD



Special engineering competence and exceptional test facilities mark Admiral's Antenna Group

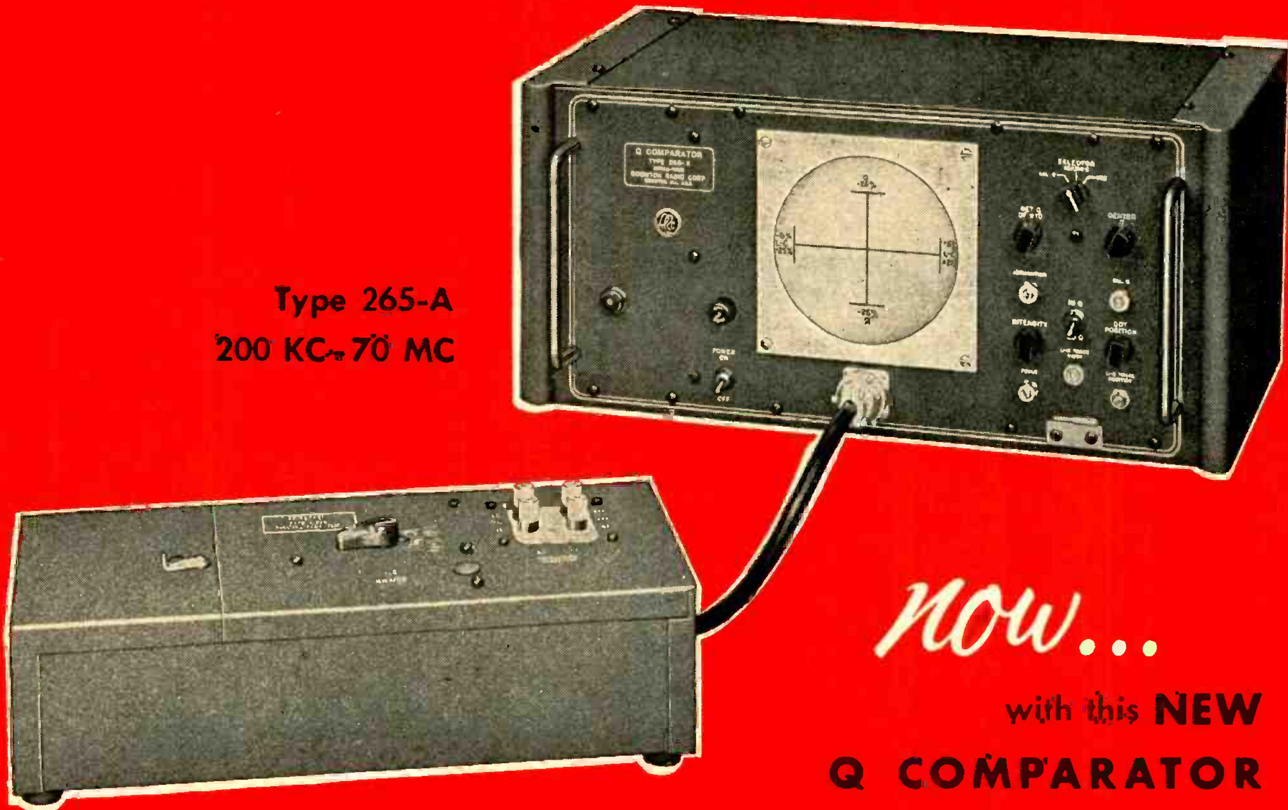
Infinite space is your medium, and the antenna is the gateway through which your signal must enter or exit. Think of the antenna as the all-important terminal stage that makes or mars the effective performance of your brilliantly conceived electronic system. Then assign responsibility for optimum antenna design to Admiral's Antenna Development Group. In conjunction with ARDC, BuAer, the Signal Corps and CAB, members of this group have designed antennas for radio direction finders, radars, microwave relay systems and a variety of special military equipments. Three separate test facilities are available to the group for plotting precise radiation patterns.

Admiral's Antenna Development Section is one of eight engineering groups organized for "task force" attack on research and development problems in the fields of military electronics and nuclear radiation. Send for detailed information.

Admiral CORPORATION
GOVERNMENT LABORATORIES DIVISION
Chicago 47, Ill.

ENGINEERS. The wide scope of work in progress at Admiral creates challenging opportunities in the field of your choice. Write Director of Engineering and Research, Admiral Corporation, Chicago 47, Illinois.

Type 265-A
200 KC-70 MC



now...
with this **NEW**
Q COMPARATOR

INSTANT PRODUCTION TESTING
of Coils, Capacitors, and Resistors!

SPECIFICATIONS

OSCILLATOR FREQUENCY RANGE: 200 Kc. to 70 Mc. in 11 ranges, using 6 plug-in inductors.

INDICATING SYSTEM: Large 5" cathode ray tube, calibrated in % Q on the vertical axis and % L-C on the horizontal axis.

TOLERANCE LIMITS: ±25% Q, calibrated in increments of 5%; ±5% and ±20% L-C, calibrated in increments of ±1% and ±5% respectively.

Q RANGE: 50 to 500

INDUCTANCE RANGE: 1 Microhenry to 10 Millihenries.

CAPACITANCE RANGE: 2 MMF. to 1000 MMF.

RESISTANCE RANGE: 1000 to 500,000 Ohms.

POWER SUPPLY: 105-125 Volts, 50-60 Cycles.

PRICE: $750.00 F.O.B. Boonton, N. J.

▶ **SAVES VALUABLE INSPECTION TIME**
Gives you instantaneous readout

▶ **EXTREMELY SIMPLE TO USE**
No operator training required

▶ **NO TUNING OR ADJUSTMENT NECESSARY**
Gives simultaneous indication of both Q and L-C

▶ **ELIMINATES OPERATOR MEASUREMENT ERROR**
Single readout on large CRT screen

Write for complete information

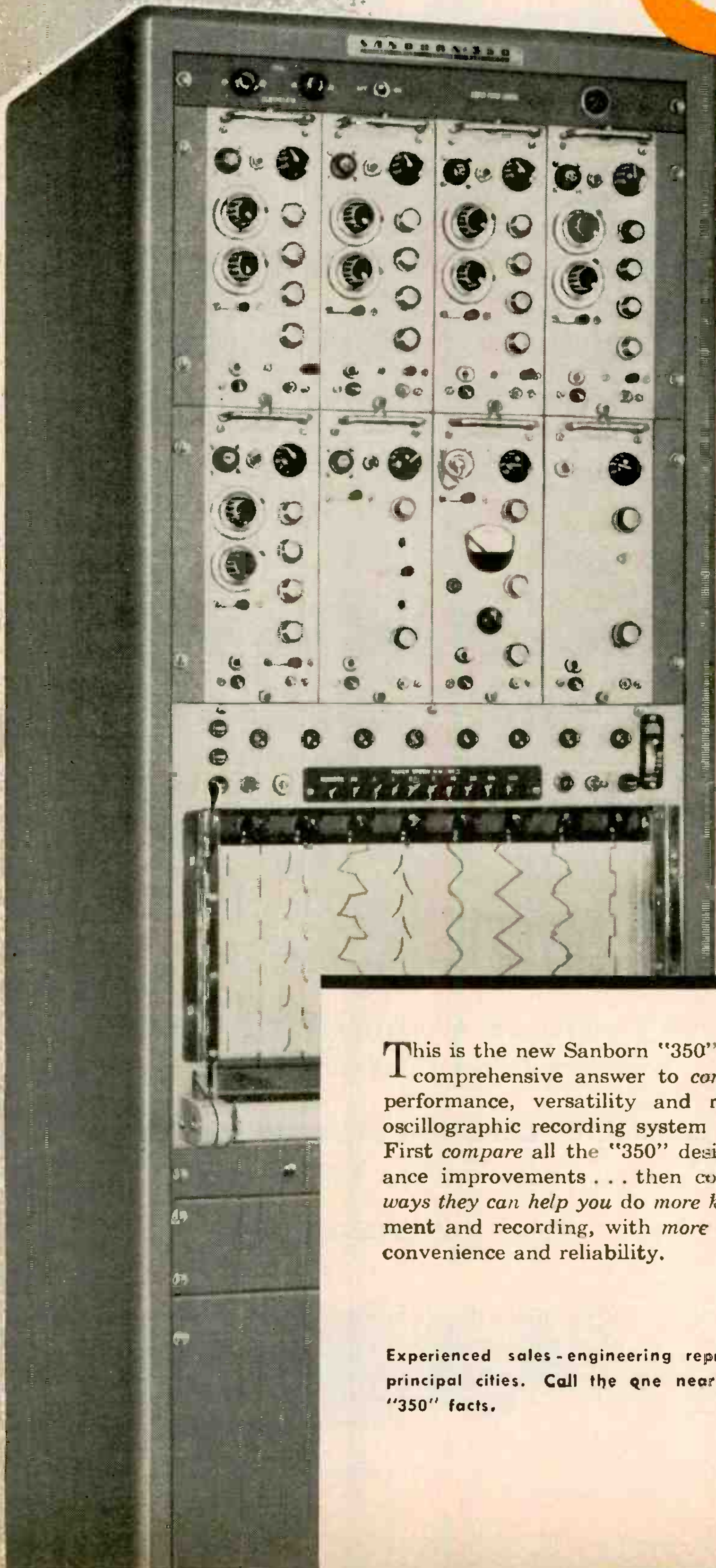
BOONTON RADIO CORPORATION
Boonton, New Jersey

CIRCLE 49 READERS SERVICE CARD

CIRCLE 50 READERS SERVICE CARD →

only one direct writer

...THE NEW SANBORN 350



6- OR 8-CHANNEL OSCILLOGRAPHIC RECORDING SYSTEM

6- OR 8-CHANNEL SYSTEM IN ONE CABINET

Each module of four Preamplifiers takes only 10½" of panel space, complete Recorder-Power Amplifier package only 17½". All controls are on front panel. Total panel space, including ventilating fan and master power panel, 49". Entire system normally installed in one cabinet 22" x 22" x 73¾", to place recorder and controls at convenient height.

FREQUENCY RESPONSE TO 120 CPS

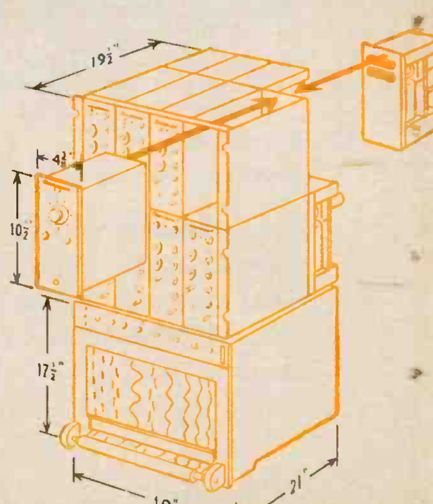
Essentially flat from 0 to 100 cps at 10-division amplitude peak-to-peak, 3 db down at 120 cycles. Built-in pre-emphasis circuit in Power Amplifier.

HEAVY CURRENT FEEDBACK, TRANSISTORIZED POWER AMPLIFIERS

Long term drift less than 0.2 div. over 20°C. changes, short term less than 0.1 div. for 24 volt line voltage changes. Response time 4 ms. In-phase rejection ratio 100:1. Gain stability better than 1% with 20°C. and 20 volt changes.

LINEARITY: 0.2 DIVISION OVER ENTIRE 50 DIV. CHART WIDTH

This is the new Sanborn "350" — today's most comprehensive answer to *combined* improved performance, versatility and reliability in an oscillographic recording system of compact size. First *compare* all the "350" design and performance improvements . . . then consider *the many ways they can help you* do *more kinds* of measurement and recording, with *more* accuracy, speed, convenience and reliability.



Experienced sales-engineering representatives in all principal cities. Call the one near you for complete "350" facts.

gives you all these features

INTERCHANGEABLE PREAMPLIFIERS WITH INDIVIDUAL POWER SUPPLIES

Compact, plug-in units with 4³⁄₁₆" x 10½" panels. Present types include Carrier, Servo Monitor (demodulator), DC Coupling, True Differential DC. Can be used separately for driving optical oscillographs, 'scopes, tape recorders, etc.

LIMITER CIRCUIT AHEAD OF POWER AMPLIFIERS ASSURES DAMPING AT ALL TIMES

Limiting at input prevents amplifier saturation or cut off; so that galvanometer damping is never lost.

RUGGED, RELIABLE, LOW VOLTAGE, LOW IMPEDANCE GALVANOMETERS

Fewer turns of heavier wire and completely enclosed coil increase reliability. High torque (250,000 dyne-cm.). Hysteresis level less than 0.1 division. Designed for easy replacement in field.

RECORDER-POWER AMPLIFIER PACKAGE IN ONLY 17½" OF PANEL SPACE

Integral, tube-free package includes eight power amplifiers and power supply, which use power transistors and solid state rectifiers. Operates on 115 volts, 60 cycles. Simple paper loading from front. Individual stylus heat controls, chart speed pushbuttons, motor switch, timer-marker switch, fuses, paper footage indicator all on front panel. Connectors for input signals, output monitoring (± 1 volt with respect to ground from 2.5 ohm source) and complete remote control provided at rear.

VELOCITY FEEDBACK DAMPING

True damping by velocity signal from separate winding over galvanometer driving coil. Damping control accessible from front of Recorder for easy adjustment.

(ALL DATA SUBJECT TO CHANGE WITHOUT NOTICE)

GALVANOMETER NATURAL FREQUENCY 55 CPS

Higher natural frequency provides higher over-all system frequency response.

INKLESS RECORDINGS IN TRUE RECTANGULAR COORDINATES

Heated stylus creates sharp, smudge-proof trace on plastic coated Permapaper. Chart channel width 1⁹⁄₁₆" (approx. 4 cm), ruled in 50 div. of ¹⁄₃₂" each.

RECORDER-AMPLIFIER UNIT HAS 0.1 VOLT/CHART DIV. SENSITIVITY

Can be used alone, when preamplification is not needed. (Three complete 8-channel Recorder-amplifier-power supply units can be mounted in one cabinet.)

ELECTRICAL PUSHBUTTON CHART SPEED CONTROL, WITH PROVISION FOR REMOTE CONTROL

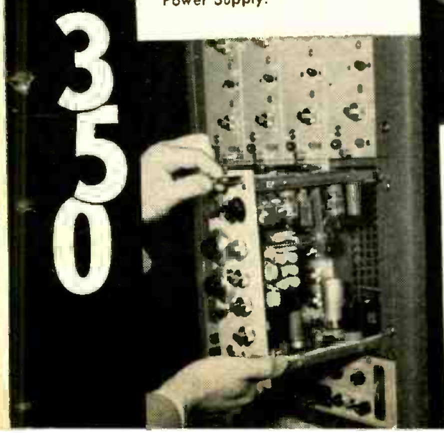
Any of nine speeds (0.25, 0.5, 1.0, 2.5, 5, 10, 25, 50, 100 mm/sec.) instantly selectable by pushbutton. Plastic strip for channel identification markings.

QUALITY COMPONENTS USED THROUGHOUT

JAN components used wherever practicable; for example, note in the photos hermetically sealed MIL-T-27 power transformers, MIL-approved electrolytic condensers in all power supplies, ruggedized premium-type tubes in Preamp power supplies, etc.

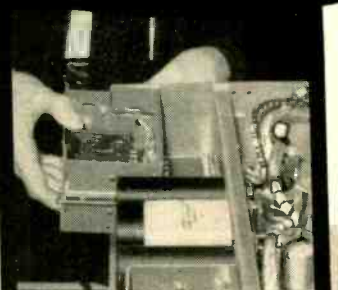
SANBORN COMPANY
INDUSTRIAL DIVISION
175 WYMAN STREET, WALTHAM 54, MASS.

Any "350" Preamplifier installs easily in any channel. Electrical connections made by mating connectors on Preamp and Power Supply.



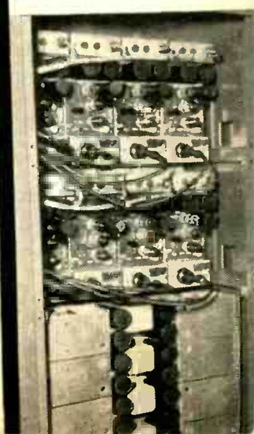
Quick, simple paper loading is done from front; hinged viewing window is removable. About 8" of record visible. All controls on front panel.

Any of nine chart speeds can be instantly selected by pushbutton. Remote control of all functions provided by connectors at rear.



Recorder back plate holds eight plug-in Power Amplifier modules (one shown unplugged in photo), four on either side of Power Supply section. Entire back plate removable for servicing.

Eight-channel "350" from rear, showing (upper half) eight individual Preamp Power Supplies on four-unit module frames, and below them, Power Amplifiers and Power Supply on rear of Recorder Assembly.

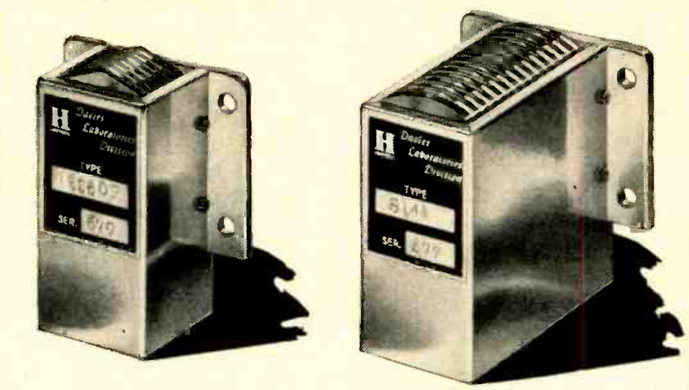


Multi-track magnetic recording reproducing heads . . .

Laboratory-designed, precision-built by Davies

Series	Track Data		Crosstalk (db)	Number of Tracks for Various Tape Widths							
	Width (Mils)	Spacing C to C (Mils)		¼	½	¾	1	1¼	1½	1¾	2
700	50	140	-60*	2	4	5	7	9	11	13	14
800	40	125	-60*	2	4	6	8	10	12	14	16
1000	40	100	-55*	3	5	8	10	13	15	18	20
1200	32	85	-50*	3	6	9	12	15	18	21	24
1300	26	78	-40**	3	6	10	13	16	19	23	26
1400	40	72	-40**	3	7	10	14	17	21	24	28
S1400	32	70	-40**	3	7	10	14	17	21	24	28
1600	32	62	-35**	4	8	12	16	20	24	28	32
2000	20	50	-35**	5	10	15	20	25	30	35	40

*For Direct Recording, 1000cps
**For Digital Pulse Recording



MODEL 1206 DP MODEL 814 A

Davies multi-track recording and reproducing heads for magnetic tape data recording are offered in a wide selection of designs for every practical tape service.

Davies single-stack heads are precisely aligned for those applications requiring coincidence of time and phase among tracks. Gap alignment is held to within ± 0.1 mil per inch of tape width.

For services requiring a large number of tracks, but where time and phase displacement can be tolerated, Davies 700, 800 and 1000 Series Heads can be interleaved to provide 14, 16, or 20 tracks on 1″ tape.

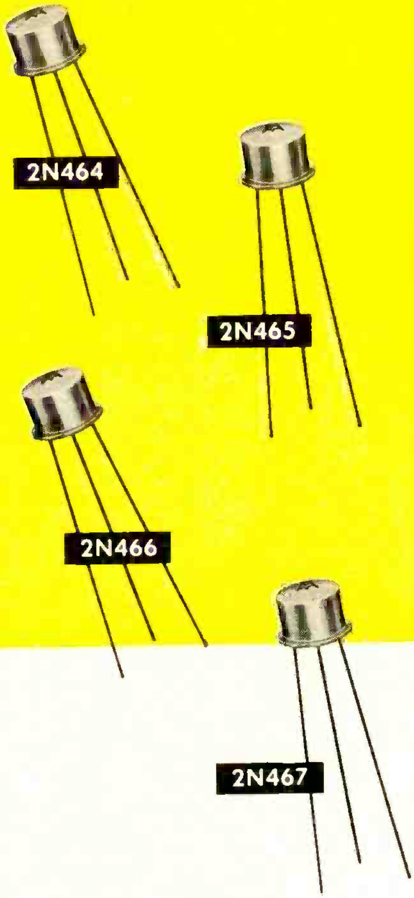
All-metal tape contact area on Models with the "P" designation (1206 DP above) essentially eliminate oxide build-up at high tape speeds.

In all types, plastic encapsulation protects and preserves the characteristics, even under adverse environmental conditions such as shock, vibration and extremes of temperature and humidity.

Additional technical and application information may be obtained by writing Minneapolis-Honeywell, 10721 Hanna Street, Beltsville, Md.

Honeywell

H HONEYWELL DAVIES LABORATORIES DIVISION



NEW GPA TRANSISTORS

from MOTOROLA

for General Purpose Audio applications including amplifier and switching service

TECHNICAL DATA

Motorola General Purpose Audio Transistors
Germanium PNP Alloy Junction

JETEC NUMBER	h_{fe} min.	h_{fe} typ.	V_{CB}	V_{CE}	P_C
2N464	14	26	45	40	150 mw
2N465	27	45	45	30	150 mw
2N466	56	90	35	20	150 mw
2N467	112	180	35	15	150 mw

Junction Temperature – 65 to 85°C

- **WELDED TO-9 PACKAGE**
  meets or exceeds mechanical and environmenta' requirements of MIL-T-19500A.
- **LOWER DISTORTION**
  with maximum signal output.
- **WIDE VOLTAGE RANGE**
- **OUTSTANDING CIRCUIT STABILITY**
- **LOW IN COST**
  thanks to Motorola's "multiple-assembly" mass production technique.

FOR COMPLETE TECHNICAL INFORMATION concerning these and other Motorola Semiconductors write, wire or phone Motorola, Inc., 5005 East McDowell Road, Phoenix, Arizona. BRidge 5-4411. Teletype PX 80.

"DEPENDABLE QUALITY – IN QUANTITY"

MOTOROLA SEMICONDUCTORS

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5005 E. McDOWELL
PHOENIX, ARIZONA

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WHitney 5-7500

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4900 West Flournoy Street
EStebrook 9-5200

HOLLYWOOD 28, CALIFORNIA
6555 Sunset Boulevard
HOllywood 5-3250

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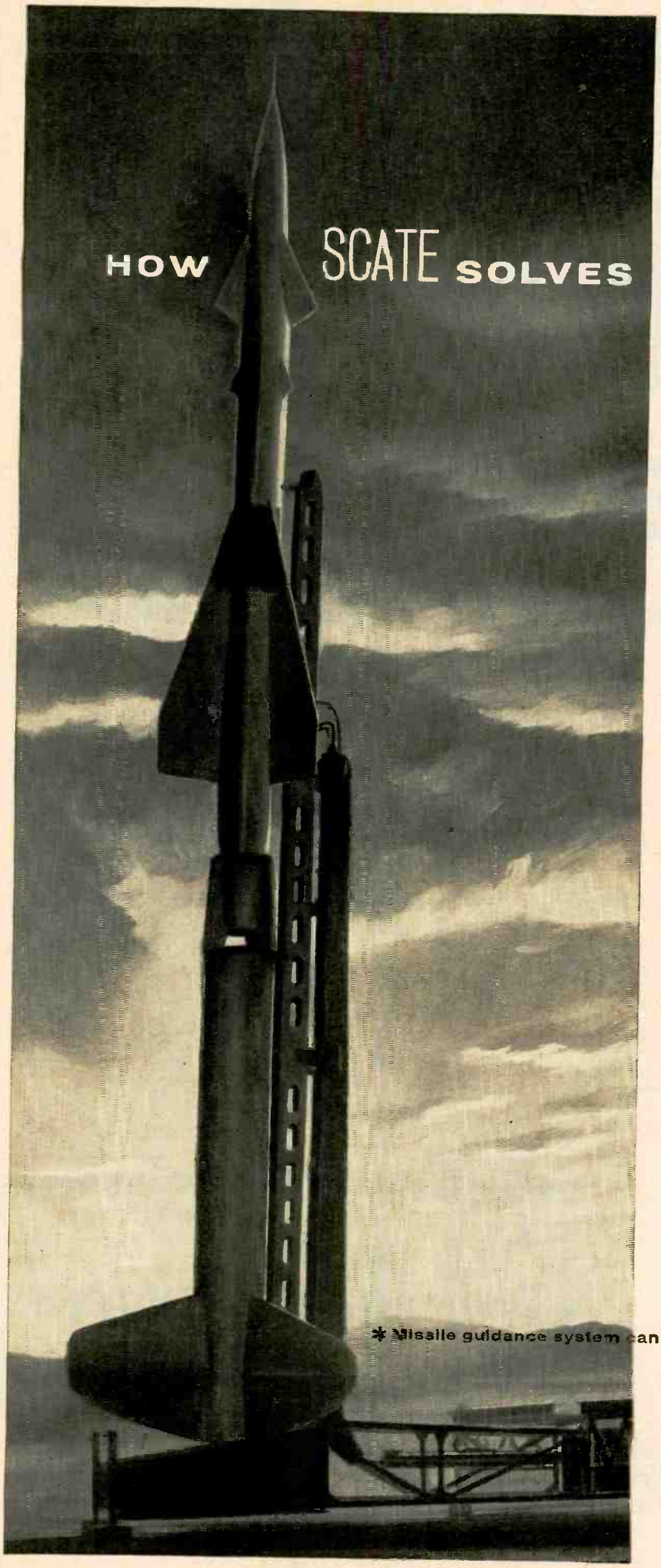
CIRCLE 53 READERS SERVICE CARD

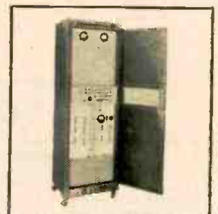


HOW SCATE SOLVES 2 BASIC PROBLEMS in testing electronic systems

Many complex electronic systems—missile guidance is a good example—may require testing that takes days by conventional methods. Yet the end function of such a system may last only a few minutes—**even seconds.**

Other systems, though less complex, must be tested in such large numbers that adequate personnel are frequently unavailable to perform tests by conventional means.

The SCATE system of automatic test equipment can solve **both** problems. It provides **self-checking** automatic testing which is **fast, flexible** and **foolproof.**



The system evaluates all important parameters of equipment under test, including:

1. RF sensitivity, center frequency, band width, power output, noise figure.
2. Audio frequency gain, band width, power output.
3. Video pulse circuitry, including pulse decoding, logic, digital comparison, pulse delays.
4. Voltage levels, DC and AC.
5. Servo response.
6. Mechanical response.

Stromberg-Carlson has standing designs for all the standard components which go into a SCATE system, and is fully experienced in designing custom components which may be required in any test system.

Complete details on the SCATE system and other Stromberg-Carlson automatic test equipment are available on request.

* Missile guidance system can be tested automatically by the SCATE system.

"There is nothing finer than a Stromberg-Carlson"

S-C **STROMBERG-CARLSON** GD
A DIVISION OF GENERAL DYNAMICS CORPORATION
1464 N. Goodman Street • Rochester 3, N. Y.

Electronic and communication products for home, industry and defense

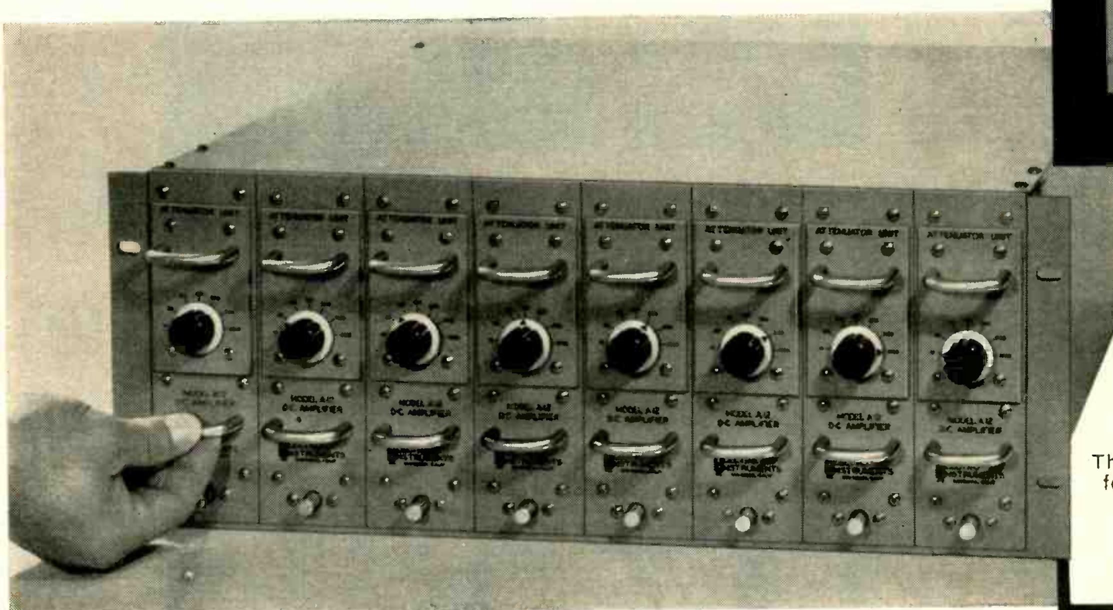
New Electro Instruments A-12 DC amplifier totally transistorized

equal to or better than the best vacuum tube instruments!

The new Model A-12 DC Amplifier is the preferred systems link for amplification, normalization and impedence transformation. Use of solid state elements assures maximum reliability; power dissipation is only seven watts. Mil-type components are mounted on coated plug-in printed circuit boards for protection against vibration and corrosion.

versatility plus economy

Electro Instruments produces a series of plug-in mode selectors and attenuators for the A-12: single ended, differential and operational, fixed and variable gain.



Eight to a rack
The A-12 is packaged for high density use; mounts eight across in 19" relay rack panels.

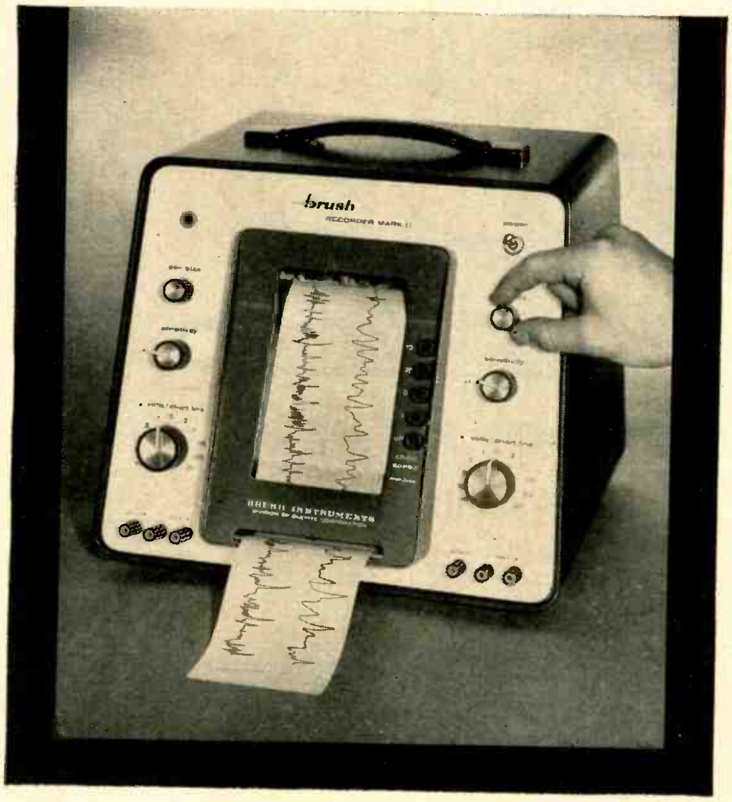
SPECIFICATION SUMMARY

	Single Ended Input	Differential Input
Gain:	Fixed gain set to any value from 10 to 1000 inclusive by front panel plug-in units. Gain switching plug-in attenuator available with gains of 0, 10, 20, 50, 100, 200, 500 and 1,000. Adjustable upward 6db from setting with potentiometer.	Fixed gain set to any value from 10 to 1000 inclusive by front panel plug-in units. Gain switching plug-in attenuator available with gains of 0, 10, 20, 50, 100, 200, 500 and 1,000. Adjustable upward 6db from setting with potentiometer. (Fixed gain plug-in units only.)
Input Impedance:	100 megohms shunted by 0.001 mfd (typical).	10,000 ohms.
Source Impedance:	5K or less (to meet noise specification).	
Drift:	Less than 2 microvolts in 200 hours at constant ambient temperature. Less than 0.4 microvolt per degree centigrade.	Less than 2 microvolts in 200 hours at constant ambient temperature. Less than 0.4 microvolt per degree centigrade.
Ambient Temperature:	0° to 50°C.	0° to 50°C.
Noise (Referred to input):	0-3 cps 5 microvolts peak to peak 0-750 cps 4 microvolts rms. 0-50 kc 8 microvolts rms.	0-3 cps 10 microvolts peak to peak 0-750 cps 6 microvolts rms. 0-50 kc 11 microvolts rms.
Frequency Response:	±3db to 50 kc (typical); ±1.0% to 2 kc	±3db to 50 kc (typical); ±1.0% to 2 kc
Output Capability:	±10 volts at ±100 ma DC or peak AC to 10 kc	±10 volts at ±100 ma DC or peak AC to 10 kc

Write today for complete specifications on single-ended, differential and operational models.

Electro Instruments, Inc.
3540 Aero Court
San Diego 11, California

CIRCLE 55 READERS SERVICE CARD



New!

Brush

Mark II

plug it in . . . put it in writing . . . anywhere!

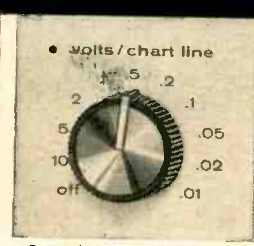
Recording with the new Brush Mark II is remarkably simple.

Operation is foolproof, with pushbutton chart speed selection . . . fast paper loading . . . self-cleaning, self-priming pens... built-in, permanently calibrated amplifiers.

Recordings are accurate . . . easy to interpret . . . easy to reproduce. Mark II operates over a wide amplitude and frequency range (d.c. to 100 cps), provides high stability, extreme sensitivity with an input range of 10 millivolts to 400 volts.

See how Mark II can speed your work, help you obtain data — the Brush way.

Convenient operation: fast paper loading without threading, pushbutton controls for 4 convenient chart speeds.



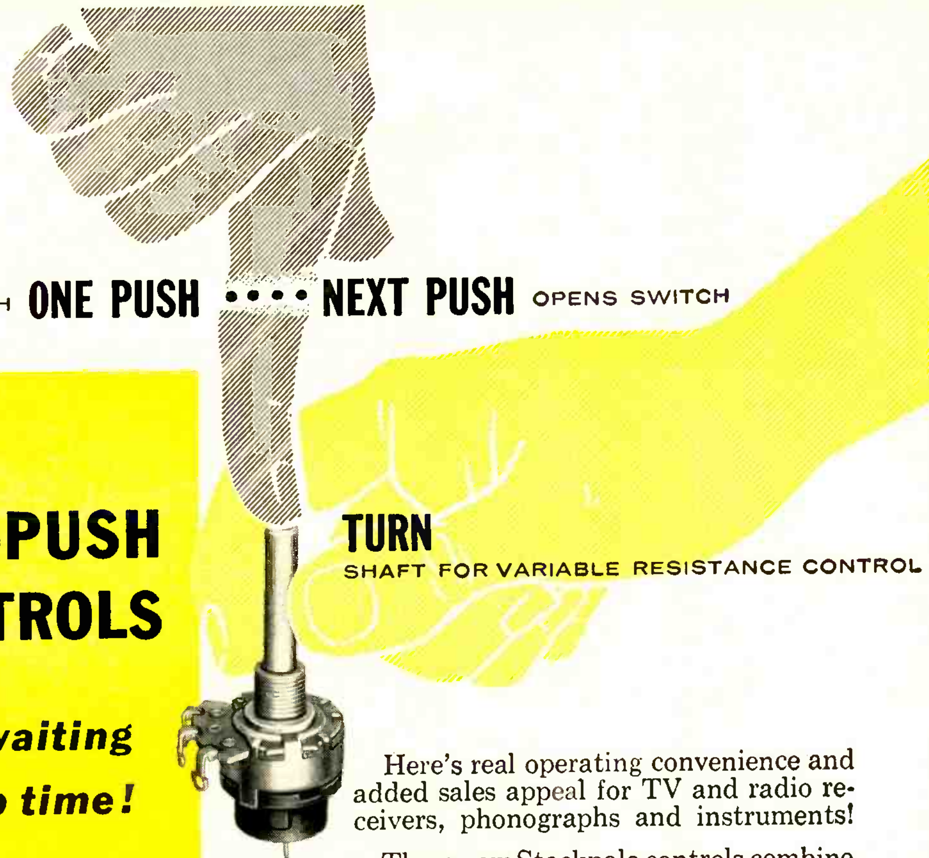
Complete recorder with built-in, permanently calibrated amplifiers. Ten millivolt input signal gives a deflection of one chart line.

Trouble-free writing system features self-cleaning, self-priming, rugged pens and extra-large ink reservoir.

brush INSTRUMENTS
DIVISION OF CLEVITE CORPORATION
3405 PERKINS AVENUE CLEVELAND 14, OHIO

CIRCLE 56 READERS SERVICE CARD

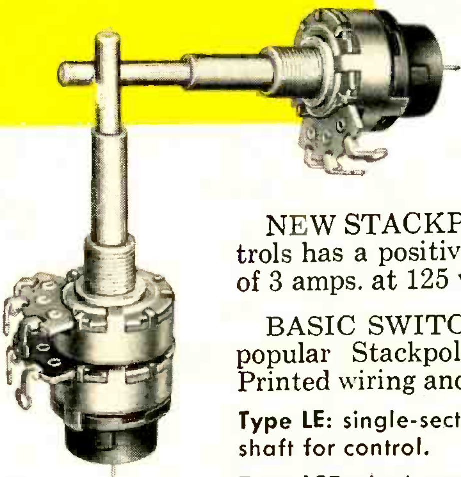
CLOSES SWITCH WITH **ONE PUSH** •••• **NEXT PUSH** OPENS SWITCH



TURN
SHAFT FOR VARIABLE RESISTANCE CONTROL

NEW PUSH-PUSH SWITCH CONTROLS

. . . take the waiting out of warm-up time!



Here's real operating convenience and added sales appeal for TV and radio receivers, phonographs and instruments!

Three new Stackpole controls combine pushbutton switching with rotary control of volume, tone, contrast or similar functions. "Waiting for the warm-up" before making final adjustments is a thing of the past. Just one push and the circuit is "on" and adjusted to the last selected setting of the variable resistor.

NEW STACKPOLE TYPE "E" SWITCH used on these controls has a positive, SP-ST snap-action. It carries a UL rating of 3 amps. at 125 volts ac-dc or 1 amp. at 240 volts ac-dc.

BASIC SWITCH/CONTROL COMBINATIONS using the popular Stackpole L-type control are available as follows. Printed wiring and wire-wrap terminals obtainable on each:

Type LE: single-section, single-shaft. Push shaft for switch, turn same shaft for control.

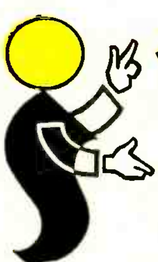
Type L3E: single-section, dual-shaft. Push inner shaft for switch, turn outer shaft for control.

Type LXE: dual-section, dual-shaft. Push inner shaft for switch, turn inner shaft for rear control, turn outer shaft for front control.

NEW DATA SHEET

Containing complete specifications and dimensions sent on request.

STACKPOLE



VARIABLE COMPOSITION **RESISTORS**

Electronic Components Division
STACKPOLE CARBON COMPANY, St. Marys, Pa.

Coldite 70+® fixed composition resistors • Snap and Slide Switches • Ceramag® ferromagnetic cores
Iron cores • Ceremagnet® ceramic magnets • Fixed composition capacitors • Brushes for all rotating electrical equipment
Electrical contacts • Hundreds of related carbon, graphite and metal powder products.

CIRCLE 57 READERS SERVICE CARD

FOR THE FIRST TIME... ALL IN ONE WIRE!

WINDABILITY
SOLDERABILITY
VARNISHABILITY
RELIABILITY...

IT'S PHELPS

- **BETTER WINDABILITY**—"lays in" easier.
- **LOW TEMPERATURE SOLDERABILITY**—no damage to copper conductor.
- **IMPROVED VARNISHABILITY**—safer in hot varnish solvents.
- **FIELD-TESTED RELIABILITY**—uniquely balanced properties provide better thermal life.

Phelps Dodge magnet wire is available in modern non-returnable spools, reels and "Pakeze" containers

Nyleze* is another example of the advanced magnet wires developed by Phelps Dodge through its Applied Research. It is a new combination of materials with highly desirable properties for use in such applications as series armatures and fields, stators, potted coils, random wound coils, toroids and other difficult winding designs. These properties suggest possibilities for cost economies and improved designs that result in better operating performance of your equipment.

*Nyleze is red in color

CIRCLE 58 READERS SERVICE CARD

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

FIRST FOR LASTING QUALITY —FROM MINE TO MARKET!

PHELPS DODGE COPPER PRODUCTS CORPORATION

PHELPS DODGE COPPER PRODUCTS CORPORATION

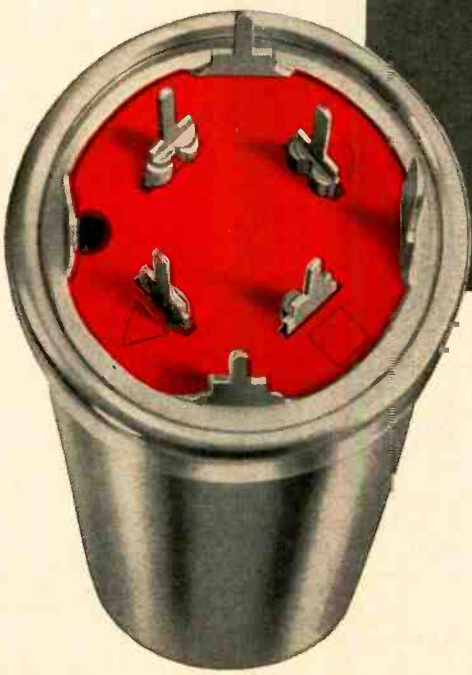
INCA MANUFACTURING DIVISION

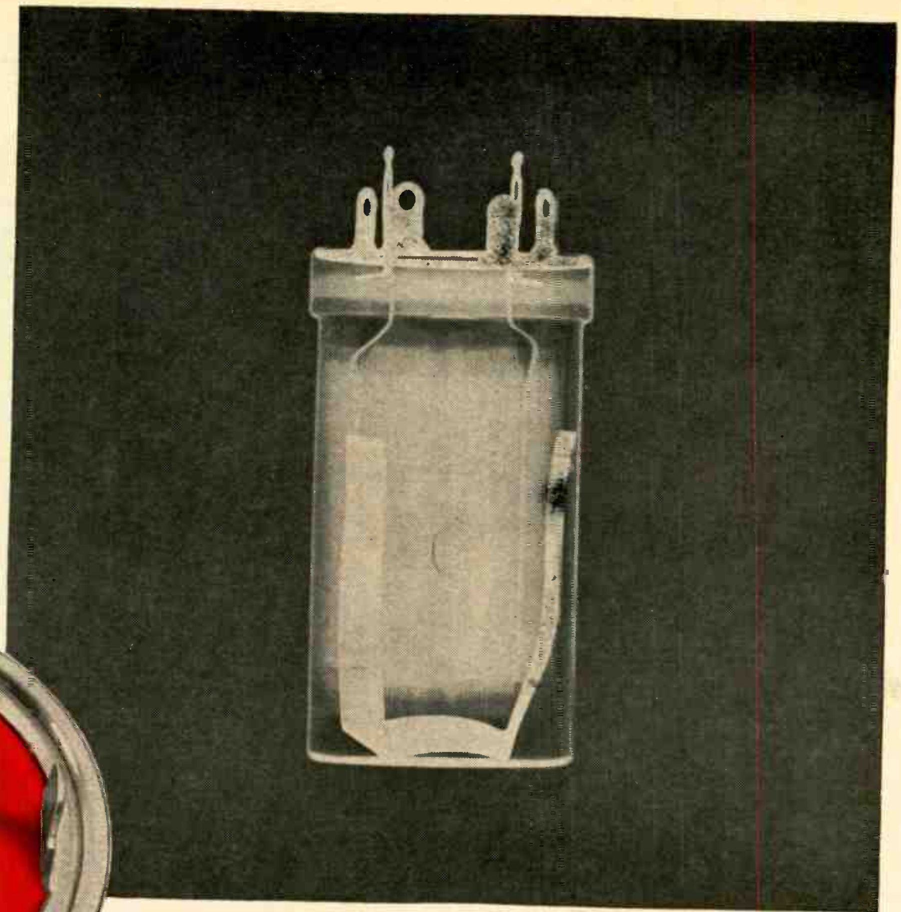
FORT WAYNE, INDIANA

... another

MALLORY (P.R. MALLORY & CO. Inc.)

service-engineered product





The red top tells you it's a new FP capacitor . . . . this X-ray shows you the new, rugged construction.

the inside story of an

Outstanding Capacitor

Look for the Red Top

MALLORY FP Capacitors have been accepted standards for many years . . . proven in performance by every single application.

Now—a brand new 'plus' feature makes these capacitors better, more dependable than ever before. The secret is in the internal mounting of the capacitor within the can—by means of a novel spring clip* that holds the unit snugly in place.

- **The unit is lighter in weight—therefore less susceptible to vibration and shock.**
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electronics
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JUNE 6, 1958

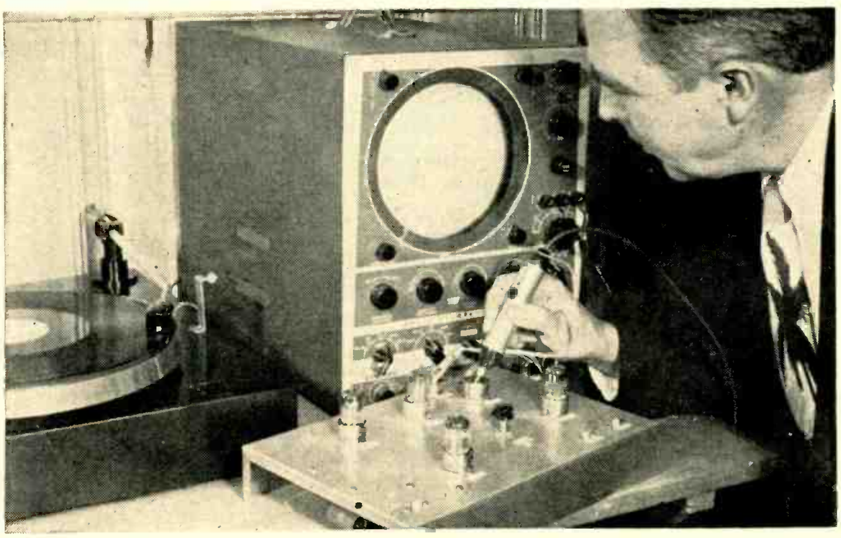
Compatible Stereo Disk Uses F-M Multiplexing

A 25-kc carrier, frequency-modulated by the differential output signal from two stereophonically placed microphones, is superimposed on a monaural signal derived from the sum of the outputs. The composite signal is recorded conventionally on a disk with a lateral cutter. For stereophonic playback, an auxiliary preamplifier limits and detects the difference signal and combines it with the sum to recover the original two channels

By JERRY B. MINTER, Components Corporation, Denville, N. J., and

JOHN H. McCONNELL, Electro-Sonic Laboratories Inc., Long Island City, N. Y.

MODERN HIGH-FIDELITY recordings are the product of many man-hours of research, tempered by years of practical experience. It seems logical to the authors to utilize the vast experience accumulated with lateral disk recordings in coping with the problems presented by stereo disk recording, and avoid recourse to any stereo system requiring the development of complex cutting heads and playback pickups.



Author checks experimental setup of development model of stereo preamplifier and high-quality monaural pickup arranged for stereo disk playback. Power amplifiers are not shown

A basic objective is to make a stereo disk capable of being played monaurally on any monaural phonograph in good working order without sacrifice in performance or damage to the disk. The introduction of such a record would present no inconvenience to those not having stereo equipment, while permitting subsequent inexpensive conversion to a stereo system.

The system described here utilizes f-m carrier multiplex above the audible spectrum to record the difference information which results when two stereophonic channels are subtracted vectorially. The vector addition of the two channels is recorded normally and simultaneously using the standard RIAA curve. The resulting groove resembles a normal lateral recording except that there is a super-

ABOUT STEREO DISK RECORDING

With the rapidly increasing popularity of stereo tapes, the record industry has been stimulated to great activity in the field of stereo disk recording. Some industry quarters are seeking a compatible system whereby stereophonic reproduction may be added to a monaural system simply and inexpensively. Disk recordings can be economically produced in quantity and are easily handled by the nontechnical music lover.

One early area of stereo-disk development was the vertical/lateral technique, which achieves stereophonic effects by having one channel recorded laterally, and the other vertically in a single groove. The quality of most of these early stereo disks was poor. The system suffered from mechanical difficulties caused by the increased mass of the cutters and playback heads, and cross-coupling between the channels. Similar problems beset the early 45/45 system, in which two channels were cut at a 45-degree angle to the vertical on the walls of a single groove. Attempts to play back these disks monaurally resulted in severe distortion.

However, recent improvement in the techniques of 45/45 and vertical/lateral recording have overcome many of the technical difficulties presented by stereophonic reproduction as well as compatibility with monaural playback.

imposed 25-kc carrier of moderate level (4 cm/sec velocity).

Since this carrier frequency is far above the limit of human hearing, it is not audible when the record is played on a standard monaural system. A special auxiliary preamplifier may be arranged to amplify the carrier and its associated sidebands sufficiently for limiting and detection of the audio vector difference signal. After detection, the difference signal must be combined with the vector sum or monaural signal to reproduce the original stereophonic channels.

Recording System

Reference to Fig. 1A indicates two microphones, *A* and *B*, which are placed for stereophonic recording. The outputs of the two microphones are added in phase by the lower mixer to produce a signal of greater amplitude than either signal alone. In general, the added signal or vector sum is the equivalent of a monaural signal which would result if the microphone were located midway between the microphones *A* and *B*.

The output from channel *B* is inverted in phase by passing it through a single stage of vacuum-tube amplification; the inverted or $-B$ signal is then added to channel *A* to yield the vector difference signal, $A-B$. This signal contains the stereophonic information and it will be zero (neglecting room acoustics) if the source is concentrated equidistantly in front of the two microphones. The vector difference will increase as sources move either side of center, thus yielding information as to position of the source.

The $A-B$ signal is fed into an f-m modulator to shift the 25-kc carrier between the limits of 20 and 30 kc. The carrier and sidebands are then combined with sum signal $A+B$ in a mixer and fed into the recording amplifier. The recording amplifier and associated lateral cutter are equalized for the RIAA curve up to 18 kc and flat from 20 to 30 kc, on a velocity basis.

After the master recording has been cut, it is processed in normal fashion and vinyl pressings are made in the conventional manner. There are no special problems associated with this operation.

Playback Preamp

Figure 1B is a block diagram of the playback preamplifier. A high-quality lateral pickup is connected through a low-pass R-C filter to a normal dual-triode preamplifier equalized for the RIAA curve. In addition, the output of the pickup is fed through a high-pass filter to the carrier amplifier which amplifies the band between 20 and 30 kc. The amplified carrier and sidebands are passed through a limiter, discriminator and filter to recover the difference modulation $A-B$ from the carrier. This difference signal is then combined with the $A+B$ signal in a mixer to yield the original *A* signal channel in the output, since the $-B$ cancels the $+B$. The difference signal and the inverted $A+B$ signal are then added to produce the *B* signal channel. Both channels are then fed to power amplifiers and speakers.

If only a normal monaural preamplifier and single channel are available, the output of the pickup can be amplified in ordinary fashion. The high-frequency RIAA roll-off characteristic will remove most of the f-m carrier and its sidebands, which are above the audible range of the ear anyhow.

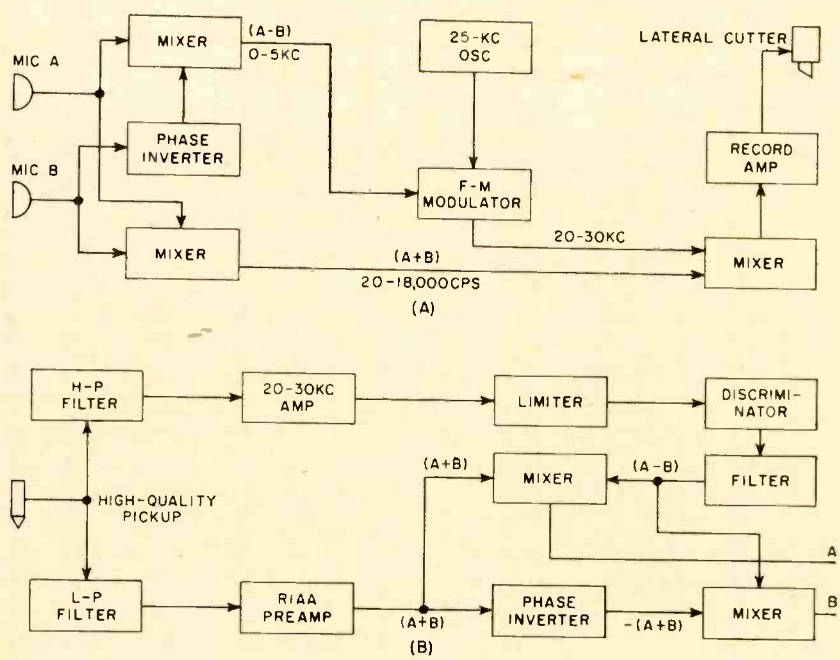


Fig. 1—Block diagram of (A) the recording system, and (B) the playback system. A monaural system could be converted to stereo by addition of (B) and a power amplifier

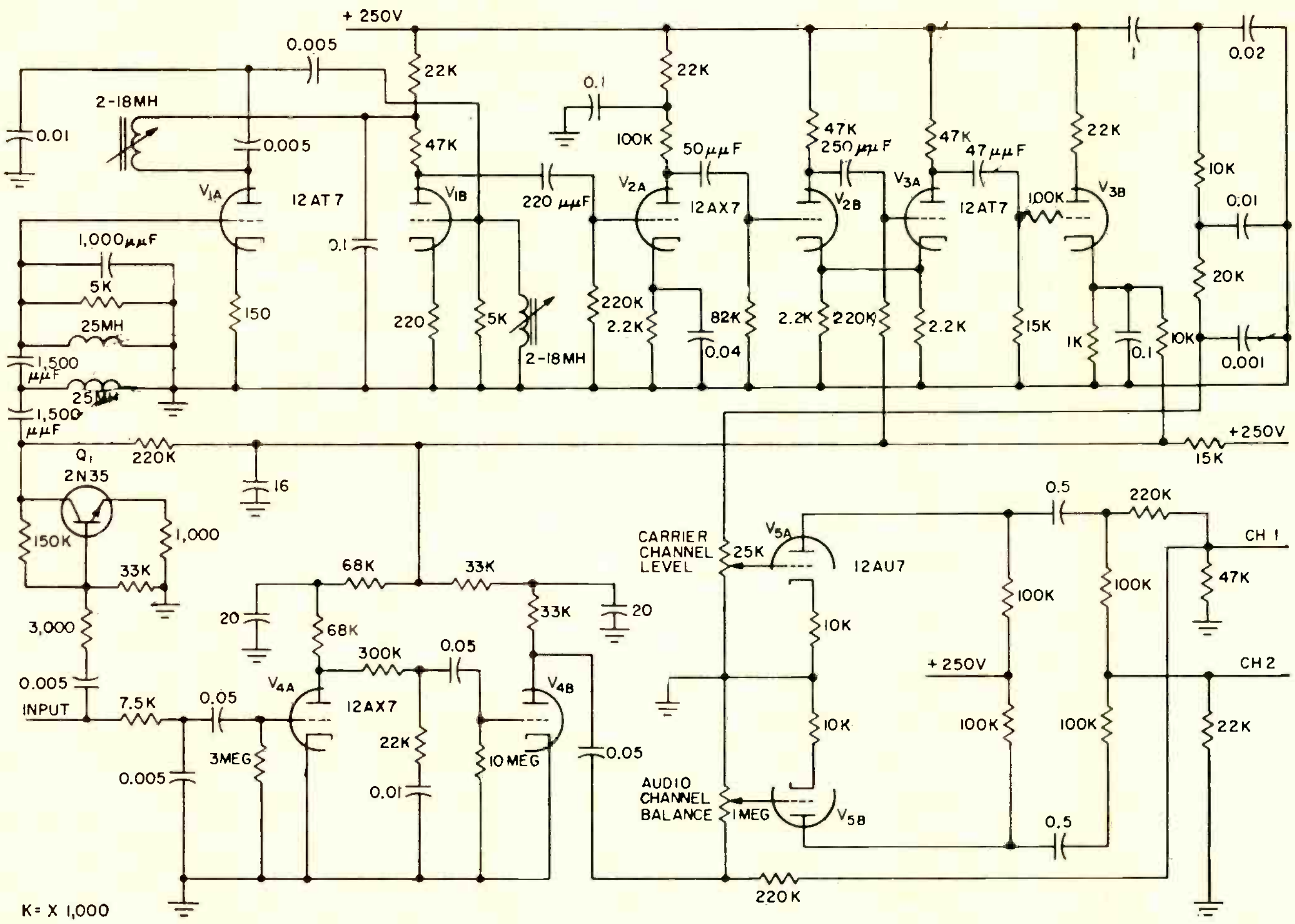


FIG. 2—Schematic diagram of auxiliary playback preamplifier. Limiting of the f-m carrier is performed by a Schmitt trigger circuit comprised of V_{2B} and V_{3A}. The detected stereo information is therefore in the form of pulse-sampled audio at the output of V_{3B}

No detectable noise or distortion results from the presence of the carrier on the disk. The first-order intermodulation products are low and above the audible range of hearing with most types of music. It has not been necessary to lower the l-p recording levels appreciably below that considered good practice (8 cm/sec). Overmodulation of the groove will cause tracking problems and gives rise to tracing distortion. If severe tracing distortion does appear, and the stylus loses momentary contact with the groove, a carrier dropout will occur. This can be reduced to a minimum by proper adjustment of the vertical stylus force. A force of 3 to 4 grams with a 1-mil tip radius seems satisfactory for the several pickups used to date. Some sophisticated circuitry will undoubtedly permit more tolerance in carrier dropout. This problem bears a resemblance to horizontal tv synchronizing problems at the time when phase-controlled oscillators were introduced.

Circuit Diagram

The schematic diagram of the playback system is shown in Fig. 2. The input from the pickup feeds through a low-pass filter which serves as the RIAA roll-off to V_4 which is a conventional preamp. The output of V_4 is the $A+B$ signal and it is fed directly to channel 1 and, after phase inversion in amplifier V_5, to channel 2.

Another amplifier channel is provided for the f-m carrier through a transistor preamp Q_1 and a high-pass filter to V_{1A} which has a double-tuned plate circuit to remove extraneous signals from the f-m carrier and its sidebands. This stage has a uniform response from 20 to 30 kc. Stages V_{1B} and V_{2A} provide further amplification of the f-m carrier and stages. V_{2B} and V_{3A} form a Schmitt trigger which is used as a limiter. The limiter output is differentiated and fed to counter-type detector V_{3B}, which is a high g_m triode with fixed bias bled from the $B+$ bus. The plate current pulses of the counter stage contain the difference information sampled at the carrier rate. It is necessary to filter out the carrier ripples to reduce background noise in the difference channel. Initially, L-C filters were used. However, saturation of the iron-cored inductors and the high cost of these elements caused a shift to a simple R-C filter which has proved effective. This filter gives some roll-off which can be equalized by preemphasis in the difference modulator circuit.

The difference signal, $A - B$ is amplified by V_{5A} and combined with the monaural channel through appropriate resistive networks to form the two stereo channels. The carrier level control is actually a spread control, in that it tends to spread the apparent speaker distance when level is increased.

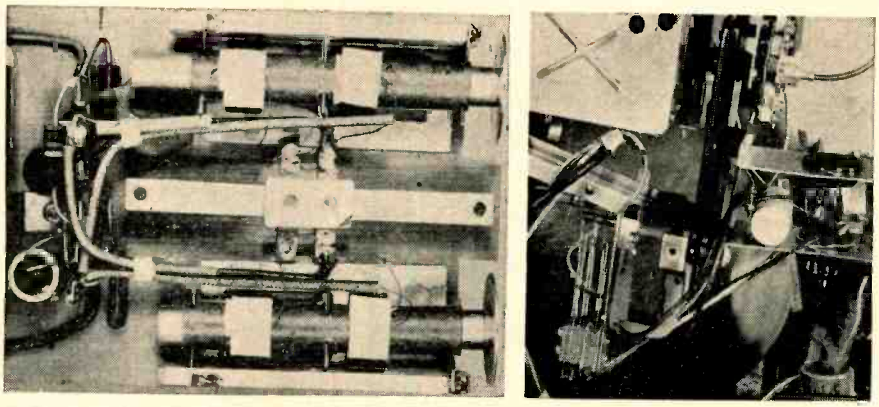


FIG. 1—Nickel tubes surrounded by coils (left) are heart of magnetostriction unit. Pull-in of rotor on control motor (right) actuates receiver muting contacts

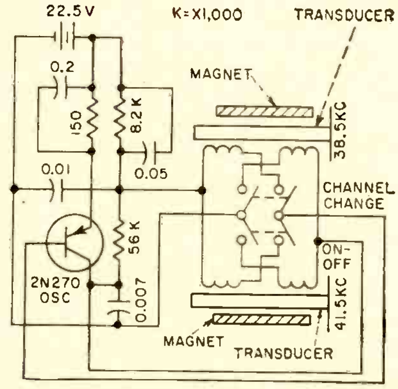


FIG. 2—Schematic of ultrasonic generator, comprising transducers and oscillator

By NEIL FRIHART Chief Engineer, and JAMES KRAKORA Senior Project Engineer, Advanced Tv Development, Motorola, Inc., Chicago, Ill.

Ultrasonic Tones

Frequency shift of continuous ultrasonic tone activates tuning motor on tv receiver. Skip-tuning is possible, and both audio and video are killed during tuning. Output of ultrasonic transducer is transmitted through air path to microphone in receiver where tones are detected in balanced 120-kc discriminator. Remote on-off control of power is also provided

REMOTE CONTROLS for tv receivers have become increasingly numerous in recent years. Control media for the several systems[1,2] have included light, r-f and superaudible frequencies. The unit to be described here uses a continuous ultrasonic tone produced by a magnetostriction generator.

Magnetostriction[3] is the change of dimension in certain materials when subjected to a magnetic field. The ultrasonic transducer[4] shown in Fig. 1 comprises a transistor oscillator whose frequency is controlled by either of two lengths of nickel tubing with aluminum diaphragms at their ends. The tubing in turn floats inside a coil form.

Wound on the forms are two coils, one at either side of the center of each piece of tubing. One coil acts as a driver, the other as a pickup to provide a feedback voltage to sustain oscillations.

When a-c is applied to the driving coil, the tubing is magnetized and the rod contracts. This causes strain waves to be propagated along the length of the rod, and they are reflected from the ends. When the driving frequency is such that those strain waves reinforce, resonance occurs. At this frequency the variation in length is at its greatest, which is only about 1 part in 1,000.

This motion induces a voltage in the pickup coil which is fed back to control the oscillator frequency. Nickel tubing with a wall thickness of 0.015 in. is used to reduce eddy currents from those obtained with solid rod. Nickel contracts with

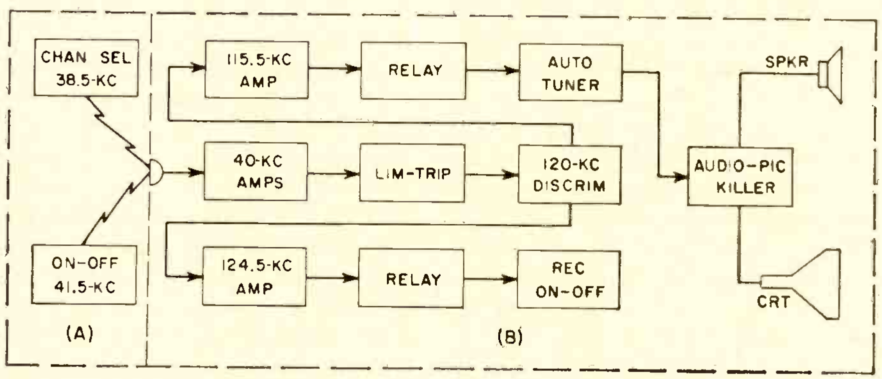


FIG. 3—Block diagram of complete control system. Box (A) comprises remote generator, while equipment in box (B) is included within the television receiver

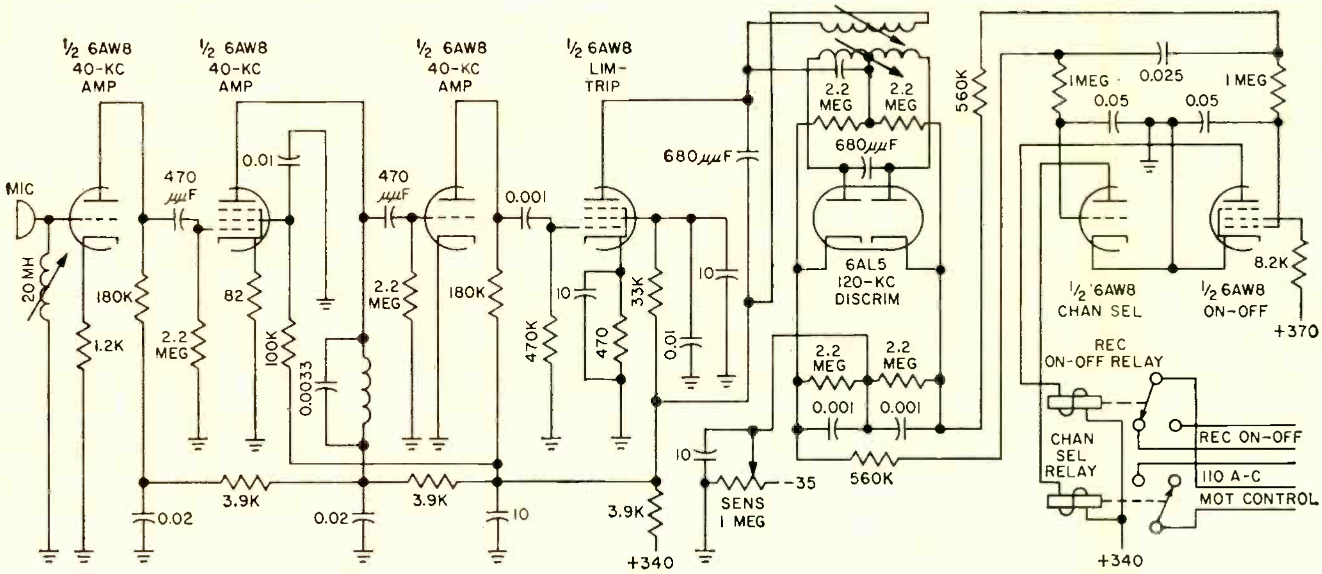


FIG. 4—Complete schematic of control receiver. On-off switches in receiver and remote unit are spdt for independent operation

Select Tv Channels

either half-cycle of an alternating magnetic field. To avoid double-frequency output the tube is biased magnetically so that the induced field never exceeds the bias field. For best operation the biasing flux density is about 60 percent of the saturation value. In this unit small sections of Cunife magnets are placed on the sides of each assembly.

The use of tubing permits construction of a stable oscillator, but the acoustical power radiated is quite low. By placing light aluminum diaphragms of an optimum size on the front ends of the tubing it is possible to increase the acoustical output many times. Maximum power is about 40 μbars at 1 ft.

The schematic diagram of the ultrasonic transducer is shown in Fig. 2. The current drain is limited to about 10 ma and the duty cycle is such that good battery life is obtained. Only 2.5 sec are required to bring the automatic tuning mechanism back to the starting position.

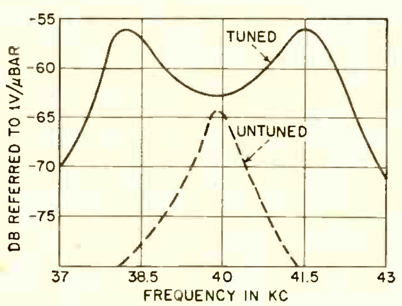


FIG. 5—Microphone characteristics with and without inductive tuning

Complete System

The block diagram of the complete system is shown in Fig. 3. The receiver uses a barium titanate transducer as a microphone. As shown in Fig. 4, the microphone is tuned with a 20-mh coil to broaden the frequency response. The electrical and mechanical response complement each other to provide peaks at the control frequencies of 38.5 and 41.5 kc, as shown in Fig.5. The sensitivity at these frequencies is influenced considerably by the Q of the microphone coil, which must be 40 or greater to obtain optium circuit operation.

The total beam angle of the microphone is 50 deg at the 6-db points. It is connected to a R-C amplifier stage that is degenerative to raise the input impedance and reduce microphone damping. The stage following is tuned to reduce the noise bandwidth and to increase gain and selectivity. A conventional R-C stage follows which is used to drive a limiter-tripler. Finally, a balanced discriminator detects the two ultrasonic tones. The two positive control voltages developed are fed through integration circuits to further reduce the possibility of noise causing false operation.

In the complete television receiver the sound and video output are muted during the tuning operation. The receiver can be used manually or remotely without requiring switching. A housing is provided for the ultrasonic transmitter which turns the power supply of the remote receiver off when the transmitter is placed in the housing. By the use of a continuous tone it is possible to skip-tune the receiver, or continuously control an additional function such as volume or contrast.

The authors appreciate the assistance on this project of J. Davis, G. Heisig, E. Salners, A. Heppner, M. Pettroff and F. Massa.

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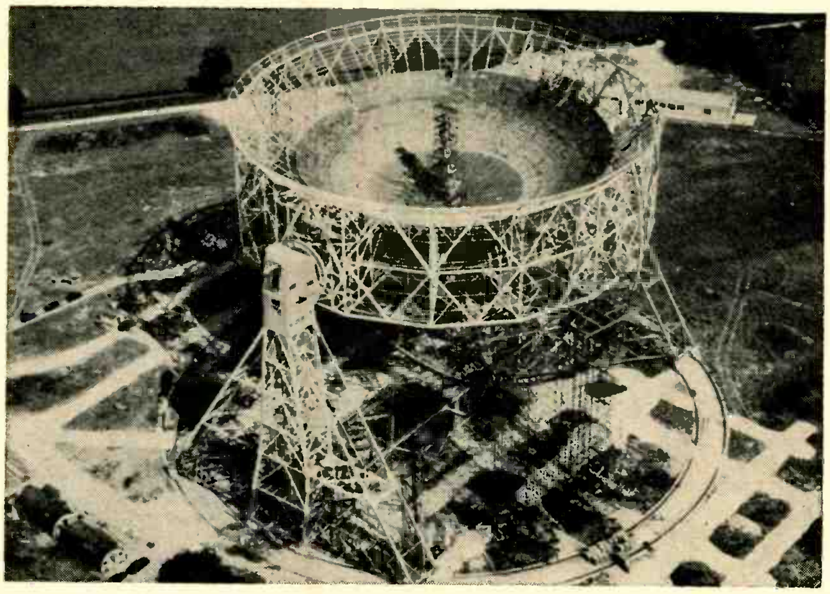


FRONT COVER—Aerial view of radio telescope showing partially completed 250-ft reflector, 62.5 ft antenna tower and remotely located control room (upper right). Azimuth positioning is accomplished by moving entire mechanism about on circular railroad tracks. Elevation positioning is accomplished by rotating reflector on trunnions at top of the support towers. Reflecing surface is suitably painted to prevent concentration of heat at the focus during solar observations and to provide a high degree of diffuse reflection to prevent overheating of membrane

Reflector membrane is built up of 7,000 sheets of 0.5-in. steel plate which are welded to one another and to the support structure. This arrangement gives a high-degree of electrical conductivity, provides adequate pickup of the important 21-centimeter wavelength

Radio Telescope Sees

Free world's largest and most sensitive radiation detector locates, identifies and tracks astral bodies emitting low-energy radio waves and measures geometric properties of solar bodies. Altazimuth antenna assembly is automatically positioned by computer-controlled servo system accurate to within nine minutes of arc. Analog computer solves complex equations describing antenna attitude required to track radiating source.

By C. N. KINGTON Chief Mechanical and Electrical Engineer, Husband & Co., Sheffield, England.

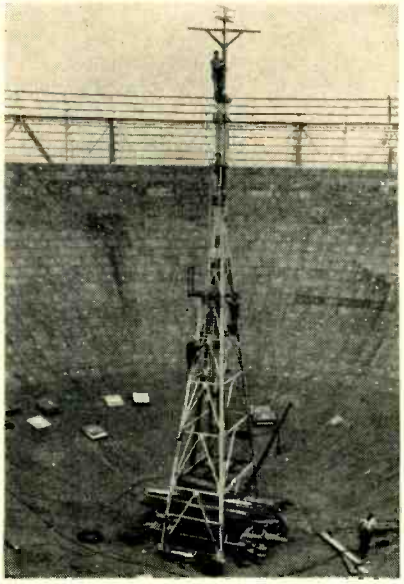
RADIO ASTRONOMY is based on the fact that radio waves emitted from numerous sources in space impinge on the earth's surface and can be detected by suitable receiving apparatus. At present, the largest and the most sensitive radiation detector in the free world is the radio telescope discussed here. In operation since June, 1957 (see p 8, Sept. 1957), it is being used to help solve the prime cosmological problems relating to the origin of the universe and to investigate properties of bodies within the solar system.

System Capabilities

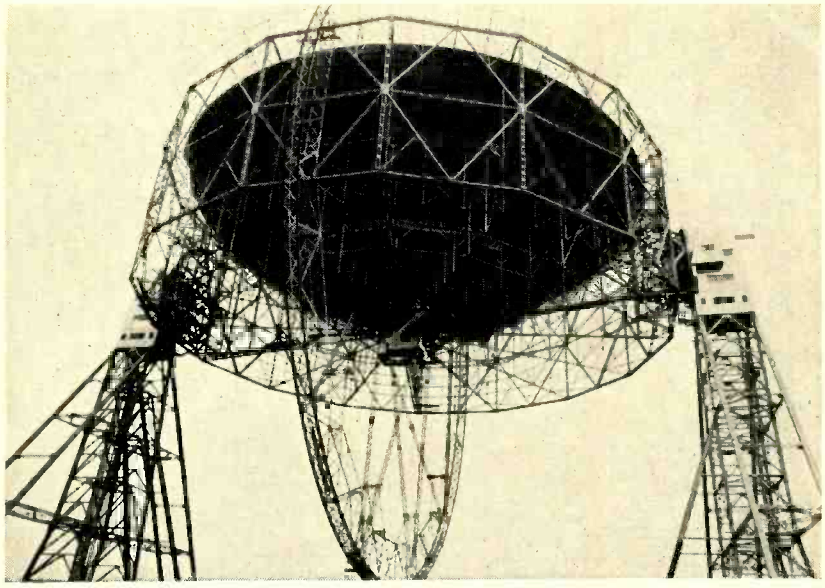
The detection system is a computer-controlled servo-operated antenna capable of picking up extremely low intensity radiations emitted at a wavelength of 21 centimeters by clouds of cold hydrogen and faintly luminous gases drifting in interstellar space.

Movements of bodies in the solar system can be measured using a radar-like tracking mode of operation. Various time relationships established by this technique have enabled astronomers to successfully determine orbital information for Russian and U. S. satellites.

It is expected that a detailed study of the ionosphere and of the changes that occur in it will be possible using this instrument. Valuable discoveries concerning re-



Antenna tower diameter diminishes greatly as its elevation above the reflector increases. This is done to avoid obsuring and scattering radiation from the primary feed. Special structural design is used to prevent the tower from bending when bowl is elevated



Steel laboratory hung immediately below the center of the reflector is mounted on trunnions to keep the floor level and is equipped with damping devices to prevent oscillations resulting from high winds. Two towers supporting reflector allow a full 360-deg rotation plus some overlap. Steel construction withstands great stress changes created during rotation of reflector and provides sufficient weight to add stability and offset the overturning effects of the wind. System will automatically correct for parallex when tracking bodies in the solar system

2 Billion Light Years

flection and absorption of short wavelengths used in long-distance radio communications are anticipated.

Physical Description

Two integrally related but physically dissimilar installations make up the complete radio telescope system. These are: the reflector bowl and antenna with associated support and drive equipment, shown in Fig. 1; and the control station which houses the computer, readout and recording devices.

At the geometric center of the 250-foot paraboloidal reflector is a 62½-foot tower to which the antenna is mounted. The focus of the reflector is in the aperture plane and coincides accurately with the position of the antenna.

Infinitely variable movements of the telescope around its axis are produced by two Ward-Leonard motor-generator sets. These units are housed in a substation located immediately over the center pivot. The generators supply variable amounts of electrical energy to motors which position the telescope in azimuth and elevation.

Azimuth motors are mounted in carriages which drive the whole antenna structure about its vertical axis. Elevation motors are mounted in laboratories at the top of each support tower and rotate the reflector bowl about its horizontal axis.

An electromechanical computer system situated in a control station 200 yards away regulates the output of the generators. Banks of instruments surrounding the control desk give full information regarding the position of the antenna assembly. A large window looking towards the instrument enables the operator to see the reflector movements by day and, with the aid of floodlights, by night.

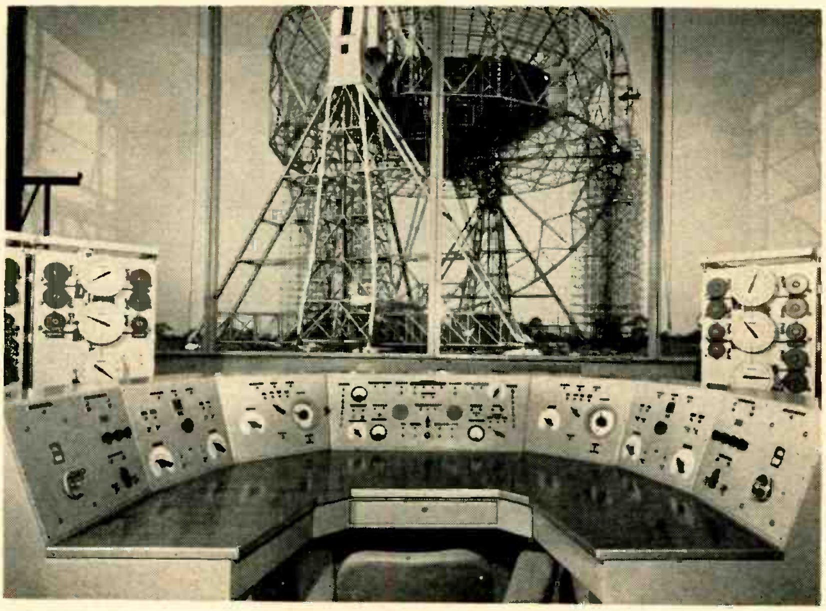
An underground tunnel extends

BACKGROUND OF RADIO ASTRONOMY

Radio telescopes are similar in principle to optical telescopes except that they receive electromagnetic radiations having wavelengths a million times longer than those of light. Since long wavelengths are relatively unaffected by clouds, fog or daylight, radio astronomers have a marked advantage over those using conventional methods of observation.

Also, radio waves, created in some unknown manner by galaxies in collision, penetrate much farther into space than do light waves. For this reason, radio telescopes can investigate space more deeply than optical telescopes.

Major difficulty experienced with small radio telescopes is that sufficient resolution is hard to obtain at the long wavelengths used. Since the beam width, or angle of the receiving cone, depends on the ratio of wavelength to the diameter of the telescope's reflector, antenna masts thousands of miles long would be required to get adequate resolution. An alternate approach—increasing the physical size of the reflector—has been used in designing modern systems such as the Jodrell Bank Telescope.



View of radio telescope looking through control room window. Antenna assembly can be operated remotely by one person sitting at the desk-type console which houses all necessary controls. A wide range of telescope movements can be selected including: automatic sidereal motion at a given right ascension and declination; motion in galactic latitude and longitude; motion in azimuth and elevation; and various automatic scanning motions with a choice of rasters

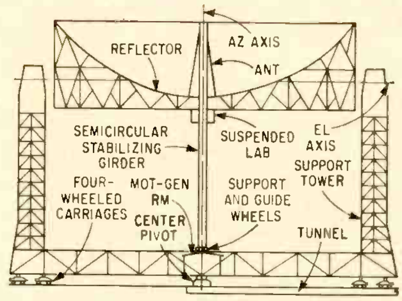


FIG. 1—Physical arrangement of antenna assembly. Twelve four-wheeled carriages support the entire antenna structure. Four carriages are used under each tower to help distribute the load and to counteract toppling effect of wind. Two driving carriages are used to move each tower around on two circular sets of railroad tracks

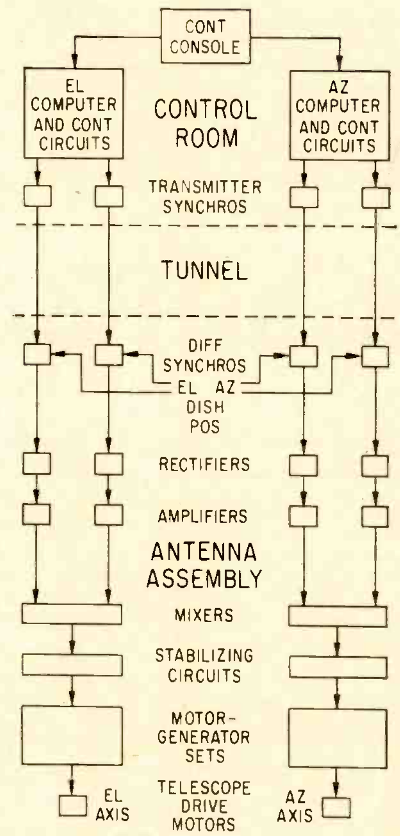


FIG. 2—Servo loop diagram of radio telescope. Command position signals from the computer and control circuits are compared with actual position signals from the reflectors. Difference, or error, signals control the excitor field of motor-generator sets. Output of the motor-generator sets drive d-c motors which compensate for the error by positioning the reflector

from the basement of the control room to an annular chamber surrounding the center pivot of the antenna assembly. This tunnel is large enough for pedestrian use and has racks on which power, control and radio cables are laid.

When the telescope receives radiations from outer space, the amount of energy concentrated on the antenna at the focal point is extremely small. To amplify and analyze these radiations before they are dissipated or contaminated by local atmospheric disturbances or man-made radio waves, the radio-frequency preamplifiers and other parts of the receiving equipment are placed immediately adjacent to the antenna. The main amplifiers are located in a suspended laboratory below the reflector.

Two distinct types of radio equipment are required to detect radio-waves generated in remote parts of the universe and to meassure the properties of solar bodies. An extremely sensitive receiver operating on 90, 168, 408 and 1,420 mc picks up radio emissions from the local galactic system and also from various types of extragalactic nebulae. A transceiver operating on 120 megacycles tracks and records the motion of the planets, the moon, meteors and artificial earth satellites.

Operational Requirements

The telescope is of the altazimuth type. This means that the aiming and following movements of the antenna and reflector are obtained by a combination of motions in azimuth and elevation. In practice, the whole antenna assembly is rotated in a horizontal plane while the reflector is titlted about a horizontal axis.

To permit realization of the full capabilities of the telescope, three operational modes are used: tracking—in which the telescope is locked onto the course of and moved with a radio energy source; scanning—in which the arc of the sky to be scanned is set into the telescope in either terrestial, galactic or celestial coordinates by raster scanning steps dependent on time or position; and traversing—in which the telescope makes rapid movements from one preset position to another.

To function properly in these operating modes, the control system must: provide infinitely variable rotational speeds in azimuth for the whole 2,000-ton structure up to a maximum of 20 deg/min; provide infinitely variable rotational speeds in elevation for the 750-ton parabaloidal bowl and antenna up to a maximum of 24 deg/min; aim the bowl focus at any point above the horizon and continuously track the point; scan a chosen area of the sky; function by automatic controls installed in a remotely located building; and execute all aiming and following operations with the greatest possible accuracy.

The act of aiming accurately at any chosen object in the sky and of following that object as it moves across the sky involves ability to convert rapidly and continuously the coordinates defining the position of the chosen point into azimuth and elevation angular settings, and to adjust the position of the telescope correspondingly. This must be done under conditions of variable wind, snow or ice loads.

There must be negligible creep or overrun as the heavy reflector is decelerated to rest and then accelerated in the reverse direction. Also, the drive system must be inherently stable and tight throughout the whole speed range.

Control System Operation

To meet the operational requirements, a closed loop positional servo control system is used. The control system is split into two parts: an electromechanical analog computer and a drive assembly. The computer solves 14 trigonometric equations derived from sideral time and astronomical coordinate inputs. Calculated azimuth and elevation command signals are then sent to the main drive system to physically position the reflector. A block diagram of the control system is shown in Fig. 2.

Functionally, the control desk, automatic control panels and computer are more complex than the rest of the control system because any one of three different sets of positional coordinates can be used to define the position of a point above the horizon. Coordinates used are: galactic latitude and longitude; celestial right ascension and declination; and terrestrial azimuth and elevation.

Since antenna movement is obtained by a combination of movements in azimuth and elevation, the computer must convert galactic to celestial and celestial into terrestrial coordinates. Furthermore, correction must be made for the effect of the earth's rotation about its own axis. Allowance must also be made for the earth's orbital movement when aiming at the sun or planets and for parallax correction in altitude when observing the moon.

Celestial and terrestrial coordinates are related by spherical trigonometric equations. Since some of the equations are more suitable for various positional conditions than others, the control system is required to select automatically the best equations for any specific case.

Since all coordinate relationships involve sine and cosine terms, resolvers are used to solve the equations. Three pairs of resolver shafts deal with coordinates and one repeats back to the control equipment the actual angular position of the reflector.

Correction for the earth's rotation is made to right ascension by an oscillator-regulated synchronous motor. The oscillator is tied to a master sideral time clock by correction impulses. Resolvers dealing with hour angle are driven by both the right ascension synchro shaft and the clock motor. The resultant hour angle is used to convert right ascension and declination into azimuth and elevation angles. When observing the sun or planets, the necessary corrections to right ascension and declination coordinates are continuously introduced signals from the sidereal time system.

The coordinate pair to be used is selected manually; however, the signal to the telescope driving system is always taken from the azimuth and elevation shafts. Coarse and fine transmitter synchros on the shafts order the antenna to azimuth and elevation angular positions which correspond to the angular positions of their rotors. If a transmitter motor position is different from a receiving synchro rotor position established by the actual antenna position, an error voltage proportional to the angular difference is generated in a differential synchro. These error signals are sent to the motor generator room, amplified and used to vary the exciter fields of motor-generator sets which drive the variable-speed 50-hp d-c motors mounted on the elevation axis and on the azimuth driving carriages.

Fine and coarse repeat-back synchros transmit the azimuth position of the reflector through coupling on the center pivot of the antenna assembly. Elevation position pickoff is taken from another set of double synchros mounted on the tower trunnions.

Scanning and autoset circuits

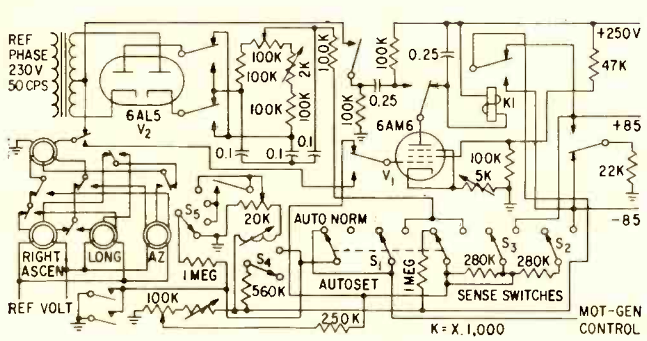


FIG. 3—Scanning and autoset circuit. This circuit controls scanning motions of the reflector. Arc in the sky to be scanned is set in using terestial, galactic or celestial coordinates

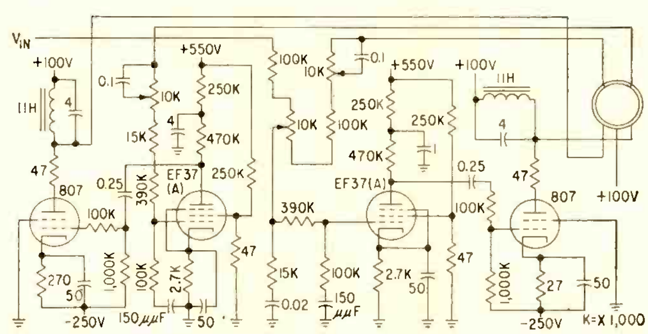


FIG. 4—Twin-feedback resolver amplifier circuit. This amplifier compensates for inherent electrical errors in resolvers used to solve trigonmetric equations in the computer

are shown in Fig. 3. These circuits set up required driving coordinate positions of the controller and provide means for scanning the sky by various methods.

When switch S_1 is in the NORM position, a continuous drive is applied to the motor-generator of the driving coordinate controller. The positive or negative sense of the drive is controlled by switches S_2 or S_3. When the autoset switch S_1 is in the AUTO position, the coordinate can be set up automatically. In this case, tube V_1 becomes a single-stage amplifier and, by way of phase-sensitive rectifier tube V_2, drives the coordinate until coincidence is obtained in the synchro circuit.

Rack-mounted instruments (left) are arranged in circular pattern around control desk (right). Indicator dials are large enough to be read from the operator's chair. Telescope's actual position is expressed in degrees and minutes for each of the terrestial, galactic and celestial coordinates. Sidereal time is also presented

Driving coordinates can be arranged to scan about a predetermined center. The center is established by setting up a scan-center coincidence synchro which is coupled to a transmitter synchro on the coordinate shaft. Output of the scan-center coincidence transmitter is coupled to and compared with the preset amplitude bias applied to the tube V_1. The circuit determines the limit of the scan by energizing or deenergizing relay K_1 when the synchro error signal exceeds that of the bias. Required driving voltage is applied by contact on relay K_1 through switch S_4 to coordinate controller motor-generator.

One coordinate can be stepped in either at predetermined time intervals or on reaching the limit of scan in another coordinate using step switch S_5. Stepping can take place at a controlled speed either forward or in reverse over any of five arcs preselected on a commutator located in a remote place.

Most resolver errors result from the high effective resistance of the windings and the presence of unwanted flux in the windings. These shortcomings are overcome with the twin high-gain two-stage R-C coupled amplifiers shown in Fig. 4. The circuit uses antioscillatory input circuits and also has provision for gain and phase adjustment. Outputs from the resolver amplifiers are passed through a resistive network and fed to the R-C coupled amplifier shown in Fig. 5. The amplifier is transformer-coupled to a phase-sensitive rectifier having a balance control.

Sidereal Time Oscillator

The hour angle resolvers are driven by a synchronous motor running at sidereal time. Amplified output from the R-C coupled, regenerative oscillator with amplitude control, shown in Fig. 6, drives the synchronous clock motor.

Motor speed is compared at 30-second intervals with a pendulum driven master clock and is arranged to drive a little faster than sidereal time. If at the time of checking the motor driven clock is in advance of the master clock, a check capacitor is closed across the input of tube V_1. The frequeny of oscillation and the speed of the motor are then reduced bringing the motor back into coincidence with the master.

Repeatback Circuit

The repeatback circuit detects the actual position of the reflector and displays it in degrees and minutes of elevation and azimuth on dials in the control room. To assure fast and accurate correspondence between actual and indicated position,

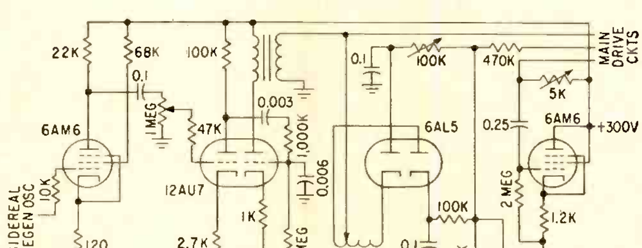


FIG. 5—Second resolver amplifier and phase-sensitive rectifier. This circuit amplifies the output from the circuit shown in Fig. 6 and converts it to control the main drive circuits

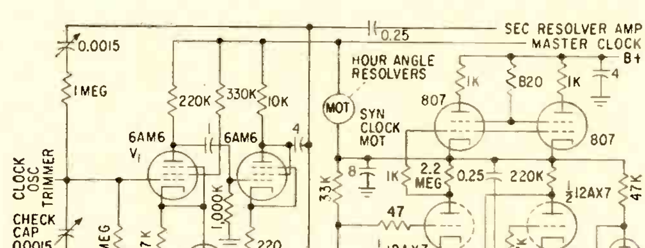


FIG. 6—Sidereal regenerative oscillator. This circuit keeps the output of a synchronous clock motor in coincidence with a master sidereal time clock. Motor output provides input to computer

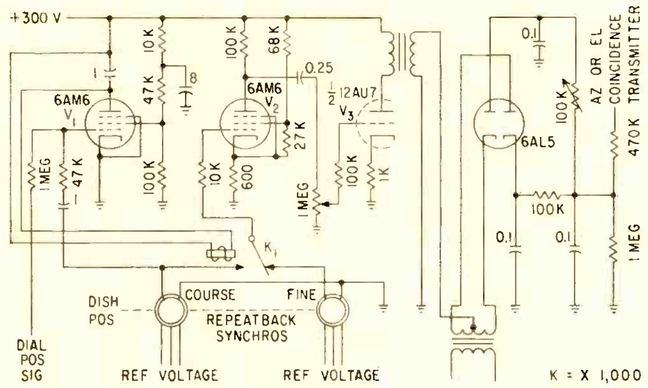


FIG. 7—This circuit amplifies signal from repeatback synchros and converts it into a d-c signal which controls the coincidence transmitters of the repeatback dials

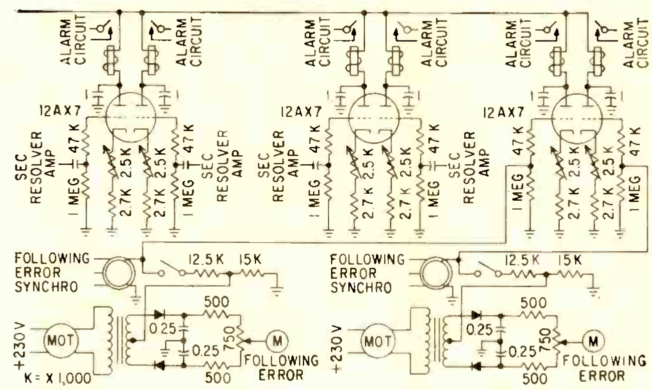


FIG. 8—Malfunction circuits. Six tube-operated relays protect telescope circuits against overload caused by component failure or against inaccuracies caused by system errors

the special amplifier-rectifier circuit shown in Fig. 7 is used.

Mounted on both the elevation and azimuth axis of the reflector are a fine and a coarse synchro. The coarse synchro is driven by the reflector while the fine synchro is geared to the coarse synchro at a ratio of 36:1. Outputs from these synchros are electrically coupled to relay-control tube V_1 and to the two-stage R-C coupled amplifiers V_2 and V_3. Signals generated in the repeatback circuit are applied to a coarse and fine coincidence transmitter used to position control room dials. Transmitter positioning signals are also fed back to grid of tube V_1 in the repeatback circuit.

If the difference angle between the actual reflector position and that on the dials exceeds 3.5 deg, V_1 triggers and relay K_1 is energized. The input to V_2 now becomes the signal from the coarse repeatback synchro and the repeatback dials are able to follow the reflector movements.

When the reflector slows down, the difference angle becomes less than 3.5 deg and the relay is deenergized. Input tube V_1 now becomes the signal from the fine repeatback synchro and the repeatback dials follow the reflector movements with more accuracy.

Malfunction Circuits

Provisions are made to stop normal tracking of the telescope and set off alarms in the event of component breakdown or other faults causing computational or tracking errors. The circuit used consists of six tube-operated relays arranged as shown in Fig. 8.

Four of the inputs to the alarm circuits are from the secondary resolver amplifiers; the remaining two are obtained from synchros whose error voltage is proportional to the difference between the computer position in azimuth and elevation, and the position taken by the reflector. In the event any of the signals increase beyond a predetermined level, the relays are operated, tracking ceases, and the source of the error is indicated.

Operating Data

To set the telescope to given bearings, the positon defining coordinates are selected by hand on dials in the control room. Pushbutton operation sets the coordinate shafts to the corresponding position. Error signals between transmitter and receiver synchros cause the telescope to move to the required position. The sidereal time correction is then automatically applied.

Normally, tracking speeds are in the range of 1 deg/min to 15 deg/hr. At tracking speeds up to 4 degrees per minute, the position is maintained to an accuracy of one fifth of a degree for both azimuth and elevation motions. When the permissable limit of angular rotation is reached for either motion during automatic tracking, forward drive is cut off and reverse motion applied at full speed until the original bearing plus time correction is reached. At this time, forward tracking recommences.

For scanning purposes, any one of the three pairs of coordinates can be selected manually and the corresponding second coordinate of the pair varied in manually selected steps. This selection is achieved by setting the center of the required scan as an angle on a synchro and the angular range of the scan as a setting on a calibrated potentiometer. The potentiometer output voltage is then compared with the error signal from a transmitter synchro on the scanning coordinate shaft. When they are equal, one relay reverses the direction of drive and a second produces the required angular step in the other coordinate.

The whole of the automatic control apparatus can be switched out and both motions controlled manually from cabinets in the Ward-Leonard room on the telescope structure. Emergency crash stop buttons are provided in the control room and at various strategic positions on the moving structure. An interlock system makes it impossible to rotate the bowl until personnel have left the elevated walkways and are in either the small suspended laboratory below the reflector or in one of the towers.

There is a warning and signal light display panel in the control room. This system indicates whether the brakes are on or off, if the suspended laboratory is occupied and if crash button has been operated in the event of an emergency stop.

Heat Program Timer

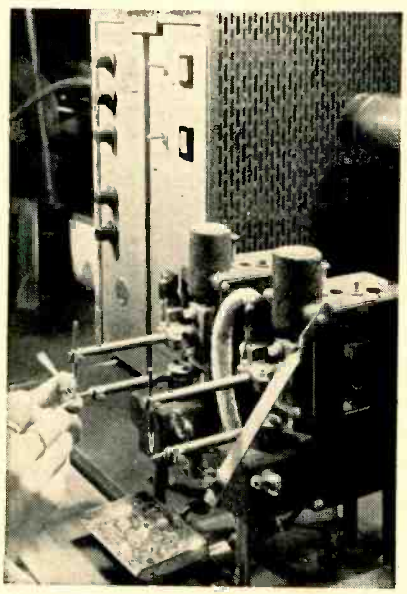
Compact, bench-sized electronic switch, to control weld energy for production-line welding of small components, features five independent control functions that cover most of the welding problems encountered by a manufacturer of special-purpose electron tubes

By A. V. RANIS, Senior Engineer, Weldpower Group, Raytheon Manufacturing Co., Newton, Mass.

VARIETY OF METALS, shapes and surface conditions of parts that must be welded in reliable vacuum tube assembly presents a problem that cannot be solved by conventional synchronous resistance welder controls.

An example is the welding of carbonized nickel anodes where application of sufficient heat to fuse the nickel causes expulsion of particles of molten metal (weld splash) because of the high resistance of the carbonized surfaces. These particles are a potential source of failure in the finished tube. Reducing heat to reduce splash results in a weak weld.

Abilty to vary the heat level during a weld interval permits the changing conditions of the work pieces to be matched in a limted manner by the power supply, thereby eliminating weld splash and most other similar problems encountered in the tube assembly plant.



Heat program timer chassis (left) and power head (right) in operation on the electron tube assembly line

Electronic Switch

The timer is basically an electronic switch controlling the flow of current from a 230-v, 60-cps power line to the primary of a welding transformer.

Figure 1 is a block diagram of the unit, and the accompanying photo shows an actual bench setup.

Five independent control functions provided in the heat program timer are low heat, weld heat, upslope time, weld time and downslope time. Line power is applied to the contactor thyratrons. The settings of the controls determine the shape of a d-c voltage developed in part of the circuitry and this voltage is impressed upon a pulse generating circuit whose output pulses are phase shifted with respect to line voltage in accordance to the impressed d-c voltage. The pulses are used to fire the thyratron contactor tubes and supply the desired variation in welding current.

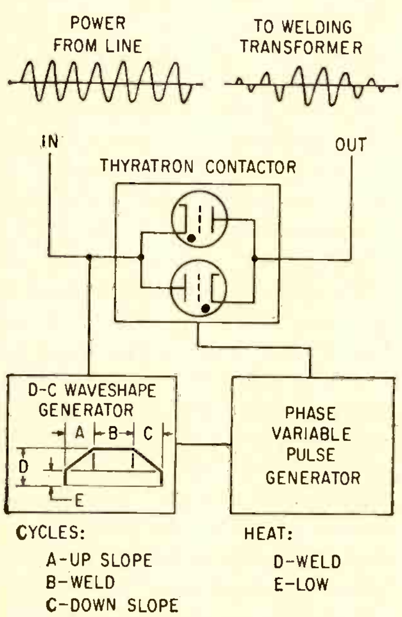


FIG. 1—Block diagram of weld timer

Thyratrons

In Fig. 2, thyratron tubes V_1 and V_2 are connected in inverse parallel and placed in series with the power line and welding transformer. Grids of V_1 and V_2 are biased negatively by the transformer secondaries of T_1, capacitors C_1 and C_2, and dry rectifiers D_1 and D_2.

Indicator lamp I_2, capacitor C_3, and resistor R_1 form a voltage indicator for adjusting the power factor to the welding transformer and load. Normally open contacts of K_1 prevent application of line voltage to V_1 and V_2 until after a timed warmup period. Application of primary power to transformers T_1 and T_3 applies heater voltages to all tubes, energizes delay relay K_3 and energizes all bias, control and power supply windings.

Thyratron V_4 is nonconducting because it is shorted by a set of normally closed contacts of K_2. Thyratron V_6 is nonconducting because its grid is at approximately -15 v derived from the divider network formed by R_2 and R_3. Tube V_7 becomes conducting and the

Controls Weld Energy

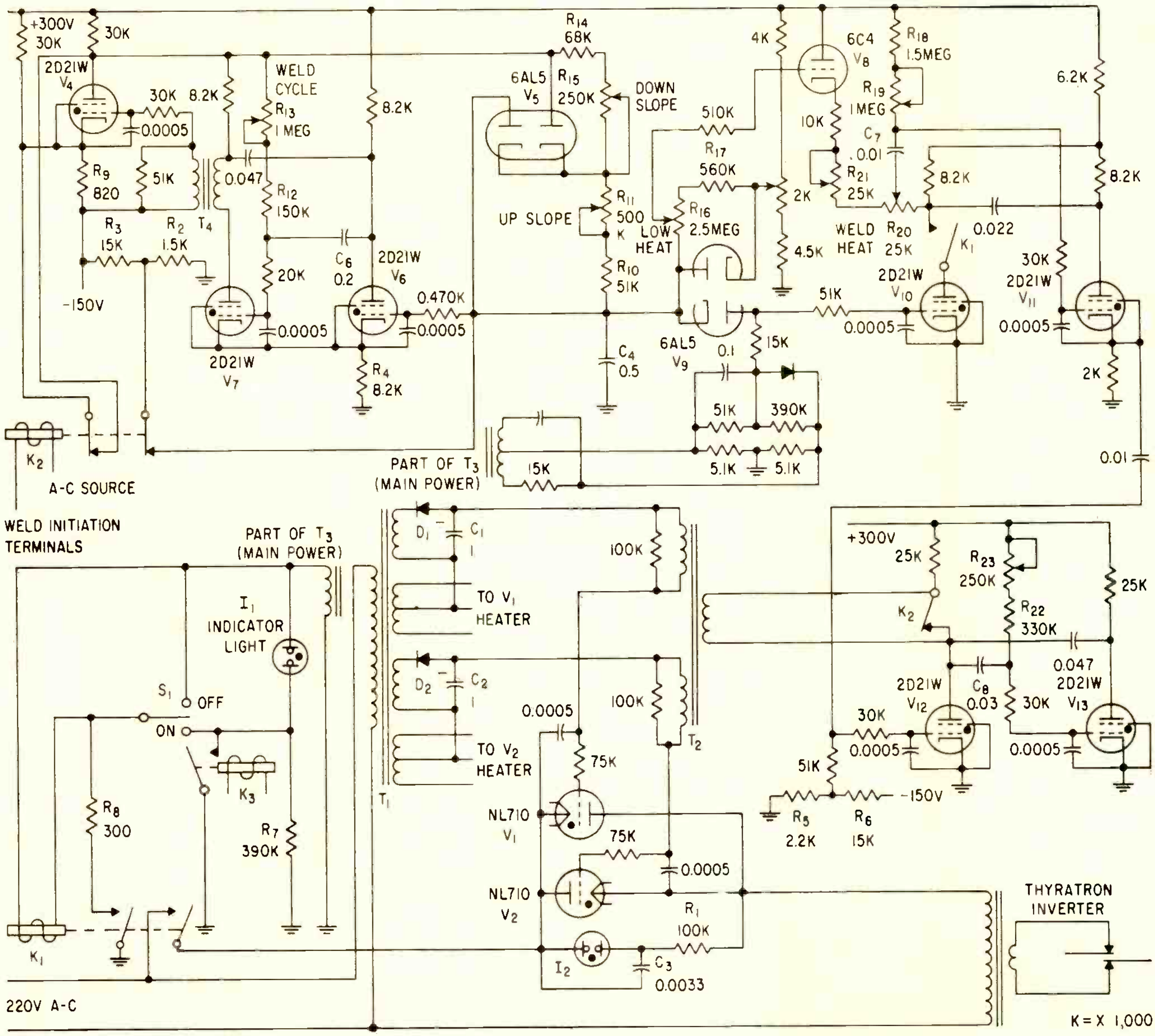


FIG. 2—Schematic of the heat program timer, showing the adjustable potentiometers that control the heat functions

resulting voltage drop across R_4 adds approximately -150-v d-c to grid bias of V_6. Tube V_{10} is nonconducting because of the normally open contact of K_1 in its plate circuit. Tube V_{11} is conducting. Tube V_{12} is nonconducting because of the negative grid voltage derived from voltage divider string R_5 and R_6. Tube V_{13} is conducting.

When delay relay K_3 completes its cycle, it shorts out R_7 and allows indicator light I_1 to glow. Operation of weld switch S_1 to the momentary ON position energizes K_1 which locks itself in through R_8. The normally open contacts of K_1 close applying line voltage to thyratrons V_1 and V_2. Normally open contacts of K_1 close applying plate voltage to V_{10}. However, V_{10} remains nonconducting because of the negative voltage applied to its grid through V_9 and K_2. The equipment is now ready for welding.

Closing the initiating circuit energizes relay K_2. The normally closed contacts open and the anode of V_4 rises to approximately 300-v d-c. Tube V_4 remains nonconducting because of the large bias voltage developed across the cathode resistor R_9. A second set of normally closed contacts on K_2 open allowing capacitor C_4 to charge from -15 towards $+300$ through resistor R_{10}, potentiometer R_{11} and V_5. As the voltage across C_4 rises, the grid of V_6 approaches its cathode potential as determined by the voltage across R_4. When this voltage is reached (approximately 150 v) V_6 conducts.

The time required for the voltage across C_4 to rise to positive

150-v d-c is the up slope cycle and is adjustable with R_{11} over the range of 2 to 10 cps.

Tubes V_6 and V_7 form an inverter circuit. Conduction of V_6 extinguishes V_7 by commutating capacitor C_6. Tube V_7 is held nonconducting for a time determined by C_6, R_{12} and potentiometer R_{13}. Clamper V_9 prevents the voltage across C_4 from rising more than a few volts above 150 v d-c. After the time period, V_7 conducts, extinguishing V_6.

Start of conduction in V_7 applies a voltage to T_4 primary producing a voltage pulse in T_4 secondary which makes thyratron V_4 conduct. The anode of V_4 now drops to approximately −120 v. Capacitor C_4 starts discharging from +150 v towards −120 v through R_{14}, potentiometer R_{15}, and V_5. The time for C_4 to discharge from +150 to 0 volts is designated as down slope cycle and is adjustable by R_{15} over a range of 2 to 10 cps.

A voltage develops which started at −15 v and rose to +150 v in an adjustable time period, was maintained at 150 v level for another adjustable time period and then decreased through zero to a negative value in another adjustable time period. The voltage developed across potentiometer R_{16} and resistor R_{17} is equal to the difference between +150 and the voltage across capacitor C_4. The slider on R_{16} allows developing a voltage which is the sum of the instantaneous voltage on C_4 and a selectable portion of the voltage difference described above. The section of tube V_9, which supplies negative bias to V_{10}, acts as a switching device in the following manner. As long as C_4 is negatively charged, V_{10} is biased negatively. When C_4 approaches 0 volts or goes positive, this section of V_9 ceases to conduct and bias is removed from the grid of V_{10} allowing this portion of the circuit to operate.

Pulse generating circuits function only when C_4 is at zero volts or positively charged.

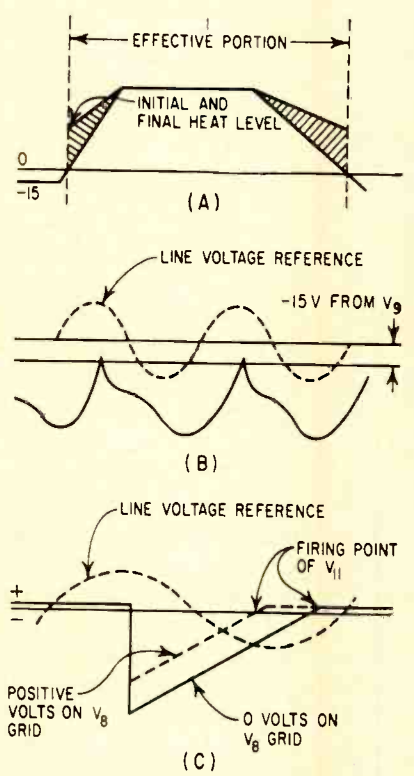


FIG. 3—Pulse-generating circuits operate in effective portion (A), with shaded section representing voltage added by low heat adjust. Triggering in (B) occurs once each cycle. The instant of start of conduction is controlled by weld heat adjust

Waveform

Figure 3A shows the voltage developed from the slider of R_{16} to ground. The vertical dashed lines indicate the interval during which the pulse generating circuits are operative. The shaded portion represents the voltage added by R_{16} to that of C_4. Adjustment of R_{16}, designated as low heat, varies the initial and final heat level without influencing any of the timed periods or the 150-v level.

The grid of V_{10}, in addition to the biasing circuit described, contains a phase-shifted full cycling voltage. This voltage is as shown in Fig. 3B. When no negative bias is present on V_{10} its grid will be triggered once each cycle. Tubes V_{10} and V_{11} form an inverter circuit and V_{11} is normally conducting.

When V_{10} is made to conduct, V_{11} is extinguished and held nonconducting for a time period determined by C_7, potentiometer R_{19} and resistor R_{18}. This period is also influenced by the voltage across potentiometer R_{20} in the following manner. Before initiating conduction in V_{10}, capacitor C_7 is charged to nearly 200 v. When V_{10} conducts, the resultant drop at the base of C_7 puts a negative voltage on the grid of V_{11}.

If the time constant formed by C_7, R_{19} and R_{18} is kept constant, the period will now depend on the voltage drop at the instant of conduction of V_{10}. This is illustrated in Fig. 3C. This voltage drop is affected both by the position of the slider of R_{20} and the voltage developed across R_{20}. This voltage across R_{20} is determined by the voltage on the grid of cathode follower V_8. This voltage is the special waveshape described earlier and shown in Fig. 3A.

With a low voltage on the grid of V_8, little voltage is developed across R_{20}, the slider is effectively at the anode potential of V_{10} hence the timed period is the longest. With higher positive voltage on the grid of V_8 the slider point does not drop in voltage (depending on the potentiometer setting) as far and the time interval is shorter.

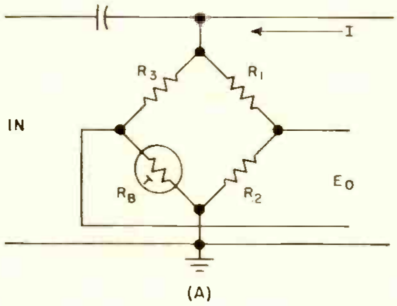
Weld Heat

Potentiometer R_{20} is termed weld heat and sets the higher heat level. It does this by effectively varying the amplitude of the trapezoidal wave shown in Fig. 3A. This variation does not affect any of the other control functions except for low heat which will change in magnitude but remains fixed if calibrated in percent of weld heat. Potentiometer R_{21} performs a function similar to that of R_{20} and limits the maximum advanced position of pulses for matching load power factor.

When V_{11} conducts the output pulse is sufficient to overcome the negative bias on the grid of V_{12} and make it conduct. Tubes V_{12} and V_{13} from another inverter circuit where the time period is determined by C_8 and R_{22}. Potentiometer R_{23} is fixed so that V_{13} will conduct a half-cycle after initiation of V_{12}.

Transformer T_2 primary in the plate circuit of V_{12} receives a voltage pulse each time V_{12} or V_{13} conducts. The secondaries of T_2, plus V_1 and V_2 control the welding transformer primary current.

The author acknowledges the contributions of E. Kolm who conducted the application evaluation phase of this development and J. R. Arsenault who was a co-designer of the equipment. This development was part of a program sponsored by the U. S. Navy.



Capacitor discharge test set (left) is evaluated by discharging capacitor through mercury switch into ergmeter (right). Meter at left of ergmeter panel balances bridge and sets calibration while output indication meter is at right

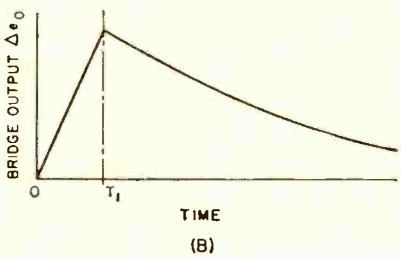


FIG. 1—Ergmeter input is bolometer bridge (A) brought to balance by current I. Until T_1, bolometer integrates input-pulse power with respect to time; thereafter element cools exponentially as shown in (B)

Ergmeter Measures Bursts of Energy

Bolometer bridge converts input signal to heat by integrating input power with respect to time. Heat upsets the bridge balance and produces output signal that is amplified and applied to peak holding voltmeter whose output corresponds directly to energy. Possible applications of instrument include study of switching losses, surge resistance of capacitors and thyratron efficiencies in pulsed operation in devices such as radar modulators

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ENGINEERS AND PHYSICISTS frequently find it necessary to accurately measure the energy content of a pulse. Such measurements can now be greatly simplified.

Designed primarily for evaluating the energy delivered by a discharging capacitor[1] into an electric primer, the ergmeter described here can be used whenever a burst of energy is to be measured.

The portable ergmeter has a maximum sensitivity of about 100 ergs full scale, where 100 ergs correspond to 10 μwatts of power flowing for a time interval of one sec.

The energy-measuring techniques of the ergmeter improve sensitivity over a thermocouple or a thermoelectric converter-integrator by about 1,000. In addition, the ergmeter contains an energy calibration source for measuring absolute energy levels.

The ergmeter consists primarily of a bolometer bridge, an amplifier, a peak holding voltmeter and a calibrated energy source.

The first three components indicate input energy. An adjustable energy source[2], which is an independent circuit switched in for calibration purposes, delivers a known amount of energy into the bolometer bridge.

Bolometer Bridge

The bolometer bridge, the heart of the entire ergmeter, consists of resistive arms R_1, R_2, and R_3 and bolometer R_B shown in Fig. 1A. The bolometer, a type KP85, is a 0.3-

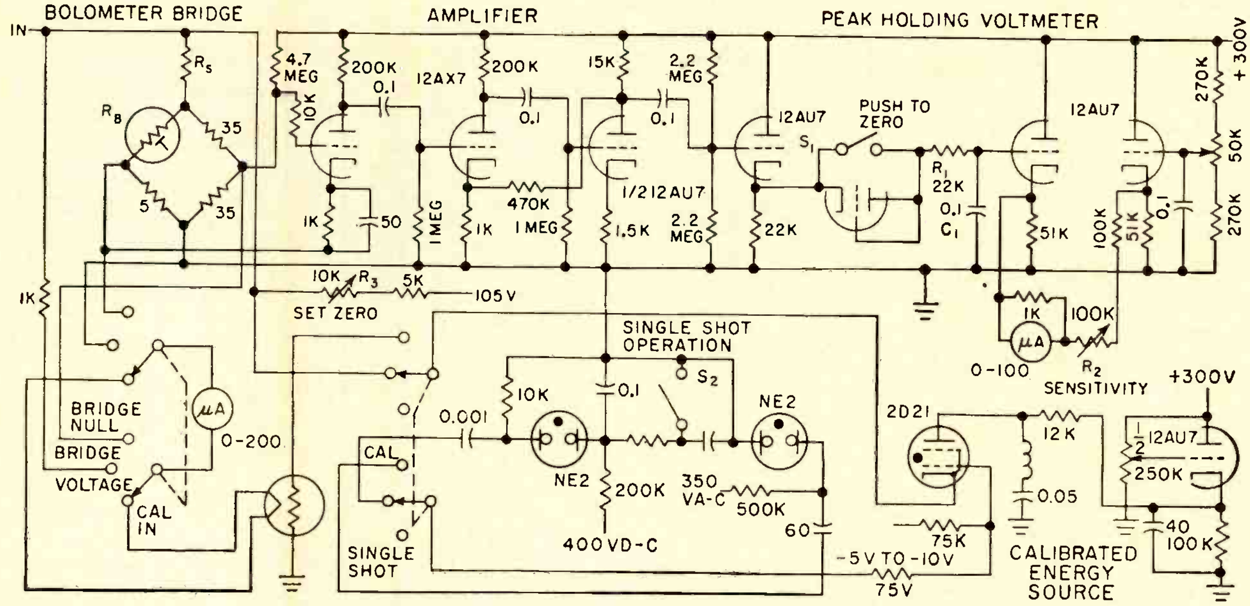

FIG. 2—Ergmeter consists of bolometer bridge, three-stage amplifier, peak-holding voltmeter and calibrated energy source

mil tungsten wire, 0.1-in. long, mounted in a short, 7-pin, miniature, evacuated glass envelope. Its nominal cold resistance is slightly under five ohms whereas the comparison arm R_3 is exactly five ohms. If a constant current I is supplied to the bridge, a balance point is reached when the bolometer increases its resistance to five ohms from self heating. Ambient temperature changes or external power delivered to the bolometer produce deviations from the balance point. Output voltage E_o from the bridge is directly proportional to the consequent change in the bolometer resistance ΔR_B and the bridge voltage. Temperature variations are linearly reflected in the output as a proportional voltage Δe_o. Equations describing the temperature increment θ, caused by energy burst into the bolometer, also describe the output voltage characteristic Δe_o. When the balancing current I and its heating effect place the bolometer at a quiescent temperature, the dynamic thermal equation for the bolometer is given by

$$C_P \, d\theta/dt + \gamma \, \theta = P(t). \qquad (1)$$

Each term in the equation is a power term. The constant C_P is the heat capacity of the bolometer in watt-sec/deg C, γ is the linear heat loss factor assuming heat lost is directly proportional to θ, and $P(t)$ is the input power as a function of time. If the thermal time constant of the bolometer C_P/γ is made large compared to the duration of the power pulse $P(t)$, then the second term of the bolometer equation can be ignored yielding

$$\theta \cong 1/C_P \int_0^{t_1} P(t)\, dt \qquad (2)$$

Temperature rise is approximately directly proportional to the energy in the pulse and inversely proportional to heat capacity for the bolometer. The thermal time constant limits the accuracy of Eq. 2.

The output voltage Δe_o is directly proportional to the time integral of the input power pulse. Increments must be small for the linearity to be preserved, and second order effects, such as bolometer resistance variations and radiation heat-loss nonlinearities, are completely masked.

The temperature rise and the consequent bridge unbalance depends solely on the energy input. After the pulse expires, the bolometer starts to cool.

Figure 1B indicates the bridge output with time for a rectangular input pulse of duration T_1. At T_1 the bolometer cools in accordance with

$$\theta = \theta_m \epsilon^{-\gamma / C_{Pt}} \qquad (3)$$

Since the bolometer time constant is close to 25,000 μsec, there is sufficient time to measure the maximum temperature rise of the bolometer θ_m or an equivalent voltage. The shape of the cooling curve is independent of the input signal, and the integration action of the bolometer is sufficiently accurate for input signals approaching 20 percent of the bolometer time constant.

Calibration

The peak value of the output signal Δe_o is linearly related to the energy contained in the input pulse providing bridge voltage, ambient temperature and operating resistance are constant. If the signal is amplified and applied to a peak holding voltmeter, the peak value can be read on an output meter. To calibrate the bolometer bridge and subsequent amplifier-indicator stages, an input pulse with known energy content is applied, and the output meter is calibrated for some convenient full scale sensitivity.

A periodic, half-sine wave, 100-μsec pulse, adjustable up to 250 milliamps in peak value, is generated by a half-sine wave pulser[2]. If the pulse is read on an rms thermocouple meter, the energy contained in a single pulse is found where the repetition rate and the resistance, into which the pulse is dissipated, are known[3]. The ergmeter input resistance is 10 ohms. Since 60 pps are generated for calibration purposes, the energy per pulse is $E = i_{rms}^2 \, RT \, 10^7$ ergs or $E = i_{rms}^2 \, 10^8 \, 1/60$ ergs where i_{rms} is the pulse current measured by using a thermocouple type meter.

Thus, to calibrate the ergmeter, repetetive pulses are generated and measured. Then a single pulse, identical to the repetitive pulse, is applied to the ergmeter input.

The sensitivity of the instrument can be set and several points calibrated for a smooth curve. The resistance selected determines the attenuator design and the calibration accuracy.

Circuit Details

The bridge, amplifier, peak-holding voltmeter and 60 pps half-sine wave calibration circuits are shown in the schematic of Fig. 2.

Resistance R_s in series with the entire bridge brings the input resistance up to exactly 10 ohms. Three triode stages with a gain of about 20,000 amplify the bridge output signal up to a level of about 40 v for the peak-holding voltmeter. Feedback in the amplifier provides sufficient stability.

The amplifier is followed by a conventional peak-holding voltmeter. The storage capacitor C_1 in the peak-holding voltmeter is charged through a resistor R_1 so that spurious pulses do not confuse the integration. Resistor R_1 delays the peak reading so that only the slow cooling curve is measured.

A bridge vtvm provides the output indication. Since potentiometer R_2 is in series with the output meter the sensitivity can be set conveniently. The vtvm has a zero-set control and the indicator meter is a 0-100μa movement. A low resistance 200 μa meter can balance the bridge as a null detector, measure the bridge voltage at balance as a millivoltmeter and measure the pulser rms current when properly calibrated with the thermoelectric converter.

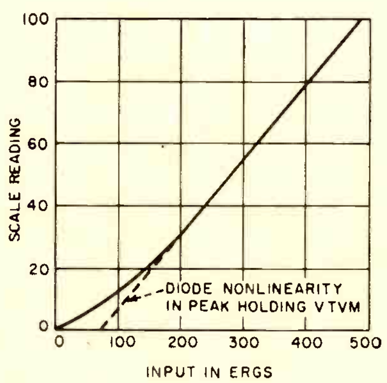

FIG. 3—Half-sine wave pulser injects energy bursts for calibration. Nonlinearity at low end of scale is caused by peak-holding voltmeter diode

To change the range of the instrument, constant-impedance 10-ohm ladder attenuator sections can be installed at the input, as external plug-in units. The ten-ohm input resistance was a convenient value for ordnance primer studies.

After the internal source is calibrated, or the energy content of the pulse, for any rms-current level, is made available as some curve, the bridge is balanced by increasing the bridge current and obtaining a bridge null. The bridge voltmeter reading is recorded for future reference. The bridge is now set up and disconnected from all meters by throwing the bridge switch to input calibrate.

The voltmeter section of the ergmeter is set to zero by discharging the storage capacitor with S_1 and balancing the bridge voltmeter with SET ZERO potentiometer R_3. The calibrator switch is now thrown to CALIBRATE and the half-sine wave pulser operates in a repetitive mode indicating an rms output current level on the 200 μa meter. The energy/burst for each pulse is found from the calibration curve. The adjustment for the energy/pulse level provides for an assortment of calibration points.

When the calibrating switch is thrown to SINGLE SHOT, then depression of the SINGLE SHOT OPERATION switch S_2 discharges the pulse into the ergmeter proper, and an output reading is obtained. The sensitivity control sets the arbitrary output scale of 0-100 for a convenient full scale sensitivity of 300 to 600 ergs. Basically, the sensitivity can be increased by about 100 ergs full scale with some sacrifice in stability. Other points can be calibrated in a similar manner.

A typical calibration curve for a convenient setting of 500 ergs full scale is shown in Fig. 3. Below 150 ergs the charging diode in the peak holding voltmeter causes some nonlinearity.

If, for example, the ergmeter range is to be extended to 5,000 ergs, a simple, resistive ladder attenuator is plugged in at the input before the bridge. The attenuator is designed to attenuate all input voltages by $1/\sqrt{10}$. The resistive pad across the input disturbs the bridge balance and the bridge current must be increased to restore bridge voltage to the previous value. At a constant impedance of 10 ohms, the basic scale can be extended by a factor of 10^6 with no difficulty.

Applications and Results

The ergmeter was used primarily for the evaluation of capacitor-discharge firing sets. A typical set consists of a precision capacitor, which can be charged up to a known voltage and then discharged through a mercury switch into the load. The theoretical energy stored and discharged in $5CV^2$ ergs, where C is in microfarads and V is in volts.

For firing an electric primer, the capacitor is discharged directly into the primer. The ergmeter measures the energy available into a 10-ohm resistor, which replaces the primer. Thus, an efficiency can be ascribed to the capacitor-discharge set.

As an example, the curve of Fig. 3 was obtained by discharging a 0.1-μf capacitor into the ergmeter with the voltage varied between 18 and 30 v. The scale reading with reference to the basic calibration curve for the ergmeter can be interpreted as an energy. The efficiency can be computed for this discharge, and it is a function of the capacitor surge resistance and the mercury switch losses.

For these tests, discharge efficiency is about 80 to 90 percent for well designed circuits. A poor mercury switch and excessive cable length reduce it to 50 percent.

Thanks are due to Mr. I. Kabik and W. Schaal. This work was sponsored by the U. S. Naval Ordnance Laboratories, under contract NORD 15005.

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Four Ways To Simulate

Delayed pulses gated to simulate azimuth, elevation and range produce realistic target patterns on radar indicator. Course generator simulates target speeds up to 2,400 knots. Side effects, including sea and land clutter are also generated and add to realism of presentation used to train radar operators

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TRAINING PERSONNEL to correctly read and interpret radar display information is costly in both time and money if live aircraft or surface targets are used. Radar targets can be generated synthetically, however, which produce a realistic pattern on the indicator. A pulse, delayed in time with reference to a trigger pulse, will simulate target range. Azimuth and elevation can be simulated by gating the target pulse so that it appears only at a particular spot on the indicator. Four methods of radar simulation, varying in complexity and versatility, are described with detailed explanations of important circuitry.

The radar presentation most commonly used for display of targets is a plan position indicator. Target, size and proximity to the radar antenna, appear as an illuminated arc on the face of the indicator. Polar position of the target is read from the indicator as range and bearing. A separate radar scans angles above or below a plane tangential to the earth to obtain elevation data. Azimuthal position data obtained from this range-height indicator is correlated with the plan position indicator sweep line or other reference.

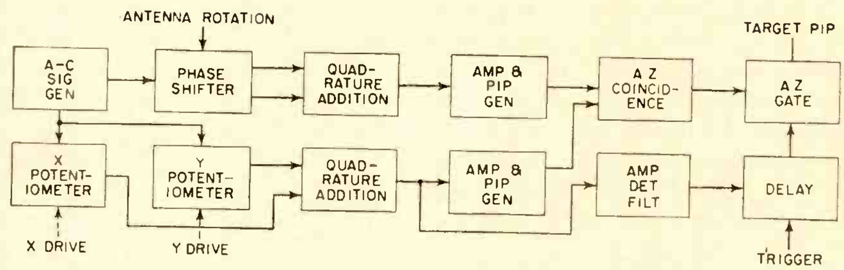
Two Dimensions

Figure 1 shows a two dimensional radar-target simulator for use with a radar repeater scope. A course generator, described later in the article, turns the shafts of the X and Y potentiometers in accordance with the X and Y rates of target motion. The potentiometers are energized with a balanced a-c voltage from a generator. The arms of the potentiometers deliver two identically phased a-c voltages to a quadrature addition circuit. Amplitude of the voltages is proportional respectively to the X and Y components of the target's position.

The X and Y voltages are combined in the quadrature circuit which adds them as if they differed in phase by 90 deg. The resultant voltage, called target a-c, has amplitude proportional to target range and phase which indicates target azimuth.

Target a-c is amplified, detected and filtered to obtain a target d-c pulse. The pulse is delayed with reference to a periodic trigger pulse to indicate range. A gating circuit limits appearance of the time delayed range pip to the correct azimuth. Target position and antenna position control the gating action.

An electromechanical phase shifter coupled to the antenna shaft relates instantaneous position of the antenna beam to target position. Input to the phase shifter is an a-c signal from the same signal generator that drives the X and Y potentiometers. Output of the phase



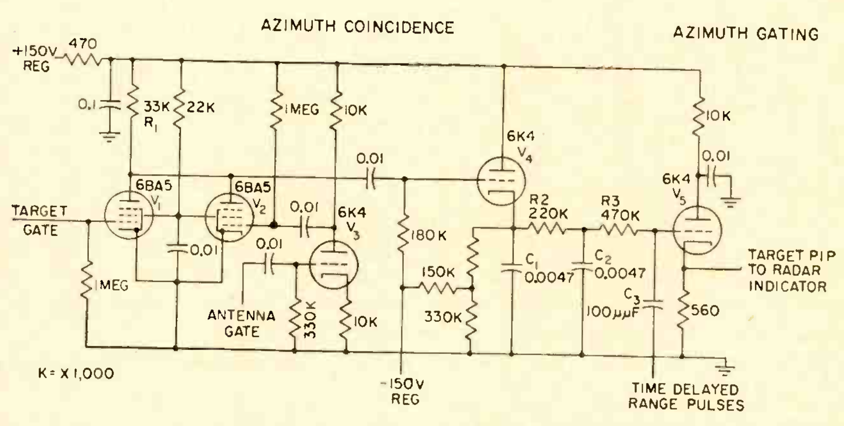
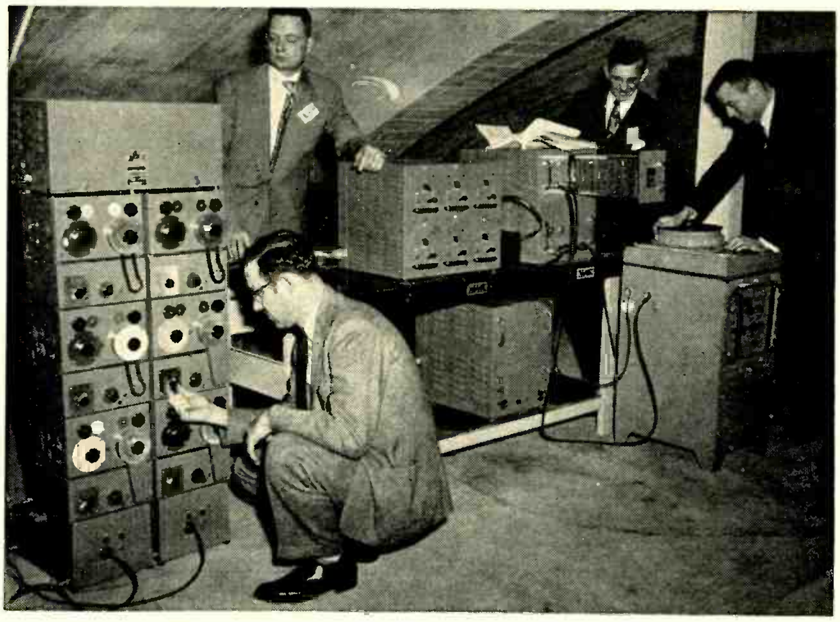


FIG. 1—Two dimensional radar target simulator supplies target pip to radar indicator

Radar Targets



Course generator settings on simulator front panel determine target motion

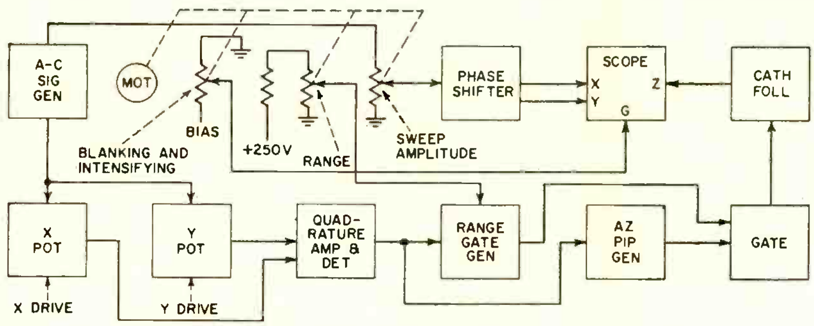
Radar target simulator produces realistic pattern on operational radar indicator without using expensive live aircraft or surface targets

shifter is a constant amplitude a-c wave with the same frequency as the target a-c, but traveling in phase as the antenna rotates. The azimuth coincidence circuit compares the phase of target a-c and antenna a-c.

Azimuth Coincidence and Gate

The two signals, one representing the angular position of the target and the other angular position of the radar antenna, are fed to the azimuth coincidence circuit shown in Fig. 1. When the signals coincide in time, indicating that the radar antenna is pointing toward the target, the delayed pulses representing a target are permitted to pass through the azimuth gating circuit to the radar plan position indicator.

Pentodes V_1 and V_2 have a common plate load resistor, R_1 and are both normally conducting, with a resulting plate voltage of about 10 v. The negative gate representing the target position cuts off V_1. The positive gate representing the antenna position is inverted by triode V_3 and used to cut off V_2. The 10-v plate voltage of V_1 and V_2 rises to about 35 v when either tube is cut off, giving a pulse of about 25 v on the grid of V_4. This pulse has no effect on V_4, because it is biased 50-v negative. When both V_1 and V_2 are cut off, their plate voltage rises to



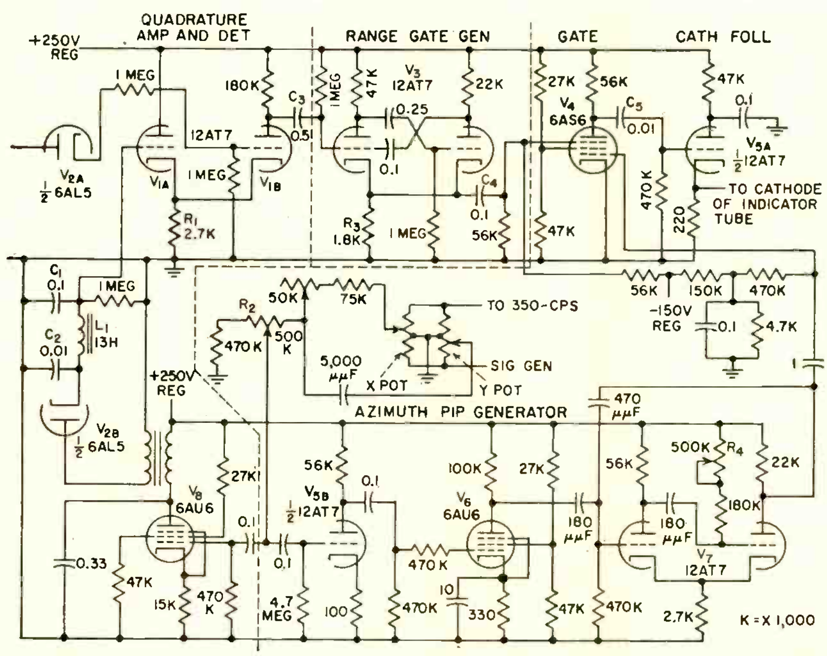


FIG. 2—Simulator does not require any operational radar equipment. Antenna signal is obtained from phase shifter and sweep amplitude potentiometer

150 v producing a large positive pulse that is detected by V_4 and filtered by the R-C combination C_1, C_2, R_2, and R_3.

Output voltage of V_4, which is grid bias for V_5, the azimuth gating triode, is changed from negative 100 v to about negative 25 v when the radar antenna is pointing at the target. The delayed target range pulses are fed through C_3 to the grid of V_5. When the bias on V_5 is negative 100 v, amplitude of the target range pulses fed through C_3 is not high enough to cause conduction. When the bias is reduced to 25 v, the target pulses pass through V_5 and on to the indicator.

Changing the width of the antenna pulse varies the length of time the azimuth gate remains open. With the correct pulse duration, azimuth width can be made to agree with the antenna beam of any specific radar. Varying range pulse duration produces a realistic radar target appearance on the indicator.

The azimuth gating circuit presents a signal to the radar indicator which causes a target to subtend a constant angle from maximum to minimum range. This unrealistic characteristic can be improved with circuit modifications.

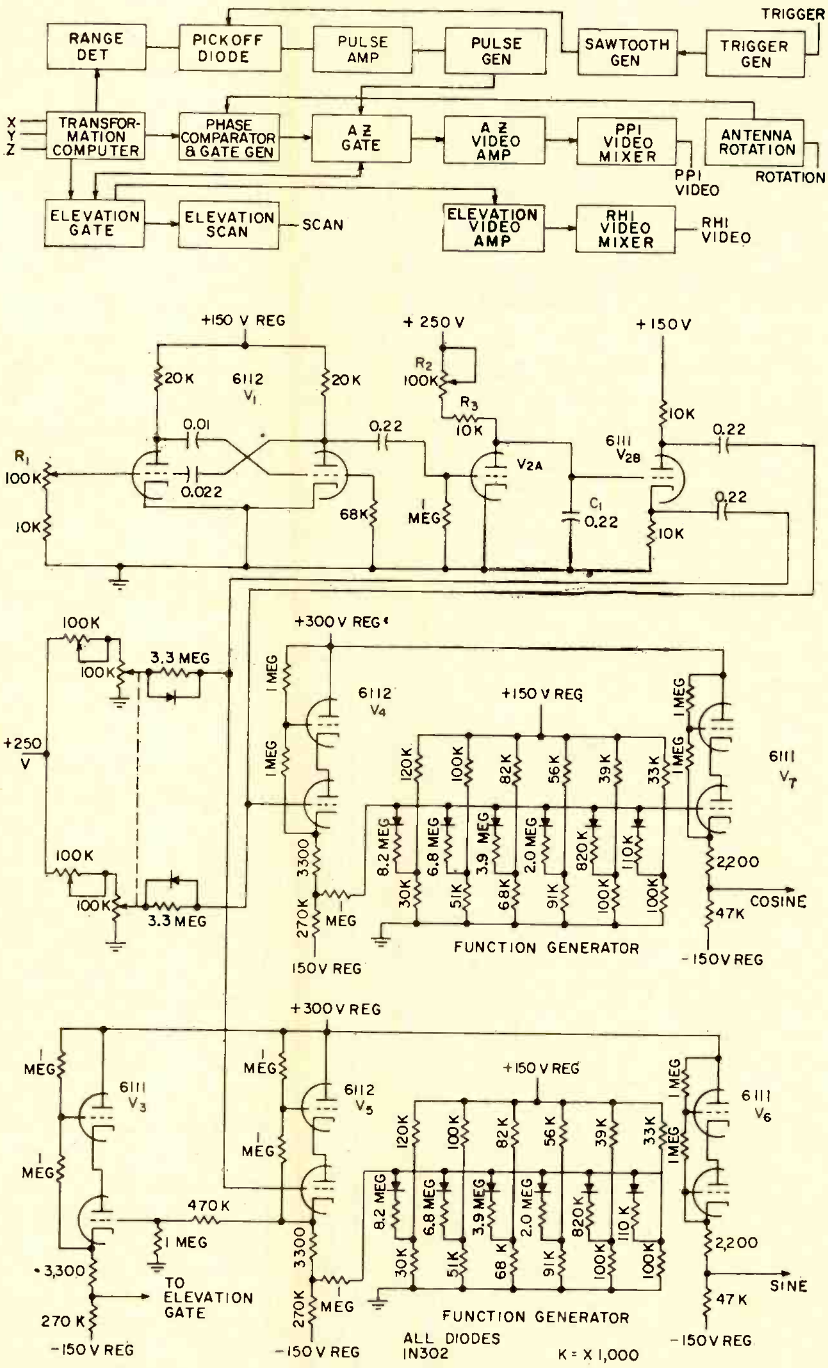


FIG. 3—Three dimensional radar target simulator uses computer approach to convert from rectangular to polar coordinates to obtain both ppi and rhi information

Spiral Sweep Simulator

A less expensive type of simulator, which does not require radar operational equipment, is shown in Fig. 2. The target signal is generated in much the same manner as the simulator just described. The antenna signal is obtained from a phase shifter and sweep amplitude potentiometer which provide a spiral sweep for the target on an oscilloscope.

Range of the target is indicated by gating the target to the correct radius of the spiral sweep. Azimuth is indicated by another gate which limits target appearance to the correct angle on this spiral sweep.

A course generator turns the shafts of the X and Y potentiometers in accordance with the X and Y rates of target motion. A low-impedance 350-cps sine-wave generator feeds the potentiometers. Output from the potentiometers is fed to a quadrature amplifier V_8 and detector network V_{2B}.

The d-c voltage out of the filter L_1, C_1, and C_2 is applied to the grid of cathode follower V_{1A}. A one-cps saw-tooth waveform generated by the motor driven range potentiometer is applied to the plate of V_{2A}. Output from the cathode of V_{2A} supplies the grid of V_{1B}. Since the range potentiometer is ganged to the sweep amplitude potentiometer, its instantaneous voltage represents sweep distance from the center of the cathode-ray tube.

A common cathode resistor R_1 for both V_{1A} and V_{1B} makes the cathode potential of V_{1B} proportional to the range voltage from the X and Y potentiometers. Amplifier V_{1B} is cut off until its grid becomes positive enough to overcome the cathode bias developed by the range voltage. Plate voltage of amplifier V_{1B}, which is normally high, quickly drops to a low value when the tube conducts. The cutoff action of V_{1B} provided by the range potentiometer gates the range voltage to the cor-

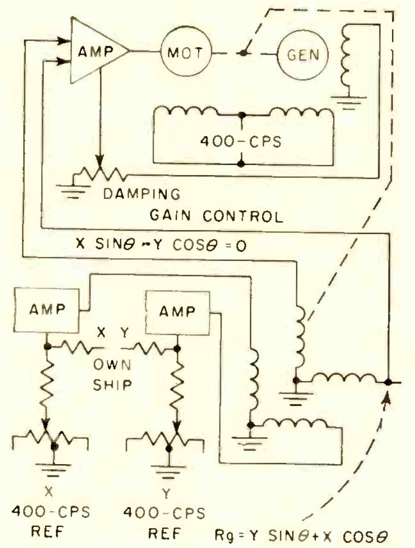


FIG. 4—Target position relative to moving own ship position can be obtained from this arctan computer circuit

rect radius of the spiral sweep.

Tube V_{1B} conducts for a period equal to one cycle of the a-c signal generator frequency. This period corresponds to 360 deg of sweep and permits the target to traverse the circle at nearly the same range.

The negative going pulse from V_{1B} is coupled through C_3 to the range gate generator, a monostable multivibrator, which produces a 3,000-μsec pulse. The pulse is taken from cathode resistor R_3 and coupled through C_4 to the suppressor grid of V_4, the gating tube. It is positive enough to overcome suppressor grid bias on V_4, and allow the tube to conduct when a signal is applied to the control grid.

The phase-shifted sum of the X- and Y-potentiometer voltages is also coupled to the azimuth pip generator, comprised of amplifier V_{5B}, limiter V_6 and monostable cathode coupled multivibrator V_7. Width of the multivibrator pulse, controlled by R_4, corresponds to antenna beam width, and determines the length of the arc appearing on the indicator. Since the voltages for the X and Y potentiometers are added in quadrature, the pulse occurs at a time which represents target azimuth.

Although a pulse is generated for each of the 350 sine waves which make up one revolution of the spiral scope sweep, suppressor grid bias on V_4 permits only one pulse to be displayed for each complete spiral sweep. The output of V_4 is coupled through C_5 to cathode follower V_{5A} and then to the crt cathode.

The P7 phosphor of the indicator tube helps to minimize target flicker. Range scale is arbitrary and assigned on the basis of target speed. The sweep value for the simulator is selected to reduce or eliminate target flicker.

Three Dimensional Simulator

A three dimensional radar target generator, for use with ppi and rhi scopes is shown in Fig. 3. Zero time reference for the ppi and rhi scopes and circuits of the radar simulator is supplied by a trigger generator. The course generator provides voltages proportional to target coordinates X, Y, and Z. A transformation computer resolves the X, Y, and Z, coordinates into polar coordinates R, θ, and E. Range voltage from the computer is compared with a linear saw tooth to obtain a time delay proportional to the range of the target.

At the comparison time, a voltage pulse appears as the target and occurs once for each timing pulse. A gate displays the target when the radar antenna simulator is at the same azimuth as the target. This gate allows targets within an angle of 0.5 deg to 4 deg of the antenna to appear on the ppi scope. This represents antenna beam width of 1.5 deg to 8 deg. Pulses or targets which have been gated by the azimuth gate circuit are regated by the elevation gate circuit at the correct elevation angle for presentation on the rhi scope.

Elevation Scan Simulator

The elevation scan circuit provides selection of an 11-deg or 22-deg nodding sector which can be adjusted to any portion of 0 to 90 deg of elevation angle. The simulator also provides a sine and cosine d-c voltage of its instantaneous elevation angle for driving the rhi scope.

The elevation scan simulator consists of a free running multivibrator V_1, with an adjustment R_1 to control the vertical scan rate. The multivibrator output drives a saw-tooth generator V_{2A}. Capacitor C_1, charged through resistors R_2 and R_3, produces a constant-height saw-tooth at different frequencies of multivibrator V_1. Phase splitter V_{2B} produces both positive slope and negative slope saw-tooth waves. The nod position dual potentiometer is connected so that one part produces an increasing voltage for a clockwise rotation and the other a decreasing voltage. The saw-tooth is added to the increasing voltage and subtracted from the decreasing voltage. The increasing voltage is proportional to the instantaneous antenna angle and the decreasing voltage is proportional to the complement of the instantaneous antenna angle.

Two voltages are fed to cathode followers V_4 and V_5. The linear output from the cathode followers feeds sine and cosine function generators made up of diode-resistor networks. Cathode follower V_3 drives the elevation gate coincidence circuits of each height target. The output cathode followers V_6 and V_7 are scaled to produce the proper voltage for the angle. The diodes in the function generators conduct when the input voltage exceeds the voltage of the divider connected to them. The input is loaded by the series resistor of each diode circuit. Six diodes produce a sine wave from a linear function that is within 0.5 percent of an actual sine wave.

Transformation Computer

The transformation computer shown in Fig. 4 resolves the target position identified by rectangular coordinates X, Y, and Z into polar or radar coordinates R, θ, and E. It makes the change by solving right triangles. Inputs to the transformation computer are voltages from readout potentiometers on the course generator. Target position relative to a moving own ship may be obtained by introducing the own ship components of position. A differential may be introduced at the junction between the speed component shaft output and the potentiometer, or a voltage summing circuit may be used at the input to the arc-tangent computer.

The complete three dimensional solution requires two computers. One solves for azimuth; the other for elevation. The elevation computer provides slant range output also in the form of a 400-cps voltage. Booster amplifiers are the key to the solution. They have a high

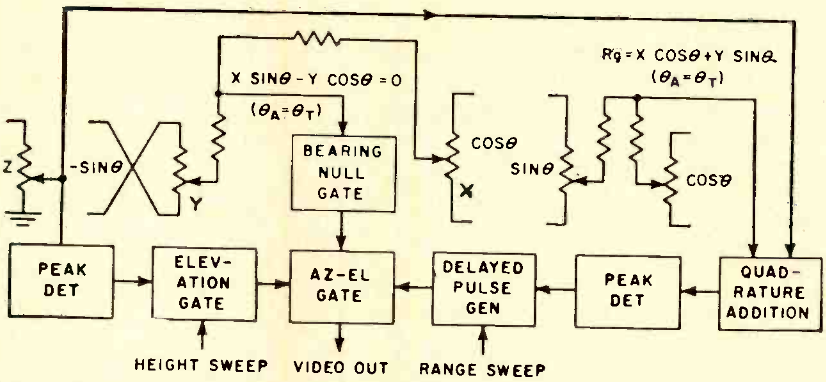


FIG. 5—Three dimensional radar target simulator uses a resolver to supply X, Y and Z potentiometers. Signal for ppi is modulated at height scan rate

input impedance, low output impedance and a high loop gain.

Course Generator

An important component of a radar target simulator is a course generator to obtain target motion. Basically it is made up of an integrator which accepts an input rate and supplies an output equal to the time integral of the input plus the output it had before the rate was instigated, which is the constant of integration.

The electromechanical target course generator simulates target speeds up to 2,400 knots. It has a servo that operates at 400 cps and, through a gear reduction, drives a ten-turn potentiometer having a linearity of 0.1 percent for X and Y positions, and a single turn potentiometer having 0.5 percent linearity for height.

Mechanical scaling of the integration follows the best gear ratio to obtain a desired maximum rate on the output shaft so the motor will be running at a maximum speed of 60 percent synchronous. This gives the best linearity to the system. Rate input speed can be double its assigned value and more, before power requirements of the servo become an important factor. In this specific application, the climb-dive rate has a gear ratio of over 20,000 to 1, and the X and Y integrators have a gear ratio of 12,500 to 1. Stall torque of the motor is 0.25 in.-oz and regulation torque 0.1 in.-oz. For regulation alone, over 1,000 in.-oz of torque exist on the output shaft allowing for a relatively poor gear efficiency. Output torque available is more than sufficient by several magnitudes. Thus, the speed characteristic of the course generator definitely is not limited by servo power.

Another method of obtaining a three-dimension radar target is shown in Fig. 5. The excitation voltages to the X and Y potentiometers are obtained from a resolver. The Z potentiometer gets its voltage from the reference source which excites the resolver. The ground range voltage is added in quadrature with height voltage. This signal is peak detected as a slant-range voltage when compared with a range sweep voltage. The signal is amplified and peaked to form a video pulse.

Since the bearing null becomes sharper with increased X and Y voltage, width of the azimuth gate diminishes as target range increases. This effect is more realistic than that obtained by gating the target with a signal having a constant angle with range. Output of this simulator is fed to either a ppi or rhi scope. If fed as shown, the ppi video signal is modulated at the height scan rate. A complete three-dimensional system therefore requires two such units with ganged pots fed from a course and speed plus climb and dive generator.

Adding Realism

Radar target simulators described so far have had no side effects added to produce greater realism. Sea or land clutter is a random reflection of the radar wave bounced back to the antenna from ocean waves or from the uneven terrain of the earth. A thyratron noise generator followed by a video amplifier will simulate this effect. Varying amplitude, range, and slope will simulate clutter for various operational conditions.

It should also be possible to insert a delay equivalent to aircraft height to display an altitude circle on the ppi indicator. The circle will change size with each range scale of the radar, appearing large on the short range setting.

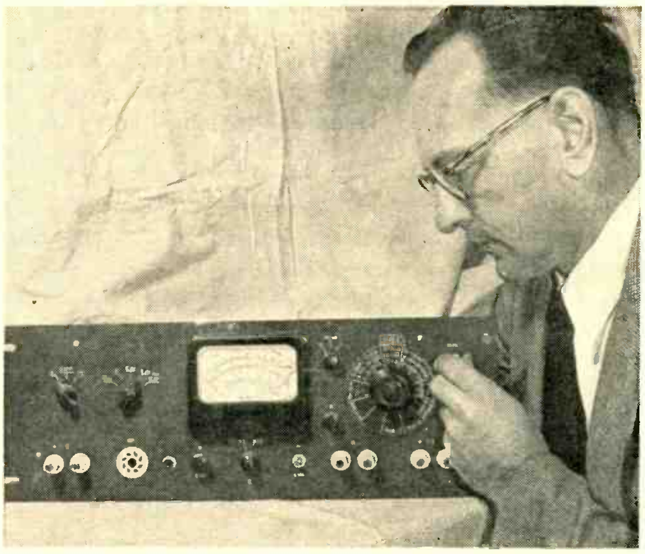
A modulator inserted in the video lead of each target will simulate target fading. An aperiodic low-frequency oscillator will provide random fading. As target range increases, an automatic attenuator to diminish the target amplitude will make detection more difficult.

Beacon radar replies simulate a landmark or shipborne reference point. A beacon enables a radar-equipped plane to find its way back to its starting point or other location when landmarks are not available for radar pickup. Beacons are effective to maximum radar range.

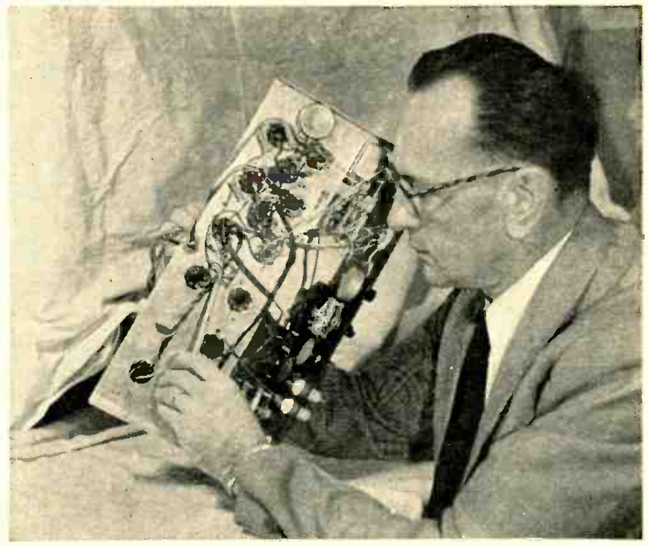
A simulated radar target return is used as the beacon location. The pulse is gated to trigger a beacon reply. The reply appears as a single pulse or a train of pulses having a short delay with reference to the target pulse. Amplitude control and spacing of the pulse gives a high degree of realism. Azimuth width of the reply is usually the same as receiving antenna beam width and can be gated in the same manner as the simulated radar return.

Land mass adds further realism to a radar picture. A film transparency mounted on an east-west, north-south carriage is scanned by a flying spot scanner. For a fixed radar range, own ship motion is shown by varying the X and Y position of the film. Moving radar targets must also move relative to the own ship to create realistic effects which are shown in a plot.

Instead of using a film, a more realistic display is obtained by scanning a relief map under water with an ultrasonic transducer. Positioning the scanner can be in X and Y while Z gives the effect of radar shadow as a function of elevation. A signal beamed from the transducer is reflected back to it from the submerged map. The ultrasonic signal travels at 1/200,000 the speed of radio waves.



Zero adjustment of differential voltmeter containing two infinite input d-c amplifiers is made from front panel. Calibration is not needed since amplifier gains are within 0.0005 percent of unity



Construction of the differential voltmeter is straightforward. Resistors can be the plain carbon type. Matching is not required because operation is negligibly affected by changes

D-C Amplifier Expands Input Voltage Range

Infinite input impedance is obtained in a direct-coupled d-c amplifier by continuously and automatically feeding back a bucking voltage to the input which is equal to the signal voltage. Input voltage can vary over wide range and is dependent only on magnitude limitations of bucking voltage. Grid current is reduced to zero by balancing positive and negative currents. Because amplifier detects and responds linearly to small voltage changes at high input levels, it is ideal for analog computer and voltmeter applications

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SIGNAL VOLTAGES are held to relatively low levels in conventional d-c amplifiers because of limited input voltage range. Where precision is paramount, the range is further restricted by the nonlinearity caused when output tube parameters depart from the quiescent operating point. Also, when large signals originating in a source of low-energy content are used, the signal level must be reduced to within the working range of the amplifier.

The amplifier described here is designed to hold the grid bias and current and the plate voltage and current of the input tube constant as the signal voltage varies throughout the design range. Since grid bias can not change with variations in signal, the input for any signal level is seen by the input tube as a zero voltage.

Advantages of Amplifier

Two characteristics of the amplifier—infinite input voltage range and infinte input impedance—are especially desirable in certain analog computer applications where signal voltages represent considerable extremes of magnitude and originate in sources of low-energy content. By using input signals ten or more times those ordinarily used, the relative drift and effects of line-voltage fluctuations are reduced proportionately. In some cases, this property eliminates the need for drift compensating devices.

When used in vacuum-tube volt-

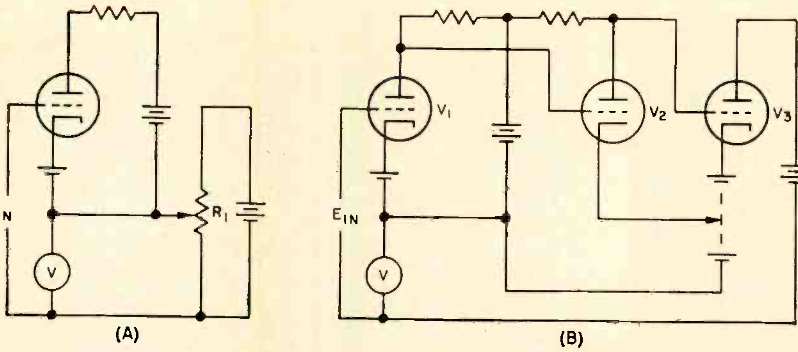

FIG. 1—Evolution of infinite input impedance d-c amplifier. Cathode-to-plate voltage in slideback voltmeter (A) is held constant by physically adjusting potentiometer R_1. In the completely automatic vacuum-tube circuit (B), the cathode-to-plate voltage of tube V_1 is continuously maintained at a constant level by feedback from tubes V_2 and V_3

meter circuits or the like, input range dividers can be eliminated entirely and range resistors placed at the output. This technique gives higher input impedance. Another advantage is that relatively low-valued resistors can be used resulting in an appreciable reduction of cost.

Conventional Limitations

In conventional plate or cathode loaded d-c amplifiers, a signal voltage variation causes a corresponding variation of grid bias which changes the plate voltage and current. With 100-percent negative-feedback amplifiers, signal voltage variations result in corresponding variations of grid bias and changes in plate voltage of the input tube; however, the plate current remains constant.

In either of these amplifiers, signal voltage variation changes grid bias which varies the amount of grid current drawn. Grid current can, therefore, be different for any voltage in the input range. For certain applications, grid current becomes undesirably large. Special tubes can be used to alleviate this condition but grid current is not completely eliminated.

A change in any or all of the input tube parameters causes the quiescent operating point to move toward the region of plate bottoming, or, toward the low plate current region brought about by grid cut off. For this reason, both input voltage range and input impedance are finite. Precise operation of conventional amplifiers requires that the input voltage range be kept small.

A small negative grid current, generated by attraction of positive ions, and a comparatively large positive grid current, generated by impinging of electrons, coexist in all vacuum tubes. By biasing the grid to the point where the negative grid current becomes as great as the positive grid current, the effective grid current can be reduced to zero.[1]

Bias potential required is equivalent to the floating grid potential generated when the grid is not connected externally while the tube is in operation. If the bias can be adjusted sufficiently to keep the parameters of the grounded-grid tube equal to the parameters of the floating-grid tube, the grid current will be zero and the input impedance will be infinite for a zero input signal.

Grid bias and current and plate voltage and current can be held constant over any range of input level by using the slideback voltmeter circuit shown in Fig. 1A. If the bucking voltage is adjusted to hold the plate voltage constant as E_{IN} is increased, the plate current and grid bias and current will remain constant as long as E_{IN} does not exceed the range of the bucking voltage. Within this range, the input tube sees an input voltage that appears to be zero. The voltmeter indicates E_{IN} precisely without loading the input tube or the circuit to which E_{IN} is connected.

Automatic Circuit

Since the slideback voltmeter circuit must be manually adjusted, it is impractical for computing or measuring devices. For the circuit to be usable in these applications, the bucking voltage must continuously and automatically be obtained as E_{IN} changes. This can be accomplished using the circuit shown in Fig. 1B.

Necessary bucking voltage is supplied by tube V_3. Any change in plate-to-cathode voltage of tube V_1 is detected and amplified by tube V_2. The amplified error signal is applied to V_3 where it is further amplified. The output signal appears across the voltmeter as a bucking voltage whose magnitude is always equal to the signal voltage on the grid of V_1.

To clarify the explanation of the circuit, it is assumed that infinite

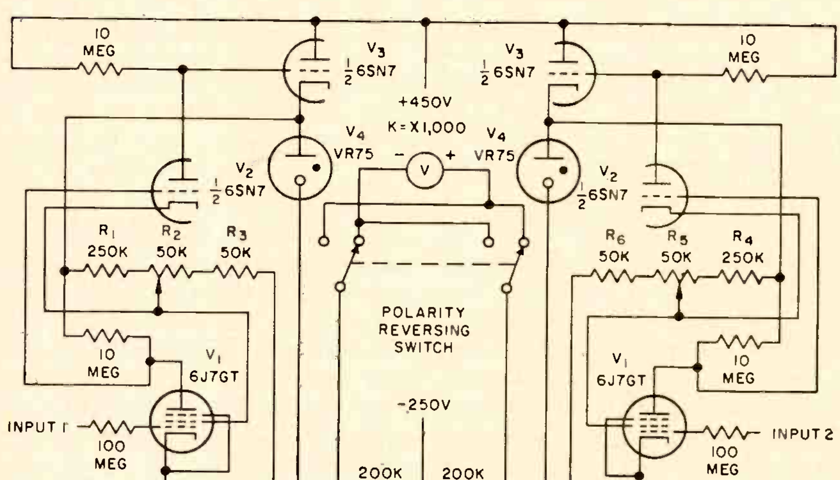

FIG. 2—High-impedance differential vtvm with input range from —150 to +150 v. Conventional input voltage dividers are eliminated; range resistors are in output circuit. A polarity switch is provided to eliminate nuisance of transposing leads. Any simple half or full-wave unregulated voltage supply is suitable for use with this circuit

gain is available from V_2 and V_3. Actually, the gain is finite, the plate-to-cathode voltage of V_1 is not held precisely constant, and the tube parameters vary. Change in grid bias is given by the equation:

$$\Delta E_{gk} = \Delta E_{IN} - \Delta E_{OUT}$$

where $E_{OUT} = E_{IN} [G/(G + 1)]$, E_{gk} is grid bias, G is overall gain without feedback, and E_{IN} is input voltage.

A typical amplifier with an internal gain of 2,000 will have an E_{OUT} of 0.9995 E_{IN}; that is, the grid bias change will be 0.0005 v for each 1-v change in E_{IN}. Thus, a signal of 300 v causes only 0.15-v change in grid bias and a corresponding change in the other parameters. Since the amplifier gain is considerably greater in practice, the operating point of an actual tube does not change as much.

Practical Application

A practical application of the amplifier is in the differential voltmeter circuit shown in Fig. 2. With either input grounded, the instrument can be used as a conventional vtvm; however, the absence of input voltage dividers and the input tube's constant operating point gives an input impedance far beyond that of other instruments.

The use of both inputs allows differential measurements of small signal voltages at mean levels between −150 and +300 v. For example, with the meter selector set on the 0.3-v scale, simultaneous measurements of two voltages of 300 and 300.3 v, give a full-scale deflection of the meter. This differential feature is particularly useful for measuring grid-to-cathode potentials in high-impedance circuits or for balancing high-impedance push-pull circuits.

Grid-to-cathode potential of the series regulator tubes in regulated voltage supplies can be observed under varying load and output voltage conditions. Elimination of the input dividers permits the use of this device in applications where an electrometer is normally used.

The practical differential voltmeter shown in Fig. 2 incorporates two identical amplifiers. For high stability on low-voltage ranges, resistors R_1, R_3, R_4, and R_6 and po-

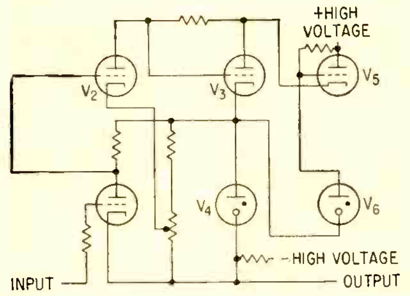

FIG. 3—D-c amplifier for high input voltages. High-voltage series regulator tube V_5 maintains plate voltage of V_3 at virtually constant level

tentiometers R_2 and R_5 should be wire wound since any resistance change causes a slight zero shift. High-frequency oscillations can be eliminated by connecting a small capacitor from the grid of V_3 to ground.

A type 6J7GT tube was chosen for V_1 because of its top-cap construction which reduces leakage from the input grid to the other elements. Leakage across the glass envelope can be reduced by connecting the base shield to the cathode. Since operation is not dependent on tube type or characteristics, a high- or low-mu triode can be substituted for the 6J7GT without an appreciable change in operation. If a pentode is used for V_2, its screen can be supplied from V_3 cathode or by tapping R_1 or R_4.

For other than relatively low-voltage measurements, the cathode-to-heater voltage ratings will be exceeded unless separate filament supplies are provided for the two amplifiers. Supply voltage changes have no effect on operation or calibration other than to change the input voltage range. To provide a 300-v input range, the positive supply should be at least 450 v.

Either potentiometer R_2 or R_5 can be mounted on the panel; the other should be mounted on the chassis. Moving the slider of R_5 the chassis mounted potentiometer is used to change the operating point of V_1 while initially setting the floating grid bias. Thereafter, the panel-mounted potentiometer is used for zero adjustment.

When setting the floating grid bias, small, well insulated 100 to 1,000$\mu\mu$f ceramic capacitors are connected across each input to ground. The input is temporarily grounded and the capacitor across input 2 is discharged by momentarily touching it with a grounded lead. Rate and direction of drift of the voltmeter pointer is then noted and potentiometer R_5 given a trial adjustment. The discharge and adjust procedure is repeated until the meter pointer remains stationary but not necessarily at zero. Input of amplifier two is then grounded and the procedure is repeated on amplifier one. The input tubes are now operating at their zero grid-current point.

During stand-by periods when the instrument is turned on but the inputs are not grounded or connected to an external source, the grids will be left floating. Without a conductive path to ground the grids are not constrained and are freely affected by stray currents and by random fluctuations within the tubes. These tube characteristics cause an annoying vibration and swinging of the meter pointer, especially when set on a low range. This difficulty can be eliminated by connecting a small capacitor between the input grid and ground. If a range of input voltages beyond the amplifier rating is required, the arrangement in Fig. 3 can be used.

Ultra-High Impedance Voltmeter

If full advantage is to be taken of the high input impedance feature of the voltmeter, conventional input jacks or binding posts and test leads cannot be used. These convenient accessories are impractical because the insulation resistance of jacks and leads is considerably lower than that of a clean, shielded 6J7GT input tube.

A simple method of reducing test lead leakage is to connect the lead directly to the series grid resistor of V_1, place a shield over the lead, and drive this shield by connecting it to the low impedance output. This procedure effectively increases the leakage resistance by a factor approximately equal to the internal gain of the amplifier; that is, if the internal gain is 2,000, the resultant effective resistance will be 2,000 times the original resistance.

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(1) G. E. Valley, Jr. and H. Wallman, "Vacuum Tube Amplifiers", *Rad Lab Ser*, **18**, p 418, McGraw-Hill Book Co., New York, 1948.

Signal-Strength Chart

Computations of signal strength input to a receiver can be solved graphically by using nomograph based on a formula that converts field intensity at the receiving antenna to receiver input voltage

By A. W. EMMONS Ramo-Wooldridge Corp., Guided Missile Research Division, Patrick AFB, Fla.

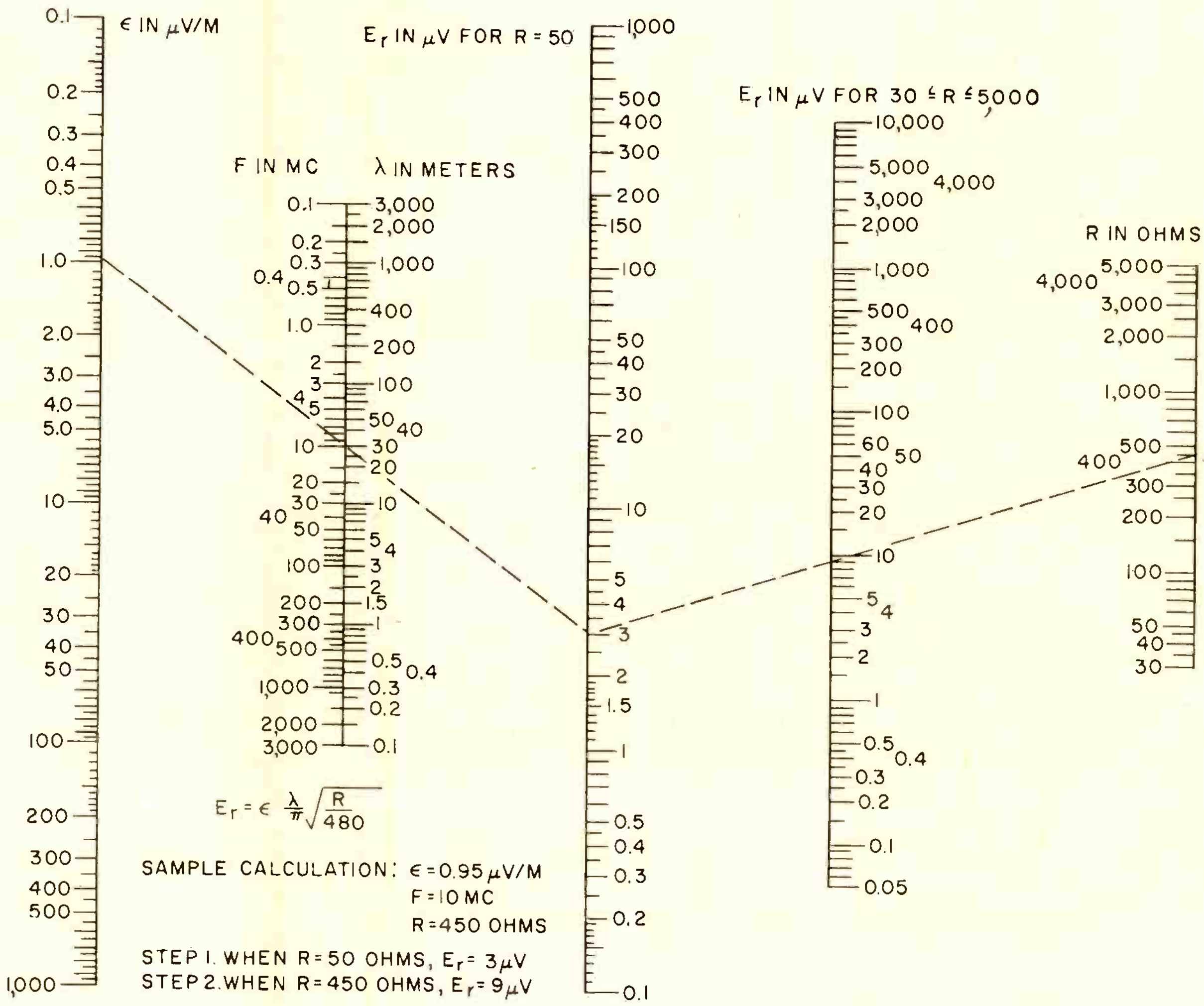
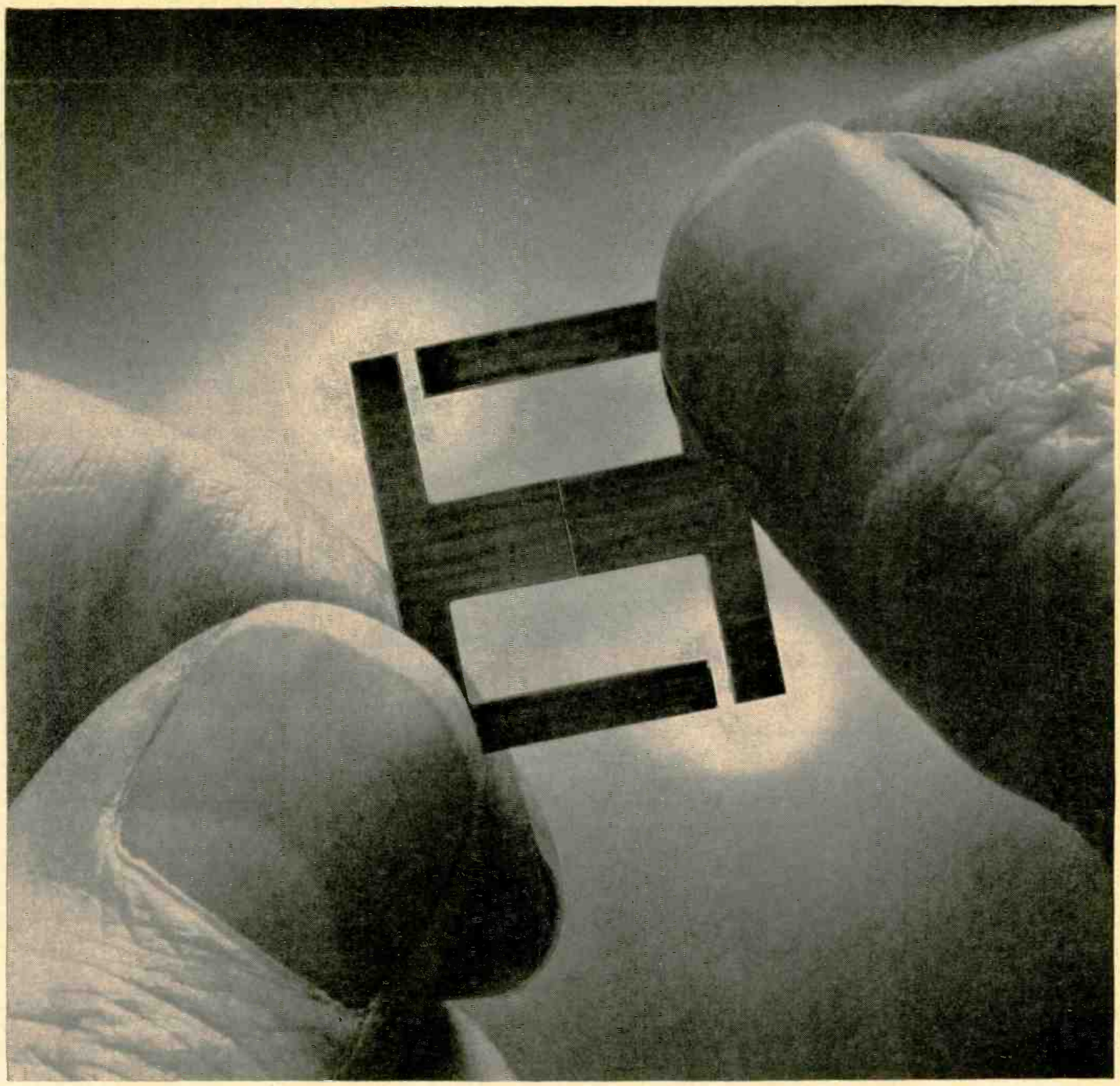


FIG. 1—Nomograph for converting field intensity to receiver input voltage

If field intensity ϵ, in μv per meter, of a given signal f, in mc, is known, the signal strength E_r, in μv, is determined for an input impedance of 50 ohms (E_r in μv for $R = 50$) and may be adjusted for any value of input impedance between 30 and 5,000 ohms (E_r in μv for $30 \leq R \leq 5{,}000$). An isotropic antenna, no-loss transmission line is assumed.

Signal strength for receiving antennas of gain > 1 (0 db) are solved first by finding from the chart the voltage input for a system with an isotropic antenna and then adjusting the answer using the relation: $G = 20 \log (E'_r/E_r)$ where G is the gain of the antenna referred to isotropic; E'_r is the voltage input to be found; and E_r is the voltage input.



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Look at the air-gaps on this new performance-guaranteed lamination we have developed and are stocking. The F-187's fixed air-gap provides constant inductance or linear inductance, as needed, because it prevents d-c saturation of the stacked core.

The F-187 3/16" wide center leg is designed for miniaturized filter circuits for communication applications. It is ideal for carrier equipment, and can be used most successfully for microwave, computer or other applications where frequency control is critical.

Being an "F" shape, the new standard stacks more easily than EI-187, and thus offers welcome savings on the production line. There can be advantages to you, too, in being able to order any quantity, prototype or production, directly from stock.

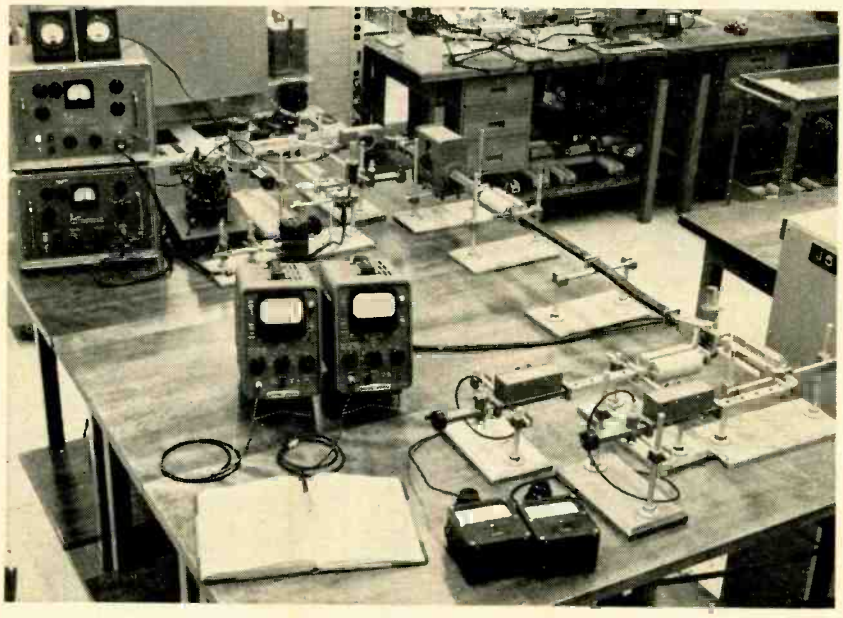
There's more detailed information on this new member of Magnetics, Inc. family of "Performance-Guaranteed" laminations—and all of our other standard laminations. Just write—*Magnetics, Inc., Dept. E-49, Butler, Pa.*

MAGNETICS inc.

CIRCLE 61 READERS SERVICE CARD

Microwave Component Tester

By A. F. POMEROY Bell Telephone Labs, North Andover, Mass.



Simple operation and calibration are key features of setup for measuring losses in microwave devices

MANY MICROWAVE devices have better characteristics at frequencies between their extreme operating frequencies. Such devices can be checked at their edge-band frequencies with the assurance that they will be satisfactory at frequencies in between.

A simple, fast method of measuring the insertion losses of a waveguide component at two frequencies simultaneously is described. Losses from 0.1 to 38 db have been measured using this method.

Many factors affect the accuracy of measurement, including reflected power at the flanges, interaction factor, stability of the test circuit and readibility and accuracy of calibration of the loss-indicating device.

A typical test setup is shown in the photograph. Losses from 0.1 to 1.5 db at 10,700 and 11,700 mc can be measured to an estimated accuracy of 0.02 db.

The circuit is shown in Fig. 1. Two klystrons generate c-w at 10,700 and 11,700 mc. Directional couplers, frequency meters and detectors provide for checking these signals. The two frequencies are combined in a hybrid junction before being applied to junction *A-B* under test.

The two frequencies are separated again by bandpass filters. The d-c out of one detector is proportional to one klystron output, and that out of the second detector to the other. The operating levels at the detectors are chosen so that a one-db change in input will cause a 25-division change on each of the output meters.

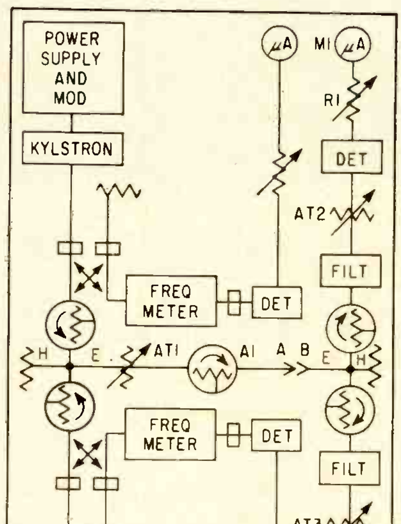


FIG. 1—Circuit measures losses in microwave components at two frequencies

Precision attenuator AT_1 must have the same change of loss at both frequencies as the dial is moved from one setting to another. This attenuator is calibrated at the ½-db points between 2 and 3.5 db. This makes these points more accurate than the intermediate divisions. Experience has shown that errors of 0.05 db can occur by using the intermediate divisions on AT_1 and a reference reading on the meters to measure insertion loss.

Calibration is effected as follows: Precision attenuator AT_1 is set to a scale reading of 2 db. Attenuator AT_2 is adjusted for full scale reading on M_1. Then AT_2 and resistor R_1 are adjusted to values that yield 25 divisions on M_1 for a change from 2 db to 3 db in the setting of AT_1. The AT_3, R_2 and M_2 combination is calibrated similarly.

A typical calibration yields 13 divisions on the meter for the change on AT_1 from 2 to 2.5 db; 12 divisions for the change from 2.5 to 3 db; and 10 divisions for 3 to 3.5 db. The meter readings for each setting of AT_1 are recorded and plotted on a calibration chart.

To make a measurement, AT_1 is set at 2 db, and AT_2 and AT_3 are adjusted for full scale readings on M_1 and M_2. Insertion of the component under test between flanges *A* and *B* will cause M_1 and M_2 to read less. Entering the calibration chart yields the insertion losses.

Changes in insertion loss of 0.01 db can be observed using this test setup. Return losses attributable to differences between the impedances looking into isolator A_1 and into the component under test can account for loss changes of this order. Slight rotation of one flange with respect to the abutting flange can also reflect power of this same order.

Stability is achieved by measuring in a temperature-controlled room and by regulating the filament and plate supply voltages for the klystrons.

The range of loss measurements can be extended to about 38 db by modulating the klystron oscillators with a 1,000-cps square wave and *first in Performance Reliability and Quality*

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Model SC-18-2-M

VRPS*

0.1%

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*Two units mounted in Rack Adapter RA-2

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Model SC-18-4-M

* VOLTAGE REGULATED POWER SUPPLIES

MODEL	OUTPUT VOLTS DC	OUTPUT AMPERES DC	OUTPUT IMPEDANCE DC-1KC	OUTPUT IMPEDANCE 1KC-100KC	SIZE W	SIZE H	SIZE D	PRICE
SC-18-0.5	0-18	0-0.5	.04	.4	8⅛"	4⅛"	13⅝"	$195.00
SC-18-1	0-18	0-1	.02	.2	8⅛"	4⅛"	13⅝"	250.00
SC-18-2	0-18	0-2	.01	.1	8⅛"	4⅛"	13⅝"	295.00
SC-18-4	0-18	0-4	.005	.05	19"	3½"	13"	395.00
SC-36-0.2	0-36	0-0.2	.1	1.0	8⅛"	4⅛"	13⅝"	275.00
SC-1836-0.5	18-36	0-0.5	.08	.8	8⅛"	4⅛"	13⅝"	250.00
SC-1836-1	18-36	0-1	.04	.4	8⅛"	4⅛"	13⅝"	295.00
SC-1836-2	18-36	0-2	.02	.2	19"	3½"	13"	395.00
SC-3672-0.5	36-72	0-0.5	.15	1.0	8⅛"	4⅛"	13⅝"	295.00
SC-3672-1	36-72	0-1	.08	.8	19"	3½"	13"	395.00

Patent Pending

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- **REGULATION** (for line or load) 0.1% or 0.003 Volts (whichever is greater)
- **RIPPLE:** 1 mv. rms.
- **RECOVERY TIME** 50 microseconds
- **STABILITY** (for 8 hours) 0.1% or 0.003 Volts (whichever is greater)
- **TEMPERATURE COEFFICIENT** 0.05% per °C. Ambient operating temperature 50°C maximum. Overtemperature protection included. Unit turns off when over-temperature occurs.
- **SHORT CIRCUIT PROTECTION:** NO FUSES CIRCUIT BREAKERS OR RELAYS! Designed to operate continuously into a short circuit. Returns instantly to operating voltage when overload is removed. Ideal for lighting lamps and charging capacitive loads.
- **OVER CURRENT CONTROL** can be set from 0 to 120% of full load.
- **REMOTE PROGRAMMING** at 1000 ohms per volt.
- **REMOTE ERROR SIGNAL SENSING** to maintain stated regulation directly at load.
- Suitable for square wave pulsed loading.
- Continuously variable output voltage without switching.
- Either positive or negative can be grounded.
- Units can be series connected.
- Power requirements: 105-125 volts, 50-65 cycles. 400 cycle units available.
- Terminations on front and rear of unit.
- High efficiency. Low heat dissipation.
- Compact, light weight for bench or rack use.
- Color: grey hammertone.

ORDERING INFORMATION:

Units without meters use model numbers indicated in table. To include meters add M to the Model No. (e.g. SC-18-1-M) and add $30.00 to price.

*Rack adapter for mounting any two 8⅛" x 4⅛" units is available. Model No. RA2 is 5¼"h x 19"w, is $15.00

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by using standing-wave indicators as amplifier detectors. The standing-wave indicator is set on an expanded scale so that 0.1 db spans about ⅛ inch.

The detector and standing-wave indicator combination are used at fixed level input. Losses are read on AT_1. The stability is not as good as that of the unmodulated circuit. The accuracy under these conditions is about 0.2 db.

Experience has shown that this type of circuit is very useful for quickly measuring the loss of a component at two frequencies, especially in those cases in which adjustments are made on the component in order to meet test requirements.

Infrared Analyzer for Missile Safety

SAFETY is a major problem in the launching of satellites and missiles. Elaborate precautions are taken including electronic gear such as closed-circuit tv and telemetering.

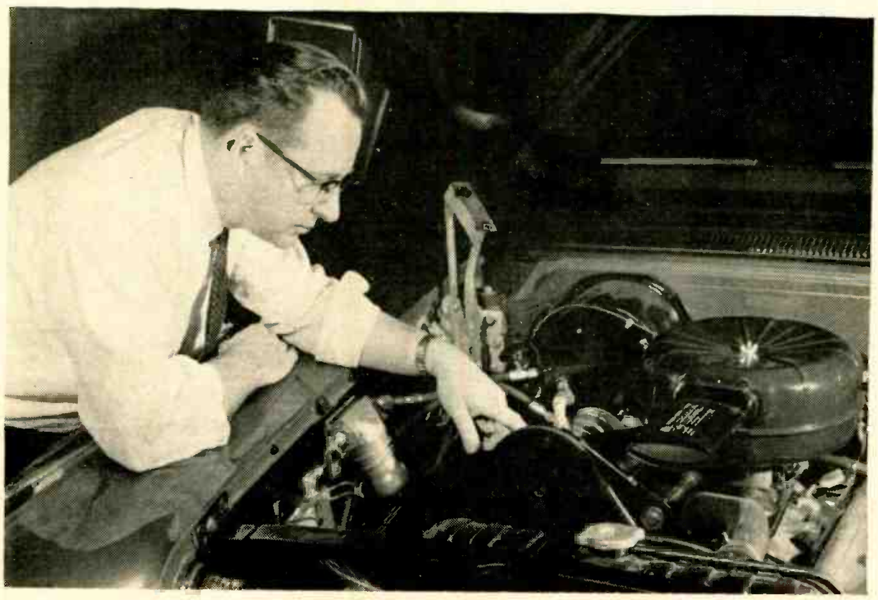
Three specially designed infrared gas and liquid analyzers developed by Mine Safety Appliances were used on the launching pad of Explorer III. The instruments monitor hydrocarbon content of the liquid air, nitrogen and helium streams with which the missiles are fueled and pressurized. Should the hydrocarbon content approach a critical explosive point, the detectors, by means of mercury switches, shut down the operation.

The infrared analyzer is described by MSA engineers as a nondispersive deflection type infrared absorption comparison instrument. Two similar Nichrome filaments are the separate radiation sources for the test and reference beams. A motorized rotating interrupter alternately interrupts these in such a way that superimposing the two blinking beams would result in a single steady beam.

The stream sample flows through a gold-plated stainless steel cell in the optical path of the test beam; a comparison cell in the other beam is completely sealed.

After passing through the sample and comparison cell, the two beams unite in a pneumatic microphone capacitor. The result is an electrical signal of amplitude proportional to the difference in infrared absorption between test sample and reference. This signal drives a meter and recorder to read either directly or proportionately the calibrated range of the analyzer.

Servo System Steers Car



Servo system tied in with power steering on test car is checked by J. Bidwell, department head on GM's research staff. Car follows buried cable carrying low-frequency a-c

Circuit Shifts Phase 360 Degrees

By W. BACON
Runeberginkatu 67 B 31
Helsinki, Finland

TWO VOLTAGES that are out of phase with each other by a known angle are often necessary. It is also desirable to be able to vary this angle over as wide a range as possible.

The circuit described below does this at a fixed frequency. It uses resistances and capacitances only, making it useable down to very low frequencies. It requires only one variable component and provides a phase difference between the two output voltages that can be varied from −180 degrees to +180 degrees without substantial change in magnitude. Theoretically magnitude can be made absolutely constant, the actual variation depending on the maximum impedance that can be tolerated in the output circuit.

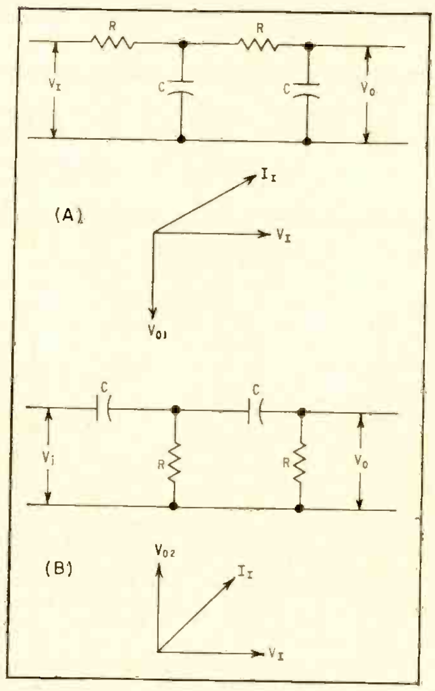


FIG. 1—Simple network at A produces 90-degree phase lag, while that at B produces 90-degree lead

The single-phase input is first split in two by means of two two-loop networks of the types shown in Fig. 1A and B. The network in Fig. 1A, by a suitable choice of components produces a phase lag of 90 degrees. The network in Fig.

Shores of Tripoli

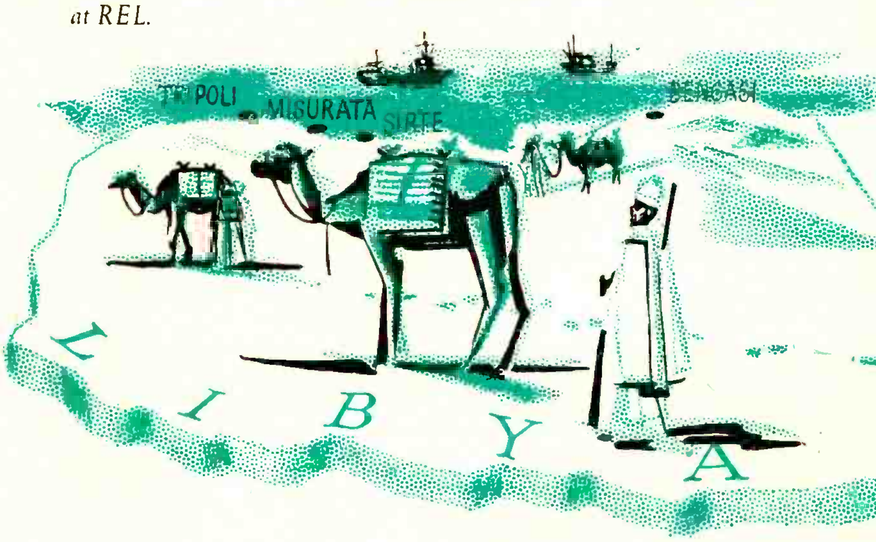
A most advanced communication network engineered by Hycon-Page Libya is being manufactured for the ancient shores of Tripoli. Civil and military service for the United Kingdom of Libya will be provided by a national telecommunications system.

For the tropo scatter spans, Hycon-Page Libya has chosen radio equipment by REL: driver exciters, 1 kw and 10 kw klystron amplifiers, diversity combiner receivers, and special test apparatus. The ultimate traffic capacity of these tropo links will be forty-eight telephone channels.

REL packaged systems have demonstrated in repeated testing their ability to withstand the extremely high temperatures (110° to 115° daily in the shade) and dust storms which will be encountered in desert installation.

The reliability for which REL equipment is world famous is a product of both imagination and experience. More kilowatt miles of tropo scatter equipment by REL are in use and on order than those of all other companies combined.

The skill and facilities for solving your specialized radio problems are available at REL.



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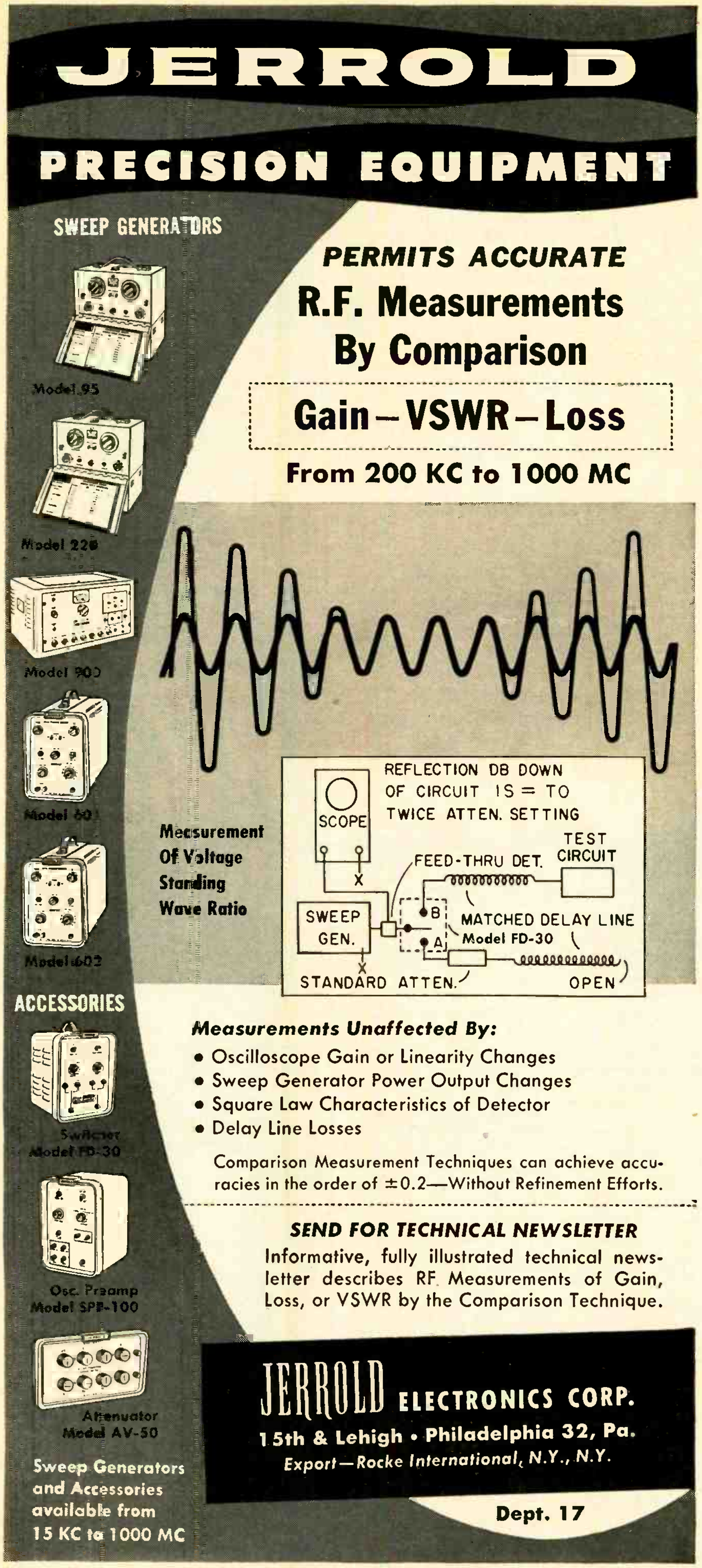


1B produces a phase lead of 90 degrees.

In Fig. 1A,

$V_i = V_o[1 + 3j\omega CR - (\omega CR)^2]$

If $\omega CR = 1$, $V_i = V_o \times 0.3\,j\omega CR$. By making $CR = 1$, an output voltage is obtained that is 90 degrees out of phase with the input and one-third the input value in magnitude.

In Fig. 1B a similar result is obtained except that it is negative.

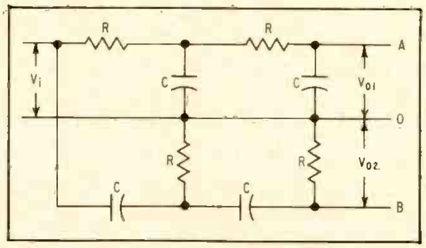


FIG. 2—Voltage across *AO* is 180 degrees out of phase with that across *BO*

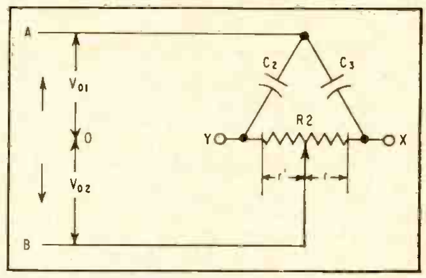


FIG. 3—Phase shift of voltage between *X* and O and input voltage increases as *r* is increased

If these networks are connected to a common input, as in Fig. 2, the output voltage between *A* and *O* is 180 degrees out of phase with the output voltage between *B* and *O*.

Assume that the impedances of R_2, C_2 and C_3 in Fig. 3 are so high that they do not load the input. Capacitor C_3 and a portion r of R_2 form a phase-shifting system if output is taken between *X* and *O*. As r is increased, the phase of *OX* is moved away from that of V_{02} until it is opposite in phase. Theoretically, exact opposite phase is approached as r approaches infinity. As r is increasing, however, r' is decreasing; hence *OY* is moving in the opposite direction.

This is illustrated in Fig. 4. *OX* is originally about 180 degrees ahead of *OY*; as the potentiometer setting is varied, *OY* and *OX* move into phase and finally *OX* is almost 180 degrees behind *OY*. Magnitude is unchanged.

A practical realization of this

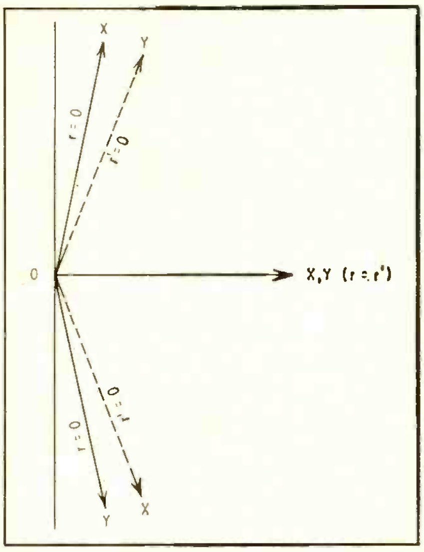


FIG. 4—Adjustment varies phase between OX and OY nearly 180 degrees

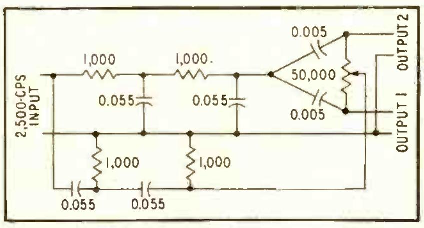


FIG. 5—Circuit produces a total phase shift between output 1 and output 2 from less than 180 degrees lagging to more than 180 degrees leading

circuit at 2,500 cps is shown in Fig. 5. It should be noted that the above explanation is completely true only if R_2-C_3-C_2 does not load the input sections. In practice behavior will be modified by the loading effect. The circuit was found to produce a change of phase from more than 180 degrees leading to more than 180 degrees lagging.

U.S. Magnetometer Used by USSR

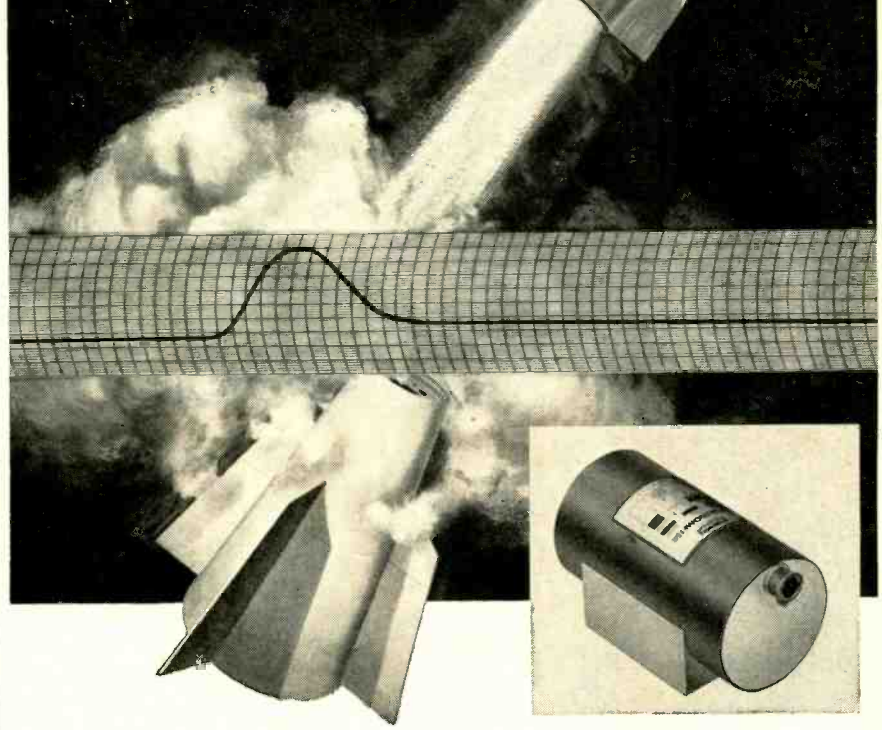
SOVIET RUSSIA has placed an order with an East German instrument maker for an absolute magnetic theodolite. The company is working with the Geomagnetic Institute of Potsdam to improve and redesign the magnetometer submited to the American National Bureau of Standards by A. E. Johnson.

The Soviets hope to use the modified instrument during the present geophysical year to gain knowledge of the structure of the geomagnetic field.

Instruments incorporated into

GIANNINI AC OUTPUT ACCELEROMETER

Wide Dynamic Range
Extremely Low Threshold
Low Null



ACCURATE, CONSISTENTLY RELIABLE AC output, proportional to linear acceleration, is provided by this new Giannini accelerometer. Available in ranges from ±1 g to ±20 g, the instrument has a full scale output of 6 volts which may be fed directly into a relatively low impedance with little or no phase shift.

NULL VOLTAGE IS 0.015 VOLTS, of which at least 90% is harmonic, assuring a wide dynamic range for the instrument. With a basic threshold sensitivity as low as 0.0001 g/g, input accelerations on the order of 0.0017 g's will provide a 10 millivolt change in output.

NO COULOMB FRICTION IS EXHIBITED in this design, bearings are eliminated by suspending the mass between two disc springs. Acceleration inputs move the magnetically damped mass, causing a proportionate change in the output voltage of a differential transformer. Cross-talk effect is minimum (0.003 g/g at 10 g cross acceleration on a 1g instrument); repeatability and hysteresis are below thresholds of measuring equipment.

IDEAL SECOND ORDER SYSTEM RESPONSE is achieved in the Model 24614 by magnetic eddy-current damping. The hermetically sealed instrument is oil-filled for stability of output under vibration. Specially designed and constructed for use in critical airborne control, stabilization, and flight test applications, the instrument is readily adapted to telemetering.

Giannini measures & controls:

ω	β	θ	ψ	τ	ν	ϕ
$\dot{h}$	Ω_x	α_i	h	P	ΔP	T
T_s	P_s	Q_c	M	T_o	P_T	TAS

PRECISION INSTRUMENTS AND CONTROLS

Giannini

G. M. GIANNINI & CO., INC., 918 EAST GREEN STREET, PASADENA, CALIF.

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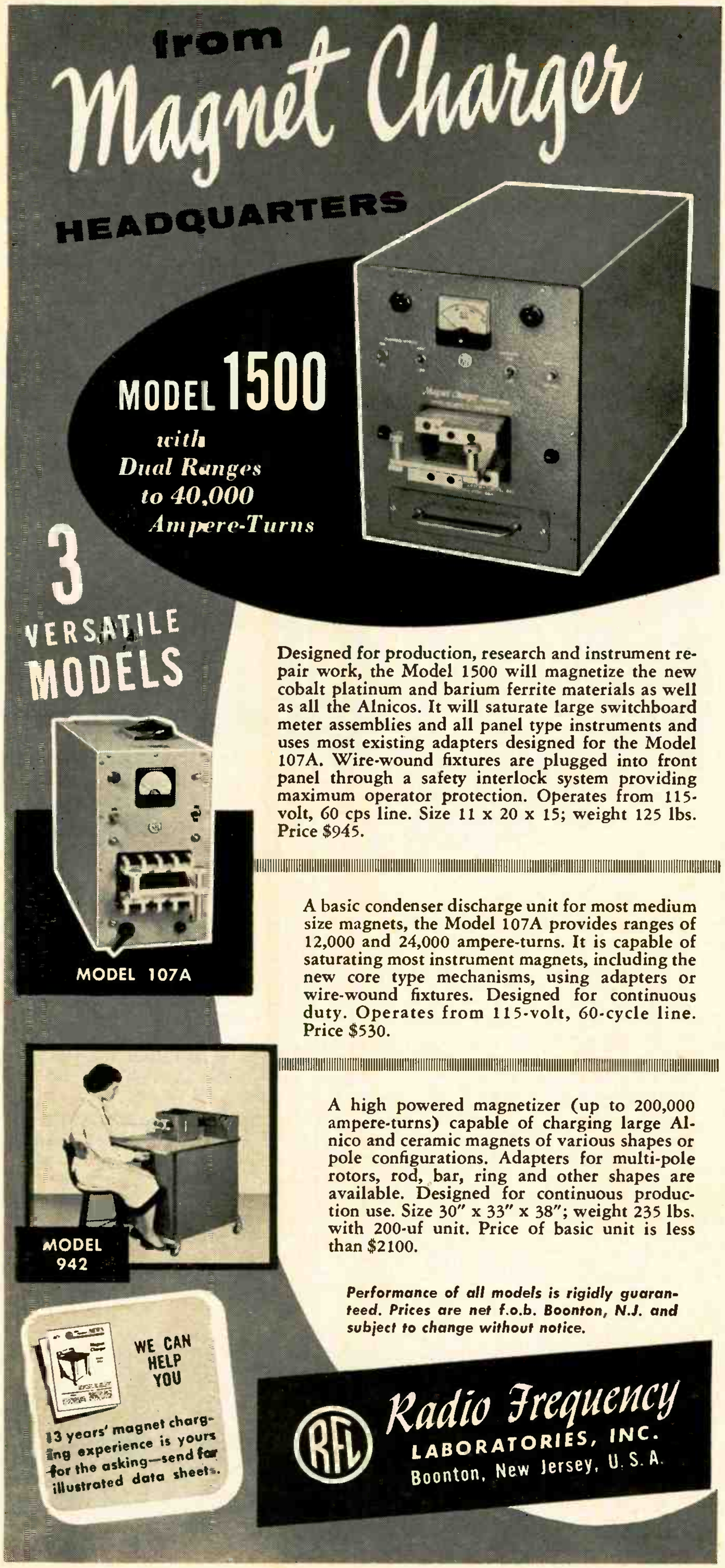


the design for measuring length are claimed to be accurate to within a thousandth of a millimeter. A compensator used to measure the current of the Helmholtz coils had to be provided with dielectric resistors rated at a million megohms. Also a number of thermostats are required to keep temperature constant at 68 F so that no losses will be incurred.

This unit can be used to measure the horizontal, vertical and total field intensities, as well as the magnetic variation and magnetic inclination of the terrestrial field.

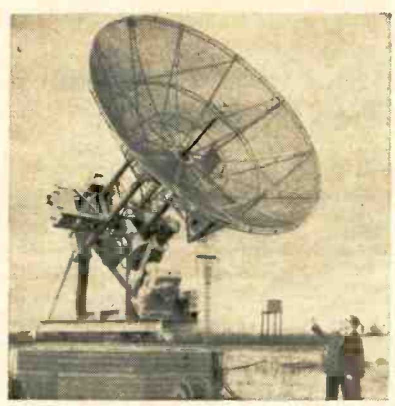
Path Attenuation Nomograph

By NAOMI KASHIWABARA
U. S. Navy Electronics Lab, San Diego, Calif.

ATTENUATION between closely spaced antennas can be determined rapidly and easily with a nomograph. This nomograph was prepared for finding path attenuation between microwave antennas spaced from 85 to 2,700 ft apart at the Navy Electronics Lab in San Diego, Calif.

The power received by an isotropic antenna from an isotropic source is directly proportional to the total power radiated and inversely proportional to the square

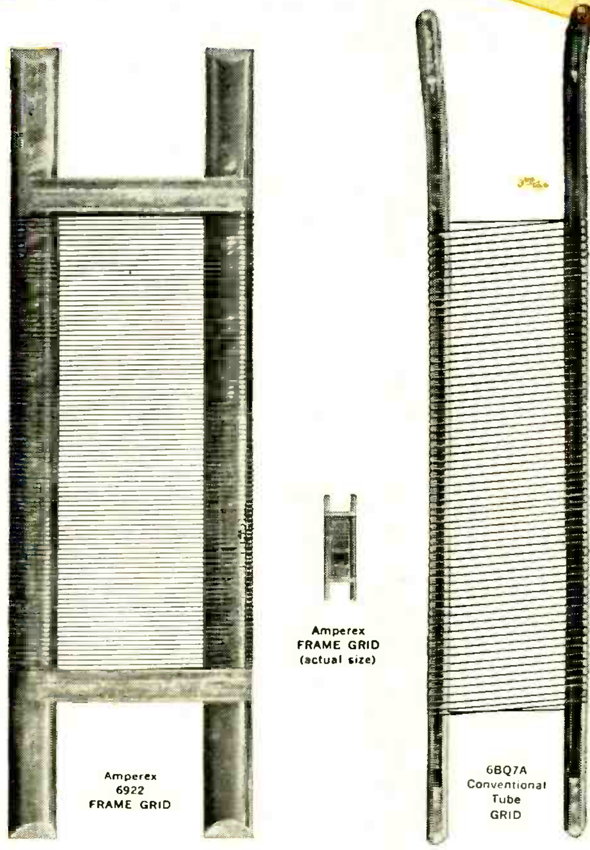
Parabolic Follows Sun



Seventeen-foot parabolic antenna follows the sun to enable Cornell scientists to pick up radio waves emitted from the solar atmosphere. Simultaneous measurements of intensities of right and left circularly polarized waves, correlation coefficient and phase difference between them and time checks are recorded by Brush oscillograph

A NEW Amperex FRAME GRID TUBE

It's the frame grid construction *that makes the difference...*



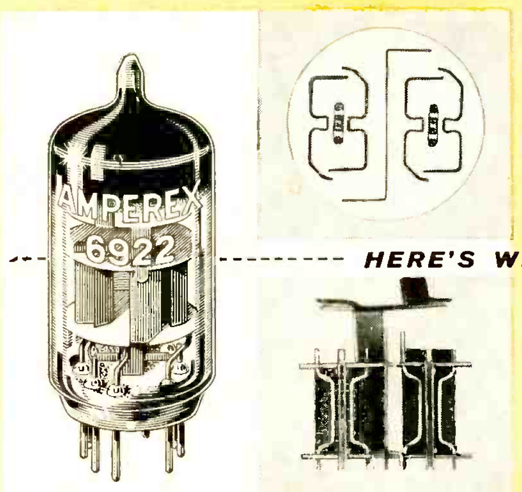
- Higher transconductance
- Tighter G_m tolerance
  (all tubes — $G_m = 12{,}500 \begin{smallmatrix}+2500) \\ -2000)\end{smallmatrix}$
- Low transit time
- Low capacitances
- Better grid and plate current division

In the Amperex 6922 Frame Grid, note the fine wires under tension with the tight tolerances of the grid-to-cathode spacing determined by the carefully controlled diameter of the centerless ground grid-support rods and the frame cross-braces between these rods.

In conventional tubes, the grid dimensions are obtained by stretching on a mandrel. The tolerance of grid-to-cathode spacing is therefore dependent upon this operation as well as the tolerances of the holes in the top and bottom mica rod supports.

ADDITIONAL FEATURES

- Passive cathode for long life
- Ruggedized construction
- New 'dimple' anode



Amperex PREMIUM QUALITY 6922

ruggedized, low-noise, broad-band twin triode

HERE'S WHAT THIS MEANS TO THE DESIGN ENGINEER...

- Reliable radar cascode stages
- Higher speed computer operation
- Lower noise, higher gain RF amplifiers
- Minimum guaranteed 10,000 hour life

TYPICAL OPERATION	
Plate Supply Voltage	100 volts
Grid Supply Voltage	+9 volts
Cathode Bias Resistor	680 ohms
Plate Current	15 ma
Transconductance (min. 10,500; max. 15,000)	12,500 umhos
Amplification Factor	33
Equivalent Noise Resistance	300 ohms
Grid Voltage (rms)	0.75 volts

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about "premium quality" frame grid tubes for communication, instrumentation and industrial applications.

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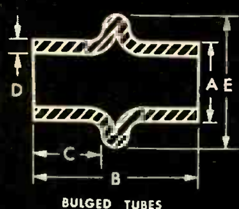
We are equipped for precision production of parts cut, flared, flanged, and bulged from tubing.

Original wall thickness is maintained in the finished parts with square ends and they vary from no burr to a maximum burr of .001" on the I.D. or O.D.

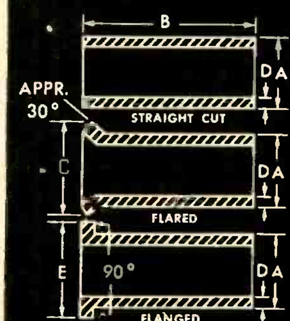
Improve your own production efficiency and reduce your assembly costs with uniform tubular components.

Eliminate secondary operations and tooling costs by specifying tubing.



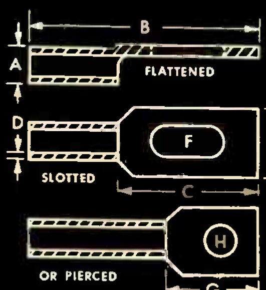
BULGED TUBES

A	B	C	D	E
.040	.125 TO .625	.040 TO .500	.005	.060
.050			.007	.075
.060			.010	.090
.075			.010	.110
.090			.010	.120
.125			.010	.160
.156			.010	.200



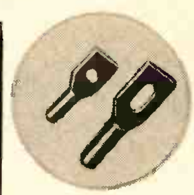
STRAIGHT CUT, FLARED, FLANGED

A	B	C	D	E
.040	.090 TO 1.250	.050	.005	.055
.050		.060	.007	.070
.060		.075	.010	.080
.075		.090	.010	.100
.090		.115	.010	.115
.125		.160	.010	.170
.156		.185	.010	.200



FLATTENED, SLOTTED, OR PIERCED

A	B	C	D	E	F	G	H
.040	.250 TO .688	.185 TO .230	.005	.070		.125 TO .156	.045
.050			.007	.090	.045 X .120		.060
.060			.010	.105	.055 X .120		.062
.075			.010	.120	.060 X .125		.075



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of the distance between source and receiver. Received power is also inversely proportional to the square of the frequency, since the effective area of an isotrope is equal to the square of the wave length divided by 4 pi.

Specifically, the relationship between attenuation, frequency and distance for two isotropic antennas is:

$$a = 37.9 + 20 \log_{10} d + 20 \log_{10} f$$

where a is attenuation in db, d is distance between antennas in ft and f is frequency in mc. This relationship is valid when d is much greater than $2a^2\lambda$, where a is the largest linear dimension of either antenna.

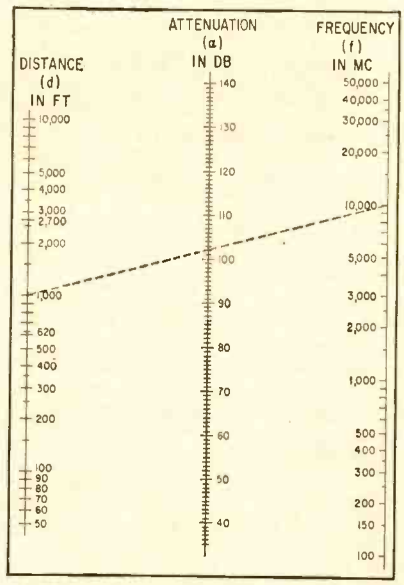

FIG. 1—Nomograph provides attenuation in db between two isotropic antennas

To find path attenuation for any desired frequency and distance, a straightedge should connect the designated values on the vertical lines on the left and right sides of the nomograph. The point at which the straightedge intercepts the vertical line in the middle gives path attenuation in db.

For example, at a distance between isotropic transmitting and receiving antennas of 1,000 ft and a frequency of 10,000 mc, path attenuation is 102 db.

REFERENCES

(1) "Reference Data for Radio Engineers," International Telephone and Telegraph Corp., p 752, 1956.

(2) John D. Kraus, "Antennas," McGraw-Hill Book Co., p 45, 1950.

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COMPONENT DESIGN

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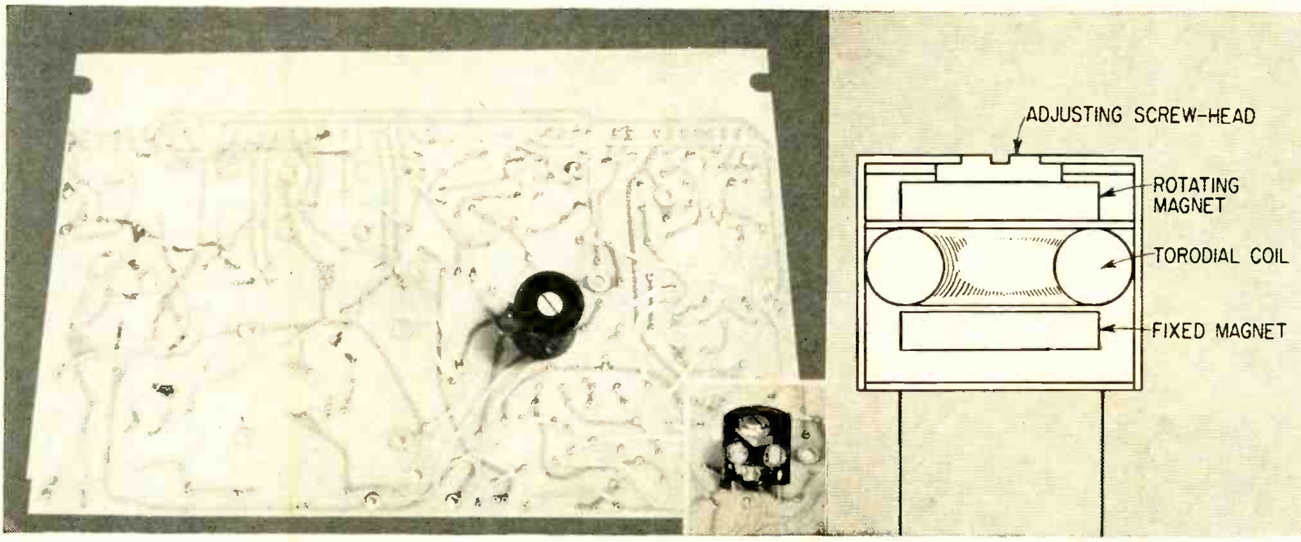


FIG. 1—Miniature variable inductor developed especially for printed circuits. Inductance is varied by rotating the top permanent magnet to change toroidal flux.

FOR OPTIMUM performance of tuned circuits, phase shift networks, and similar impedance devices, the reactance must be an exact quantity. Even if the required reactance is available in a fixed value capacitor or inductor, pickup from other circuit components may change the frequency response of the impedance network.

The variable inductor shown in Fig. 1 can be set to the exact value needed—after it is connected in the circuit. It is continuously variable over a ten percent range of the inductance. Toroidal coils from 50 mh to 125 h are available from stock, and special-order coils are available up to 1000 h. All coils have the high Q value common to toroids, and are hermetically sealed to meet government MIL specifications.

A cut-away photograph and a sketch of the variable inductor are also shown in Fig. 1. Inductance is varied by bucking out flux lines in the toroidal core with a field from two permanent magnets. There is no physical contact between the adjusting screw and the toroid.

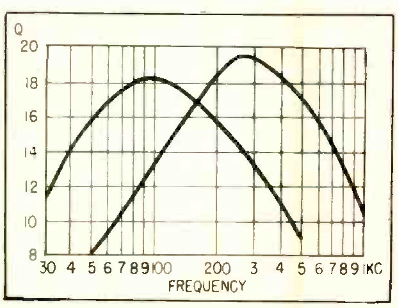


FIG. 2—Typical Q vs. Frequency characteristics for low frequency variable inductor

When the north pole of the rotating magnet is directly over the fixed magnet's south pole, flux lines

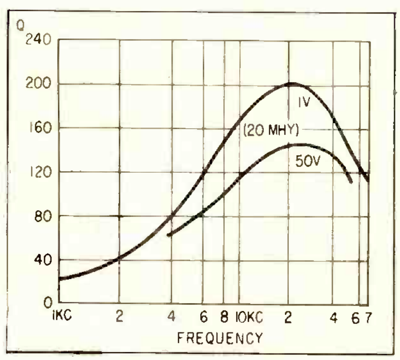


FIG. 3—Typical Q vs frequency characteristics for a 20 mh high frequency variable inductor

from the magnet are perpendicular to the core and have practically no effect on inductance. When like poles of the permanent magnets are in line, the magnetic lines of flux repel each other and pass through the core of the toroid. Inductance is reduced to the extent that lines of flux from the permanent magnet cancel out flux in the core itself.

Ten Percent Range

Nominal inductance value for a coil is the maximum value, and inductance range is the nominal value minus approximately 10 percent. Range can be increased to as much as 20 percent on special orders. A typical Q vs. frequency curve is shown for low frequency in Fig. 2 and high frequency in Fig. 3.

The encapsulated variable toroid weighs approximately one-half ounce. It was developed especially for printed circuits and light weight requirements. It is being used in guided missiles and similar miniaturization fields.

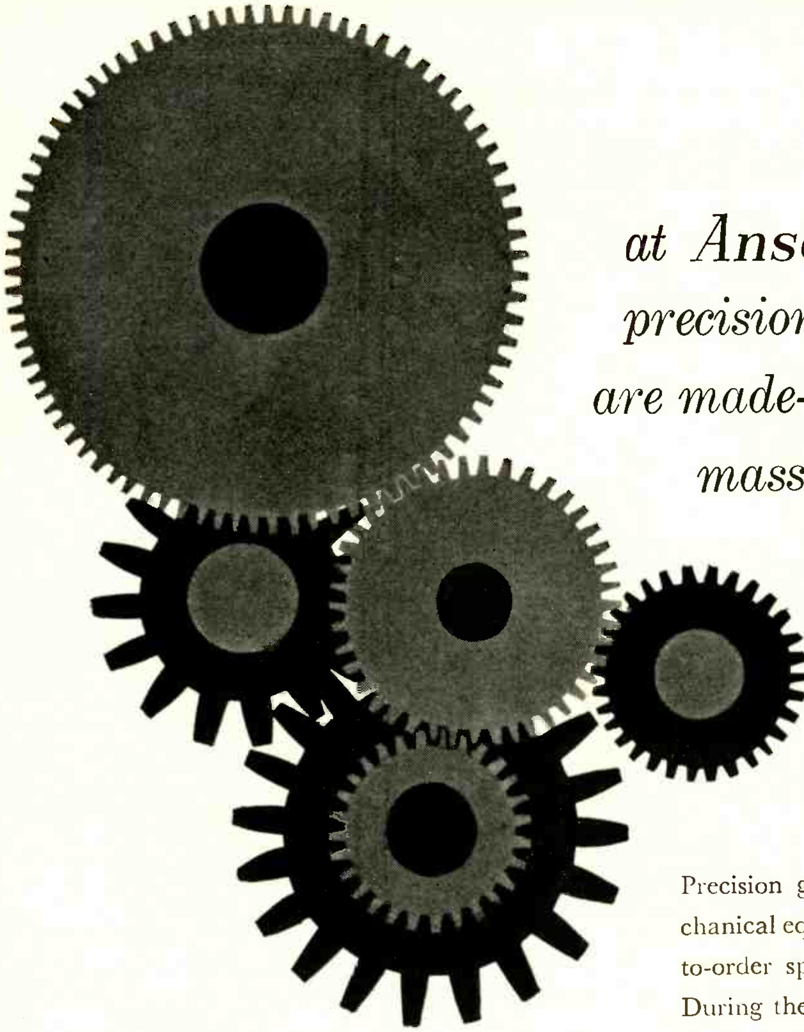
Burnell and Co., Inc., 10 Pelham Parkway, Pelham Manor, N. Y.

Panel Mounted VTVM

Multi-range electronic voltmeters cause less circuit loading and are more versatile than standard panel meters

ONLY AN ELECTRONIC voltmeter will provide accurate a-c voltage measurements over a wide frequency range. In rack-mounted circuitry which has a wide frequency range, a rack-mounted VTVM is therefore the most practical test instrument. High input impedance of an electron tube instrument is also very desirable for voltage measurements.

The meters designed by Metronix, Inc., require no more panel space



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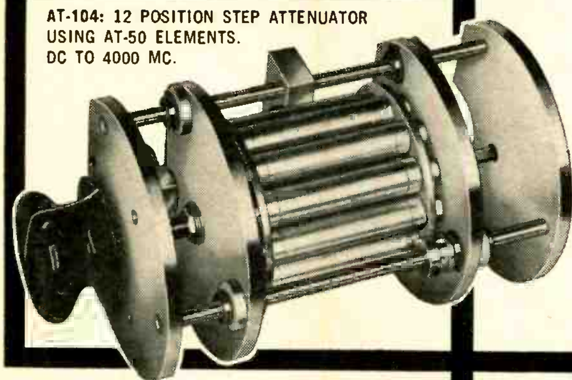
USING AT-50 ELEMENTS.
DC TO 4000 MC.



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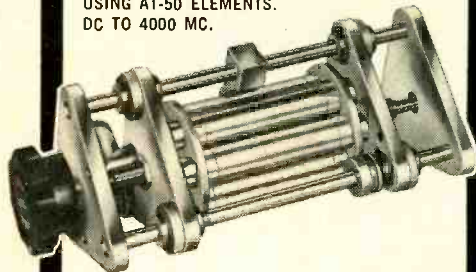
Accuracy is held to ±½ DB, VSWR is better than 1.2 to 1. Any attenuation values up to 60 DB are available. Deposited carbon elements are used for stability and operations at higher pulse levels. Standard impedance is 50 ohms, other values upon request. These units have excellent temperature characteristics and are vibration and shock resistant. Standard connectors are type "N", attenuator pads are also available with type "C".

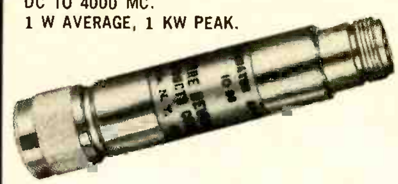
The attenuators may be obtained as individual pads (AT-50, AT-60), or as multi-position step attenuators AT-103 (six positions) and AT-104 (twelve positions). For even greater flexibility, several step attenuators may be series connected.

For complete technical information about attenuators for your laboratory or production needs, write for free catalog.

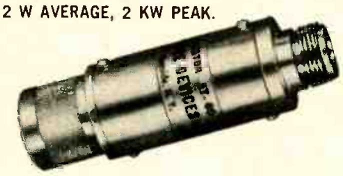
AT-103: 6 POSITION STEP ATTENUATOR
USING AT-50 ELEMENTS.
DC TO 4000 MC.



AT-50: ATTENUATOR PAD,
DC TO 4000 MC.
1 W AVERAGE, 1 KW PEAK.



AT-60: ATTENUATOR PAD,
DC TO 3000 MC.
2 W AVERAGE, 2 KW PEAK.



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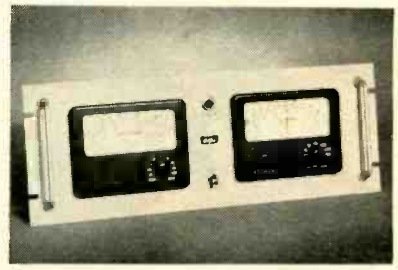
than a standard six inch meter. Three of them will fit into a 19 inch rack.

The d-c meter has seven ranges from zero to 1000 v, and is accurate to plus or minus three percent. Input terminals and the calibration adjustment are located at the rear. The a-c meter has ten ranges in 10 db steps from 10 mv to 300 v. Frequency response of the a-c voltmeter is from 20 cy to 100 kc. Both d-c and a-c types may be isolated from ground, if desired.

In most cases panel-mounted electronic voltmeters cost less than



Rack-mounted electronic voltmeters are accurate over a wide range frequency range.

conventional bench—type vtvm's required for high impedance, wide frequency range measurements. They are naturally more expensive than standard panel-type voltmeters built for only one frequency.

The meters are completely self contained with built-in power supplies and all necessary operational controls. *Metronix, Inc., Chesterland, Ohio.*

The Three Tube Rating System

THREE RATING SYSTEMS are now being used for electron tubes. Each system uses a different standard to analyse tube capabilities. Since the rating systems describe the permissible area of operation for a tube, a conscientious circuit designer is compelled to understand the systems and their merits and limitations.

At first glance it would appear that three systems are redundant. And the proponents of one rating system for all tubes believe this to be so. There are others however who find merit in this redundancy.

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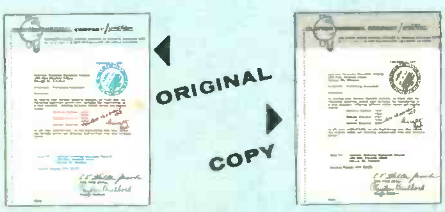

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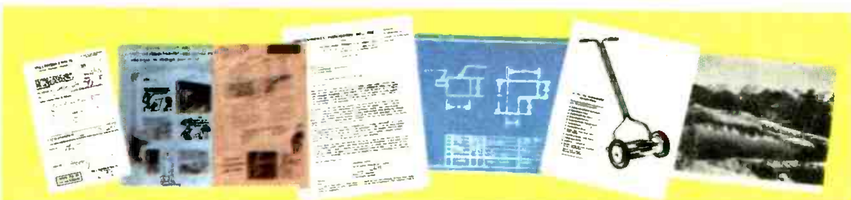

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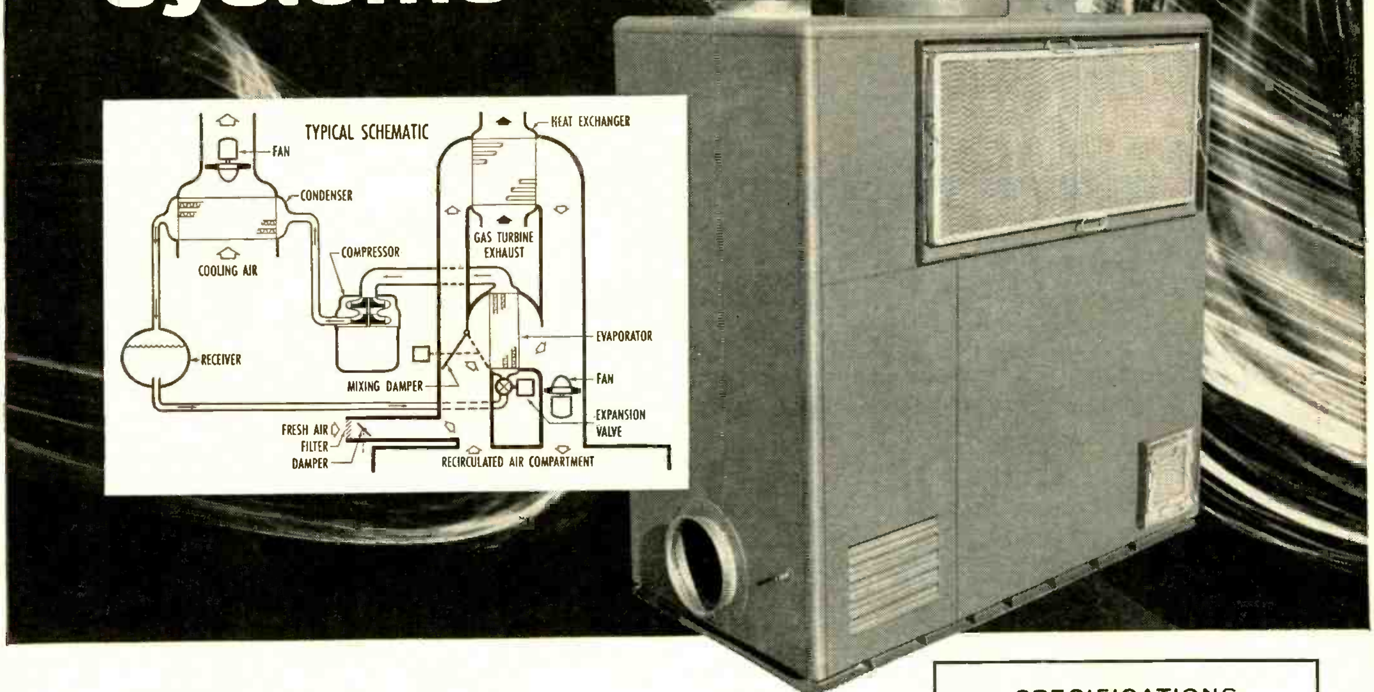

The mobility problem in cooling electronic equipment in vans and for missile pre-launching has been answered by new AiResearch Freon air conditioning units. *One-fourth the weight and one-third the size* of conventional equipment, these lightweight, air-transportable units utilize highly efficient AiResearch Freon components (see diagram) originally developed for commercial aircraft applications.

Heat source for the circuit can be either electrical, or exhaust gas from an AiResearch gas turbine. When the gas turbine assembly includes an alternator, it supplies *400 cycle power to run both the refrigeration unit and all electronic gear in the van.*

Easily operated manually or automatically, this compact air conditioning unit provides from 5 to 12 tons cooling capacity and up to 85,000 BTU's per hour heating capacity. It operates on 400 cycles, 208 volts. The unit shown stands 54" high, 52" wide and 27" deep, with a charged weight of only 452 lbs.! Your inquiries are invited.

SPECIFICATIONS
Performance Data:
Typical operation—cooling

Refrigerant	Freon 12
Evaporator tonnage	7.5
Ambient temperature	100F
Condenser air flow	5000 cfm
Condensing temperature	131F
Evaporator air flow	1230 cfm
External distribution ducting pressure drop	2 in H_2O
Evaporating temperature	48F
Electrical power	26KVA

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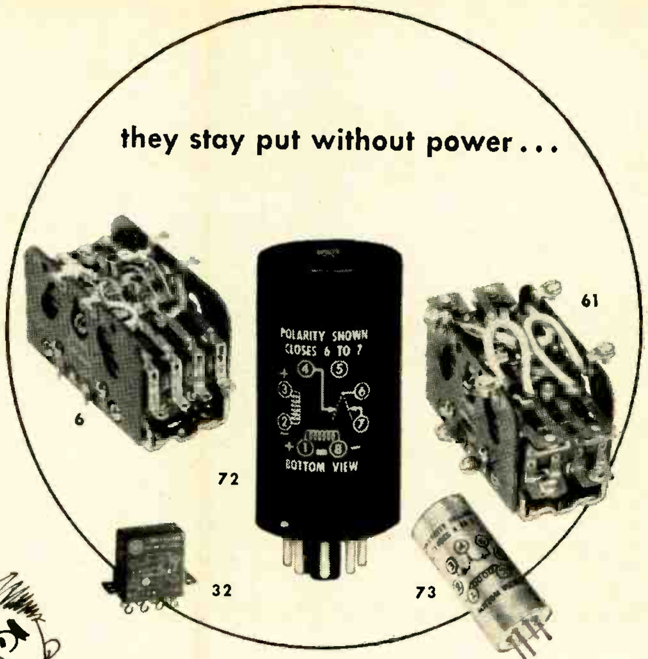
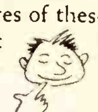


WHAT'S THE CATCH?

The catch or latching arrangement on all these Sigma relays is a permanent magnet. While this fact is not fraught with serious or far-reaching consequences, magnetic latching does have advantages worth considering. Since there are no triggers, catches or springs to wear out, magnetic latching relays do not fear early commitment to an eleemosynary institution. They do not continuously nibble a little stand-by power, adding their own little body warmth to the already stuffy environment; nor do power interruptions make them change position. What the armatures of these Sigma relays *do* do is stay where the last coil signal sent them, moving to the other fixed position only when a resetting signal comes along.



An up-to-date inventory shows that there are now five Sigma magnetic latching relays available, with the following distinguishing traits. **SERIES 6** will switch 2 or 5 ampere loads on inputs from 22 to 450 mw., with contacts up to 4PDT; useful in memory circuits, fast enough for follow-up systems, reliable latching contactor. **SERIES 61** is a modification of the "6", with DPDT contacts capable of switching 20 ampere loads on 225 or 450 mw. signals; small, considering its ratings. **SERIES 32** is the newest and smallest of the group; DPDT, measures 0.800" x 0.400" x 0.900" high, max., has pins spaced equally on 0.200" centers; price is low. **SERIES 72** is the most sensitive (0.3 — 2.0 mw.), and is designed for bounce-free, high speed switching. Sensitivity is adjustable, contacts replaceable. **SERIES 73** is a small hermetically sealed SPDT type for use in miniature devices and guided missiles. Dimensions ¾" dia. x 1 11/16" high. Contacts rated 1.5 ampere, sensitivity 6 mw. and 12 mw.

If any of these magnetic latching relays (Sigma Form "Z") offer the characteristics you're looking for, write for more data. If they don't, write anyway and tell us what you expect. Maybe one of us could be talked into making a small modification, so that a Sigma relay *will* work.

SIGMA

SIGMA INSTRUMENTS, INC.,
62 Pearl Street, So. Braintree 85, Mass.

ents Conference A. J. Heitner of Sylvania's Tube Division delivered a paper entitled, *Making Sense of The Three Tube Rating Systems.* We would like to pass along some of his observations.

Seven factors are considered by the tube rating systems: (1) Physical Dimensions, (2) Element voltages (3) Element currents (4) Element power dissipation (5) Bulb or environmental temperature (6) Impact shock and (7) Altitude.
In order to know when a rating violation exists or when a circuit is compatible with the tube ratings, a design engineer must know the basic concepts of the rating systems.

Design-Center System

The most common system for receiving tubes is the Design-Center System. JETEC definition of this system is:

"Design-Center ratings are limiting values of operating and environmental conditions applicable to a bogey electron device of a specified type as defined by its published data, and should not be exceeded under normal conditions.

The device manufacturer chooses these values . . . taking responsibility for normal changes in operating conditions due to rated supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

The equipment manufacturer should design so that, initially, no design-center value for the intended service is exceeded . . ."

When the majority of receiving tube usage was for home radio this system worked fine. As tube applications became more complex two disadvantages became apparent: (1) Protection offered the tube is variable and depends on the circuit and environment. (2) The circuit designer has no assigned responsibility for maintaining circuit environmental conditions compatible with design-center ratings.

Even during the radio age transmitting tubes, power rectifiers, gas filled types, etc. did not lend themselves to the design-center system. The tube manufacturer found that

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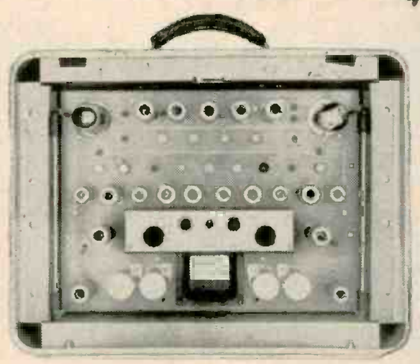
The Telechrome Model 1008-A Vertical Blanking Interval Keyer is a self-contained portable unit that makes possible transmission of television test and control signals between frames of a TV picture. Any test signal (multiburst, stairstep, color bar, etc.) may be added to the composite program signals. The keyer will operate anywhere in the TV system and operates from composite video, sync, or H & V drive. The test signals are always present for checking transmission conditions without impairing picture quality. The home viewer is not aware of their presence.

These continuous reference signals may be used in connection with various Telechrome devices for automatic correction of video level, frequency response, envelope delay, differential gain and differential phase.

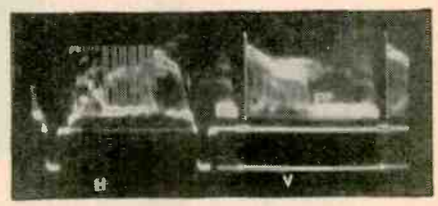
MODEL 1008-A



VERTICAL BLANKING INTERVAL TEST SIGNAL KEYER

Portable or standard rack mounting. Self-contained power supply.

Test signal is thin line between frames. All test signals can be transmitted during vertical blanking portion of program.



Video picture with multiburst test signal inserted, as seen on ordinary wave monitor.

IMPORTANT:

Checking after programming is costly and at best highly inefficient since conditions constantly vary. The Telechrome Vertical Interval Keyer minimizes post-program checking and overtime expenses. It provides instant indication of deteriorating video facilities so that corrective measures can be undertaken immediately—manually or automatically during programming.

Now in use by CBS, NBC, ABC, BBC ITA (Brit.)

1003-C VIDEO TRANSMISSION TEST SIGNAL GENERATOR

Completely self-contained, portable. Produces multi-frequency burst, stairstep, modulated stairstep, white window, composite synch. Variable duty cycle. Regulated power supply. 12¼" standard rack mounting or in carrying case. Integrates with above model 1008-A Test Signal Keyer.

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BALLANTINE Model 316 VOLTMETER

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SPECIFICATIONS

FREQUENCY RANGE 0.05 cps to 30KC down to 0.01 cps with corrections

VOLTAGE RANGE 0.02 to 200V peak to peak lowest reading corresponds to 7.07mv rms of a sine wave

ACCURACY 3% throughout ranges and for any point on meter scale

IMPEDANCE 10 megohm by any average capacitance of 30 μμf

OPERATION Unaffected by line variation 100 to 130V, 60 cycle, 45 watt

FEATURES

- Pointer "flutter" is almost unnoticeable down to 0.05cps, while at 0.01cps the variation will be small compared to the sweep observed when employing the tedious technique of measuring infrasonic waves with a dc voltmeter.
- A reset switch is available for discharging "memory" circuits in order to conduct a rapid series of measurements.
- The reading stabilizes in little more than 1 period of the wave.
- Meter has a single logarithmic voltage scale and a linear decibel scale.
- Accessories are available for range extension up to 20,000 volts and down to 140 microvolts.

For further information on this and other Ballantine instruments write for our new catalog.

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100 Fanny Road, Boonton, New Jersey

CIRCLE 77 READERS SERVICE CARD

it was not possible to reflect into the ratings the known variations of all of the various usages.

Absolute-Maximum System

An absolute-maximum rating system was established which placed the responsibility of circuit design which is compatible with tube ratings directly on the circuit designer. JETEC definition of the absolute-maximum system is:

"Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

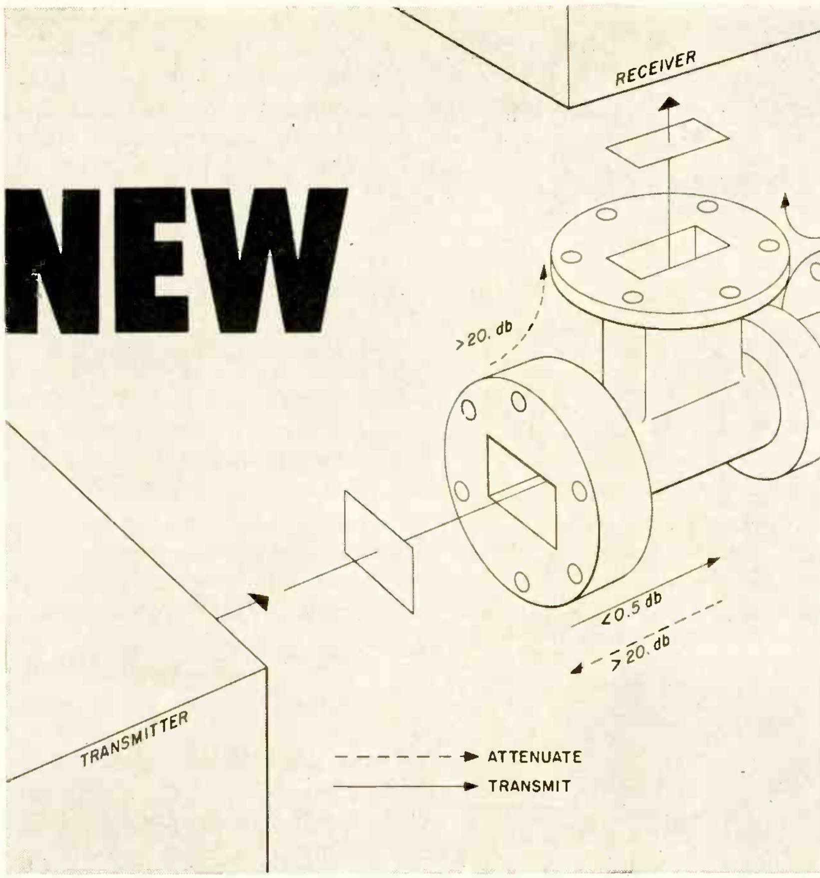
The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics".

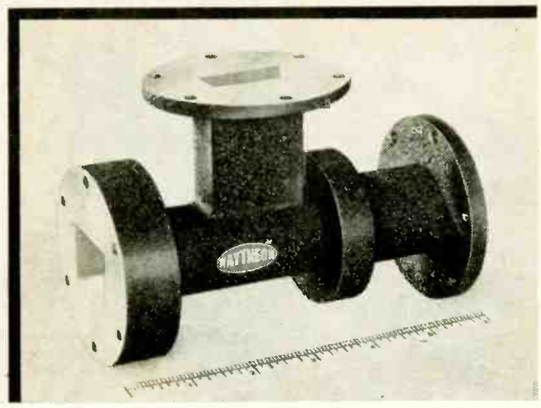
A careful look at both of these systems shows the disadvantages of each. With the design-center system the tube manufacturer effectively assumes responsibility for both variations in tube characteristics and circuit operation on tube performance. However, under the conditions imposed by the absolute-maximum system, the complete responsibility for variations in tube characteristics and operating conditions is assigned to the circuit designer.

The absolute-maximum system came into more wide spread use in the low power or receiving tube field with the advent of the JAN and MIL specifications. The system, however, is extremely demanding on the circuit designer.

In order to make the absolute-

NEW





MICROWAVE FERRITE CIRCULATOR...

RAYTHEON MINIATURIZED X-BAND ISOLATORS weigh as little as 2.2 oz. For somewhat different requirements in the lower frequency L-band, Raytheon recently introduced the first high-power L-band isolator commercially available.

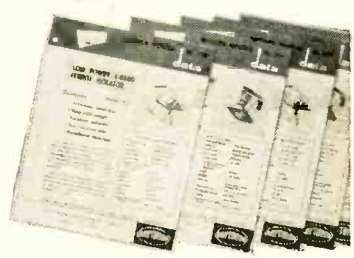
Compact C-band unit replaces gas-tube duplexer; needs no external power.

System designers: This new circulator is lighter and more compact than the differential phase-shift type unit and readily replaces typical TR or ATR gas tubes in C-band microwave transmission systems.

The Raytheon Model CCM1 weighs less than 5 lbs. and is less than 6 inches long. Its permanent magnet design eliminates the need for external drive power. The CCM1 reduces requirements for filters and klystron isolation common to systems using T-junction duplexers.

With Raytheon's advanced microwave component designs like this new C-band circulator, systems designers now have more freedom than ever before to design compact lightweight packages. Other devices now available and in advanced stages of development include isolators, both high and low power, ranging from L-band to Ku-band; ferrite switches; modulators; and side-band generators.

FOR COMPLETE FACTS or assistance in solving your microwave ferrite component problems, simply write to the address below, outlining your requirements.

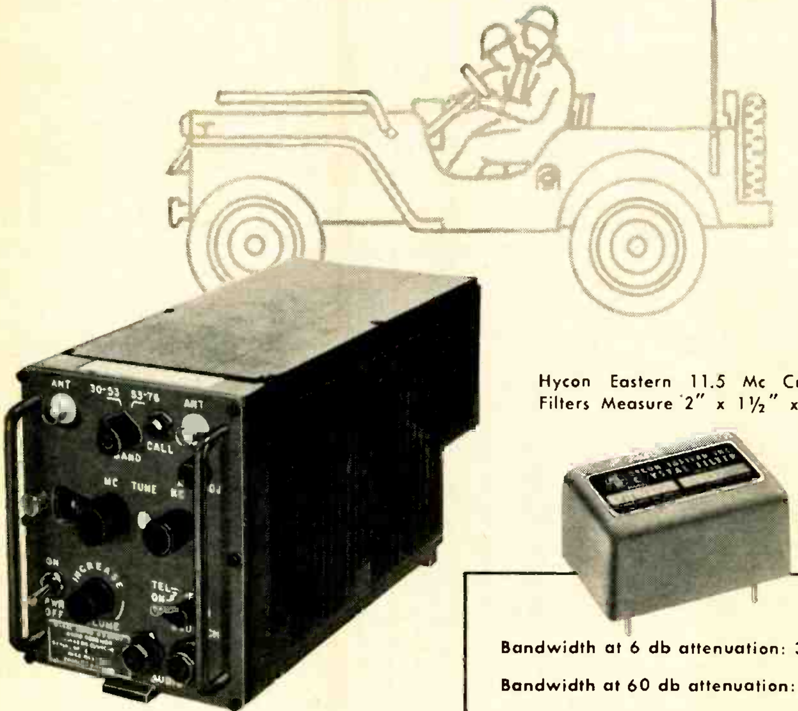


Excellence in Electronics

RAYTHEON

RAYTHEON MANUFACTURING COMPANY
Special Microwave Device Group
100 River Street, Waltham 54, Massachusetts

FIRST 920 Channel Single Conversion VHF Mobile Receiver Uses HYCON EASTERN CRYSTAL FILTER



VHF, 920 Channels, fully transistorized Radio Receiver by Avco Mfg. Corp., Crosley Division

Hycon Eastern 11.5 Mc Crystal Filters Measure 2″ x 1½″ x ¾″

Bandwidth at 6 db attenuation: 33 Kc
Bandwidth at 60 db attenuation: 60 Kc
Insertion Loss: 4 db
Ultimate attenuation: 80 db

Mobile communications for today's fast moving military operations require equipment which is rugged, compact, highly accurate and dependable. Filling this need is the Avco-Crosley, fully transistorized, 920 channel, mobile VHF-FM Radio Receiver incorporating a Hycon Eastern 11.5 Mc Crystal Filter and matching Discriminator.

The use of only one frequency conversion provides excellent image rejection in combination with high adjacent channel selectivity. By eliminating multiple conversions, cross modulation and receiver desensitization are reduced even in the the presence of strong interference from any of the other 920 channels.

High Frequency Crystal Filters for mobile applications offer the advantages of small size, freedom from microphonic behavior, and ability to maintain their characteristics throughout the entire temperature range of $-60°C$ to $+90°C$. Hermetically sealed, no realignment or readjustment is ever required.

There are Hycon Eastern Crystal Filters designed to solve selectivity problems in AM or FM receivers and SSB transmitters, whether fixed or mobile. Hycon Eastern engineers can assist you in choosing filter characteristics best suited to your needs. Write for Crystal Filter Bulletin.

HYCON EASTERN, INC.

75 Cambridge Parkway Dept. A Cambridge 42, Mass.

maximum rating system as realistic as possible for some of the known applications, the tube industry established multiple ratings on high power tubes.

The complex nature of both military and commercial electronics indicated the need for a . . .

Design-Maximum System

It was with this intent that the Design-Maximum system was developed. JETEC definition of the Design-Maximum System is:

"Design-Maximum ratings are limiting values of operating and environmental conditions applicable to a bogey electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking responsibility for the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no design-maximum value for the intended service is exceeded with a bogey device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, and environmental conditions."

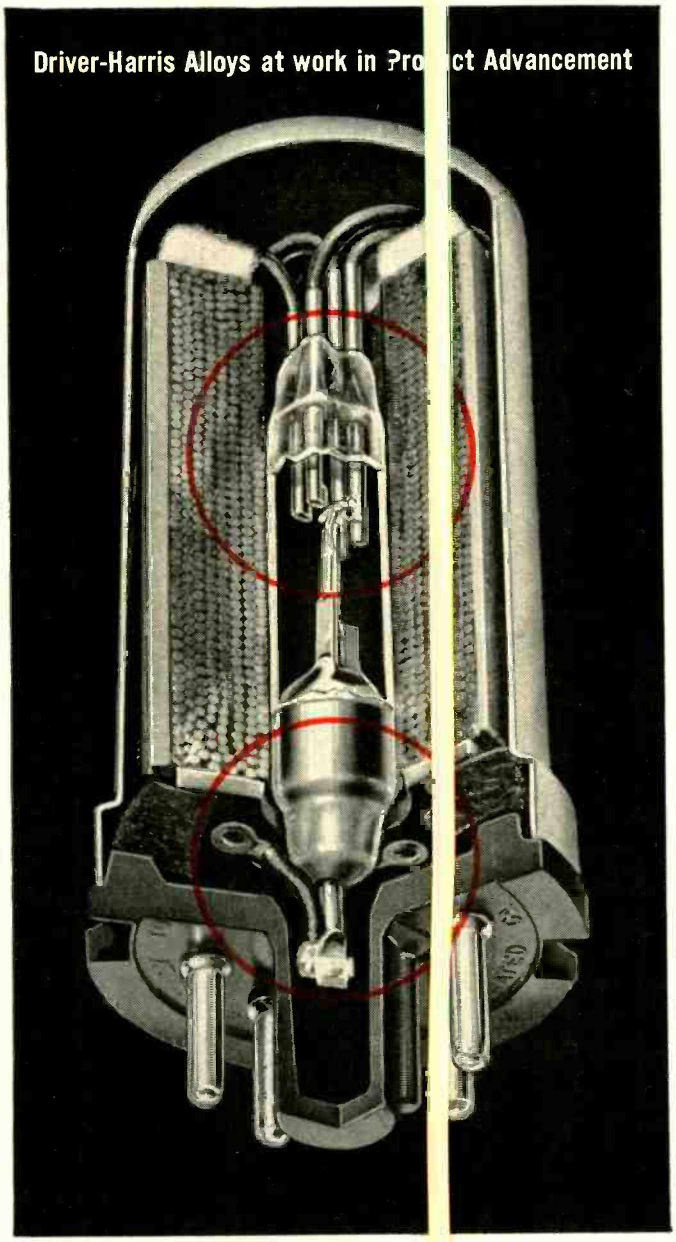
In the TV industry the worst probable operating conditions for any circuit are usually easy to establish. The worst probable operating conditions for military equipment are more difficult to determine.

Mr. Heitner feels that a dual trend exists in the use of rating systems. Low power or receiving type tubes designed chiefly for the home entertainment market are being rated in accordance with the design-maximum system. Special purpose tubes, transmitting tubes and military tubes are continuing to use the absolute-maximum system. Since the function a rating system is to classify tubes so that they can be properly used, it appears that the dual system is best for present needs.

CIRCLE 79 READERS SERVICE CARD

Improved Metal-To-Glass **Alloy Holds Seals Tight** Against Hydrogen **at 250 Pounds Pressure**

Development of Clare† Mercury-Wetted Contact Relays aided by special gas-free Driver-Harris #152 Alloy



For all kinds of high-speed switching machines and devices which demand accuracy and dependability of the highest order, this new Clare Type HG Relay offers a combination of high speed, high current-and-voltage capacity with remarkably uniform long-life performance. It has a conservative life expectancy of more than a *billion operations* when operated within its ratings and can be driven at speeds up to *100 operations per second*.

In this cutaway view (2¾ x) a magnetic switch, hermetically sealed in a high-pressure hydrogen filled glass capsule, and a coil, are enclosed in a steel vacuum tube type envelope. The switch forms the core of the coil which provides the magnetomotive force for operating it.

The glass enclosed switch is very compact and small (5/16" diameter x 2" long) yet its handling capacities of 5 amperes and 500 volts maximum are truly remarkable.

These features of its construction make this possible. In the switch segment, the platinum contact surfaces are wetted and protected from electrical and mechanical erosion with mercury by means of a capillary connection to a mercury reservoir below the contacts. In addition, the high hydrogen pressure enables the contact gap to withstand a high voltage gradient without breakdown.

Keeping the gas from leaking posed a production problem. The specifications for the lead wires at the top of the switch and the tubular vacuum stem at the bottom were stiff. 1. Gas-tight seal against hydrogen at 250 PSI. This was difficult. 2. Perfect match to thermal expansion characteristics of the glass. 3. Good ferromagnetic properties. 4. Exceptional surface bonding properties since the permissible maximum 5 ampere 500 volt limits are dictated rather by factors relating to heating of the metal-to-glass seal than the current handling capacities of the contacts.

Driver-Harris was called upon to produce such an alloy and succeeded in developing a special gas-free nickel-iron alloy No. 152 which meets all these requirements to the complete satisfaction of Clare Engineers.

Do your engineering and product development plans hinge upon a special alloy — why not discuss it with Driver-Harris. We have, since 1899, produced 132 special purpose alloys in just this fashion — in answer to a particular problem and extraordinary specifications. We have a special bulletin on Sealing Alloys if you care to have one. Your inquiry is awaited.

†C. P. Clare & Co., Chicago, Ill.
*T.M. Reg. U.S. Pat. Off.

DRIVER-HARRIS* COMPANY

HARRISON, NEW JERSEY • BRANCHES: Chicago, Detroit, Cleveland, Louisville

Distributor: ANGUS-CAMPBELL, INC., Los Angeles, San Francisco • In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

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CIRCLE 80 READERS SERVICE CARD

Grinding Ceramics by Dual Method Is Faster

By **R. B. McPHERSON** Thermo Materials, Inc., Menlo Park, Calif.

COMBINING through-feed and in-feed techniques of centerless grinding sharply reduces the time required to finish grind cylindrical high temperature ceramic components.

While the combined method is primarily used to grind alumina components, it is also applicable to metals. Its best use is when a relatively large amount of stock must be removed and the component is out-of-round or tapered.

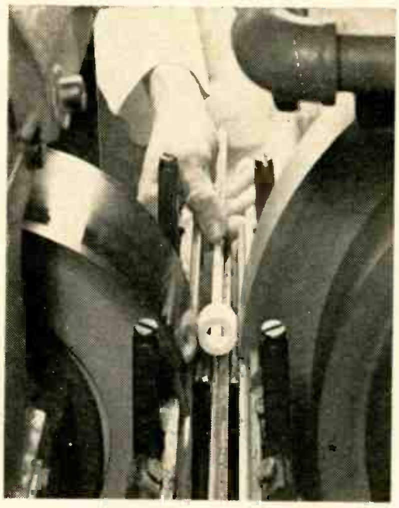
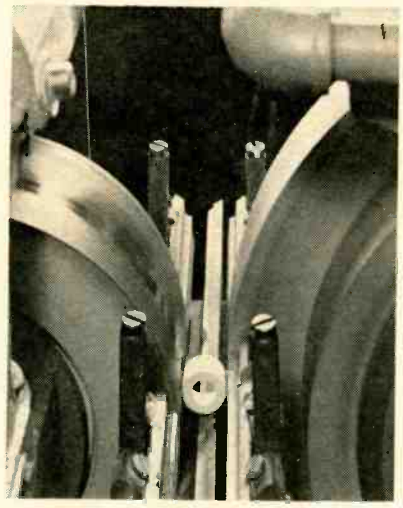
Used to finish parts whose irregularity had posed severe problems, the method has cut handling time from 90 seconds to 15 seconds per part at the Thermo Materials plant.

In one case, several thousand hard-fired alumina components had to be finish ground to 1.115 inches outside diameter, round and straight. Before grinding the parts were ⅝ inch long, with a ⅞ inch hole and an outside diameter of 1.150 inches. They tapered to 1.135 inches OD and were out of round by 0.020 to 0.030 inch. The grinding wheel is a D100 N100M 20-by-2-inch diamond.

In grinding, the operator places the workpiece in position on the blade inside the front edge of the wheel by sliding the workpiece along a lucite stick. Then the in-feed lever is carefully operated until the workpiece contacts the grinding wheel. Next, the gap is closed rapidly, the grinding phase continuing until zero position of the in-feed lever is reached. The part moves laterally during grinding thus clearing the entering side of the wheel. The lever is retracted in preparation for the next piece.

Grinding time is approximately 15 seconds per part, with no breakage. The advantages of straightness and finish that result from thru-feed grinding add to the longevity of the diamond wheel. Traversing eliminates the risk of grooving the wheel and prevents excessive wear in any one place.

First trials on grinding ceramic cylinders made use of work feed chutes and the thru-feed method.

Operator positions workpiece by sliding it along lucite stick (left). As part traverses diamond wheel, grinding of another part may start

This resulted in excessive handling, breakage and other difficulties. Attempts were also made to use in-feed grinding. The lightness of the workpiece and its rough out-of-true face caused the piece to break on contact with the in-feed stop.

In the final successful attempt, the in-feed stop was removed and the pieces allowed to traverse the face of the wheel during the plunge cut. After the in-feed lever had been brought to zero position, the work cleared the wheel as in thru-feeding.

The slight set-over and a moderate control wheel speed gave the operator time to in-feed (plunge) grind to size. Any taper or wheel marks were removed while the in-feed was on zero position and the work traversed the remainder of the wheel.

There was no need to wait for a piece to clear before starting another. The second piece could be started shortly after the plunge was completed. The lever was retracted in readiness for loading the next piece. This stopped the traversing movement of the part being ground, but the part resumed traversing when the in-feed lever again reached the zero position.

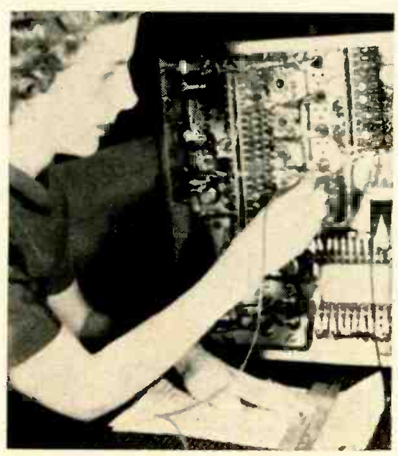
Wire Lists Simplify Assembling

By **J. D. WINGFIELD**
Melpar, Inc., Arlington, Va.

WIRING LISTS prepared by methods technicians cope with the problem of quickly producing, with non-technical personnel, small quantities or single units of assemblies during developmental manufacturing.

The methods technician first prepares a "master wire list" from the schematic. He identifies every connection. Each wire item is numbered and identified by color, gage, connections linked and route followed.

Wiring decisions are next re-



Inspector checks completed unit by following master wire list

ACTUAL SIZE
(3 5/8")

GENERAL SPECIFICATIONS

Frequency Range (mech. tuning)	12.4 to 15.5 kmc
Heater Voltage (a-c or d-c)	6.3 v
Heater Current	0.55 amp.
Beam Voltage	350 v max.
Beam Current	40 ma max.
Reflector Voltage	0 to –350 v
Heater-Cathode Voltage (peak)	45 v

NEW FROM SPERRY

SRU-95 LOW-VOLTAGE KLYSTRON FOR Ku BAND MICROWAVE TESTING

Now in full-scale production is Sperry's new SRU-95 reflex oscillator klystron developed especially for use as a signal source in radar test equipment.

The SRU-95 covers the frequency range from 12.4 to 15.5 kmc with two reflector-voltage modes, one with broad bandwidth and the other with high power. It delivers a minimum r-f power output of 20 mw into a load with a VSWR of less than 1.1. Small but rugged, the SRU-95 has superior mode characteristics for automatic frequency control operation.

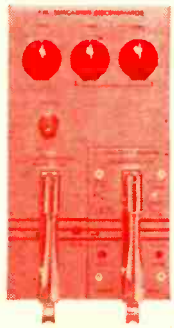
Important features include waveguide output, integral cavity and tuner, single-screw tuning covering full frequency range in only 9 turns.

Other applications for the SRU-95 are local oscillator in microwave receivers and spectrum analyzers, low-power transmitting tube, and bench oscillator. Write or phone for data sheet on the Sperry SRU-95.

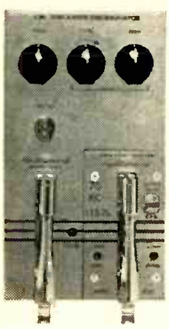
SPERRY ELECTRONIC TUBE DIVISION
SPERRY RAND CORPORATION
Gainesville, Florida

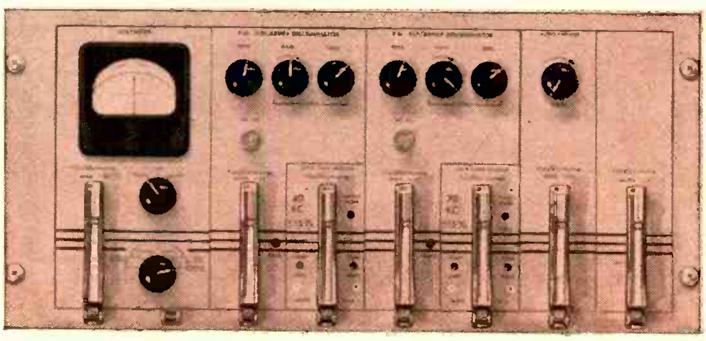
ADDRESS ALL INQUIRIES: GAINESVILLE, FLORIDA, OR SPERRY GYROSCOPE OFFICES IN BROOKLYN, CLEVELAND, SEATTLE, SAN FRANCISCO, LOS ANGELES, NEW ORLEANS, BOSTON, BALTIMORE, PHILADELPHIA.

immediate delivery...



phase-lock discriminators by Hallamore





Ready, as a "building-block" for your system application...Hallamore Model 0162, phase-lock discriminator, a compact plug-in type unit, has been thoroughly proven in telemetering systems of major missile programs. Designed around a concept entirely new to telemetry, it eliminates signal suppression by noise...non-linearity as a result of filtering...thresholding, common at low signal-to-noise levels. For quick action, wire Hallamore Electronics Company, Dept. 24P, 8352 Brookhurst Avenue, Anaheim, California / TWX: AH-9079.

HALLAMORE ELECTRONICS COMPANY

a division of The Siegler Corporation

Forerunner in System Development

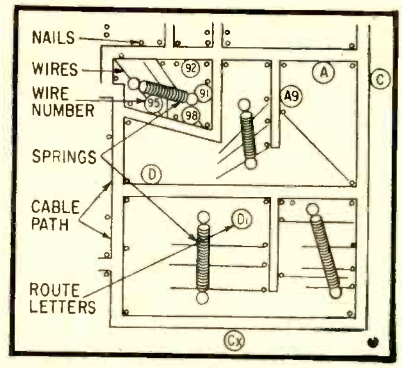


Diagram shows how a portion of the cable board is laid out

corded on four working lists used by assemblers.

A "cable running list", used in conjunction with a cable board, guides cableforms in harnessing. The board requires the only drafting time. Prints made from the vellum are pasted on plywood. Common nails are used as guide pins and springs hold wire ends.

A "board wiring list" duplicates the appearance of the finished component board, to guide assemblers of component boards, jumpers and pigtailed wires. A "jumper list" locates jumpers. Jumpers are short wires, not precabled, which are first to be put into the chassis. After the cables and component boards are installed and ready for final hookup, a "hookup list" is followed by the assembler who connects and solders all harness and pigtailed wires.

Simple Code

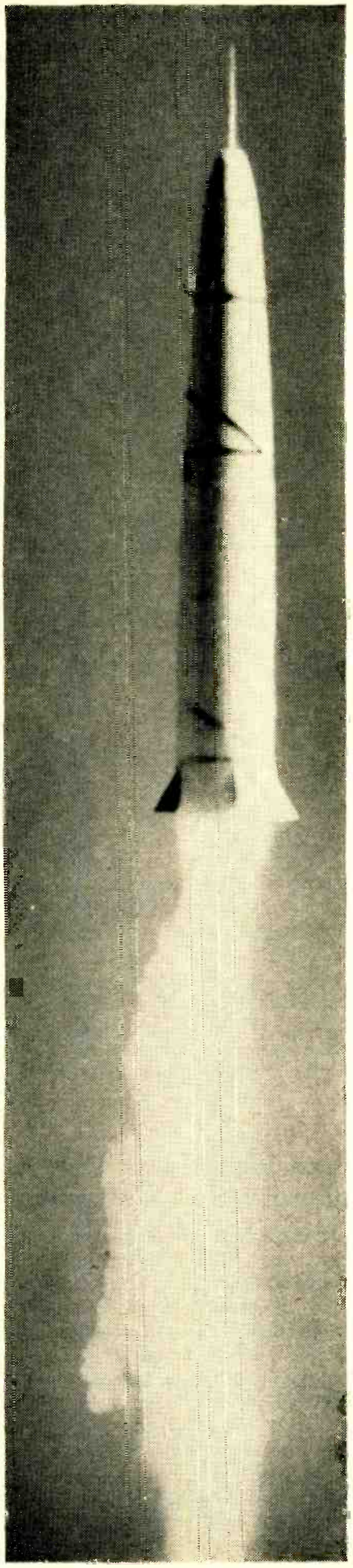
An elementary code is used in the lists. "From", "to" and position columns refer to circuit symbol numbers on the chassis (required by most military specifications) and schematics. The dash numbers refer to component pin numbers or location.

Cable routes are lettered on the cable board. Routes are assigned only if a wire may be routed in different ways. Small, non-cabled jumpers are not given routes and no routing is required for preformed cable.

Additional work performed by the methods technician in recording his decisions and designing a harness board is offset by several advantages.

The procedure enables use of production workers with specialized

CIRCLE 82 READERS SERVICE CARD



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ELECTRICAL:

Air Force space and operational programs offer you unique professional challenge and opportunity as a civilian

Among the myriad current and projected programs of the U. S. Air Force lies a challenge and opportunity for civilian electronic and electrical engineers with varying degrees of specialty and experience. These areas include: the research, development and maintenance essential to sustaining qualitative superiority for the operational Air Force; research and development in IRBM and ICBM fields; the projection into outer space and return of manned, piloted vehicles. Stimulating assignments now exist for qualified men in these categories.

As an Air Force Civilian Electronic or Electrical Engineer you:

WORK . . . in a fine creative atmosphere . . . with foremost men in the field . . . with most modern equipment and facilities . . . in more than one specific program . . . in geographic location of your choice.

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ENJOY . . . expanded scope of assignment . . . professional prestige and recognition . . . job satisfaction . . . participation in opening new frontiers and conquering space.

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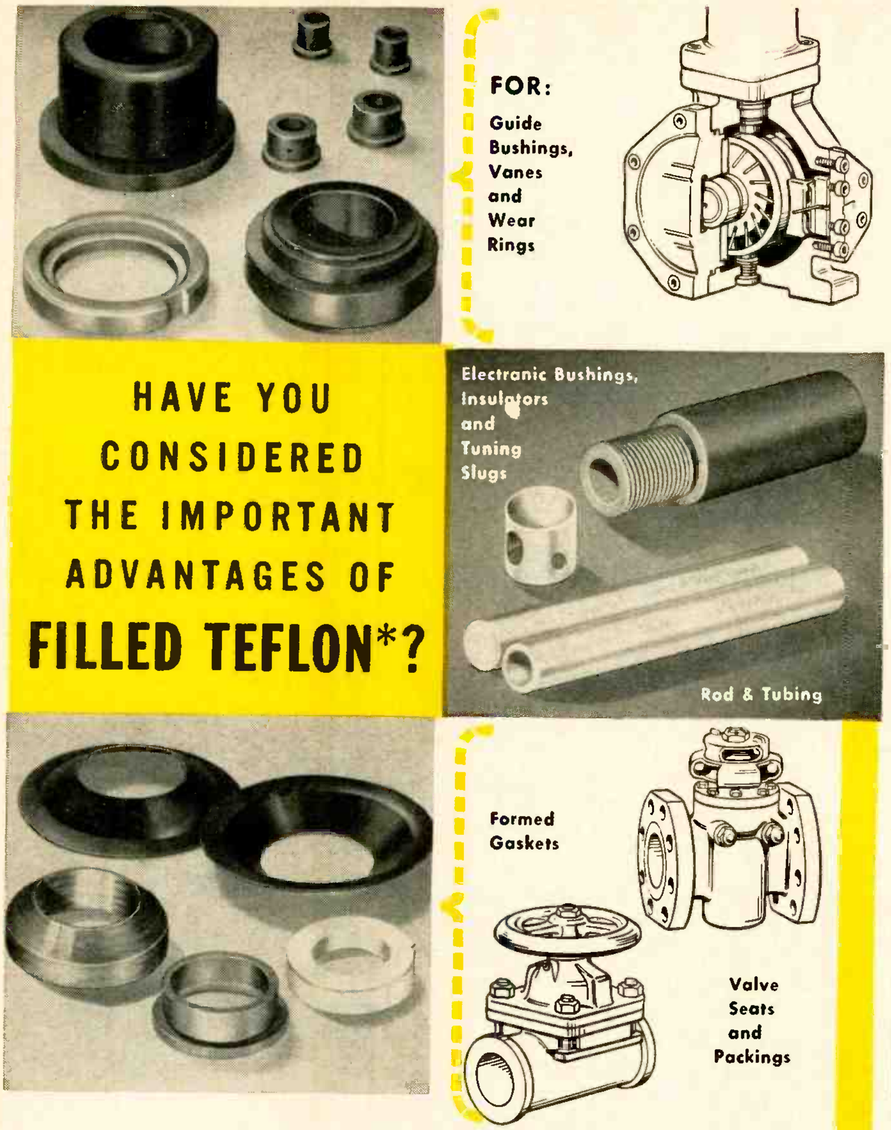

HAVE YOU CONSIDERED THE IMPORTANT ADVANTAGES OF FILLED TEFLON*?

It has been definitely established that the value of Teflon can be considerably enhanced by the use of fillers in certain applications. Laboratory and field experience has demonstrated that the use of fillers permit Teflon to be more readily tailored to a wide variety of chemical, electrical and mechanical applications. Also, some mechanical properties can be improved. These include:

1) resistance to deformation under load
2) resistance to wear
3) thermal conductivity
4) compressive strength
5) hardness

By thus improving its properties, Teflon now offers even greater industrial potential. This is the reason filled Teflon has become an important item in the "John Crane" Chemlon® line of better Teflon products.

Chemlon is available with such fillers as glass fiber, carbon, graphite, copper and bronze, talc, calcium fluoride and other inorganic materials.

Tell us about your requirements. We'll tell you the advantages you can get from filled Chemlon. Request Bulletin T-104.

Crane Packing Company, 6402 Oakton Street, Morton Grove, Illinois, (Chicago Suburb). In Canada: Crane Packing Co., Ltd., Hamilton, Ont

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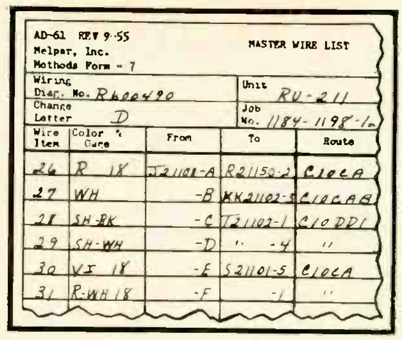
CRANE PACKING COMPANY

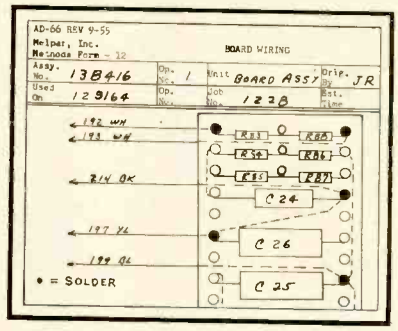


AD-61 REV 9-55
Melpar, Inc.
Methods Form - 7

MASTER WIRE LIST

Wiring Diag. No. R600490 | Unit RU-211
Change Letter D | Job No. 1184-1198-1

Wire Item	Color & Gage	From	To	Route
26	R 18	J21101-A	R21150-2	C10CA
27	WH	-B	KK21102-5	C10CAB
28	SH-BK	-C	J21102-1	C10DD1
29	SH-WH	-D	" -4	"
30	VI 18	-E	S21101-5	C10CA
31	R-WH 18	-F	-1	"



Wire lists have columns for wire number, color and gage, route and, if needed, soldering directions. Exception is board wiring list, which looks like component board

skills. There is product consistency and the process may be repeated later without methods participation. The lists simplify wiring inspection in quality control.

Shops get all information in a standard form regardless of variances in customer specifications and engineering group standards. Production lead time is reduced because all engineering changes in the design prototype are incorporated in the process sheets. Prototypes are made almost as quickly as units in production runs.

Tension Meters Clip Onto Wire in Winding

TENSION MEASUREMENT and control are often important in the processing of filaments and tapes and in production of wire-wound components. Excessive tension may stretch wire, changing its resistance, damaging insulation or otherwise influencing component quality. Tension can also affect performance of recording tape, cables and other products.

A simple method of monitoring tension during winding is afforded by tension meters, according to

FREQUENCY STANDARDS

PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*

Frequencies: 240 to 1000 cycles
Accuracies:—
Type 50 (±.02% at —65° to 85°C)
Type R50 (±.002% at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

*3⅛" high
400 - 1000 cy.

FREQUENCY STANDARD
TYPE 50L

Size 3¾" x 4½" x 5½" High
Weight, 2 lbs.

Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L (±.02% at —65° to 85°C)
Type R50L (±.002% at 15° to 35°C)
Output, 3V into 200,000 ohms
Input, 150 to 300V, B (6V at .6 amps.)

PRECISION FORK UNIT
TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.*

Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above

*3½" high
400 to 500 cy.
optional

FREQUENCY STANDARD
TYPE 2005

Size, 8" x 8" x 7¼" High
Weight, 14 lbs.

Frequencies: 50 to 400 cycles (Specify)
Accuracy: ±.001% from 20° to 30°C
Output, 10 Watts at 115 Volts
Input, 115V. (50 to 400 cycles)

FREQUENCY STANDARD
TYPE 2007-6

NEW

TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.

Frequencies: 400 — 500 or 1000 cycles
Accuracies:
2007-6 (± .02% at —50° to +85°C)
R2007-6 (±.002% at +15° to +35°C)
W2007-6 (±.005% at —65° to +125°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

FREQUENCY STANDARD
TYPE 2121A

Size
8¾" x 19" panel
Weight, 25 lbs.

Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)

FREQUENCY STANDARD
TYPE 2001-2

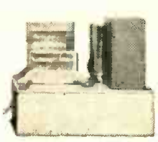
Size 3¾" x 4½" x 6" H., Wght. 26 oz.

Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V., at 5 to 10 ma.

FREQUENCY STANDARD
TYPE 2111C

Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.

Frequencies: 50 to 1000 cycles
Accuracy: (±.002% at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.



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.

This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government departments, armed forces—where maximum accuracy and durability are required.

WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

American Time Products, Inc.

Watch Master
Timing Systems

Telephone: PLaza 7-1430

580 Fifth Ave., New York 36, N. Y.

• R-F RECEIVER DESIGN
• INERTIAL NAVIGATION

Two of many areas in Avionics in which Bell Aircraft has openings for qualified electronics engineers

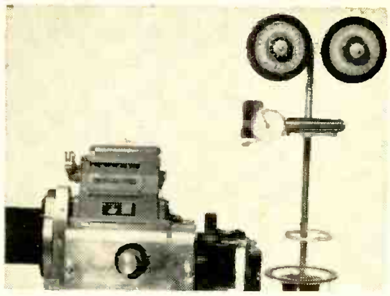
Particularly good opportunities are now available for engineers with radio frequency experience in the 100 kilocycle to 35,000 megacycle range with emphasis on transistorizing of circuits . . . and for those with experience in inertial instrumentation design and evaluation,

Present openings include assignments in:

- Pulse and Digital Coding
- Identification Systems
- Electronic Counter Measures
- Landing Systems
- Digital Computers
- Precise Instrumentation Development

These assignments embrace a wide range of high level design and development problems which will afford full scope to your creative ingenuity with unusual opportunities for rapid advancement and professional recognition. Salaries commensurate with your background, good living and working conditions, and liberal benefits. Please write: Supervisor of Engineering Employment, Dept. H-28, BELL AIRCRAFT CORPORATION, P. O. Box 1, Buffalo 5, N. Y.

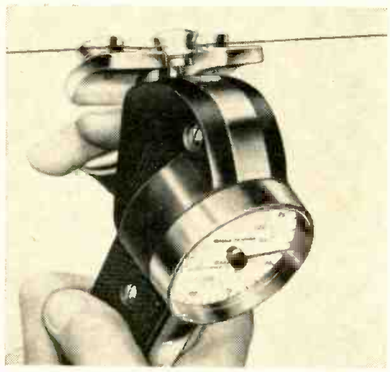
BELL Aircraft CORP.



Tension meter mounted to sum up tensions accumulated in coil winding wire

Tensitron, Inc., Harvard, Mass. In a coil-winding operation, for example, the meter may be bracket-mounted to monitor the wire just before it reaches the coil. The arrangement will sum up the tensions built up in the wire during the winding process. Adjustments to bring the wire's tension within a safe limit may be made to the winding machine's mechanism while the wire is in motion. Or, servomechanisms may be constructed for automatic adjustments.

The meter may also be used to find an approximate safe operating tension for a particular wire. A sample length of wire is tied to a post and stretched by hand with the meter placed on the wire. As the wire is stretched further by hand, the tension reading will increase up to a certain level, beyond



Trigger-operated tension meter

which the tension reading fails to increase and the wire is elongated. One-fourth of the yield tension may be taken as a safe operating tension.

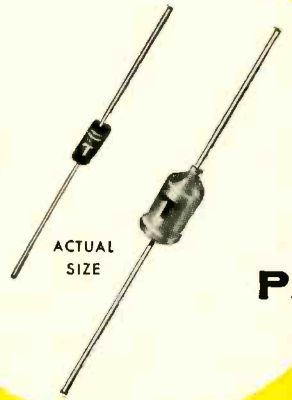
Two types of wire tension meters are illustrated. One type uses a trigger mechanism to engage running wires up to AWG 30 in size. A lever mechanism is used with heavier wires. Three rollers guide

Transitron

SILICON RECTIFIERS

Big Performance

600 volts • 450ma



IN SMALL PACKAGES

Higher voltage and current ratings are now yours in two compact packages. These hermetically sealed axial lead units are easily mounted in terminal or printed board assemblies, offering real design versatility. They are ideal for a wide range of limited-space applications.

Subminiature Glass Types

Transitron's Subminiature Glass Silicon Rectifiers now pack ratings to 600 volts and 400ma (150ma at 150°C). Rugged and reliable at temperatures to 175°C, these units are thoroughly tested under the most severe operating conditions. They give excellent service in subminiature power supplies, D.C. blocking, high voltage series strings and other applications where space is at a premium.

Type	Peak Recurrent Inverse Operating Voltage (volts)	Maximum Average Forward Current @ 150°C (ma)	Maximum Average Forward Current @ 25°C (ma)	Maximum Inverse Current @ 150°C (ma)
1N689	600	150	400	.2
1N649	600	150	400	
1N684	400	150	400	.2
1N647	400	150	400	
1N679	200	150	400	.2
1N677	100	150	400	.2

Miniature Types

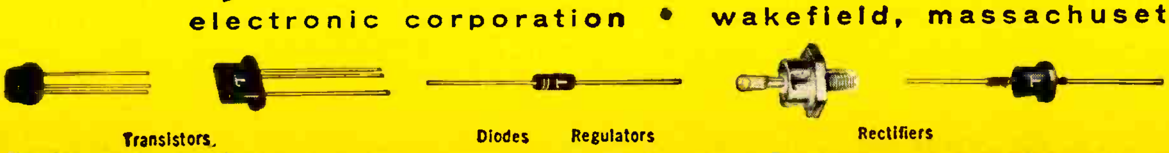
Ratings of 600 volts and 450ma (200ma at 150°C) are now available in the economical Miniature package — constructed without the wide flange that often interferes with compact mounting in printed circuits. These Miniature types serve well in blocking circuits, power supplies, and such critical applications as magnetic amplifiers, where low inverse leakage is essential.

Type	Peak Recurrent Inverse Operating Voltage (volts)	Maximum Average Forward Current @ 150°C (ma)	Maximum Average Forward Current @ 25°C (ma)	Maximum Inverse Current @ 150°C (ma)
TJ60A	600	200	450	.5
TJ40A	400	200	450	.5
TJ30A	300	200	450	.5
TJ20A	200	200	450	.5
TJ10A	100	200	450	.5

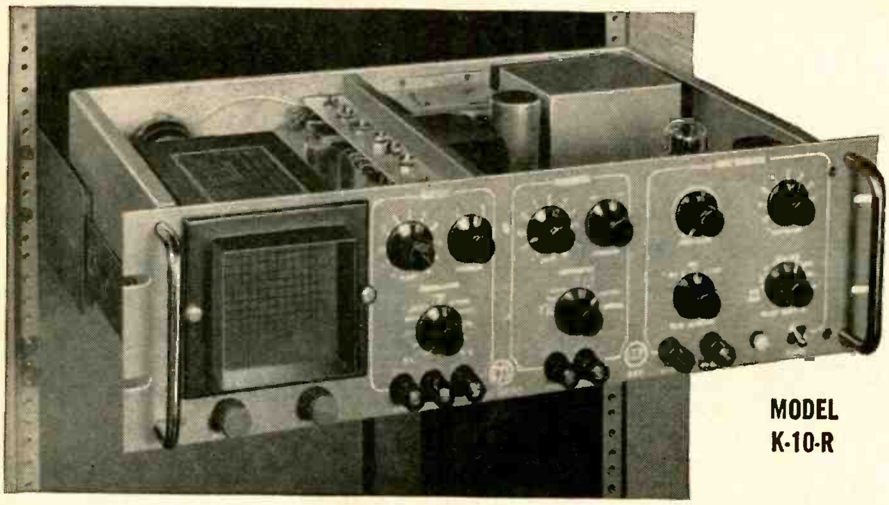
SEND FOR BULLETIN TE-1351

Transitron

electronic corporation • wakefield, massachusetts



ETC New Rack Panel Oscilloscope
that opens new testing horizons



MODEL
K-10-R

5" scope performance

WITH A NEW 3½" SQUARE TUBE

HIGHLIGHT SPECIFICATIONS

- CRT type 41HAP1.
- 115 v. A.C., 60-400 cyc. ±10%.
- Sensitivity: .028 v./in. (vertical amplifier), 0.3 v./in. (horizontal) P/P.
- Frequency response flat to D.C.; vert. amplifier 3db @ 300 kc.; horiz. amplifier 10% @ 100 kc.
- Input impedance 2 megohms, 40 μμf.
- Linear sweep time base 2 cps. to 30 kc., 0.5 sec. to 33 μsec.
- Amplitude 0.1 v. P/P. Square wave at power line frequency. Accuracy overall ±1%.
- 5.25" high x 19" wide x 11.375" deep.
- Printed circuits.

WRITE FOR COMPLETE SPECIFICATIONS

... GIVES SO MUCH, IN SUCH LITTLE SPACE ... AT SO LOW A PRICE

Here, at last, is a full quality, truly professional 'scope priced within easy reach . . . and designed to a size that can be used in practically any rack-mounting set-up, even where space is distinctly limited.

The "heart" of this miniaturized ETC Model K-10-R assembly is its unique ETC Type 41HAP1 square-faced 3½ C-R tube. This provides a raster size equivalent to that of a conventional 5" round tube.

Operational features of the K-10-R far exceed those of ordinary 'scopes of comparable size or price.

Headquarters for MULTI-BEAM OSCILLOGRAPHY and dependable C-R Tubes

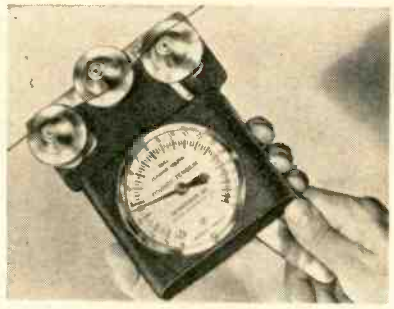
Standard and special ETC oscilloscopes range from single-channel styles such as the K-10-R (above) to types recording from 2 to 8 channels on a single tube face. ETC Cathode Ray Tubes range from single-gun to 10-gun types. Write for catalog.

ETC

electronic tube corporation

1200 E. MERMAID LANE PHILADELPHIA 18, PENNA.

CIRCLE 88 READERS SERVICE CARD



Lever is used to engage heavy wire

the wire. Two rollers are fixed as reference positions and the third, acting as a dancer arm, is deflected in proportion to tension on the wire. A gear train amplifies the deflection so that it is read on a dial as pounds or grams of tension. Rollers adapted to tapes, films, foils and webs may be used with both types.

A full discussion of the causes and effects of tension is contained in a paper which Erwin J. Saxl, president of Tensitron, presented before the 1958 IRE Convention.

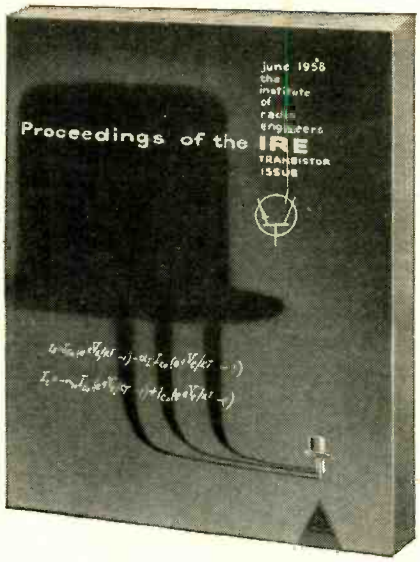
Small Speedy Shear Has Versatile Table

HIGH PRODUCTION rate on shearing of small component parts is obtained at Hewlett-Packard Co., Palo Alto, Calif., through use of new Lodge and Shipley 24 inch shear. Photo shows operator feeding 10-gage aluminum folding stock into shear at 400 per hour rate production of fan bracket plates for frequency counter.

Machine's blade operates at 120 strokes per minute. End-around work table is drilled with holes to accept varying guides and templates. Table can accommodate more than one set-up for sequenced operations on same workpiece.

THE DECADE OF THE TRANSISTOR

IRE commemorates the tenth anniversary of a major breakthrough in solid state electronics by devoting the entire June issue of PROCEEDINGS OF THE IRE to an up-to-date summary of progress and advances in transistors. So small that many can be held in the palm of one hand, these tiny components have ended our 50 year dependence on vacuum tubes. Without transistors, our intricate guidance and communication systems for missiles would be incredibly big and heavy. With them, whole new technologies are being developed, not only for defense but for industry and commerce as well.



June Issue of Proceedings of the IRE is the New Standard Reference Work on Transistors

Only once before has PROCEEDINGS devoted an entire issue to transistors. That was in November, 1952. Despite a substantial overprinting, every copy was sold within 3 months. This classic issue, coming at a time when there were no books and few papers on the subject, is still considered one of the basic references on the subject...a suitable companion to the definitive Solid-State Electronic issue of December, 1955 and the Ferrites issue of October, 1956.

Now, to mark the tenth anniversary of the transistor, PROCEEDINGS presents the latest advances in theory and application in the June, 1958 issue. Here you will find introductory articles by its inventors—Shockley, Bardeen and Brattain—specially invited papers reviewing progress in all facets of the subject, contributed papers reporting the latest and more important advances in the field. Be sure to order your copy, today!

Partial Contents:

The Institute of Radio Engineers
1 East 79th St., New York 21, N. Y.

○ Enclosed is $3.00

○ Enclosed is company purchase order for the June 1958 issue on Transistors.

Send this special issue of **Proceedings of the IRE** to:

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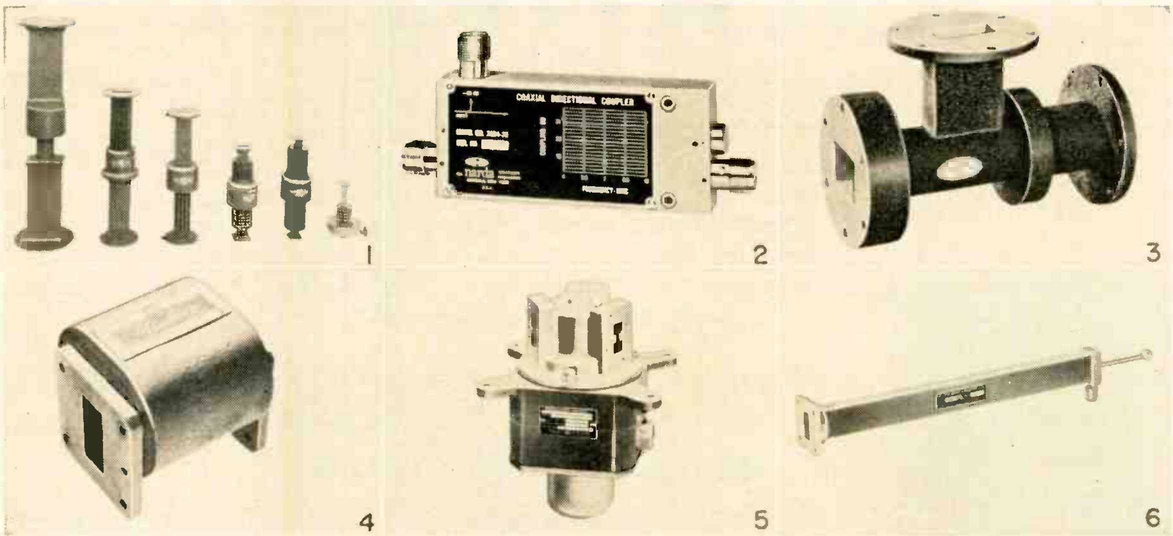
All IRE members will receive this June issue as usual.

Extra copies to members, $1.25 each (only one to a member).

Microwaves Spur New Parts



(1) Diamond Antenna & Microwave Corp., rotary joints. (2) Narda Microwave Corp., coaxial couplers. (3) Raytheon Mfg. Co., ferrite circulator. (4) Monogram Precision Industries, Inc., load isolator. (5) Thompson Products, Inc., waveguide switch. (6) PR&D Co., sliding-load waveguide.

MICROWAVE equipment business is ballooning into the multi-billion-dollar-a-year category. New equipment designs rely on availability of new and improved microwave components.

Series No. 45 waveguide rotary joints offered by **Diamond Antenna & Microwave Corp.**, 7 North Ave., Wakefield, Mass., (300), are of the in-line type and feature broadband operation at high speeds. They employ novel transducers from rectangular to loaded circular waveguide.

Narda Microwave Corp., 118-160 Herricks Road, Mineola, N. Y., (301), announces a new broadband series of coaxial couplers covering a 2½ to 1 frequency range with flat coupling and high directivity from 4,000 to 10,000 mc. Models are available for 10, 20 and 30 db coupling.

Now available from **Raytheon Mfg. Co.**, Waltham 54, Mass., (302), is model CCM1 microwave ferrite circulator for use in C-band transmission and reception systems. It is only 5⅞ in. long, 4¼ in. high, and 3⅛ in. wide. It readily replaces conventional gas-tube duplexers.

Monogram Precision Industries, Inc., Los Gatos, Calif., (303) introduces model XL157 Uniline ferrite load isolator. Used to provide substantial isolation between a microwave source and its load with negligible loss in transmitted power, it removes the reactive loading effect caused by long transmission lines or frequency pulling of magnetron or klystron.

In production at **Thompson Products, Inc.**, 2196 Clarkwood Rd., Cleveland 3, Ohio, (304), is a double ridged waveguide switch which provides broad frequency characteristics for DR19 or equivalent waveguide. The actuator is radio noise free and equipped with interlock circuitry.

Polytechnic Research and Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y. (305), announces a new series of sliding waveguide terminations with frequency ranges from 2.6-3.95 kmc to 26.5-40 kmc, and a maximum vswr of 1.01.

For more information use READER SERVICE CARD

D-C VTVM
low cost unit

MILLIVAC INSTRUMENTS, Box 997, Schenectady, N. Y. Model MV-57A sensitive precision d-c vtvm is priced at $790. Accuracy is ¼ percent absolute (not full scale). Measuring range is 100 μv to 1 kv. Input impedance is 6 megohms on low ranges, 60 meg from 1 v up. Precision measurements are made through automatic comparison of accurate calibration signals, taken from a standard cell-controlled 1 kv d-c supply, with the unknown voltage. **Circle 306 on Reader Service Card.**

(Continued on page 124)

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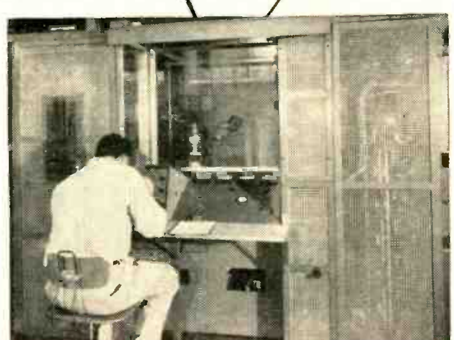
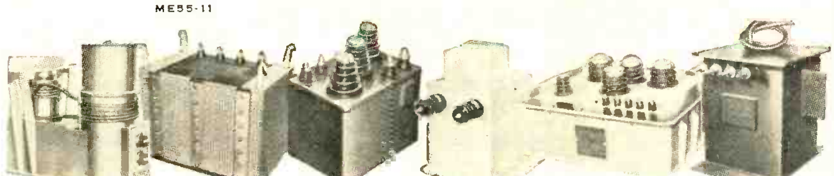
Through the four necessary steps to produce transformers for Electronic applications, Moloney uses the best . . . in men . . . in facilities . . . in material. That basically is why Moloney is recognized as a producer of quality products. Yes, recognized for the quality of engineering, processing, assembly . . . and testing. Experience and facilities thus combined assure purchasers of the best product for their needs.



TESTING

Write for Catalog SR 208 "HyperCores for Magnetic Components" and Catalog ST 3506 "Magnetic Components for Electronic Applications."

ME55-11



MOLONEY ELECTRIC COMPANY

Plate and Filament Transformers • Chokes • Unit Rectifiers • Modulation Transformers and Reactors • Pulse Transformers and Charging Chokes • HyperCores for Magnetic Components Developmental Magnetic Components • Power and Distribution Transformers

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CIRCLE 90 READERS SERVICE CARD

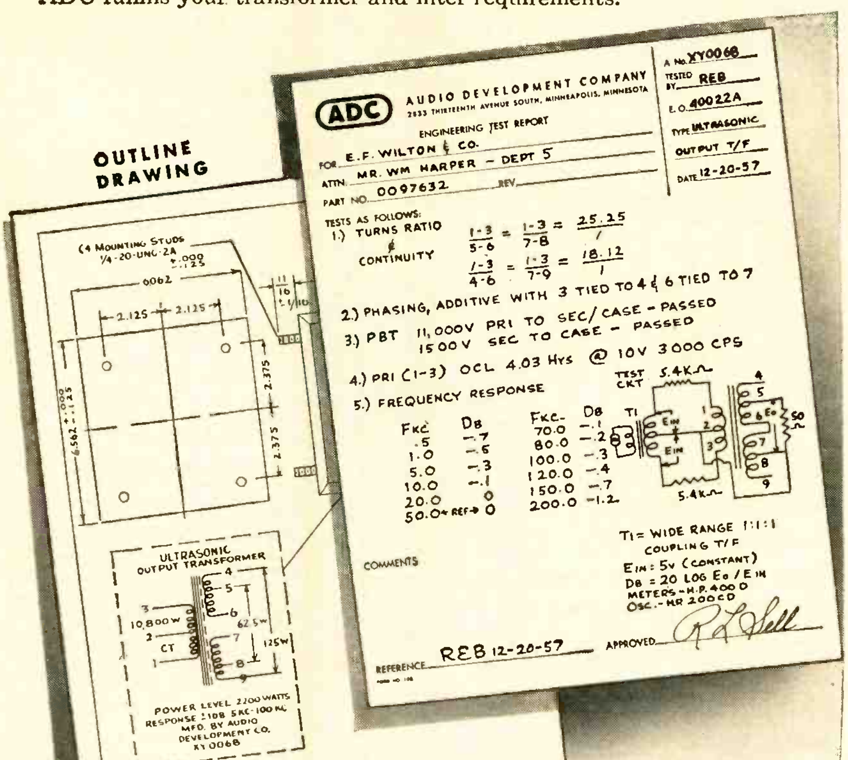
ADC's *Complete* TEST REPORTS SAVE MONEY

Expensive testing hours are saved by the accurate and complete test reports submitted with each ADC sample.
The transformer illustrated above is typical. Specifications called for an output transformer for a high power, ultrasonic application. The sample was promptly submitted with complete test data and outline drawings.

As is its custom, ADC also included the test circuit so that the customer could see how the test data was obtained, and more easily verify test results.

From sample design through production, you'll like the way ADC fulfills your transformer and filter requirements.

OUTLINE DRAWING



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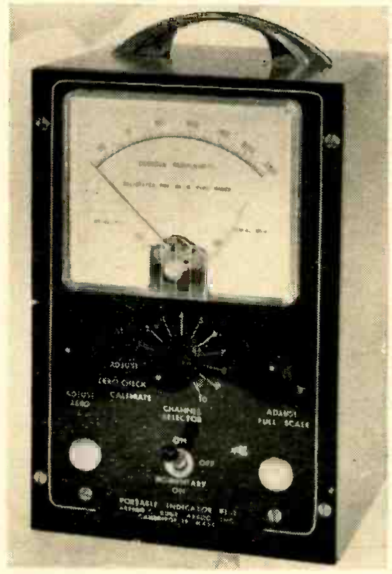
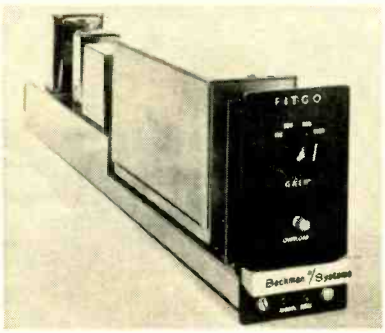


Indicators show temperature

Arthur C. Ruge Associates, Inc., 733 Concord Ave., Cambridge, Mass., has developed two portable, easily operated temperature indicating instruments—one a single channel indicator and the other multichannel—to be used with their RdF resistance thermometers. Illustrated is the multichannel type with built-in calibration controls, easy readability and simplicity of operation, and a front panel selector switch permitting monitoring of up to 10 points. There is also a provision for recorder connection through a jack on the rear of the panel. Range is 0 to 500 F standard. Scale divisions are 10 F and 10 C; readable to approximately 2.5 F. Circle 307 on Reader Service Card.

V-R Power Supplies transistorized

Western Gear Corp., P.O. Box 182, Lynwood, Calif. Operating from a 115-v 60 cps a-c power source, the model 7PVR1+ transistorized voltage regulated power supply provides three channel outputs—±2 v d-c at 2.5 amperes, ±3 v d-c at 2.5 amperes, and ±20 v d-c at 2.5 amperes. All channels are regulated to ± 0.5 percent. The regulatory circuits are referenced to temperature compensated Zener diodes. Vernier adjustments of output voltages are provided. **Circle 308 on Reader Service Card.**



D-C Amplifier
low-level type

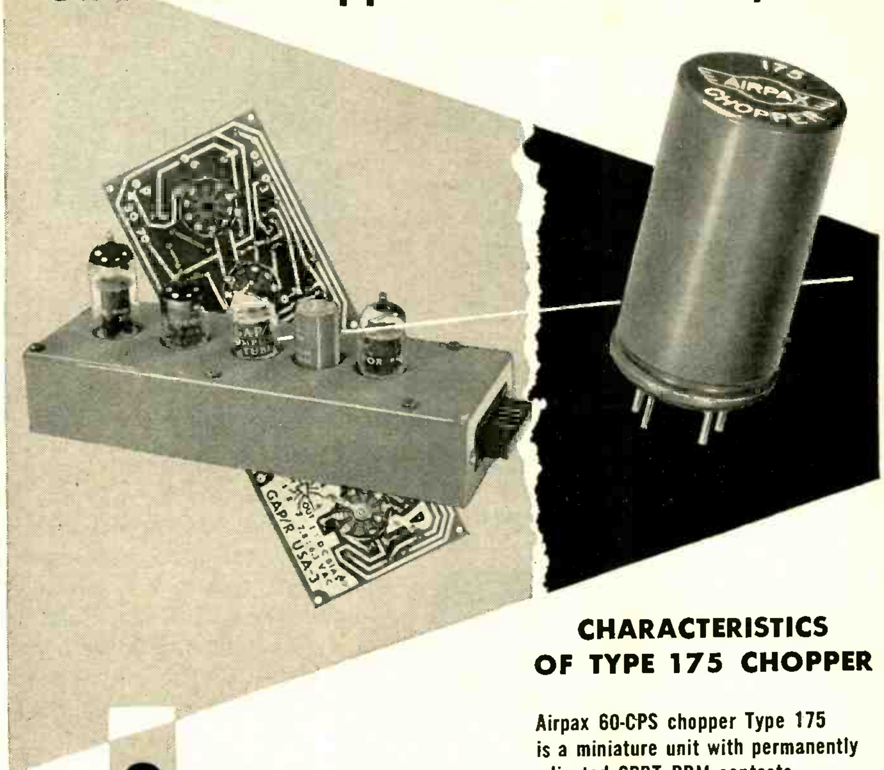
Beckman Systems Division, 325 North Muller Ave., Anaheim, Calif. The FITGO (Floating Input To Grounded Output) low-level d-c amplifier uses solid state components throughout, resulting in greater reliability. The unit is used to amplify signals from thermocouples, strain gages, pressure transducers and other sensing elements of this type. **Circle 309 on Reader Service Card.**

Receiving Tube
tiny, low-noise

General Electric Co., Owensboro, Ky., has developed a low-noise military receiving tube ½ in. long and ½ in. wide for use as an r-f amplifier in equipment operating up to frequencies of 1,200 mc. Type 7077 is a high-mu triode of planar construction intended primarily for use in grounded grid cir-

PRINTED CIRCUIT AMPLIFIER USES AIRPAX CHOPPER

Universal Chopper-Stabilized Amplifier



Open-loop gain of this operational amplifier drops at 6 db/octave over entire working range. This feature enables the user to shape the response from DC to well above 100 KC by means of feedback to meet nearly any application.

Grid current at the input is completely eliminated. Drift and noise are held under 100 microvolt referred to the input by a stabilized preamplifier stage using an Airpax Type 175 chopper.

The amplifier is manufactured by George A. Philbrick Researches, Inc., Boston 10, Massachusetts.
The chopper, naturally, is by Airpax.

CHARACTERISTICS OF TYPE 175 CHOPPER

Airpax 60-CPS chopper Type 175 is a miniature unit with permanently adjusted SPDT BBM contacts.

DRIVE

Frequency .. 60 ±3 CPS
Voltage .... 6.3 ±0.6 RMS volts

CONTACTS

Dwell Time . 167 ±10 electrical deg.
Balance .... within 15 electrical deg.
Phase Angle 20 ±5 electrical deg.
Voltage .... up to 100 DC volts
Current .... up to 2 MA
Noise ...... 50 microvolts average

Hermetically sealed for trouble-free operation in any atmosphere; internal mechanism rigidly mounted to withstand shock and vibration encountered in portable equipment.

Airpax Products Co., Cambridge Division, Jacktown Rd., Cambridge, Maryland

AIRPAX
DESIGNERS ENGINEERS

CIRCLE 92 READERS SERVICE CARD

marion

advancement in instrument design

VERSATILE MULTI-RANGE METER TESTER

Model M-2

...POWER SUPPLY...LIMIT BRIDGE

Precise, self-contained unit for laboratory and production use. For DC instrument calibration from 25 ua full scale to 10 ma full scale, and 0-100 VDC; sensitivity and resistance measurement; DC current-voltage source; limit or bridge measurements from 0-5000 ohms. Regulated power supply. Stepless vacuum tube voltage control. Accuracy exceeds ¼% (current), ½ ohm or ½% (resistance). For 115V, 60 cycle AC. Complete — needs no accessories. Bulletin on request. Marion Electrical Instrument Co., Manchester, N. H., U. S. A.

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U. S. Patent 2,740,093

marion meters

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ENGINEERS—CLIP THIS SCHEDULE

GENERAL ELECTRIC HMEE* INTERVIEWING PROGRAM FOR NEXT 3 WEEKS

INTERVIEWS	DATES
New York, N. Y.	June 11
Washington, D. C.	June 9-10
Boston, Mass.	June 16-17
Dallas, Texas	June 23-24
San Francisco, Cal.	June 24-25
Ft. Worth, Texas	June 25-26
Los Angeles, Cal.	June 27-28
Seattle, Wash.	June 27-28
El Paso, Texas	June 28-29
Albuquerque, N. M.	June 30-July 1

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Mr. James P. Kinsella, Div. 27 WV

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GENERAL ELECTRIC

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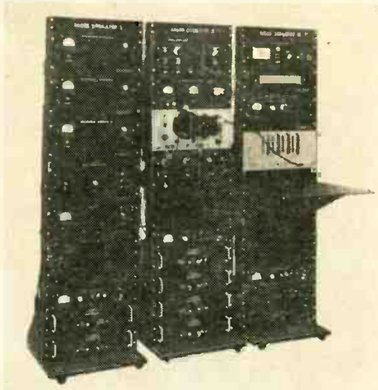
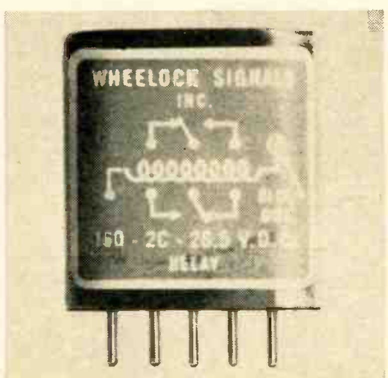
cuitry in communications, radar and navigation equipment. Amplification factor is 80, power gain 14.5 db, and noise figure 5.5 db. Circle 310 on Reader Service Card.



Radar Simulator
basic research type

FEDERAL SCIENTIFIC CORP., 615 W. 131st St., New York 27, N. Y., offers a basic search radar simulator intended to meet a wide variety of requirements. In reproducing the systematic and random portions of the radar process the instrument supplies radar video simulating that of a search type radar with complete fidelity. The effects of antenna radiation pattern, target scintillation, and receiver thermal noise are simulated with mathematical validity. Circle 311 on Reader Service Card.

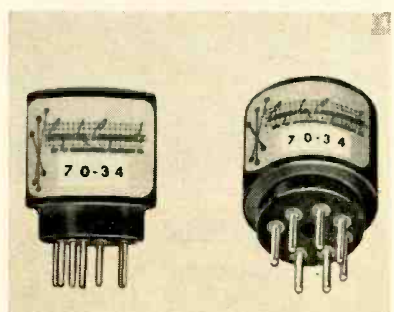


Crystal Case Relay
weighs only 0.35 oz

WHEELOCK SIGNALS, INC., Long Branch, N. J. This new miniature crystal case relay can withstand temperatures of −65 to 125 C and vibration of 2,000 cps at 20 g. Dielectric strength is 1,000 v rms, 750 v rms across contact gaps. The relay can withstand shock in excess of 100 g, all planes, has coil resistances up to 5,000 ohms and minimum coil power stud or bracket mounting with solder hooks or 3 in. leads. Circle 312 on Reader Service Card.

Voltage Divider
small, ultralinear

ELECTRO-MEASUREMENTS INC., 7524 S. W. Macadam, Portland, Oregon, announces the Dekatran, a compact panel mounted a-c voltage divider having linearity rivaling elaborate laboratory standard dividers. It employs a special tapped toroidal transformer, coaxial switches and the exclusive Dekadial. Four coaxial dials give a simple straight line reading to five significant figures. Overall linearity of the Dekatran is better than 0.002 percent. Circle 313 on Reader Service Card.



Pulse Transformers
miniaturized

INTERNATIONAL RESISTANCE CO., Computer Components Division, 401 N. Broad St., Philadelphia 8, Pa. Packaged in a special moisture

Push Button Switches Designed for your Miniaturization Program

These Grayhill Switches are designed and built for long dependable service. They are silent action momentary contact with an exceptionally long life. Series 2000 Snap Action Switch also available.

All Switches Actual Size

Series 4000 SPST 1/2 Amp.—115 V. AC Normally Open or Normally Closed

Series 35 DPST 1/2 Amp.—115 V. AC Normally Open

Series 23 SPST 1/4 Amp.—115 V. AC Normally Open

Series 30 SPST 1/10 Amp.—115 V. AC Normally Open or Normally Closed.

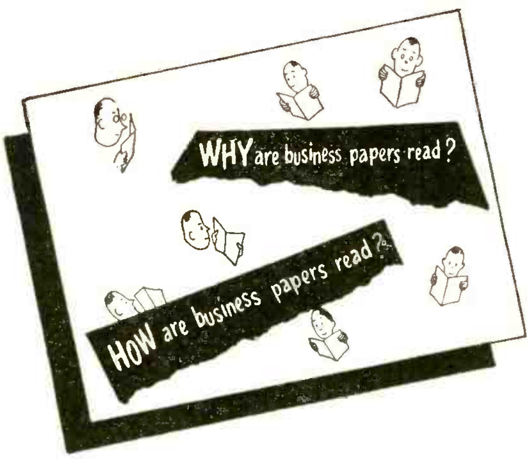
Series 39 SPST 1/10 Amp.—115 V. AC Normally Open

Request Catalog No. M-202

Grayhill

523 Hillgrove Avenue *Telephone Fleetwood 4-1040*

CIRCLE 114 READERS SERVICE CARD



A copy of this quick-reading, 8-page booklet is yours for the asking. It contains many facts on the benefits derived from your business paper and tips on how to read more profitably. Write for the "WHY and HOW booklet."

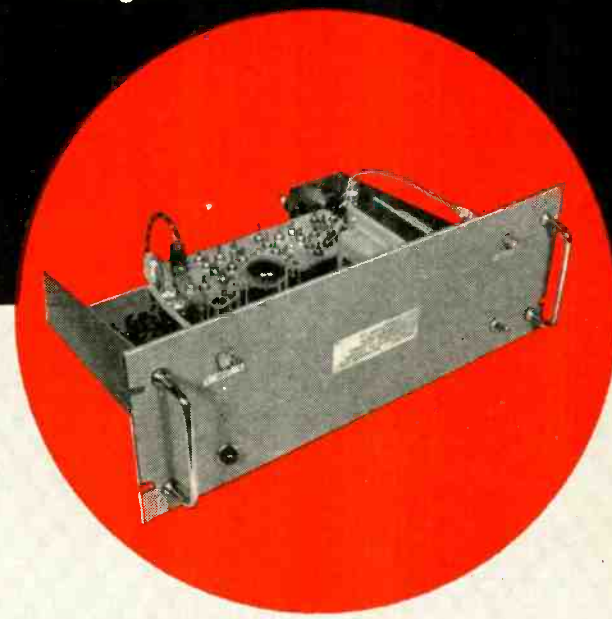
McGraw-Hill Publishing Company, Room 2710, 330 West 42nd St., New York 36, N.Y.

a big step forward in broadband RF amplification

OCTAVE RF AMPLIFIERS

40 to 600 mcs

- *low noise figure* • *low power drain*
- *high gain* • *broadband operation*
- *flat gain characteristic*



Model HFW Octave RF Amplifiers feature low noise, high gain, low power drain *plus* dependability and easy maintenance. Four basic amplifiers are available, with the following frequency responses:

40 to 80 mcs • 80 to 160 mcs
160 to 320 mcs • 300 to 600 mcs

Two additional units cover the 100-400 mcs region as follows:

100 to 200 mcs • 200 to 400 mcs

Conservatively speaking, these equipments offer a practical and realistic answer to nearly all broadband amplification requirements.

TYPICAL PERFORMANCE CHARACTERISTICS Model HFW-303

Input frequency:	300-600 mcs
Input, output impedance:	50 ohms
Input, output V.S.W.R.:	Less than 1.5 in bandpass region
Noise figure (average):	7 db
Gain	30 db
Primary power requirements:	115 VAC, 60 cps
Size (L.W.H.):	19" x 12½" x 7"
Mounting dimensions:	Standard 19" relay rack

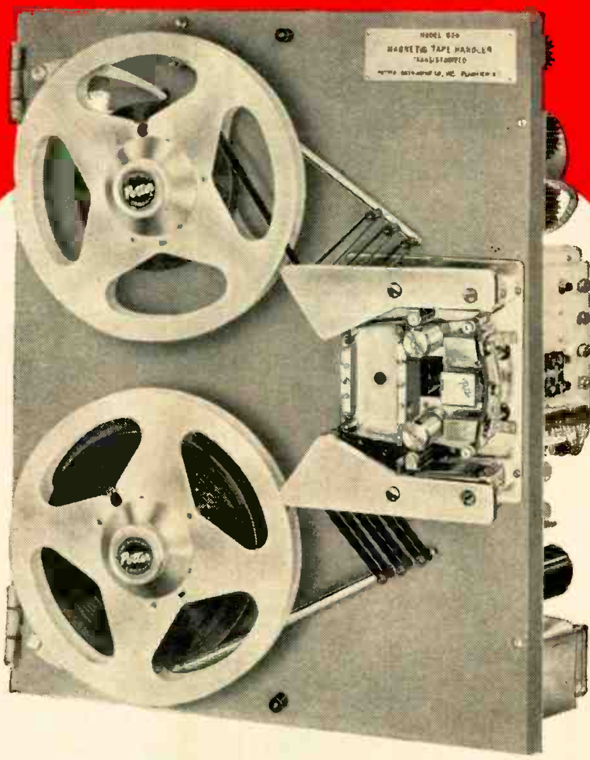
Write for further information.

Applied Research inc.

76 South Bayles Avenue, Port Washington, N. Y.

CIRCLE 95 READERS SERVICE CARD

New Speed...Versatility...Reliability...



TRANSISTORIZED DIGITAL MAGNETIC TAPE HANDLER MODEL 906

Optimum performance in virtually all tape handling applications

The advanced design of the completely transistorized Potter Model 906 Tape Handler provides improved performance in virtually any tape handling application.

Replaceable Capstan Panel permits use as Perforated Tape Reader with a remarkable new brake capable of stopping on the stop character at speeds up to 1000 characters per second. Using a small vacuum loop buffer, Model 906 features:

- Complete front accessibility—single panel construction
- Pinch rollers capable of 100 million start-stop operations
- In-line threading, end of tape sensing and tape break protection
- Speeds up to 150 ips
- As many as 4 speeds forward and reverse
- Capable of continuous cycling at any frequency from 0 to 200 cps without flutter
- Rewind or search at 400 ips
- 3 millisecond starts
- 1.5 millisecond stops
- Tape widths to 1-1/4"
- Up to 47 channels
- All functions remotely controllable

The 906 may be supplied with a transistorized Record-Playback Amplifier featuring a separate module for each channel. Electronic switching from record to playback function is available as an optional feature.

Other Potter products include Transistorized Frequency Time Counters, Magnetic Tape Handlers, Perforated Tape Readers, High Speed Printers, Record-Playback Amplifiers and Record-Playback Heads.

Potter

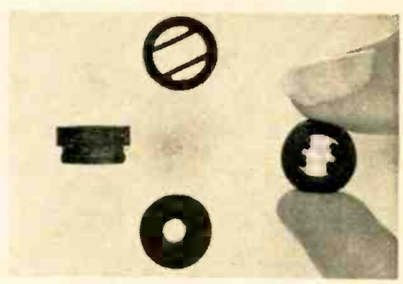
POTTER INSTRUMENT COMPANY, Inc.
Sunnyside Boulevard, Plainview, New York
OVerbrook 1-3200

CIRCLE 96 READERS SERVICE CARD

resistant epoxy resin, a new series of miniaturized pulse transformers are designed with a 7-pin miniature plug-in base or with leads for soldering to printed circuit boards. They are designed for use in blocking oscillators, impedance matching, phase inversion, interstage coupling, triggering and counting circuit.—Circle 314 on Reader Service Card.

Portable Analyzer tests galvanometers

North Atlantic Industries, Inc., 603 Main St., Westbury, N. Y. The GA-101 portable galvanometer analyzer allows a complete check of all galvanometer parameters, including damping, frequency response, static balance and d-c sensitivity, replacing the complex test equipment formerly used in these measurements. Circle 315 on Reader Service Card.



Mounting for transistors

The Delbert Blinn Co., P. O. Box 757, Pomona, Calif., announces a new transistor mounting that provides a standardized mounting of all transistors regardless of size or shape. It offers shock resistance, good heat sinking and low moisture absorption. Temperature range is from −60 C to +99 C with a hot continuous operating temperature of 85 C. It has low dissipation factor, conductivity and dielectric constant; high surface and volume resistivity. Circle 316 on Reader Service Card.

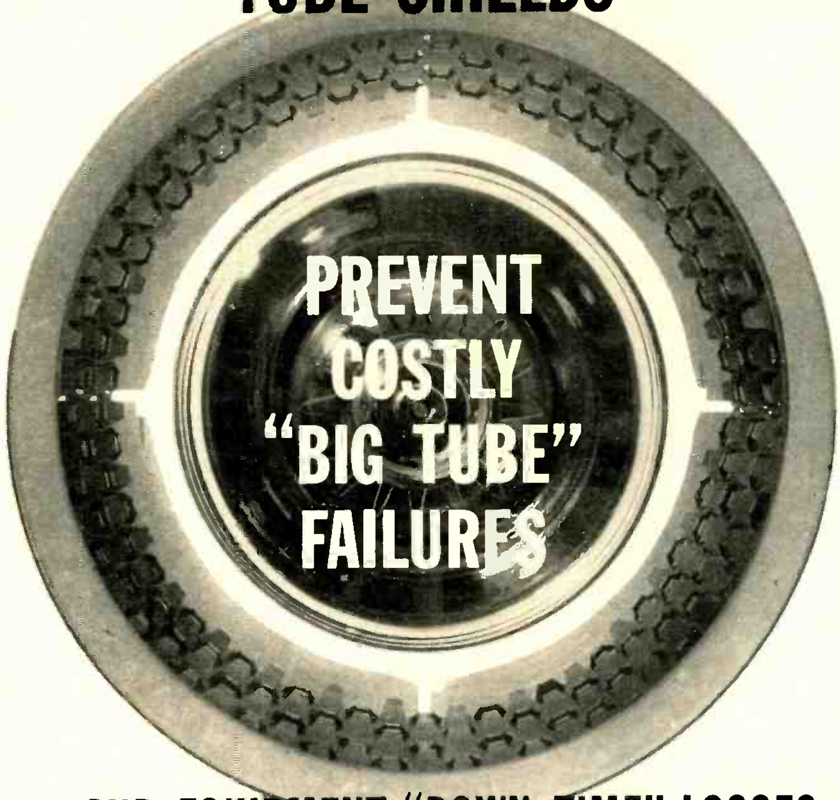
Power Supply two phase

Pacific Technical Co., 2047 Sawtelle Blvd., Los Angeles 25, Calif. A new two phase power supply is designed to speed the development and testing of 400 cycle servo systems and motors for missiles and aircraft. Three continuously variable outputs—two at 0 deg and one at ±90 deg—allow extreme flexibility in the use of this supply. Total output is in excess of 500 va. Circle 317 on Reader Service Card.

Miniature Servo high torque output

Librascope, Inc., 808 Western Ave., Glendale 1, Calif. Designed primarily for servo repeater applications, model 100-1 miniature servo meets the needs for an isolation servo between synchro components, or a synchro controlled servo drive for resolvers, potentiometer, or shaft to digital converters. It has a high sensitivity to synchro input

IERC HEAT-DISSIPATING ELECTRON TUBE SHIELDS



– AND EQUIPMENT "DOWN TIME" LOSSES CAUSED BY HEAT, SHOCK AND VIBRATION!

Investigate the extraordinary tube-saving, cost-saving potentials of IERC Heat-dissipating Tube Shields — the only complete, commercially-available line of effective heat-dissipating electron tube shields for **miniature, subminiature and octal/power** size tubes. IERC's expanded line of heat-dissipating tube shields for the larger size power tubes offer, for the first time, **a practical method to retain these tubes** in severe shock and vibration environments!

The most complete electron tube heat-dissipation information is yours for the asking! Technical data comprised of IERC and independent laboratory test reports will be sent upon request on your company letterhead.

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LATEST addition to IERC's product line is the IERC HEAT DISSIPATOR for POWER TRANSISTORS. Effective reduction of temperatures, elimination of heavy, large or finned surfaces plus adaptability for use in confined spaces are prime features. Technical Bulletin PP112 is included with general IERC information sent on request.

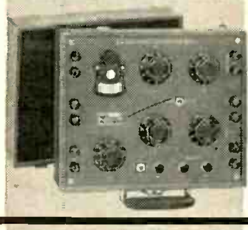
Heat-dissipating electron tube shields for miniature, subminiature octal and power tubes

CIRCLE 97 READERS SERVICE CARD

Shallcross BRIDGES

Types 6100 and 6101

Type 6320



Type 638-R

617 Series

Type 6350

ACCURATE dc RESISTANCE MEASUREMENTS

. . . 1 micro-ohm to 10^6 megohms

Among the many bridges manufactured by Shallcross, these six have become virtually "standards" for general-purpose resistance measurements. Each is easy to operate and ruggedly constructed to maintain accuracy and stability in every kind of field and laboratory service. Switch decks are inside the case for minimum maintenance.

Of special interest are the 617 Series Limit Bridges. These provide direct "GO-NO GO" production line resistor testing for any percent tolerance spread from ±0.1% to ±20%.

NEW BULLETIN L-19B contains full specifications for each instrument. For your copy write to: SHALLCROSS MANUFACTURING COMPANY, Selma, North Carolina.

New Address

Model Number	Measurement Accuracy	Maximum Setting	Minimum Setting	Circuit	Special Features
6100	±0.1% +0.01Ω (.1Ω to 1.011 MegΩ)	1.011 MegΩ	0.001Ω	Fault Location—Wheatstone	Fault Location by Murray, Varley, Hilborn & Fisher Loop Tests.
6101	±0.1% +0.01Ω (1Ω to 11.11 MegΩ)	11.11 MegΩ	0.001Ω	Wheatstone	Four dial rheostat usable as decade box.
6320	±0.02% +0.01Ω (1Ω to 11.11 MegΩ)	111.11 MegΩ	0.00001Ω	Wheatstone	Most accurate five dial Shallcross bridge for direct resistance measurement.
	±0.05% to ±20% on separate "+" and "—" percent selectors. (1Ω to 10 MegΩ)	11.111 MegΩ	0.0001Ω	Percent Limit	Rapid "GO-NO GO" percent limit testing. Built-in adjustable comparison standard.
638-R	±0.75% or better (.001Ω to 1Ω)	11.11Ω	0.000001Ω	Kelvin	Overlapping Kelvin and Wheatstone ranges selected with single ratio dial.
	±0.2% +0.01Ω (1Ω to 11.11 MegΩ)	11.11 MegΩ	.001Ω	Wheatstone	
6350	±1%, (10Ω to 10 MegΩ) ±2%, (10 MegΩ to 10,000 MegΩ) ±5%, (above 10,000 MegΩ)	1.111 x 10^6 MegΩ	0.01Ω	Wheatstone with d-c Amplifier	Modular construction dual range power supply, null indicator-amplifier, for 115V. 60 cycle operation.
617 Series	±0.1% to ±20% on separate "+" and "—" selectors from a minimum resistance consistent with number of dials in use to the maximum settings.	111,111Ω 1,111,110Ω 11,111,100Ω	0.1Ω *1Ω 10Ω	Percent Limit	For rapid "GO-NO GO" percent limit testing. Hand or foot operated for production testing. All models also usable for direct resistance measurements. Binding post for external d-c power supply.
	†±0.2% +0.01Ω from a minimum consistent with number of dials in use to the maximum setting.	111,111Ω 1,111,110Ω 11,111,100Ω	0.1Ω *1Ω 10Ω	Wheatstone	

† Except 617B and 617J ±0.1% ±0.01Ω. * Except 617G, 0.01Ω.

CIRCLE 98 READERS SERVICE CARD

producing an accurate high torque output. In a package 3 in. long and 1¾ in. in diameter it includes: motor, control transformer, amplifier, gear train and related circuitry. **Circle 318 on Reader Service Card.**

Motor Pump portable, hydraulic

TAL BENDING EQUIPMENT, INC., Milwaukee 2, Wisc., has developed a small, fast, powerful, portable hydraulic motor pump developing up to 10,000 psi pressure and weighing only 65 lb.

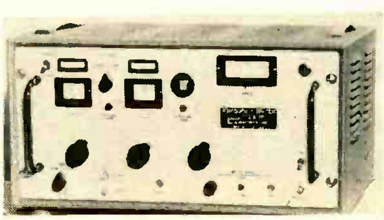
The company claims that specific uses of the motor pump in the electronic industry would be: conversion of hand or foot operated arbor and bench presses, shears, bending devices, jigs, fixtures, clamping devices, and anywhere else that smooth positive power is needed to push or pull. **Circle 319 on Reader Service Card.**

Transistor Tester general purpose

SONEX, INC., 73 South State Road, Upper Darby, Pa. A general purpose transistor tester measures small signal beta, collector leakage current, and collector resistance on all *npn, pnp*, surface barrier, grown or diffused junction transistors. Eleven operating points are provided with one convenient selector switch. The tester is self-calibrating and transistor under test is operated in a temperature stabilized circuit insuring each unit is tested under identical biasing conditions. Circle 320 on Reader Service Card.

VHF F-M System for split channel use

AERONAUTICAL ELECTRONICS, INC., Box 6527, Raleigh, N. C. Model 600 series vhf f-m mobile radio equipment uses a high frequency crystal filter for superior receiver selectivity characteristics under new split channel allocations of the FCC. It can operate on 6, 12 or 115 v without modification, extending its use thereby to smaller transmitter stations. Circle 321 on Reader Service Card.



Frequency Meter for vhf use

LAVOIE LABORATORIES, INC., Matawan-Freehold Road, Morganville, N. J. A new vhf frequency meter is accurate to one part per million (0.0001%) over a range of 20 mc to 3,000 mc. The instrument will measure frequencies as low as 10 kc and is capable of generating frequencies over the entire 10 kc-3,000 mc range. No calibration

. . . moderate and heavy duty types

. . . low voltage and apparatus types

A design which uses air as major insulation, with leakage path lengthened by forming porcelain into a bowl, eliminates losses which occur in ordinary types of bushings at radio frequency.

Lapp moderate duty insulators, suitable for a variety of low or medium voltage applications, are the standard type bowls for carrying leads through shields, equipment cases, walls, etc., and practically any indoor use where duty is not too severe.

Outdoor units are designed with corrugated surfaces which provide extra leakage distance for use in contaminated atmosphere. Corrosion-resistant hardware.

A wide variety of types of these insulators is now available as catalog items . . . or where requirements necessitate, on special design—for which Lapp engineering and production facilities are excellently qualified. Write for complete descriptive data and specifications. Lapp Insulator Co., Inc., Radio Specialties Division, 142 Sumner Street, Le Roy, N. Y.

Lapp

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when all MANKIND...

is gazing at the heavens wondering if its bleak and silent spaces will be friend or foe, our Nation's security depends, more than ever before, on the Engineers' and Scientists' determination to make major scientific break-throughs rather than mere improvements in existing hardware. The professional staff of the Vitro Silver Spring Laboratory is dedicated to this goal.

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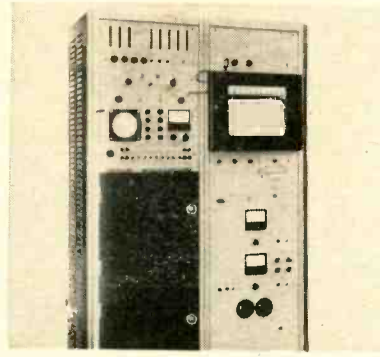
hooks or temperature correction curves are required for the direct reading unit, making it particularly useful in the mobile and military field. **Circle 322 on Reader Service Card.**

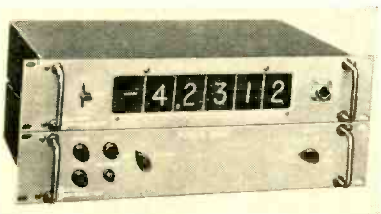


Pulse Analyzer 256-channel unit

RADIATION COUNTER LABORATORIES, INC., Skokie, Ill. Model 20609 256-channel pulse height analyzer features: 27 hours pre-set time during which background may be counted and automatically subtracted from original run data; logarithmic readout on flat-faced crt and strip chart recorder; dual-function h-v supply; and interpolation lights to aid in setting zero point and instrument maintenance. All channels are printed out in less than one minute. **Circle 323 on Reader Service Card.**

Silicon Rectifier diffused junction

FANSTEEL METALLURGICAL CORP., North Chicago, Ill. This small diffused junction silicon power rectifier is rated for continuous service at 20 amperes d-c at maximum peak reverse potentials up to 400 v. Four of these rectifiers in a full wave bridge circuit will provide power for a 10 h-p 230-v d-c motor. It is specifically designed for d-c power supply and magnetic amplifier applications requiring reliable performance in ambient temperatures up to 150 C. **Circle 324 on Reader Service Card.**



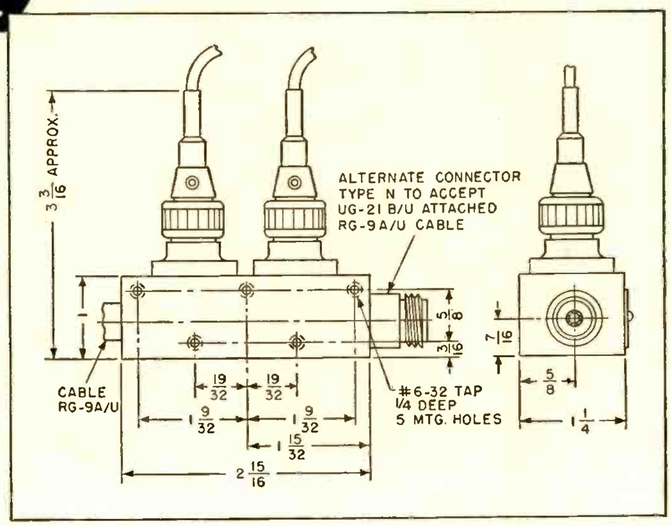
Digital Voltmeter two module unit

ELECTRO INSTRUMENTS, INC., 3540 Aero Court, San Diego 11, Calif. The DVA-500 d-c digital voltmeter consists of a switch module and a power module. The power module is transistorized and features internal modular construction. Specifications of the new instrument include a 5 digit display, automatic ranging and polarity, 0.0001-999.99 range and 0.01 percent accuracy, ± one digit. Stability is better than 0.01 percent. **Circle 325 on Reader Service Card.**

Indicating Meters shatterproof-face

HOYT ELECTRICAL INSTRUMENT WORKS, INC., Burton-Rogers Co., 42 Carleton St., Cambridge 42, Mass., has developed a new series of indicating meters with a shatterproof, transparent plastic face for original equipment or replace applications that require 5 percent accuracy. The scale extends practically the full width of these $2\frac{3}{8}$ in. square meters to give a high

No Transmitter should be without one!



OUTLINE DRAWING MODEL 575N DOUBLE COUPLER

WHEN YOU BUILD MicroMatch Directional Couplers into your transmitters, you add an invaluable feature at extremely low cost — positive confirmation of transmitter performance. Your customers stay sold by the coupler's continuous RF Power indication. Its VSWR monitor, in addition, stands watch over your customer's transmission line and antenna.

Now incorporated in most modern Government and commercial transmitters, MicroMatch Directional Couplers produce an output essentially independent of frequency. Units are available for use within the range of 20 to 4000 megacycles. Couplers are adjusted to produce full scale meter deflection at power levels of 1.2 watts to 120 KW. Accuracy of power measurements is plus or minus 5% of full scale.

For complete details on the MicroMatch line of monitoring equipment, write for our 68-page catalog.

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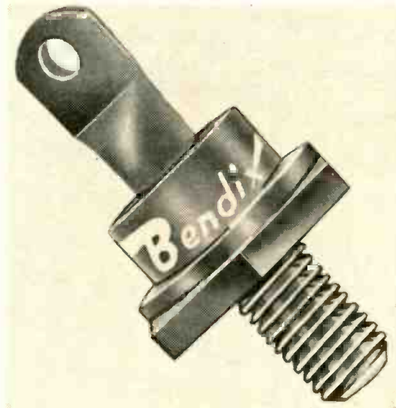
degree of readability comparable to larger instruments. They are available in ranges of d-c sensitivities from 1 ma to 100 amperes, and 326 on Reader Service Card.



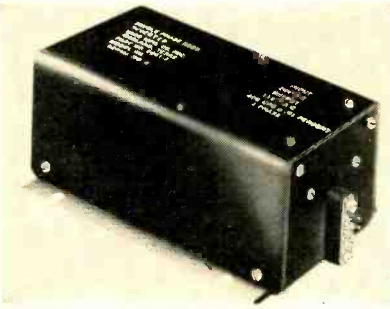
Silicon Rectifiers diffused junction

Bendix Aviation Corp., Red Bank Division, Long Branch, N. J. A series of new silicon rectifiers have peak inverse voltage ratings ranging from 50 to 600 v and can deliver 30 amperes of rectified current. Operating temperature extends from −65 C to +175 C. The rectifier package is in conformance with the latest JETEC proposed standards.

The units are of the diffused junction type for lower forward drop and lower reverse leakage current. EIA has reserved the JETEC designations 1N1434-1N1438 for this series of five rectifiers. Circle 327 on Reader Service Card.

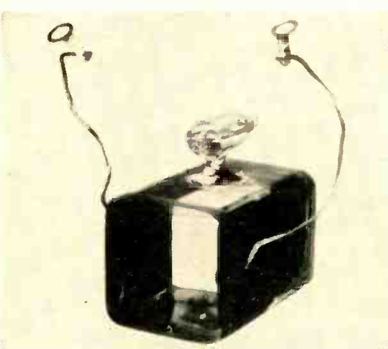
Relay Socket microminiature

Viking Industries, Inc., 21343 Roscoe Blvd., Canoga Park 3, Calif., announces a microminiature 8 and 10 contact relay socket available in four styles of mountings to assure ease of installation in any design. Contact rating is 5 amperes, wire size No. 20 Awg maximum. Insulator is mineral (asbestos) filled Melamine-type mmc; contacts are phosphor bronze; inserts either brass or steel. Circle 328 on Reader Service Card.



Transistor Inverter for airborne uses

VARO MFG. CO., INC., 2201 Walnut St., Garland, Texas, has developed a 60 va, 115 v a-c transistor inverter for airborne uses requiring precision 400 cps frequency. Use of a tuning fork reference obtains 0.01 percent accuracy in the single phase output from the 28 v d-c ± 5 percent input. Model 4303 weighs only 2.5 lb and operates through a temperature range of − 50 C to + 71 C. Unit will withstand 5 g's at 70-1,000 cps or 10 g constant acceleration. Circle 329 on Reader Service Card.

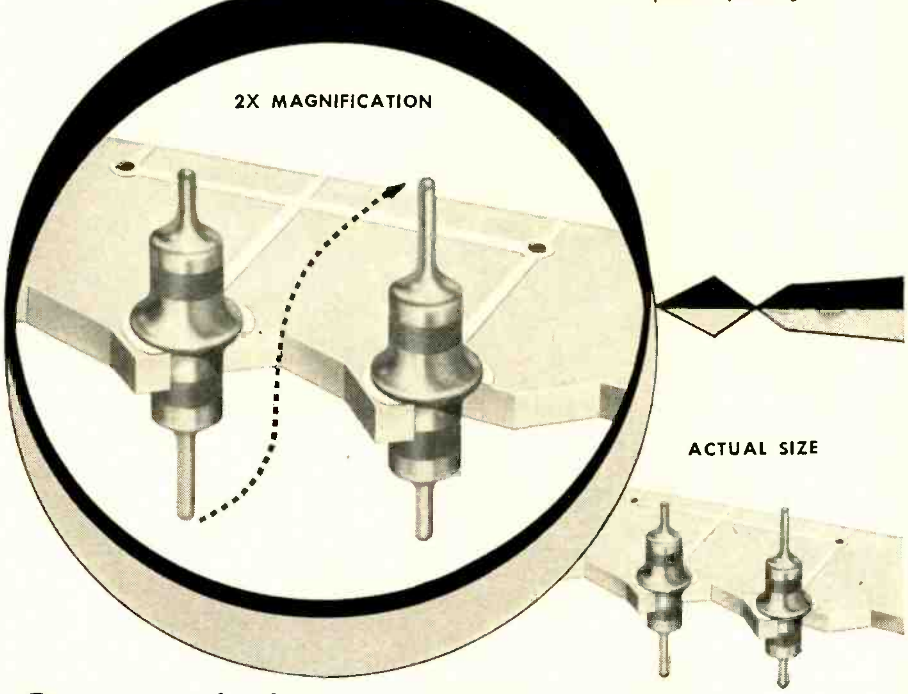


Kerr Cell Shutter .01 μsec exposure

AVCO MFG. CORP., 20 S. Union St., Lawrence, Mass. Exposure time of 0.01 μsec has been achieved with a Kerr cell electro-optical shutter and an improved pulse generator circuit. The 2-in.-sq shutter has

Speed Production... Lower Assembly Costs with this New Symmetrical Feed-Thru Capacitor*

*patents pending



Centralab's New DA-741 Hi-Kap,® the feed-thru you can't put in wrong

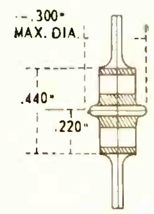
... can be inserted from either end ... a natural for machine insertion or other types of automation

... embodies a new metalizing technique that completely eliminates capacitance drop-off, silver migration, and silver burn-off during soldering operations

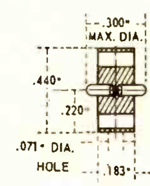
... will withstand soldering temperatures of 450°F for two minutes

... has a solder fillet around center ring eliminating need for solder preforms

... rugged 16 gauge tinned wire lead assures positive connections



TYPE DA 741



TYPE DA 740

SPECIFICATIONS:

Capacitance:	Available in values up to 1,000 mmf. GMV
Power Factor:	3% maximum, measured at 1KC
Voltage:	500 VDCW, 1300 VDCT; special units can be supplied for 900 V. RMS test
Humidity:	Meets EIA STD RS198, Class 2

DA-740, with same electrical characteristics but without solder fillet or leads, can also be supplied.

For details write for Centralab Engineering Bulletin No. EP-556. For the most complete line of ceramic capacitors in the industry see your Centralab distributor.

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CERAMIC CAPACITORS • ENGINEERED CERAMICS • SEMI-CONDUCTOR PRODUCTS

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TRANSFORMERS

Designed and Built in accordance with MIL-T-27A

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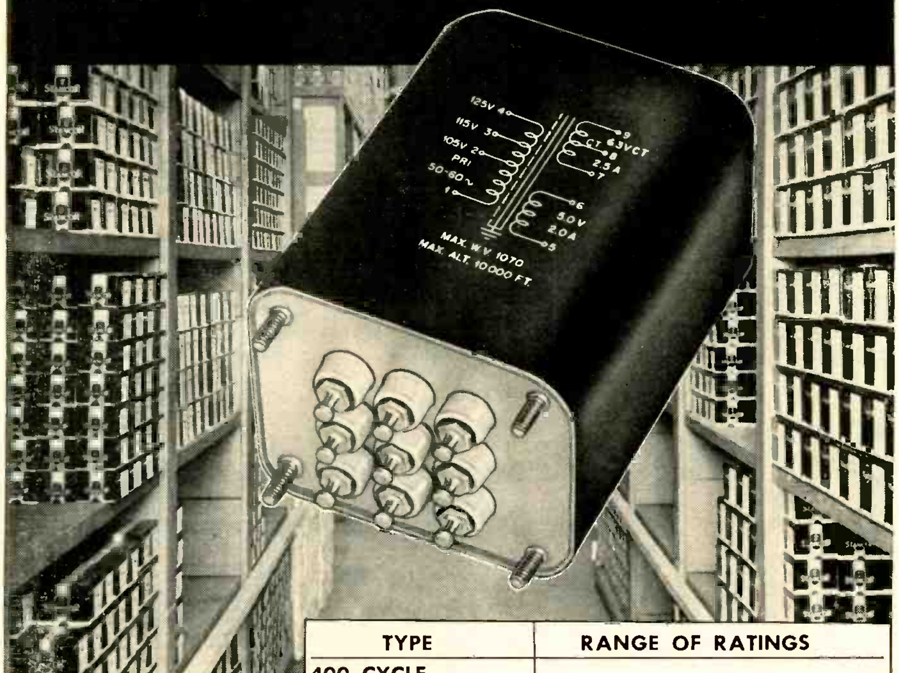


TYPE	RANGE OF RATINGS
400 CYCLE	
Power	40 to 300 DCMA, 510 V. CT to 1100 V. CT
Filter Reactors	40 to 300 DCMA, 2.0 henries
Filament	6.3 V. CT, 3 to 20 Amp.
Step-Down	140 Va, 28.5 V., 3 phase
MILITARY STANDARD	
Power	70 to 250 DCMA, 400 V. CT to 1600 V. CT
Filament	2.5 to 6.3 V., 2 to 20 Amp.
Audio	50 to 15,000 Ω pri., 4.0 to 135,000 Ω sec., .03 to 2.0 W
TRANSISTOR AUDIO	
Input	60 Ω pri., 10 Ω sec., .05 W.
Interstage	100 to 500 Ω pri., 200 to 5000 Ω sec., .03 to .25 W.
Driver	100 to 2000 Ω pri., 100 to 200 Ω sec., .05 to .5 W.
Output	20 to 9800 Ω pri., 4 to 15 Ω sec., .05 to 10.0 W.
GENERAL TYPES	
Power	10 to 300 DCMA, 500 V. CT to 1100 V. CT
Filter Reactor	10 to 300 DCMA, 8 to 15 henries
Filament	5 to 10.0 V., 1.25 to 5.0 Amp.
Multiple Filament	5 to 12.6 V., 1 to 6 Amp.
Audio Input	50 to 20,000 Ω pri., 150 - 50,000 Ω sec.
Audio Output	300 to 20,000 Ω pri., 4 to 600 Ω sec.
Saturable Transformers	2.7 to 18 W. power output

Your local electronic parts distributor can give you fast delivery on hundreds of types of transformers designed and built in accordance with MIL-T-27A specifications. They are in stock, backed up by the largest factory inventory of military transformers in the industry.

Ask your distributor for CHICAGO catalog CT3-57, listing detailed electrical and physical specifications on these units, or write to Chicago Standard Transformer Corporation.

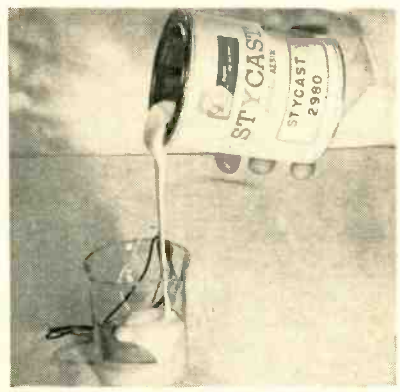
‡Under Military Reduced Inspection Quality Assurance Plan (RIQAP)

CHICAGO STANDARD TRANSFORMER CORPORATION

3502 Addison Street, Chicago 18, Illinois

Export Sales: Roburn Agencies, Inc. • 431 Greenwich St. • New York 13, N.Y.

been applied to aerodynamic simulation studies of long-range missile re-entry problems. Exposure times in the range of 10^{-8} to 10^{-7} are required to prevent image blur in Avco's work with scaled-down projectiles fired at very high velocities in its ballistic range. Key to the new technique is the pulse generator, which consists of RG8/U coax cable and the spark gap. The Kerr cell is connected directly across the load resistor on the transmission line and does not require an impedance matching network or pulse transformer. **Circle 330 on Reader Service Card.**



Casting Resin fire retardant

EMERSON & CUMING, INC., 869 Washington St., Canton, Mass. Stycast 2980 is a one component, fire-retardant epoxide casting resin and impregnant. It is used directly as supplied; no addition of curing agent is required. It can be used from −70 F to +400 F. Insulation resistance is 10^{16} ohm-cm at room temperature and remains above 10^{11} ohm-cm at 400 F. **Circle 331 on Reader Service Card.**

Scaler 7-decade capacity

BAIRD-ATOMIC, INC., 33 University Road, Cambridge 38, Mass. Model

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Help yourself to

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it's free–it's easy–it's for your convenience

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20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38						
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INSIDE FRONT COVER — INSIDE BACK COVER — BACK COVER

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INSIDE FRONT COVER — INSIDE BACK COVER — BACK COVER

MEMO:

NEW PRODUCTS RELEASES

TO: ALL MANUFACTURERS

FROM: electronics

electronics publishes all new product items of interest to makers and users of electronic and allied equipment.

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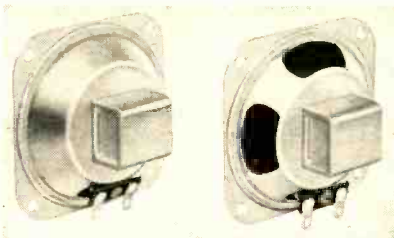
131A is a new and versatile cold cathode glow tube scaler for general purpose radioactivity counting. It is designed for integral pulse height analysis in scintillation or proportional counting. Featuring a 7-decade capacity and a built-in timer, it contains an ultra-linear, ultra stable expander amplifier type pulse height selector. Unit has a resolving time of less than 5 μsec with an electronic scale of 1,000 followed by a 4-digit electromechanical register. Circle 332 on Reader Service Card.



Transducer
9/16 in. voice coil

THE MAGNAVOX CO., 2131 Beuter Rd., Ft. Wayne, Ind., announces the new Hy-Que 3 transducer. Its applications range from single speaker instruments to multiple speaker units, including various tweeter uses in dual speaker design. The speaker uses standard EIA magnet sizes as well as several special, high-efficiency magnets in its $\frac{9}{16}$ in. voice coil. By various design modifications different response characteristics are possible. Circle 333 on Reader Service Card.

V-R Power Supply
compact, tubeless

KEPCO LABORATORIES, INC., 131-38 Sanford Ave., Flushing 55, N. Y., has developed the KM-251 magnetic voltage regulated power supply. It delivers in two ranges: 2 to 8 v, 0 to 30 amperes, and 8 to 14 v, 0 to 15 amperes. Regulation for

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It's time for plain talk on the facts of tantalum electrolytic capacitor availability. There is no "availability" problem as far as General Electric is concerned.

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- Few military directive priorities—Since the supply of Tantalytic capacitors has met demand, the military requirements can be met without directive priorities.

This is why we say—now and in the future, General Electric will continue to provide Tantalytic capacitors in the types and ratings you want—when you want them.

For specific information on Tantalytic capacitor ratings, prices, deliveries, contact your nearest General Electric Apparatus Sales Office or write to General Electric Co., Section 449-4, Schenectady 5, N. Y.

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SOLID TANTALYTIC CAPACITORS—for transistorized circuit applications—rated up to 60 volts, polar units only—sizes down to 0.125 inches by 0.250 inches.

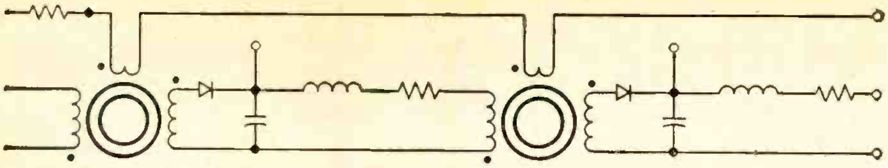
KSR TANTALYTIC CAPACITORS**—for missiles, radar, airborne electronic equipment applications—ratings up to 3500 mfd—three case sizes 1.375, 2, 2.5 inches in height.

125C TANTALYTIC CAPACITORS—for aircraft electronic systems — ratings 10–180 mfd, 30 to 100 volts. Sizes ½ to 1⅛ inches in height. Also tubular, double-cased units.

85C TANTALYTIC CAPACITORS—for applications requiring high quality but where temperatures are less severe.

GENERAL ELECTRIC

CIRCLE 105 READERS SERVICE CARD



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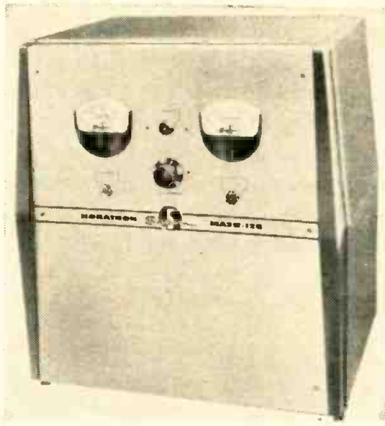
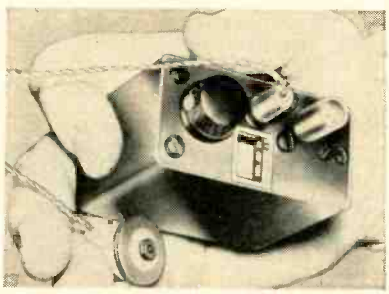
line or load is less than ± 1 percent. Ripple is less than 0.5 percent. Circle 334 on Reader Service Card.



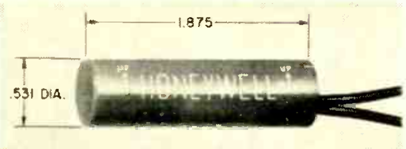
D-C Power Supply
small and light

SORENSEN & Co., INC., Richards Ave., South Norwalk, Conn. Model MA28-125 d-c power supply features high current output over a wide voltage range. A single unit can feed entire systems drawing up to 125 amperes at 18 to 36 v d-c. In addition to the convenience and accuracy of single-source power, it provides dependable tubeless operation based on a magnetic amplifier control circuit with a transistorized power reference and a zener diode comparison circuit. Circle 335 on Reader Service Card.



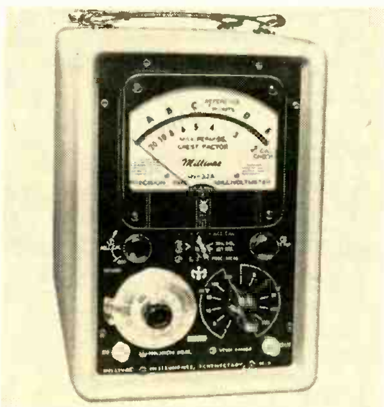
Tiny Amplifier
transistorized

MF ELECTRONICS Co., 122 E. 25th St., New York 10, N. Y. Model M-10 is a portable self-contained amplifier. Input impedance is greater than 150 kilohms. Maximum output is 150 mv rms into 350 ohms. Frequency response is flat from 20 cps to 100 kc. It is valuable for general lab use, in obtaining null indications from an impedance bridge. Checking audio systems directly by ear in the field is another application. Circle 336 on Reader Service Card.



Mercury Switch nylon-enclosed

MICRO SWITCH, a division of Minneapolis-Honeywell Regulator Co., Freeport, Ill. The 7MP1-2 nylon-enclosed mercury switch consists of a high quality gas tube mercury switch embedded in a synthetic rubber and enclosed in a nylon can. The resilient embedment material lessens the effects of shock. The switch is resistant to oil and water. Contact arrangement is spst. Circle 337 on Reader Service Card.

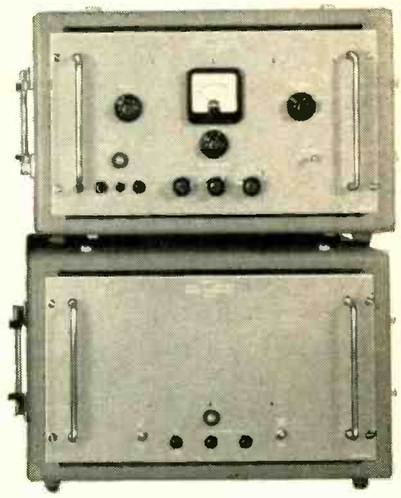


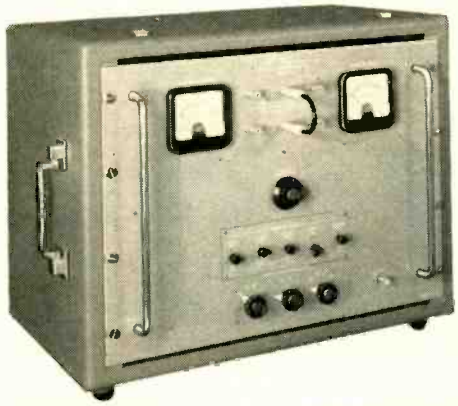
A-C VTVM precision unit

MILLIVAC INSTRUMENTS, P.O. Box 997, Schenectady, N. Y. The MV-32A precision a-c vtvm uses an electronically protected vacuum thermocouple as its rms-responsive meter-rectifier. Accurate measurements are made by comparing the unknown voltage with an accurately calibrated 1000 cps signal and adjusting the calibrator-attenuator until both the unknown voltage

Multi-Channel Link Test Equipment

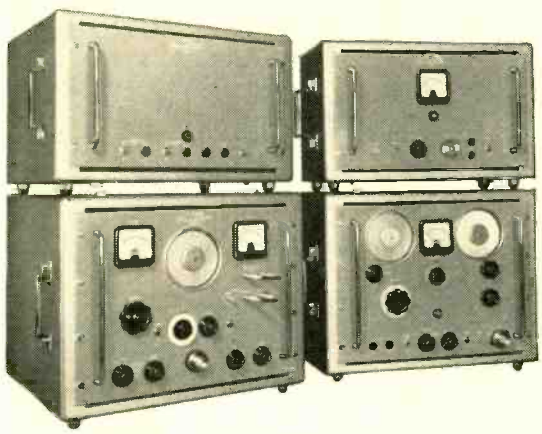
The three groups of instruments featured below are representative equipments from the wide variety of Marconi measuring facilities for both baseband and rf circuits in multi-channel links. These designs have been specifically evolved by Marconi engineers to meet the exacting test requirements in this specialized field of telecommunications.





WHITE NOISE TEST SET
OA 1249

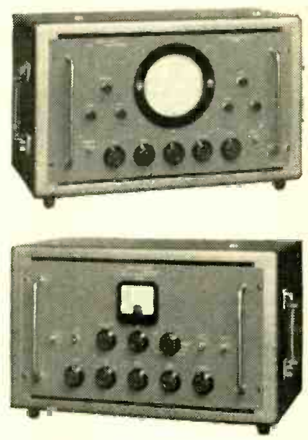
Noise generator and receiver for the measurement of baseband intermodulation and noise by slot technique covering from 24- to 960- channel bands (12 kc to 4028 kc).



U.H.F. TEST SET OA 1248

Signal generator, receiver and noise generator for general rf tests in the 1700- to 2300-Mc band.

Send for leaflet B130A



DERIVATIVE TEST SET OA 1259

Sweep generator and display unit for fast and accurate adjustment of linearity controls on modulator and demodulator stages. Sweep width : ± 20 Mc; center frequency, 65 to 75 Mc.

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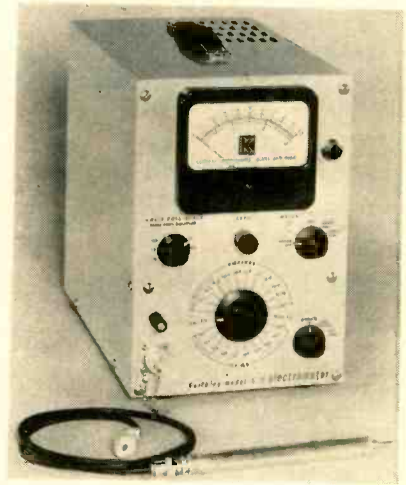
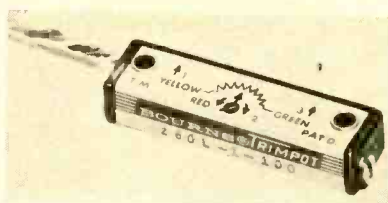
and the calibrator signal produce exactly identical needle deflections. Accuracy within the basic frequency range of the instrument (50 cps-5kc) is better than ½ percent, at other frequencies 2 percent. Calibrator accuracy is 0.1 percent. Circle 338 on Reader Service Card.



Electrometer multipurpose

KEITHLEY INSTRUMENTS, INC., 12415 Euclid Ave., Cleveland 6, Ohio. Model 610 electrometer is an all-purpose instrument for measuring d-c voltage, current and resistance over extremely broad ranges. Typical uses, in addition to numerous common tests, include measurements of voltages in piezoelectric crystals, static charges and vacuum tube electrodes; currents in ion chambers and semiconductors; and insulation leakage checks and inspection. Circle 339 on Reader Service Card.



Adjustment Pot for 175 C use

BOURNS LABORATORIES, INC., 6135 Magnolia Ave., Riverside, Calif. A new leadscrew-actuated adjustment potentiometer, designed for 175 C operation and 1.0 w power dissipation, is announced. Model 260 Trimpot uses a new Silverweld termination and ceramic resistance card for high stability and reliability. Residual resistance at either end is only 0 to 0.1 percent. Standard resistance values are available from 10 ohms to 50,000 ohms. Circle 340 on Reader Service Card.

Silicon Diodes miniaturized

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., has available miniaturized, hermetically sealed silicon power diodes. They provide d-c forward currents up to 45 amperes with a maximum piv to 500 v. The units are capable of operation at a junction temperature of 200 C. Ceramic-to-metal hermetic sealing provides added stability in environmental extremes. No soft solders or fluxes are used in the sealing operation. Circle 341 on Reader Service Card.

Power Supplies transistorized

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO., 2831 Post Oak Rd., Houston 19, Texas. TPC-8 power supplies are available with any specified outputs between 1 and 25 v d-c. Output current is rated at 350 ma with 1 percent regulation over the entire load and input volt-

NOW... ***a major improvement in telemetry receiver sensitivity***

Lowers receiver improvement threshold by at least 6db.

the Radiation, Inc., Model 8-100

RECEIVER PHASE-LOCK DEMODULATOR

This unit provides an honest system gain that may be translated into

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- less transmitter power
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Designed for simple plug-in connection in standard 1400 series receivers (other receivers may be accommodated by modified versions).

Write P.O. Box 37, Melbourne, Florida for Bulletin RAD B-110

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THE MAN WE MEAN IS A COMPOSITE **of the editorial staff of this magazine. For, obviously, no one individual could ever accomplish such a vast business news job. It's the result of many qualified men of diversified and specialized talents.**

AND, THERE'S ANOTHER SIDE TO THIS "COMPOSITE MAN," **another complete news service which complements the editorial section of this magazine — the advertising pages. It's been said that in a business publication the editorial pages tell "how they do it" — "they" being all the industry's front line of innovators and improvers — and the advertising pages tell "with what." Each issue unfolds an industrial exposition before you — giving a ready panorama of up-to-date tools, materials, equipment.**

SUCH A "MAN" IS ON YOUR PAYROLL. **Be sure to "listen" regularly and carefully to the practical business information he gathers.**

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age range. The 120 v a-c input is reduced through a specially designed transformer, rectified in a bridge circuit and filtered. A portion of the output voltage is compared to a Zener diode reference voltage, amplified in a transistor circuit, and applied to the input to maintain a constant output voltage. Circle 342 on Reader Service Card.

Power Supplies miniaturized

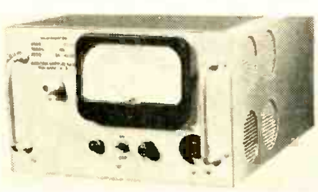
CHICAGO CONDENSER CORP., 3255 W. Armitage Ave., Chicago 47, Ill., announces a new line of miniaturized hermetically sealed power supplies for d-c. The line is engineered for reliability and oil impregnated for stability. Ripple is 1 percent. Positive or negative terminal can be grounded to case; standoff h-v terminals are designed for safe operation. Circle 343 on Reader Service Card.

Megohmmeter and hi-pot tester

GENERAL HERMETIC SEALING CORP., 99 E. Hawthorne Ave., Valley Stream, N. Y. Variable voltage ranges to 10,000 v are available in the new Megpot combination megohmmeter and high potential test set. Standard indications for the nondestructive testing of component dielectric are 0-3,000 v a-c or 0-5,000 v a-c, with higher ranges as specified. Continuously variable tests for leakage are afforded by the unit, with settings from 20 μa to 3 ma. Circle 344 on Reader Service Card.

Spectrum Analyzer two models

KAY ELECTRIC CO., Maple Ave., Pine Brook, N. J. Models 30 and 100 Spectralyzers are designed for accurate and rapid spectrum analysis for such current applications as the study of satellite signals, telemetering, transmission jamming, tube microphonics, transmission of coded frequencies and Doppler radar. Both instruments display the Fourier frequency components of sonic and ultrasonic disturbances of short duration. Circle 345 on Reader Service Card.



Calorimeter uses no controls

ELECTRO IMPULSE LABORATORY, 208 River St., Red Bank, N. J., announces a new calorimetric power meter for low r-f power measurements between d-c to 10 kmc. Full scale measurement range is 5 w. Resolution is 50 mw per division on 4½ in. meter. The instrument is self-contained, self-cooled and requires only connection to the

POWER TRANSISTOR CURVE TRACERS

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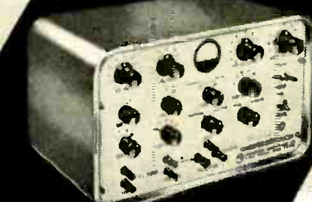

MODEL 300A

MAGNETIC AMPLIFIERS INC.

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The H series is one of ten Curtiss-Wright Thermal Time Delay Relay series which includes:

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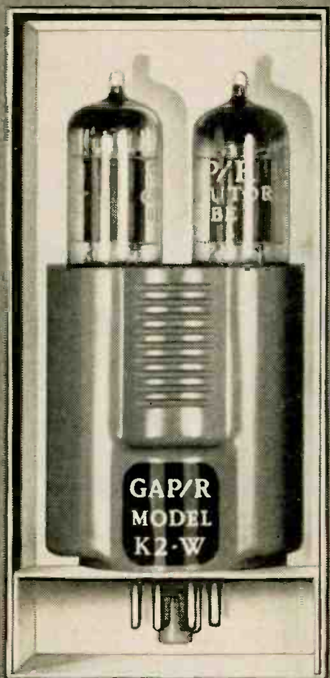
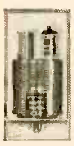
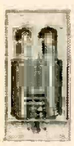


FAST DC AMPLIFIER: Model K2W is an efficient and foolproof high-gain operational unit for all feedback computations, fast and slow. A number of special varieties are also in quantity production. ($24.00)



SLOW DC AMPLIFIER: Model K2-P offers long-term sub-millivolt stability, either by itself or in tandem with the K2-W. High-impedance chopper-modulated input. Filtered output to drive balancing grid or follower. ($60.00)



SERRASSOID GENERATOR: Model K2-G produces a fixed triangular wave of 100 V peak-peak, at 500 kcps. Use it for a quadratic rounding in diode networks, and for many other non-linear recreations. ($29.00)

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All K2 Plug-ins run on plus and minus 300 VDC and 6.3 VAC. Socket wiring is simple and standardized. Write for freely given opinons on your applications.

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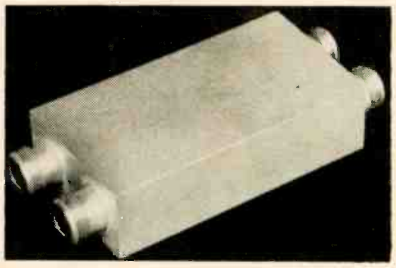
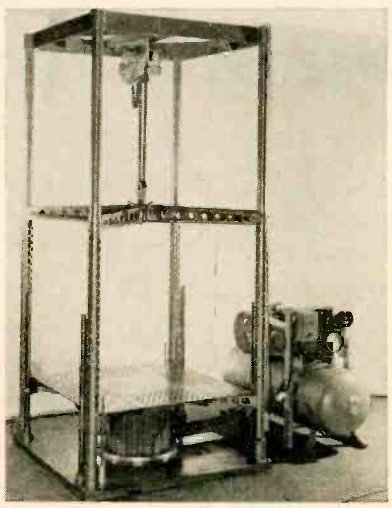
power line. It uses no controls. A sensitive thermopile and micro-ammeter measure the power dissipated in the r-f load. Circle 346 on Reader Service Card.



Coaxial Hybrid in two models

SAGE LABORATORIES, INC., 159 Linden St., Wellesley 81, Mass., has developed a new coaxial hybrid, the Sage Corbrid. It features an in-line design with output arms parallel and adjacent. Two models are available: one for the 3,500 to 4,200 mc band in ⅞ coax, and one for the 5,000 to 6,000 mc band in type N coax. Isolation is in excess of 25 db over most of the band. Output balance is within ±0.25 db. Circle 347 on Reader Service Card.

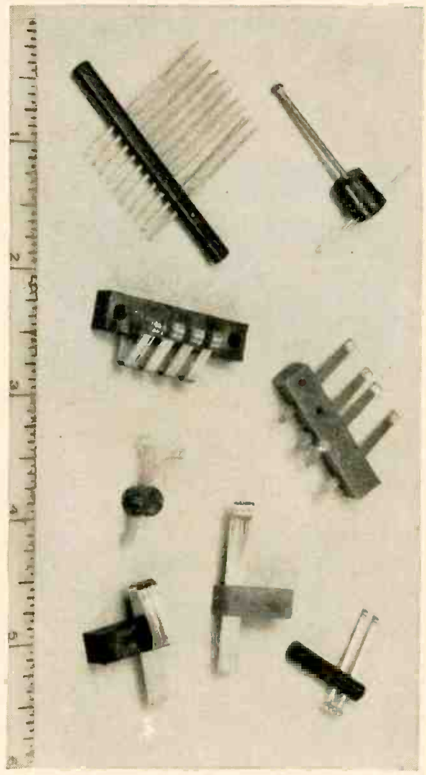


Drop Test Machine simple to operate

THE AEROFLEX CORP., 34-06 Skillman Ave., Long Island City 1, N. Y. A new drop test machine, model 30K, provides shock forces in excess of 77 g's on specimens weighing up to 400 lb. It elimi-

announcing

NEY MOLDED CONTACT ASSEMBLIES



Impressive cost savings and greater reliability are inherent in the use of the new Ney molded contact assemblies. For use with printed commutators, potentiometer windings, slip ring assemblies and printed rotary switches, these assemblies are available in a standard line now being manufactured by Ney, or can be designed to customer specifications.

Seven prime advantages are (1) a complete single or multiple brush assembly ready to use, (2) no welding or soldering, (3) reduction of adjustment during assembly into unit, (4) insured uniformity of desired gram pressure, (5) reduced inspection costs, (6) time tested Ney alloys for reliability, (7) will withstand extremes in operating environments.

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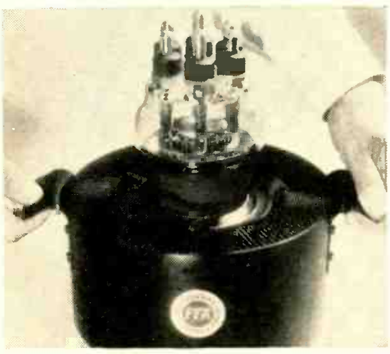
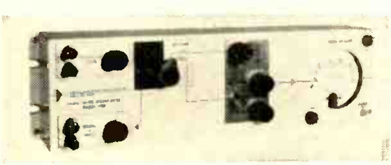
nates the uncertainty of impact repeatability inherent in the conventional type sand bed machines, according to the company. The machine consists of a piston type platform on which the equipment to be tested is mounted. The platform is then subjected to a free fall into a cylinder of air pressure. Provisions are made to mount an accelerometer to the platform which supplies acceleration data to a recording devices. **Circle 348 on Reader Service Card.**



Power Triode high vacuum

INTERNATIONAL TELEPHONE & TELEGRAPH CORP., 67 Broad St., New York 4, N. Y. Type F-7207 high vacuum power triode is designed for use as a power amplifier or modulator and particularly suitable for Class AB operation. The tube lends itself to ssb applications and shake table operations. It has an air cooled anode and is capable of 17 kw dissipation with an air flow of 1,000 cfm at a static pressure of $3\frac{1}{2}$ in. of water. **Circle 349 on Reader Service Card.**



Correlator signal-noise

GENERAL ELECTRONIC LABORATORIES, INC., 18 Ames St., Cambridge, Mass. Model I-101 signal-noise correlator can be used to make dynamic signal-to-noise measure-

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SM-60	1/100 min.	60 min.	±.002 min.
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S-6	1/1000 min.	10 min.	±.0002 min
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
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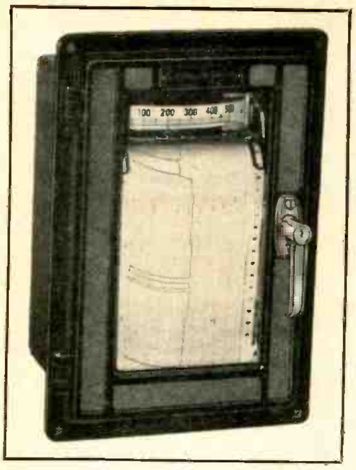

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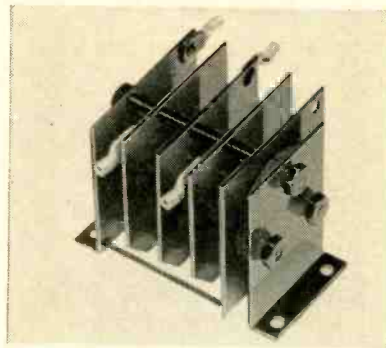
ments at the outputs of various types of communications equipment such as receivers, amplifiers, or magnetic tape systems. The signal-to-noise ratio can be measured without removing either the signal or the noise. Both may be present at the same time in the output of the equipment being tested. **Circle 350 on Reader Service Card.**

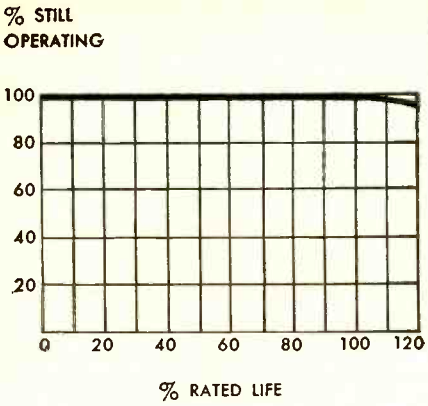


Rectifier Stacks for 150 C operation

Trans-Sil Corp., 55 Honeck St., Englewood, N. J., announces a line of diffused silicon rectifier stacks. Illustrated is a single phase bridge assembly rated to deliver 10 amperes with an rms input of 420 v, with convection cooling in an ambient of 150 C. Overall dimensions are 3 in. by 3 in. by 3 in. Stacks are available in circuit configurations to deliver up to 75 amperes with convection cooling in ambients to 150 C without derating. **Circle 351 on Reader Service Card.**

V-R Power Supply transistorized

Kepco Laboratories, Inc., 131-38 Sanford Ave., Flushing 55, N. Y. Model SC-32-15 transistorized voltage regulated power supply delivers 0-32 v, 0-15 amperes. Regulation for line or load is less than 0.01%



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We make all sorts of transformers and special assemblies for the communication industry: encapsulated, cast in epoxy or foam, and just potted in pitch. But oil transformers still have an important place.

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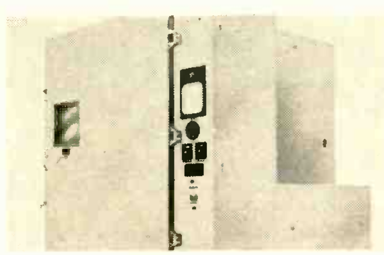
or 0.001 v, whichever is greater. Ripple is less than 500 μv rms. Recovery time is less than 50μsec. Operating ambient temperature is 50 C maximum. Temperature coefficient is less than 0.01% per deg C. Output impedance is less than 0.001 ohm. Circle 352 on Reader Service Card.

Frequency Monitor for telemetering

Magnetic Research Corp., 3160 W. El Segundo Blvd., Hawthorne, Calif., has developed a new line of magnetic frequency discriminators for the purpose of converting frequency deviation into analog voltage variation. These converters are primarily intended for telemetering instrumentation.

The units produce a well filtered 0-5 v d-c output voltage in response to a frequency deviation. One application is the measuring of the power frequency of aircraft and missile power sources and the frequency deviation from their normal value. Circle 353 on Reader Service Card.



Test Chambers walk-in type

Development Engineering Co., 9 Cross St., Norwalk, Conn. Salt spray fog test chamber line now includes large walk-in rooms designed to operate according to spec-

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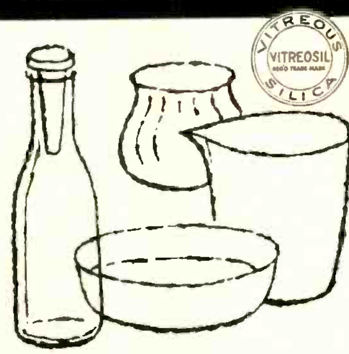

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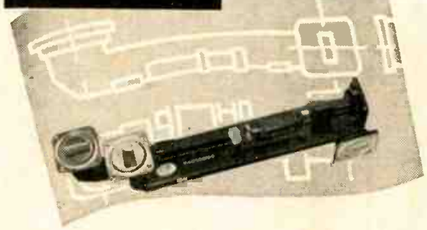

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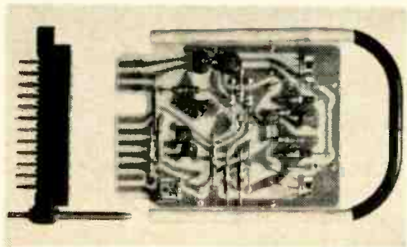
ification MIL-E-5272-A. They are available in various sizes large enough to accommodate wheeled equipment and heavy assemblies. Heated by electric blankets, these units come up to operating temperature in one hour and show temperature variations of no more than ±½ F. Illustrated (on p 147) is one of the smaller walk-in chambers—6½ by 8½ by 8 ft high. Circle 354 on Reader Service Card.



Flip-Flop
transistorized

Computer Control Co., Inc., 92 Broad St., Wellesley, Mass. Model SF 101 shift flip-flop is a transistorized digital plug-in package. The circuit is mounted on an etched copper-clad epoxy laminate. Overall package size is 2½ in. by 4 in. The 12-pin p-c connector with its polarizing guide pin is supplied with the plug-in package. Circle 355 on Reader Service Card.

Thermocouple Gage
battery-operated

Consolidated Electrodynamics Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y., has available a new, single-station battery-operated thermocouple vacuum gage, type GTC-110. Powered by a 1.5 v size D flashlight battery, contained in the gage housing, it covers the range from 0 to 1,000 microns Hg

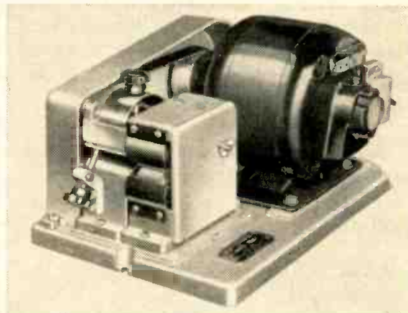
Reliable Electrical Connections

by R. George Roesch

Automatic Wire Processing with Standard Equipment

When standard equipment can be incorporated into a system for automatically stripping, fluxing and tinning coil leads, the cost of such equipment is invariably much less than that of special equipment.

The benefits of mechanizing any operation are (1) uniform quality, (2) fewer rejects and (3) lower inspection costs.



For example, using a standard wire stripper such as illustrated, we have made automatic coil lead straightening, trimming and stripping equipment for Electric Auto-Lite, Ford Motor, General Electric, Westinghouse and others. (Note: Each system was designed and built to meet the individual requirements of the user.

A COMPLETE PROGRAM generally works out like this:

1. Your Products and Your Present Methods are studied by our engineers, without obligation to you.
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4. If you accept this program, the results must meet your own specifications. Otherwise there will be no charge made by us.
5. Assuming the experiments made prove the job can be done, we will then submit Schematic Drawings and a Quotation for your consideration on all the equipment needed to perform the desired operations.

if you are making Coils in large numbers, we'd like to hear from you.

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It is said by Tin Research Institute that soldering of silver-plated contacts can be facilitated if the surfaces are first immersed in a cold solution of 8% thiourea in 5% hydrochloric acid.

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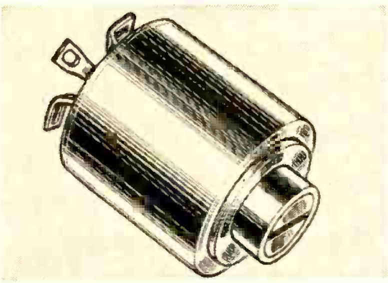
on one nonlinear scale, with 5 microns the smallest indicated marking. Circle 356 on Reader Service Card.



Precision Pot sealed unit

WATERS MFG., INC., Wayland, Mass. Absolute panel sealing is permitted by the new APH½ hermetical seal precision potentiometer. Pre-tinned, it can be easily soldered into the panel. Terminal lugs are installed with a glass to metal seal, and are positioned for easy wiring. Brass case is plated in conformance with military requirements. Circle 357 on Reader Service Card.

Connector and test bench

ALDEN PRODUCTS CO., 117 N. Main St., Brockton 64, Mass., announces a self-contained industrial control connecting assortment. Any electrical control device can be connected in 5-10 minutes using the Uni-Plug. For one-time jobs or prototype layouts new 3-wire detachable cable junctions make pos-

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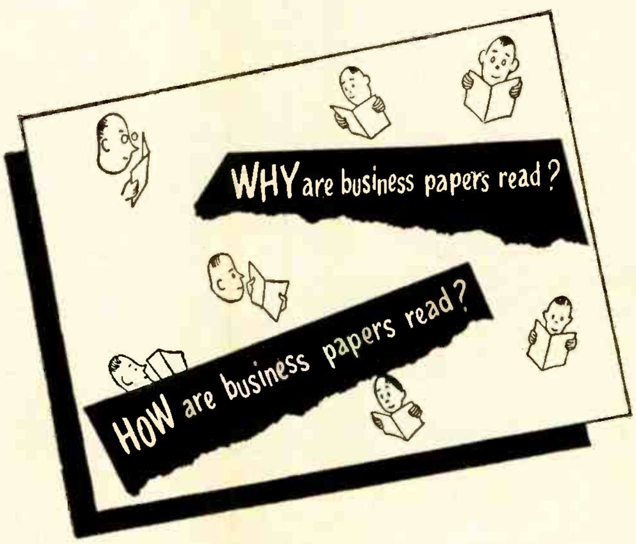

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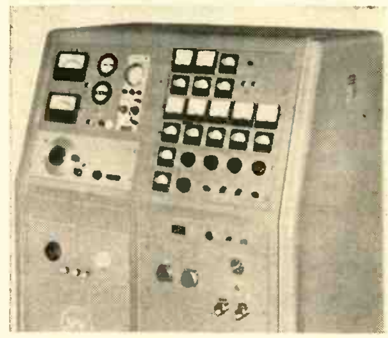

Mobile Console tests power supplies

WESTERN DESIGN & MFG. CORP., Santa Barbara, Calif. A self-contained, mobile console for laboratory, assembly or flight line testing of d-c to d-c power supplies is offered aircraft and missile manufacturers. Designed for complete functional testing under any load condition, the console is readily modified to customer specifications for testing of the principal parameters of all types and makes of power supplies having any number of d-c outputs. Circle 359 on Reader Service Card.

Phase Meter precision device

AD YU ELECTRONICS LAB, INC., 249 Terhune Ave., Passaic, N. J. Type 405 series phase meter is a highly stable and convenient device for measuring a phase angle be-

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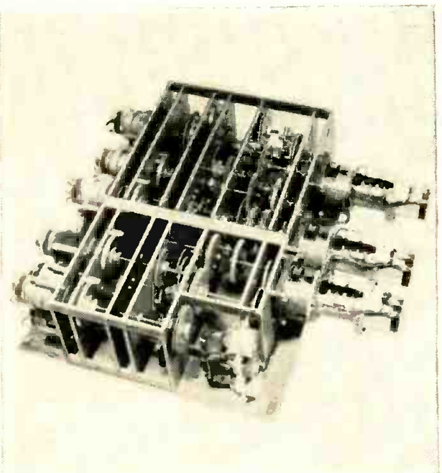

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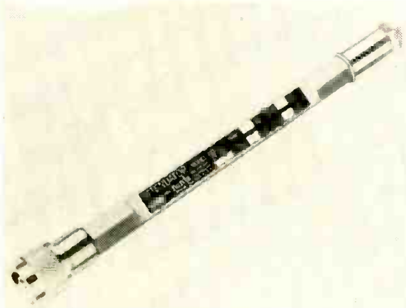
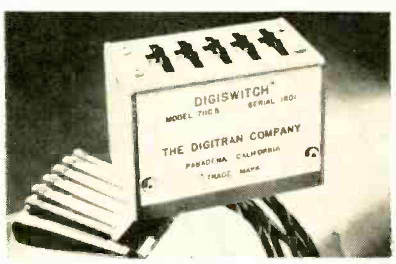
tween two alternating voltages without either amplitude or frequency adjustment. It gives direct indication of phase angle in degrees from 500 kc down to 1 cps with an accuracy of ¼ deg relative. It is also capable of plotting phase-frequency curves on a recorder or oscilloscope. Circle 360 on Reader Service Card.



Coax Attenuators accurate, stable

NARDA MICROWAVE CORP., Mineola, N. Y. A new series of precision coax attenuators carry permanently marked, accurate calibrations at four frequencies. Models are available for 1,000 to 11,000 mc, at 3, 6 and 10 db attenuation; 20 db models are available for 2,000 to 11,000 mc. All have an impedance of 50 ohms. Calibration accuracy is ±0.2 db for 20 db models; ±0.1 db for the rest. Circle 361 on Reader Service Card.



Decade Switch for automation use

THE DIGITRAN CO., 45 W. Union St., Pasadena, Calif. Model 7110 Digiswitch is a 3 for 5 decade switch featuring single and double pole, as well as binary-coded switch configurations for each decade. The desired switch position is selected by rotating the knurled knob. The

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Memory - 0.5% max. without overswing; 0.1% or less with controlled overswing.

Complete encapsulation in epoxy (stycast) or silicone resins is standard for all Cossor deflection yokes, and is done with special moulding tools ensuring accurate alignment of the yoke axis. When slip rings are added, solid silver rings are mounted in encapsulating resin. The finished slip ring yoke is precision turned to centre bore, and can include bearing mounting surfaces with dimensional tolerances approaching those associable with high quality metal parts.

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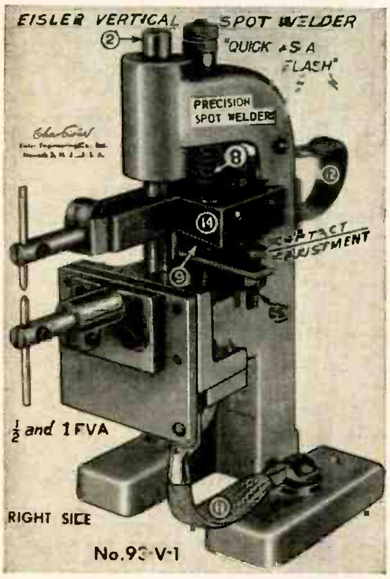

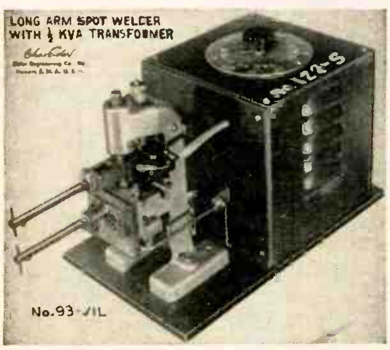

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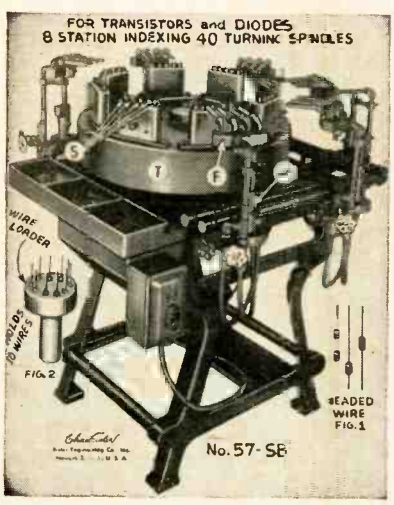

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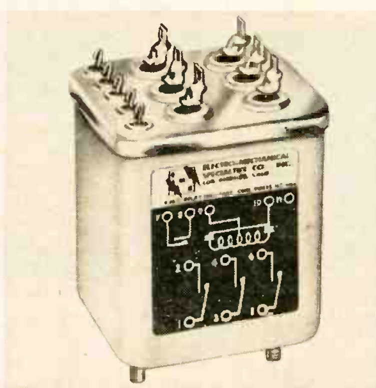
in-line Digiswitch allows the operator to read only the numbers that are visible—replacing ordinary switches with arrow indicators or standard indicator dials. Switches are available with contact ratings of 200 v and 1 ampere. Measurements are 1.84 in. by 1.75 in. by 1.87 in. Circle 362 on Reader Service Card.

Transistor Tester rapid, accurate

WESTERN INSTRUMENTS, P.O. Box 621, Ridgecrest, Calif. A new *npn* or *pnp* transistor tester determines the small signal d-c gain for the grounded emitter configuration, the collector-to-base leakage current, and the collector-to-emitter leakage current. Accurate to within 3 percent and direct reading, it is applicable in acceptance and proof testing, or any program requiring the quick evaluation of large numbers of transistors. Circle 363 on Reader Service Card.



Relay 25-ampere unit

ELECTRO-MECHANICAL SPECIALTIES CO., INC., 1016 North Highland Ave., Los Angeles 38, Calif. The No. 325ST is a lightweight

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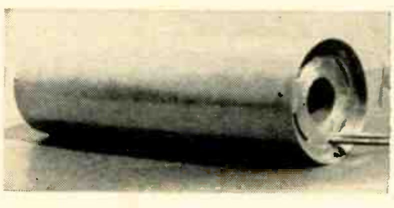
N. Y., has added a new Oldham type coupling to its line of breadboard equipment. The couplings are applicable in servo transmissions and similar drives where relatively high torques are involved. They consist of three basic elements—the two male hubs which are fastened to the shafts to be coupled, and a floating female center section. The design is such that the female connecting portion is permanently attached to one of the male sections thus simplifying assembly. Circle 366 on Reader Service Card.

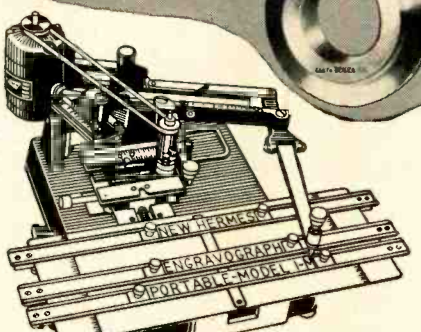
Tape Strobe checks speeds

Scott Instrument Labs., 17 E. 48th St., New York 17, N. Y., has available a tape strobe for the ready checking of tape speeds of all tape recorders. It is a precision mounted wheel housed in a machined aluminum yoke so that the user may apply it directly to moving tape. Under 60 cycle light sources, reference marks on the wheel disk appear to stand still if the tape is moving past the capstan at correct speeds. If speed is slightly slow the marks appear to move slowly backward, and vice versa. Circle 367 on Reader Service Card.



Solenoid aluminum foil type

Jobbins Electronics, 771 Hamilton Ave., Menlo Park, Calif. A new



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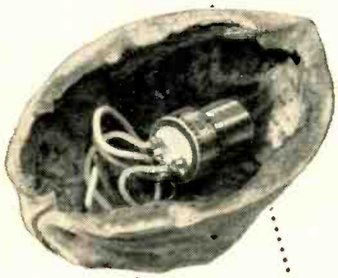

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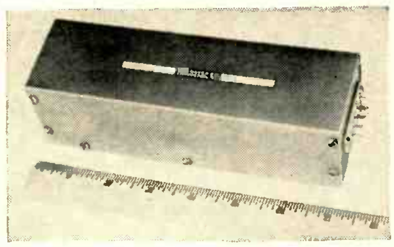
solenoid, by virtue of the use of an aluminum foil winding, has an extremely uniform field and is very light in weight. It finds its application in the focusing of traveling wave tubes and klystrons. **Circle 368 on Reader Service Card.**



Power Supply for missile uses

The Daven Co., Livingston, N. J., has developed a new high-temperature, regulated transistor power supply, series 60A, for missile and aircraft applications. Featuring the exclusive use of silicon transistors and diodes, plus high temperature resistors, capacitors and transformers, these units permit continuous operation at full load in an ambient temperature of 85 C without heat sink. Input is 24 v d-c to 30 v d-c. Output is 250 ma at 100 v d-c. Output voltage stability: temperature, less than 1.0 v change for a variation in ambient temperature from −55 C to 85 C; load variation, less than 0.125 v. change from full load to half load; input variation, less than 0.125 v change for a variation of input voltage from 24 v to 30 v. Ripple is less than 10 mv rms. **Circle 369 on Reader Service Card.**

Wiring Harness prefabricated

Methode Mfg. Corp., 7447 W. Wilson Ave., Chicago 31, Ill. Multiconductor film insulated flat wiring is now available. Called Plyo-Duct, this new application of the firm's printed circuit products is available in both standard parallel line arrangements and special custom patterns as designed by the user. **Circle 370 on Reader Service Card.**

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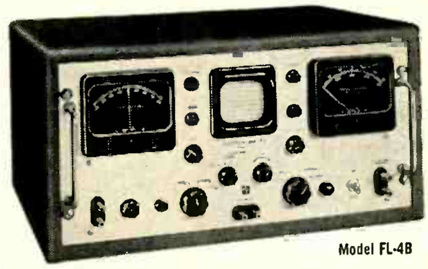

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A convenient instrument of moderate cost for use in field maintenance of music-system tape recorders and reproducers, and phonograph turntables.

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Bandwidth - within 3 db to 250 cps modulation
Bandwidth Selection - 0.5 to 6 cps, 6 to 250 cps, 0.5 to 250 cps
Scale Ranges - 2% and 0.5% full scale rms

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MODEL FL-4B WIDEBAND FLUTTER METER

Features
A very sensitive broadband instrument for laboratory use in the precise measurement of small amounts of flutter with components up to 5000 cps. Most frequently used in telemetering and data reduction systems.

Specifications
Carrier Frequncy - 14,500 cps, crystal controlled
Bandwidth - D-c to 5000 cps within 6 db
Bandwidth Selection - Full range above, 0.5 to 30 cps, 30 to 300 cps, 300 to 5000 cps.
Scale Ranges - 0.2%, 0.6% and 2.0% rms full scale
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Display - 3-inch flat-face oscilloscope for flutter analysis

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Features
An extremely stable (temperature controlled discriminator) instrument with great sensitivity and extended bandwidth for laboratory work in connection with precision instrumentation data recorders. Galvanometer outputs provided.

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Carrier Frequencies - 40 kc. and 70 kc., crystal controlled
Bandwidth - D.c. to 10 kc. with 70-kc. carrier to 4 kc. with 40 kc. carrier
Indicating Instruments - Level Meter, and ±2% Drift Meter
Output Signals - Scope, two galvanometer outputs
Sensitivity - 0.05%, 0.2% and 2.0% selectable
Drift - On d-c galvo. output, less than 10 parts per million in ½ hour

Price: $3450.00 rack mounted

MODEL FL-6A BROADCAST FLUTTER METER

Features
An instrument designed for accurate measurement and analysis of flutter and wow in high-quality audio tape recorders.

Specifications
Carrier Frequency - 8000 cps., stabilized oscillator
Bandwidth - D.c. to 1200 cps.
Bandwidth Selection - Full range, 0.5 to 30, 30 to 300, 300 to 1200 cps.
Scale Ranges - 0.2%, 0.6%, and 2.0% rms full scale
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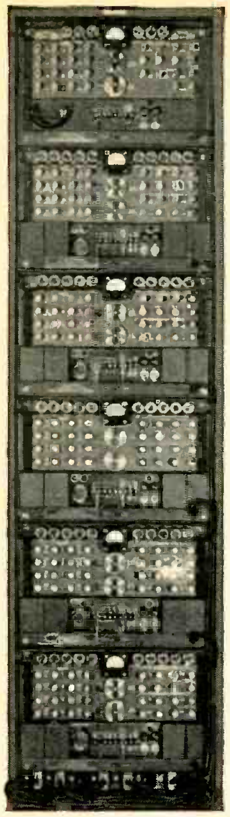

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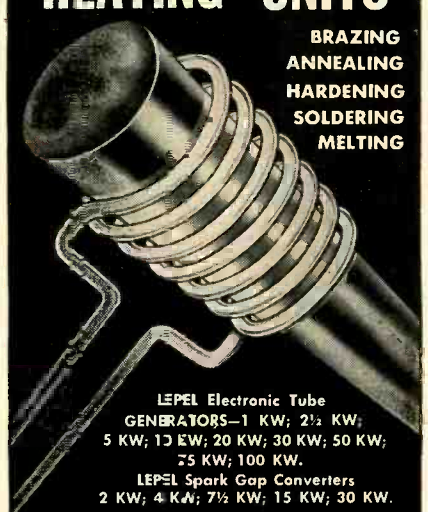

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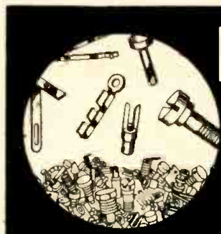

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Literature of

MATERIALS

Cadmium Strip and Foil. American Silver Co., Inc., 36-07 Prince St., Flushing 54, N. Y. A new data sheet that tabulates the physical and chemical characteristics of ultra-thin and high-precision tolerance cadmium strip and foil is available. **Circle 75 on Reader Service Card.**

Water-Repellent Coating. Beckman/Scientific Instruments Division, 2500 Fullerton Rd., Fullerton, Calif. Bulletin 262 discusses Desicote, a water-repellent coating of molecular thickness, which can be used on glass-to-metal seals (such as tube bases), thus lowering electrical leakage caused by water vapor. **Circle 76 on Reader Service Card.**

COMPONENTS

Circuit Breakers. I-T-E Circuit Breaker Co., Philadelphia 30, Pa. Complete information for the use of the current-limiting Cordon circuit breaker for short circuit protection on low-voltage systems is given in a new bulletin. **Circle 77 on Reader Service Card.**

Electric Motors. Task Corp., 1009 E. Vermont Ave., Anaheim, Calif. A four-page illustrated brochure describes a series of high power density electric motors. Included are charts indicating horsepower figures in terms of weight and volume. **Circle 78 on Reader Service Card.**

Lumped Constant Delay Lines. Control Electronics Co., Inc., Huntington Station, N. Y., has issued a 4-page catalog describing their special and standard lumped constant delay lines. **Circle 79 on Reader Service Card.**

Precision Glass. Fischer & Porter Co., 691 Jacksonville Rd., Hatboro, Pa. Catalog 80-23 contains a well-illustrated discussion of fabrication, materials, tolerances and applica-

the Week

tions of precision glass products. **Circle 80 on Reader Service Card.**

Relay Terms. Potter & Brumfield, Inc., Princeton, Ind. A 16-page booklet contains almost 200 definitions of relay terms. It also includes 21 diagrams illustrating contact arrangements and voltage and current parameters. **Circle 81 on Reader Service Card.**

Scale Panel Meter. International Instruments Inc., P. O. Box 2954, New Haven 15, Conn. An engineering data sheet completely describes model 173 1½ in. 300 deg scale panel meter. In the instrument discussed accuracy is held to ±3 percent of full scale deflection. **Circle 82 on Reader Service Card.**

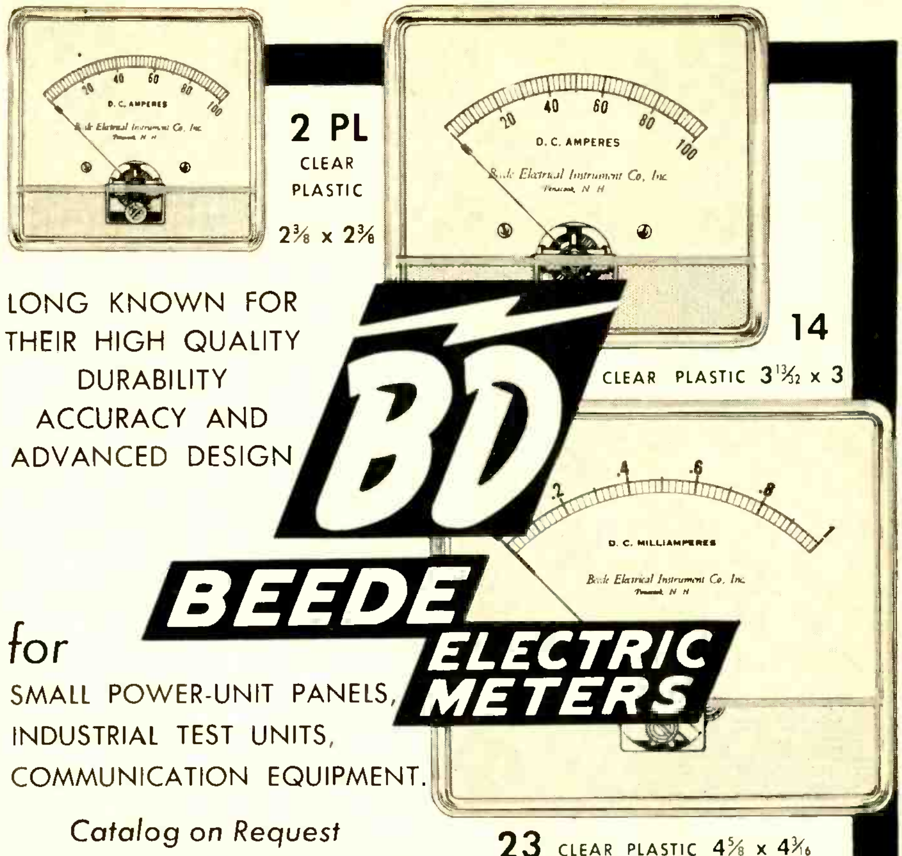
Selenium Rectifiers. Vickers, Inc., 1815 Locust St., St. Louis 3, Mo. Bulletin EPD 3116-1 is a 48-page booklet containing illustrated descriptions and complete technical data on the company's new line of Grain-Oriented selenium rectifiers. **Circle 83 on Reader Service Card.**

TWT Solenoids, Amplifiers. Menlo Park Engineering, 721 Hamilton Ave., Menlo Park, Calif. Bulletin MPE 2-58 covers solenoids for twt's and bwo's. Discussed are convection cooled, forced air cooled, and liquid cooled types. TWT amplifiers are also described. **Circle 84 on Reader Service Card.**

EQUIPMENT

Analog Computer. George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass., has available a four-page brochure on the K5-U analog computer. It contains a general description of the computer specification and a brief comparison of the K5-U technique with other methods of analog formulation. **Circle 85 on Reader Service Card.**

Current Pulse Generator. Rese Engineering, Inc., 731 Arch St.,



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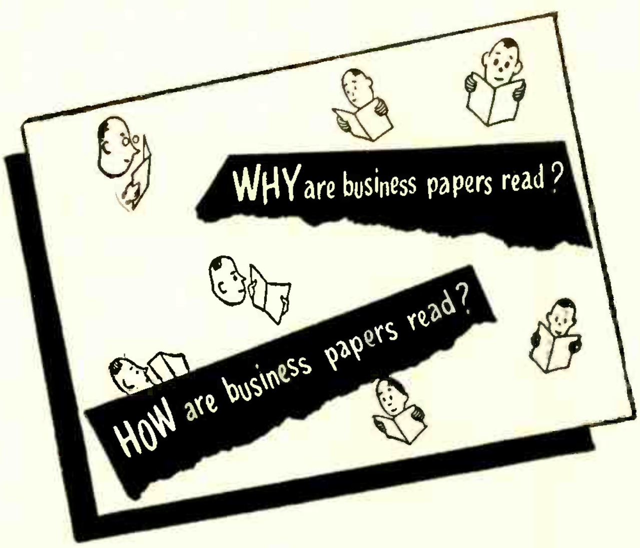

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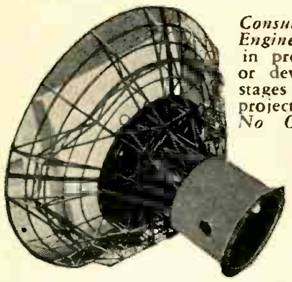

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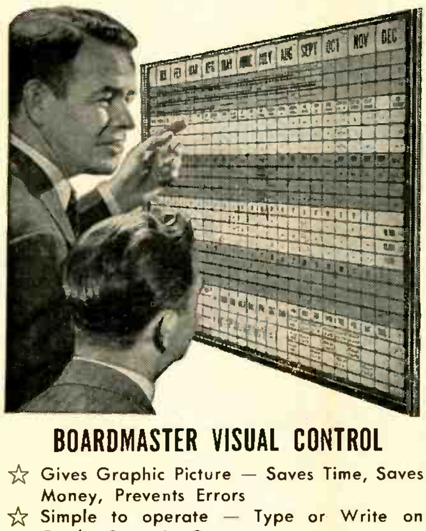

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CIRCLE 142 READERS SERVICE CARD

Philadelphia 6, Pa. Bulletin 57-C illustrates and describes model 1050 high impedance current pulse generator which delivers over 150 w of average pulse power and over 1.3 kw of peak pulse power. Complete specifications are given. **Circle 86 on Reader Service Card.**

D-C Amplifiers. Dynamics Instrumentation Co., Division of Alberhill Corp., 1118 Mission St., South Pasadena, Calif. A six-page folder presents a family of precision d-c instrumentation amplifiers. Photographs, line drawings and complete specifications are included. **Circle 87 on Reader Service Card.**

D-C VTVM. Millivac Instruments, P.O. Box 997, Schenectady, N. Y. A four page folder describes the MV-57A precision d-c vtvm and d-c calibrator. The unit discussed measures 100 μv to 1 kv $\frac{1}{4}$ percent accuracy. **Circle 88 on Reader Service Card.**

Direct-Writing Oscillograph. Offner Electronics Inc., 5320 N. Kedzie Ave., Chicago 25, Ill. Bulletin 181 illustrates and describes the type 542 Dynograph, a high-speed, sensitive and stable two-channel direct-writing oscillograph. **Circle 89 on Reader Service Card.**

Instruments. Acton Laboratories, Inc., 533 Main St., Acton, Mass. A file type brochure provides condensed catalog data on the company's complete line of instruments. Among those included are phase meters, phase standards, vtvm's and potentiometer test equipment. **Circle 90 on Reader Service Card.**

Magnetic Core Tester. Rese Engineering, Inc., 731 Arch St., Philadelphia 6, Pa. Bulletin 57-G describes model 1100 magnetic core tester, a modular, current pulse generator which delivers programmed pulse chains in a periodically repeated, basic 8 step pattern, for lab analysis and production testing of magnetic materials. **Circle 91 on Reader Service Card.**

Resistance Bridge Indicator. Datran Electronics, 1836 Rosecrans

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Ave., Manhattan Beach, Calif. A four-page technical brochure suggests many applications of the RBI which can be calibrated to indicate directly in microinches of strain, psi, pounds, etc., depending upon the type of strain gage transducer being used. **Circle 92 on Reader Service Card.**

Shock Mounting. Federal Shock Mount Corp., 1060 Washington Ave., New York 56, N. Y. Bulletin F1A describes engineered vibration and shock mounting systems for airborne electronic equipment and other applications. One section deals with a partial description of the test facilities available at Federal. **Circle 93 on Reader Service Card.**

FACILITIES

Pot Winding. Dejur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. Two of the most difficult operations in the manufacture of precision pots are bonding the wire securely to the card or mandrel, and removing insulating material where the brush makes contact. The company has developed a new method for achieving this. A free sample section of winding is available. **Circle 94 on Reader Service Card.**

Tiny Part Stamping. Be Cu Mfg. Co., Inc., 40 Kent St., Newark, N. J. A new brochure illustrates many subminiature stamped and formed components and parts made from special metals and alloys. It describes briefly methods used by the company and special equipment and facilities available for manufacturing, inspecting and testing the accuracy of the subminiature parts and components. **Circle 95 on Reader Service Card.**

Tube Construction Technique. Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y. A new 12-page booklet "Framelok Grid", describes design and performance advantages of a unique electron tube construction technique. **Circle 96 on Reader Service Card.**

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Clerk Tracks 20,000 Items

SOME 20,000 items of test and laboratory equipment are accounted for and automatically scheduled for recertification by a new record system at ARMA Division of American Bosch Arma Corp., Garden City, N. Y. The division produces integrated navigational and defensive systems involving gyroscopics, optics, radar, computing pneumatics and hydraulics.

Developed for ARMA by VISIrecord, Inc., the new system (picture) requires only one clerk. Within seconds she can tell where and by whom any instrument is being used and when the item is due back for recertification.

Records are kept on custom-designed 6 by 8 in. cards arranged in banks in open-tub units so that the right-hand margin of every card is visible. To locate a given record the clerk scans the indexed banks, flicks open the proper bank, scans the visible card margins, and extracts the proper card. All thumbing is eliminated—the only card touched is the one she wants.

About two-thirds of the work required by conventional record systems—posting instrument checkouts and check-ins onto file cards—is eliminated, says the maker, by a special triplicate snap-out form filled out by instrument users. The form is designed so two copies of it can be stood up in front of the instrument's record card in the file. The forms cover the card's visual margin, providing immediate indication the instrument has been checked out. When the instrument is returned, this information is "posted" by simply removing forms in front of the card.

One of two form copies kept in the file is used as a recertification recall notice when necessary. The third copy, designed as a manila equipment tag, goes with the instrument to the head of the using department.

On the visible margin of the form is a vertical series of blocks, each representing one quarter of a month. All instruments have been scheduled so that an equal number come up for certification during each quarter. Once every eight days, the clerk scans the file and notes which instruments are due for recertification. Scanning all 20,000 records takes only about an hour.

AIEE Elevates Six Members

THE American Institute of Electrical Engineers has raised six of its members to the grade of Fellow.

Members honored and their citations are:

Howard A. Chinn, chief engineer, CBS Television, New York, N. Y., "for his contributions to the development of measuring and monitoring equipment in the audio and video broadcasting field."

Joseph B. Epperson, vice-president in charge of engineering for Scripps-Howard Radio, Inc., Cleveland, Ohio, "for achievements in the broadcasting field."

Arthur M. Harrison, manager, large rotating apparatus department, Westinghouse Electric Corp., East Pittsburgh, Pa., "for contributions in the field of large rotating machinery."

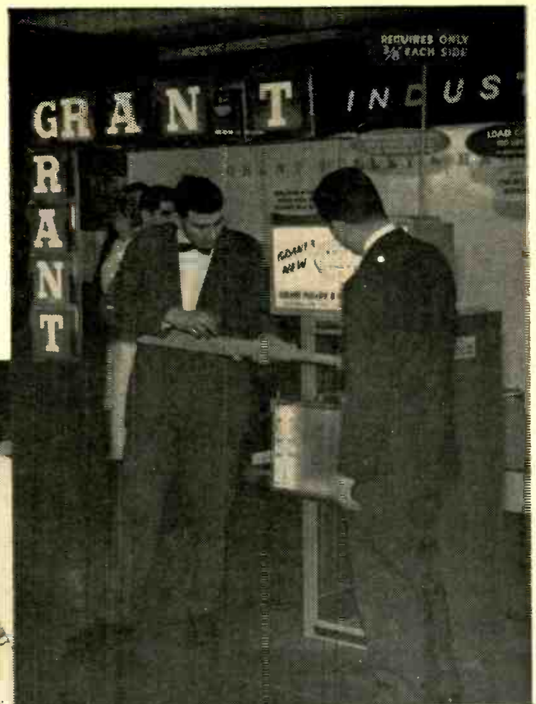
Chester L. Osenbaugh, director of the Electric Division, Memphis Light, Gas & Water Division, City of Memphis, Tenn., "for design and administrative achievement in directing the engineering, construction and operation of an electric utility system."

Clement S. Schifreen, cable and insulation research engineer, Philadelphia, Pa., "for contributions toward extended life and load ratings of underground power cables."

Millard C. Westrate, staff consulting engineer, Commonwealth Associates, Inc., Jackson, Mich., "for contributions to economic operations of power systems and to high frequency radio communication."

California Firm Gets New V-P

FORMER chief aerologist for the U. S. Navy, Howard T. Orville (picture) is now vice president at Beckman & Whitley, Inc., San Carlos, Calif. In this newly created post, he will, through the president, assist the instrument and mis-



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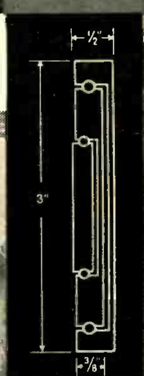

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sile products divisions as well as the board of directors in long-range scientific and technical planning. Product lines with which he will be presently concerned include meteorological instruments, high-speed research cameras, and explosive-actuated devices.

AMF Acquires New Division

In a move to further integrate its guided missile operations, American Machine & Foundry Co. has changed the status of the Associated Missile Products Corp. of Pomona, Calif., from a subsidiary to a division.

Wendell B. Sell (picture) has been named general manager, supplementing his duties as a divisional vice president of AMF. The Pomona firm will be known as the Associated Missile Products Co.

Westinghouse To Build Plant

A new building with 25,000 sq ft of floor space will be erected for the manufacturing and repair division of the Westinghouse Electric Corp. on a 2½ acre site near Utica, N. Y. Ground has been broken and the new structure is scheduled for completion in October.

The new plant will replace the present Westinghouse facilities in Utica. Thirty-six persons are pres-

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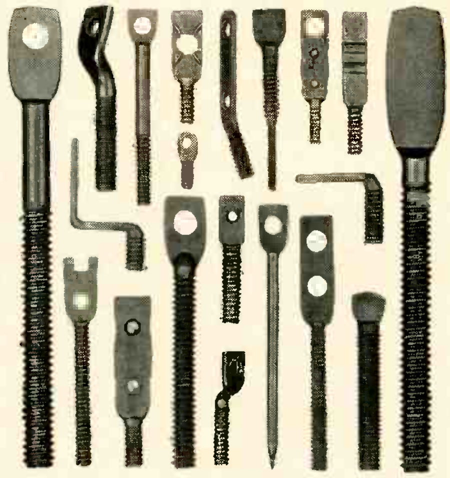

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ently employed at the Utica shop, but Westinghouse officials expect that the working force will be expanded to 50 after the new plant is occupied.

Oregon Firm Changes Name

The Research Instrument Corp., Portland, Oregon, has announced their company name change to Rinco, Inc. This follows a recent change to the new trade name Rinco-Pot for their line of potentiometers. No change in location, ownership or management is involved.

Elect Mitchell Vice-President

Trans-Sonics, Inc., Burlington, Mass., has elected Louis O. Mitchell (picture) as a vice-president of the corporation. Mitchell, who has been company production manager since 1948, is responsible for the introduction of new methods for automatic calibration and adjustment of precision instruments.

Strich Becomes Chief Engineer

Appointment of Robert Strich as chief engineer for the Los Angeles Division of Cannon Electric Co.,

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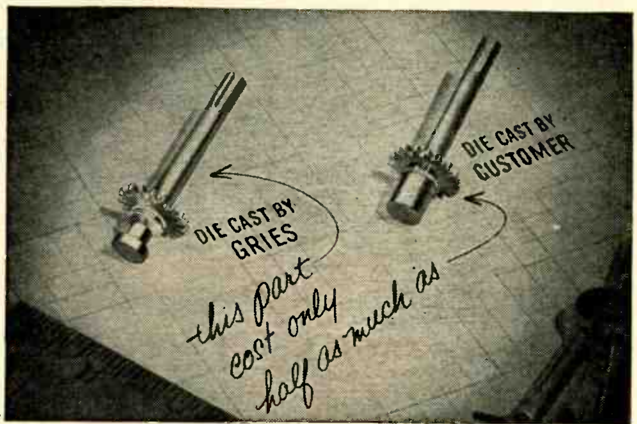

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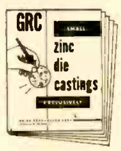

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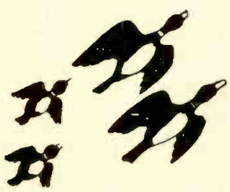

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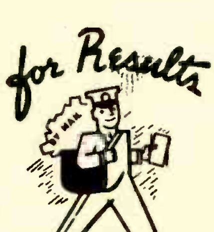

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is announced. Reporting directly to vice president Rowen, Strich will plan, direct and control the engineering of all products assigned to the division. Prior to this appointment he had been product engineering supervisor at Cannon for 2½ years.

Hagan Joins Microsonics

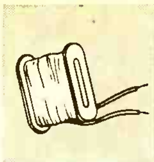
CHARLES E. HAGAN is appointed to the engineering staff of Microsonics, Inc., Hingham, Mass. He will head a newly established delay line research department. Hagan was formerly with Laboratory For Electronics, Inc.

Reorganize At CBS Labs

TO STRENGTHEN the management of CBS Laboratories, New York, N. Y., Benjamin B. Bauer (picture) has been appointed vice president. He will be in charge of the acoustics and magnetics department of the Laboratories. Before joining CBS Labs, Bauer was chief engineer and vice president of Shure Bros. Inc., Chicago, Ill.

At the same time the organization of the Labs has taken on the following form. Three major departments have been created, with v-p's in charge:

(1) Department of Reconnais-



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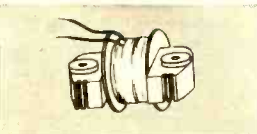

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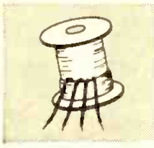

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sance and Electronic Systems headed by Joseph Bambara.

(2) Department of Acoustics and Magnetics headed by Benjamin B. Bauer.

(3) Department of Physics headed by John W. Christensen.

All major activities of the Laboratories are carried out under the three departments listed.

News of Reps

IT&T's components division appoints the **John G. Twist Co.** to handle its industrial accounts, including radio-tv manufacturers, in Illinois and southeastern Wisconsin.

Edward A. Ossmann & Associates, manufacturer's reps for upstate N. Y., is named to carry the electronic instrument line of Belleville-Hexem Corp., Los Gatos, Calif.

Knoblock & Maine, Inc. has been appointed to represent Ultronix, Inc., San Mateo, Calif., manufacturer of precision wire resistors. Rep firm covers Illinois, Indiana and Wisconsin.

Jack Geartner Co., sales rep organization in Miami Beach, Fla., has established a branch office in Orlando, Fla.

General Transistor Corp., Jamaica, N. Y., appoints the following reps:

Weller-Rahe Co., in West Virginia and western Pennsylvania.

Harry W. Gebhard Co., in the Chicago and Wisconsin territory.

Glenn M. Hathaway Electronics, Inc., in the six New England states.

Missiletronics, Inc. will represent New England Laminates Co., Inc., Stamford, Conn., in North and South Carolina, and northeastern Tennessee.

Appointment of the **Fascal Co.,** as sales engineering reps in the greater San Diego area, is announced by Neal Feay Co., Santa Barbara, Calif., makers of hardware items for the aircraft and electronics industries.

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ELECTRONIC SEMICONDUCTORS

Just Published—A useful introduction to semiconductor physics as related to rectifier and transistor problems. Precisely defined basic concepts lead to the physics of crystal amplifiers, imperfection equilibria, and boundary layers in semiconductors. By **E. Spenke.** Translated by **D. Jenny, H. Kroemer, E. G. Ramberg,** and **A. H. Sommer**, RCA Labs, Princeton, N. J. **430 pp., 163 illus., $11.00.**

An Introduction to the Theory of RANDOM SIGNALS and NOISE

Just Published—Takes up step by step the theory of probability and statistics essential to random signals and noises. Discusses applications in such areas as shot noise generated in thermionic vacuum tubes, space-charge-limited tubes, noise in amplifiers, radar, etc. By **W. B. Davenport, Jr.** and **W. L. Root**, both of M.I.T. **393 pp., 69 charts, graphs, and tables, $10.00.**

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The immediate goal, however, is to surmount the natural barriers which have limited both the range and the dependability of radio communication. First is the line-of-sight characteristic of higher frequencies which once prevented propagation beyond the horizon. The second great barrier has been the complex of sunspots, auroras, and an ionosphere that periodically varies in altitude, all of which cause communication blackouts and signal fluctuations.

A less well-known obstacle is the multipath phenomenon—the tendency of radiations to reflect from different layers of the ionosphere into two or more signal paths. This condition, which under certain circumstances produces a confused signal, is being overcome at Hughes through the use of digital techniques. Frequency is made a controllable variable. Then, with a digital computer to determine the best frequencies to use at given times, a communication system can automatically and continuously select its most favorable frequency.

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NEW BOOKS

Analytical Design of Linear Feedback Controls

By G. C. NEWTON, L. A. GOULD And J. F. KAISER.

John Wiley & Sons, Inc., New York, 1957, 419 p, $12.00.

Two objectives motivated the authors to write this book. The first was a desire on their part to make available the results of their research on the analytical design method, carried on at MIT, pointing out in the process the factors which limit the performance of linear systems. The second was to make available to engineers and scientists a consolidated and integrated treatment of the literature in this field. Both objectives have been skillfully and successfully realized.

Definition—Analytical design refers to "the design of control systems by the methods of mathematical analysis to idealized models which represent physical equipment." It is a design method which deliberately sets out to offset the disadvantages associated with the trial-and-error method of compensating feedback control systems. Users of the latter procedure are aware of the inability of this method to recognize an inconsistent set of specifications. Moreover, the resulting design does not generally yield a minimum bandwidth control system. Both shortcomings are eliminated by the analytical design method, but not without sacrificing simplicity.

In the theory of analytical design, the starting point is the specifications. These include a description of input signal, desired response, disturbances, the performance index to be used, the fixed elements and the degree of freedom allowed in the compensation. The objective is to minimize the performance index. In fact, it is the evaluation of the performance index which reveals whether the specifications imposed on the system can or cannot be met.

Performance Indices—The book confines its attention to the analytical design procedure for two types of performance indices. One is the integral-square error criterion which is used for those systems subjected to transient input signals. This subject matter is thoroughly dealt with in Chapter 2.

The second performance index is the mean-square error which is more approximate for systems where the input signal contains noise. In Chapter 3 the manner of handling such signals is treated in terms of autocorrelation and cross-correlation functions, while in Chapter 4 the analytical design theory is applied to a typical system with fixed configuration and a noise-containing input signal. To make the answers practical, however, requires reevaluating the design in terms of realistically imposed constraints such as saturation. This too is described in Chapter 4 and also in Chapter 7.

In Chapter 5 the variational approach for minimizing the mean-square error in a system having a free configuration is discussed; this is extended to a system which is semifree in configuration in Chapter 6.

Chapter 8 deals with the design of a minimum bandwidth control system using the minimum mean-square error as a design criterion.

The design of a servomechanism to drive a large radio telescope is fully explored in Chapter 9 to illustrate the use of the analytical design procedure in solving a practical problem and to point out how this method may be used to complement the trial-and-error approach.

Level—The book is written at an advanced level, and presupposes a considerable amount of mathematical background. Use is made of such mathematical tools as the convolution integral, the Fourier transforms of autocorrelation and cross-correlation functions, the calculus of variations and Lagrangian multipliers to mention a few. However, this material is concisely and clearly presented.

A rather complete appendix is included and in addition to a review of Fourier and Laplace transfrom theory, there appears a summary of the trial-and-error method of design.

The book makes a strong case

for the analytical design theory as a practical design tool, but it also recognizes its limitations. First of all, the method suffers from a restricted number (two) of performance indices which permit analytical solution of a design problem. Secondly, the labor and time involved in arriving at a solution and the mathematical sophistication required is indeed much greater. Accordingly, the real contribution of the analytical design theory in practical problems lies in its ability to serve as a guide in carrying out the trial-and-error design procedure.—VINCENT DELTORO, *Electrical Engineering Dept., The City College of New York, N. Y., N. Y.*

Industrial Electronics Handbook

By R. KRETZMANN

Philosophical Library, New York, 1957, 298 *p,* $12.00.

Industrial Electronics Circuits

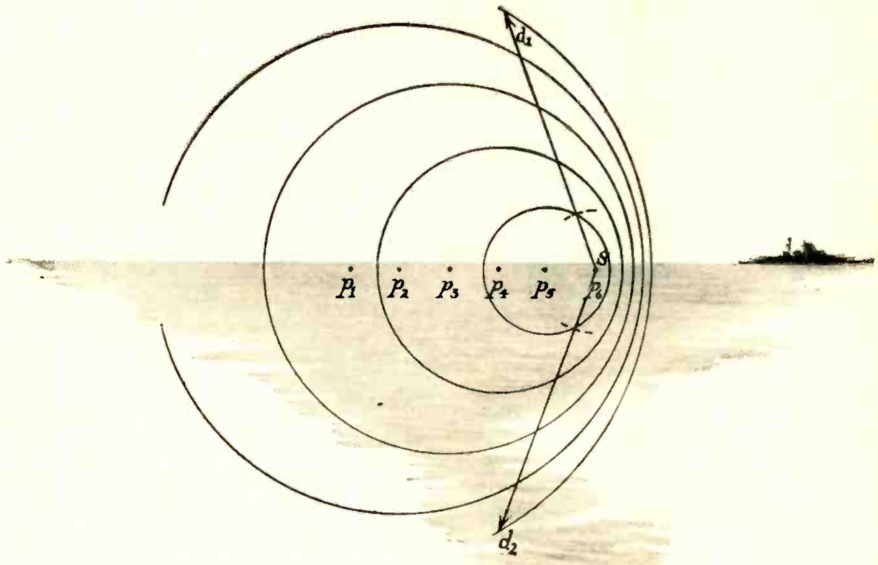
By R. KRETZMANN

Philosophical Library, New York, 1957, 195 *p,* $10.00.

These two volumes should be considered a single work, the "Circuits" book being written as a supplement to the "Handbook". Together, they comprise a concise, yet diversified collection of practical electronics circuits for industrial applications.

The books are aimed at industrial engineers involved in manufacturing problems, who desire to become acquainted with electronic controls and their applications. Although there are no detailed design methods presented here, an excellent picture of the general approach to production problems through electronics can be derived.

Handbook—The first part of the "Handbook", comprising almost a third of the book, is devoted to the fundamentals of industrial vacuum tubes and their basic circuits. Although necessarily superficial, it is well written and covers such special-purpose tubes as thyratrons, senditrons, ignitrons and excitrons, photocells and c-r tubes. This



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chapter should be valuable to the engineer with only fundamental training in electronics. The remainder of the volume and all of "Circuits" consist of practical and useful industrial circuits, accompanied by explanations of their operating principles. Such topics as counting circuits, timers, industrial rectifiers, lamp dimmers, speed and temperature control, welding control, motor control and inductive and capacitive heating are well represented. Examples of specialized control devices such as turbidity indicators, smoke detectors, tube-filling machines, metal detectors, paper-processing machine controls and the like are given.

Only the simpler circuit diagrams are accompanied by component values, but the books are profusely illustrated with photographs of examples of construction of the equipment. There is also a bibliography which is culled primarily from European sources.

These books are well put together, but unfortunately, the price tag will most likely restrict their popularity. —S.W.

THUMBNAIL REVIEWS

Nuclear Engineering. Edited by Charles F. Bonilla, McGraw-Hill Book Co., Inc., New York, 1957, 850 p, $12.50. Reference work on basic engineering principles involved in the design of nuclear core reactors and power plants. Includes many topics not treated in previous books.

Dry-Battery Receivers with Miniature valves. By E. Rodenhuis, Philips' Technical Library, Eindhoven, Holland, 1957, 240 p, $4.95. General design theory and specific tube characteristics are covered along with design of eight typical receivers including a-m/f-m models and receivers with push-pull output. Magic-eye tuning indicators for battery-operated sets are described.

ASTM Standards on Electrical Insulating Materials. American Society for Testing Materials, 1916 Race St., Philadelphia, Pa., 1957, 692 p. $6.00 (paper). Compilation of ASTM test procedures and specifications for electrical insulation for use of manufacturers and those concerned with use and distribution of electrical power.

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COMMENT

Environmental Testing

We consider this (Special Report on Environmental Testing, Mar. 28, p 59) to be an excellent summary with regard to electronic components. Evidently this opinion is shared by others, as evidenced by the bulletin from Ray H. Mattingley, editor of *Environmental Quarterly* . . .

PAUL R. DENNIS
BATTELLE MEMORIAL INSTITUTE
COLUMBUS, O.

Colleague Mattingley's April 4 bulletin began "I recommend that you see and read the 16-page report . . ." We are basking in the pleasant environment created by associate editor Tomaino's testing article. Other readers comment:

You are to be complimented on the detailed information and timeliness of your article. Your readers, I am sure, will look forward to future material on the same subject . . .

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Dot

Very peculiar circuit in Fig. 1 of "Radio Waves Power Transistor Circuits" (May 9, p 63). Transistor Q_1 doesn't look as though it could work as it is.

Seems as if it should connect to the emitter of Q_2. Should it?

W. R. MILLER
CLEVELAND, O.

It should. The dot dropped in the drawing, dash it. Same day

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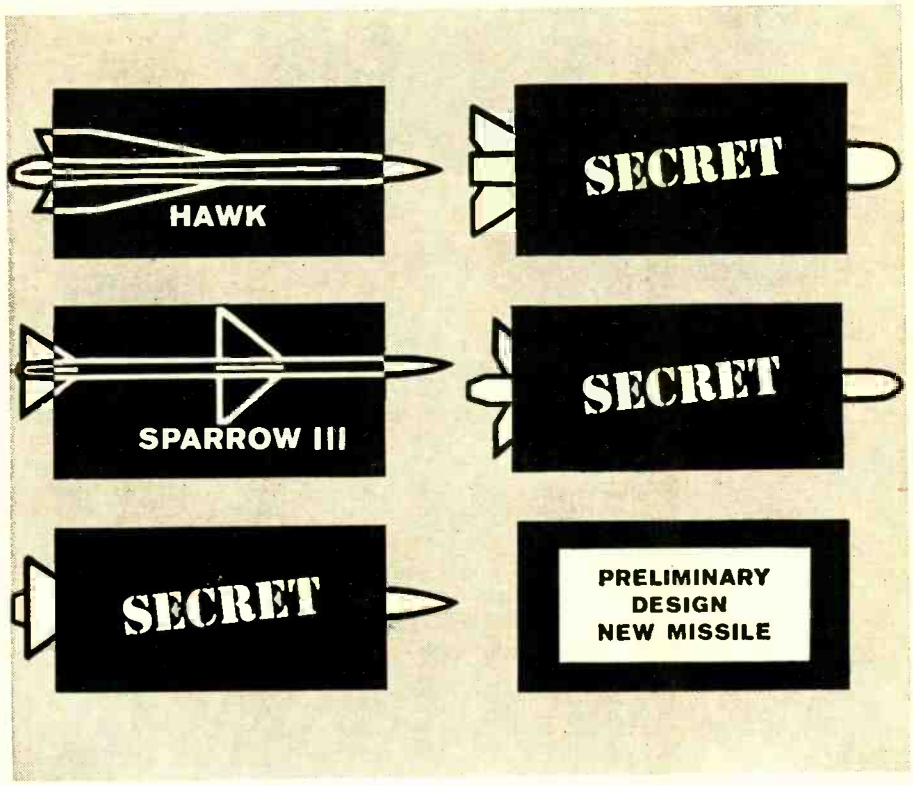

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C 4	4.6	229	1.03"
C 44	4.1	252	1.03"

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reader Miller's note arrived, we got a call from author L. R. Crump to the same effect.

Bugs in Drawing

I would like to point out the following errors in the figures in my article entitled "Magnetic Inverter Uses Tubes or Transistors" (Mar. 14, p 158).

The polarity of the battery designated E_B in Fig. 1 is incorrect. The polarity of V_{in} in Fig. 6 is incorrect. And in the caption for Fig. 5, "50 sec." should read "50 μsec."

C. H. R. Campling
Queens University
Kingston, Ontario

Microscope

The short article entitled "Soviets Describe Huge Microscope" (Apr. 25, p 18) implies that the Russians recently developed the field-emission microscope.

I think that in fairness to scientists of other nationalities working in that field you should point out that the device is more than twenty years old, and much of its development was non-Russian.

Louis E. Fay, III
Bendix Aviation
Detroit, Mich.

Splitting Up NACA

Your Military Business column "Industry to Get Space Work" (May 16, p 36) suggests that the National Advisory Committee on Aeronautics will become the basis of a National Aeronautics and Space Agency. The Space and Technology Act of 1958 (S. 3126, now before the Senate Committee on Government Operations) would make NACA part of an executive Department of Science and Technology. Which is the fact?

E. V. McIntyre
New York, N. Y.

S. 3126 if passed will take priority over President Eisenhower's suggestion that NASA be formed with NACA as a nucleus. Actually, NASA may wind up a bureau in the Department of S & T if that department is ever set up.

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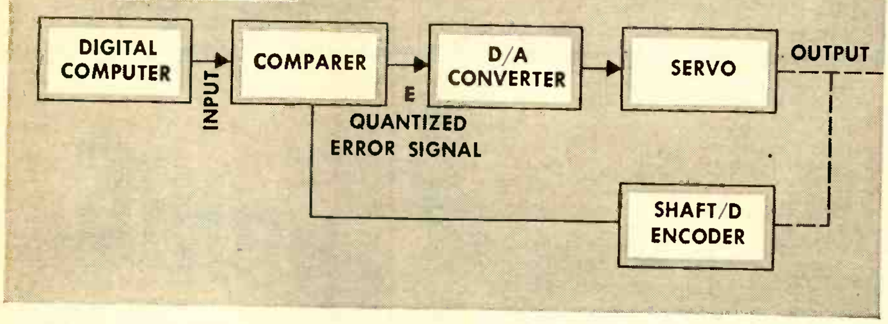

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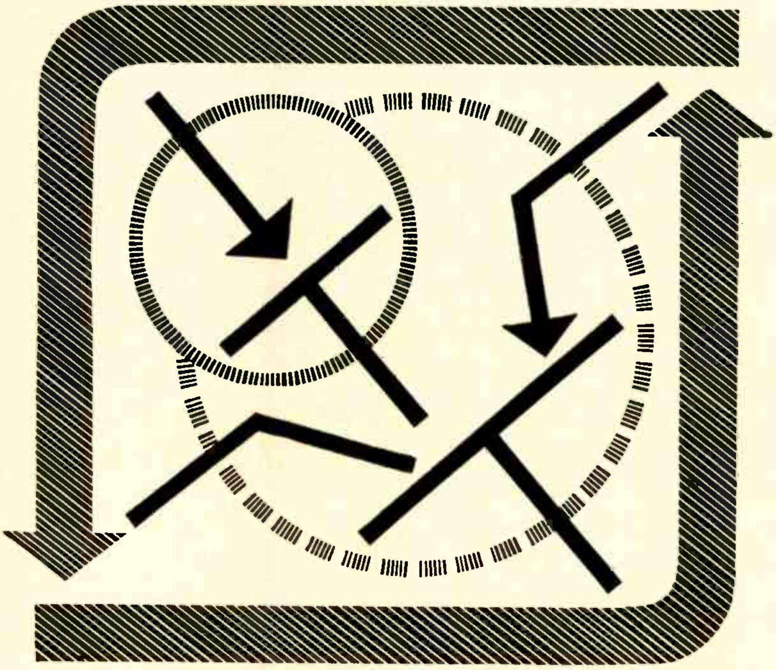

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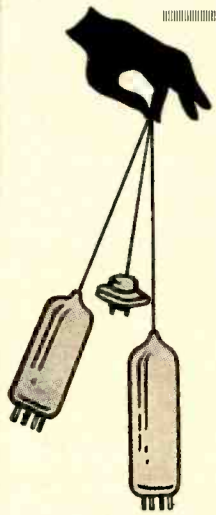

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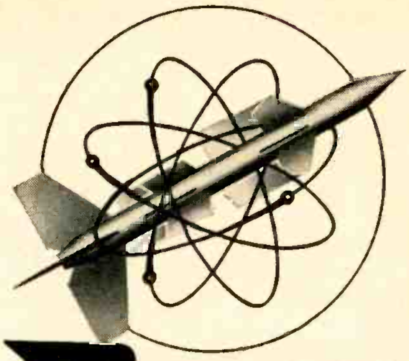

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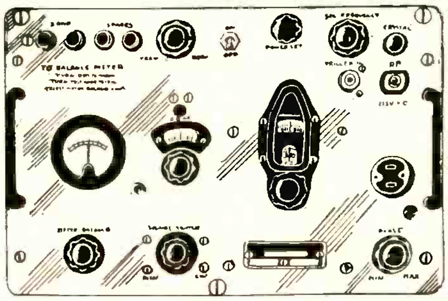

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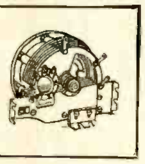

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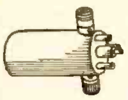

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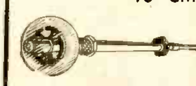

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Something you don't want
that other readers can use, advertise it in the
SEARCHLIGHT SECTION

ELECTRONIC

WAR TERMINATION INVENTORIES

WRITE OR WIRE FOR INFORMATION ON OUR COMPLETE LINE OF SURPLUS ELECTRONIC COMPONENTS. ALL PRICES NET F.O.B. PASADENA, CALIFORNIA

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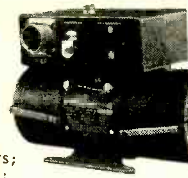
Pasadena 8, California
RYan 1-7393

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 **$25.00**

12117 Bendix
Output: 6 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**

12142-1-A Bendix
Output: 115 volts, 3 phase, 400 cycle, 250 VA. Input: 27.5 VDC, 22 amps. Voltage and frequency regulated. **$99.50**

12147-1 Pioneer
Output: 115 VAC, 400 cycles; single phase. Input: 24-30 VDC; 8 amps. **$19.95 each**

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**

10563 Leland
Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 pf. Input: 28.5 VAC; 12 amps. **$25.00**

F16 Jack & Heintz
Output: 115 volts, 400 cycle, 1 or 3 phase, 250 VA pf. 9. Input: 27.5 volts, 20 amp. Electronic frequency and voltage regulated. **$99.50 each**

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**

AN 3499 Eicor, Class "A"
Input: 27.5 volts at 9.2 amps. AC. Output: 115 volts, 400 cycles; 3 phase, 100 voltamp; continuous duty. **Price $39.50 each**

MG54D BENDIX INVERTER

Output: 200/115 volts; 400 cycle, single or 3 phase; .80 pf, 250 VA. Input: 28 VDC, 22 amps. **$99.50**

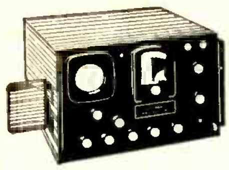
MOTOR GENERATOR TRANSICOIL TYPE 7500

115 volts, 400 cycle. Output 4 volt per 1000 rpm. Motor speed 0-7000 rpm. Gear Train ratio 2000:1. **Price $39.95**

MINNEAPOLIS-HONEYWELL RATE GYRO (Control Flight)

Part no. JG7005A-11 series 9. 115 volts A.C., 400 cycle, single phase. Potentiometer take off resistance 530 ohms. Speed 21,000 r.p.m. Angular momentum 2½ million, CM²/sec. Weight 2 lbs. Dimensions 4-7/32 x 3-29/32 x 3-31/64. **Price $22.50 each**

TS148/UP SPECTRUM ANALYZER



8430-9580 mc. For use with various X-band equipment. New, complete with accessories and carrying case. Limited quantity. **Price $895.00**

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1F Syn. Mtr. 115/90V 60 cy.	34.50
1G Gen. 115V 60 cy.	37.50
1HDG	37.50
1HCT	37.50
1HG	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
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2J1G1 57.5/57.5V 400 cy.	5.00
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C56701 Type 11-4 Rep. 115V 60 cy.	20.00
C69405-2 Type 1-1 Transm. 115V 60 cy.	20.00
C69406 Syn. Transm. 115V 60 cy.	20.00
C69406-1 Type 11-2 Rep. 115V 60 cy.	20.00
C76166 Volt. Rec. 115V 60 cy.	10.00
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C78863 Repeater 115V 60 cy.	7.50
C79331 Transm. Type 1-4 115V 60 cy.	20.00
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403 Kollsman Autosyn. Mtr. 32V 60 cy.	7.50
FPE-25-11 Diehl Servo Mfr. 75/115V 60 cy.	19.50
FPE-43-1 Resolver 400 cy.	19.50
FJE-43-9 Resolver 115V 400 cy.	15.00

60 CYCLE AC SERVO MOTOR

with gear reduction

Mfgd. by Diehl. Type FPE-25-11. Low inertia; 75/115 volts; 60 cycle, 2 phase, 4 watt output, 3200 rpm. Gear case: worm gear, spur gear and pinion, reduction ratio 100:1. **$24.50**

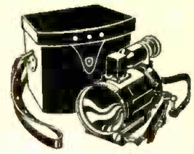
GENERAL ELECTRIC AUTO PILOT DIRECTIONAL GYRO INDICATOR and CONTROL UNIT

Mod. 8K63AC. 115 volts, 400 cps, 3 phase, 40 watts. Has settable induction pick-off.

Price $10.00

HIGH-QUALITY OPTICAL PARTS

5" Schmidt Ultra Hi-Speed Objective Lens System



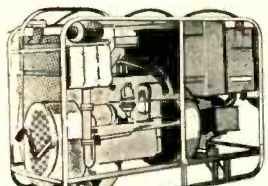
Eastman Kodak infra-red receiver, formerly known as U.S. Navy Metascope, Type B, 7" long with 5" SCHMIDT ultra-high speed Objective Lens (approx. f 0.5). Elaborate optical system, many coated lenses. Uses 2 penlight batteries. Govt. cost approx. $300. Factory-new. Shipping wt. 9 lbs. Price **$19.95**

Waterproof Carrying Case, extra. Shipping wt. 3 lbs. **Price $3.00**

Dual purpose U.S.N. floodlight throws strong beam of invisible infra-red rays. With infra-red lens, spare sealed beam lamp, batteries. Shipping wt. 23 lbs. **Price $14.95**

POWER PLANT MODEL EG-107 120/208 V AC, 400 CYCLE

Generator rated at 7.5 kw, 400 cycle, 120/208 volt A.C. Single and 3 phase at 95% pf. Current Drain at rated load 21.7 amps per phase. Also has 28 volt D.C. at 750 watts.



This unit consists of a 4-cylinder water-cooled gasoline engine directly connected to an alternator generator. Complete with control panel. Approximate weight 500 lbs. Price **$495.00**

SIMPLE DIFFERENTIAL

1 to 1 reverse ratio; 48 teeth on input and output gear, 1-1/32 inch diameter. Total outside diameter 1-25/32 inches. Shaft size is ¼ inch. One shaft is 9/16" long; other shaft is 3/16" long.

Stock No. 151 **$5.00**

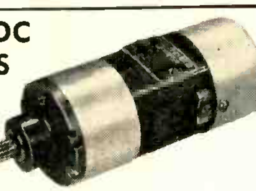
VARIABLE SPEED BALL DISC INTEGRATORS

Forward & Reverse 4-0-4. Input shaft 5/16" dia. x ¾" long. Output shaft 15/64" dia. x 9/16" long. Control shaft 11/64" dia. x 11/16" long. Cast aluminum construction. Approx. size 4½" x 4½" x 4".

No. 146 $17.50 ea.

(All Shafts Ball Bearing Supported)

SMALL DC MOTORS



(approx. size overall 3¾" x 1¼" dia.:)

5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled	$15.00 ea.
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
5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled	15.00 ea.
5BA10A118 GE 24 VDC 110 rpm	10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible	10.00
5BA10AJ52 27 VDC 145 rpm reversible	12.50
5BA10AJ50, G.E., 12 VDC, 140 rpm	15.00
206-1001 PM Planetary Gear Reduced Motor with Magnetic Brake. Mfgd. by Air Equipment 26 volts 600 ma 145 rpm	17.50
5BA10FJ33, G.E., 12 VDC, 56 rpm reversible	15.00
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-6-25 Diehl PM 27.5 VDC 10,000 rpm	4.00
6-volt PM motor mfgd. by Hansen 5,000 rpm 1¼" in dia., 2" long overall	4.00

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AN/TRC-1-3-4

100 MC RADIO-RELAY EQUIPMENT

The AN/TRC series is a mobile portable set for duplex or simplex radio telephone point to point communication. This set will operate with the CF series carrier systems to provide multi channel operation. The TRC operates on 100 MC with an output of 10-50 watts. The set is crystal controlled. Complete sets avail. Input 110v 60 cyc.

BC-342 BC-312

1.5-18MC Communication Receivers. The BC-312 Operates From 12V D.C. The BC-342 From 110V 60 Cyc. These Sets Incorporate a Crystal Filter B.F.O. Antenna Tuner Etc. We Can Supply These Receivers in Large Quantities.

AN/GSQ-1 NAVY TYPE PF SPEECH SCRAMBLER

This is a unit designed to be attached to either a radio or telephone circuit to scramble speech or code. This equipment utilizes coded cards in each terminal equipment. Unless the properly numbered card is inserted on the receiving end the speech can not be unscrambled. Complete equipment available. 24 VDC input. Spare parts avail.

AN/APG-3 AIRBORNE GUN LAYING AND SEARCH RADAR

This is a late X-band airborne search and gun laying automatic tracking radar. The set uses an antenna mounted to scan forward to search for aircraft and to provide gun fire presentation. The set consists of an indicator with a 5" B and C scope for radar operator, and a 3" indicator for the pilot for gun firing, a control stick firing grip, antenna, RF unit modulator, servos amplifier, radar central, etc. A modification of this set is the AN/APG-33 which is used in the F-89 and F-94 jet interceptors. Complete sets available. POR

SCR-682 A RADAR

10CM high power long range harbor surveillance and early warning RADAR. This equipment is a 3000 mc mobile search radar that can be transported in a truck. The equipment incorporates a 7" PPI for operation up to 240,000 yards. Azimuth accuracy is ± 1%. Range accuracy is 100 yards at 10,000 yard range and 5000 yards at 240,000 yard range. Trans. output is approx. 225KW, pulse width is one microsecond. Antenna beam width is 6°. Input is 110v 60 cyc. Can be supplied with or without operating shelter or antenna tower. POR.

AN/ASQ-1 AND 1A MAGNETOMETERS

This is an airborne magnetometer used to measure the magnetic flux of the earth and to locate submarines and other metallic objects by their distortion of the magnetic field. Sensitivity 2-3 gamma or better. POR.

SCR-291A DIRECTION FINDER

Automatic ground direction finder covering 1.5mc-30mc. Provides instant bearings on a C.R. indicator of any signal in its range. This equipment is transportable and can be set up quickly. 110v 60 cyc. POR.

AN/APR-4 38-4000 MC RECEIVER

This is a precision receiver covering 38-4000 mc. The set utilizes 5 tuning units with direct reading dials in megacycles. The receiver has a wide and narrow band-width 30 mc I.F. strip which may be selected at will. An output meter is provided to measure signal strength. Outputs are provided for a pulse analyzer and pan adaptor. Each tuning unit has an automatic sweeping mechanism which enables any portion of the tuning range to be scanned automatically. Input 110v 60 cyc. POR

SCR-536 HANDI-TALKIE

Freq. range 3.7-5.5mc crystal controlled battery operated handitalkie. The range of this equipment is approximately 2 miles. We can supply these sets to your specified freq. Completely reconditioned and guaranteed. Large quantity available.

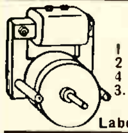
RC-115B GROUND 75 MC MARKER BEACON

This is a 75 C Marker Beacon Ground Station. This equipment comes mounted in a transporting trunk. The set can emit either inner, outer, or airways signals. The transmitter is crystal controlled. 110 Volts 60 cyc.

3" Round Elapsed Time Meter $12.75

WESTON PHOTRONIC CELL $4.50

PHOTO ELECTRIC Switch Darkness throws the switch—turns light on at dusk . . . off at dawn. Fools burglars who watch for signs of an empty house. $10.94



TELECHRON Motors

1 RPM	$3.95	60 RPM	$4.85
2 RPM	2.90	3 RPHr	2.85
4 RPM	3.90	1 RP.2Hr.	2.80
3.6 RPM	3.15	1 RP 12Hr.	3.25

1 RPM—50 Cycles, $1.85
Laboratory Special 1 of Each Motor $25

D-E-L-A-Y-E-D A-C-T-I-O-N LIGHT SWITCH Shuts light off automatically almost a minute later. Keeps porch or garage light on after you shut it off. $3.50

DEALERS WRITE FOR PRICES

6 WATT MOST POWERFUL TELECHRON MOTOR 110-V. 60 CY
1 RPM $6.50

HAYDON TIMING MOTORS

1 REV 4 Hours	$1.70
1 RPM 230v 60cy	1.00
1 RPM 110v 60cy	2.60
2 RPM 230v 60cy	1.00
30 RPM 110v 60cy	2.60
450 RPM, yes 450 RPM	1.30
HANSEN Synchron 4 RPM	4.24
CRAMER 4 RPM	4.65
Laboratory Special 1 of each Motor	$15.00

RELAY CONTACT BURNISHERS .59—2 for $1.00

PM MOTORS Made by DELCO or DIEHL $3.75
Removed from equipment

BLAN EST. 1923

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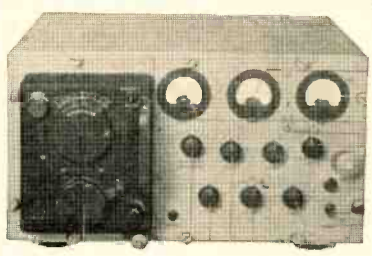
New York 7, N. Y.



V. H. F. U. H. F.

RDO RECEIVER

38 MC to 1000 MC precision Receiver covering complete range using 3 turning units. The RDO is a high quality Navy search receiver using the same turning units as the APR-4, but has additional features, such as input and output signal strength DB meters, audio output metering, noise limiter, greater stability, for noise measuring etc. Input 110V60CYC. Panadaptor output avail. Complete W/3 turning units.

Brand new, original boxes. **$159.50**

Govt. acq. cost $1500.00

3 CM Radar Installation in Brand New original boxes. This is a complete self-contained radar receiver and transmitting unit with parabolic antenna complete with 76 tubes. Indicators and control boxes. Tube complement consists of:

2 ea.—723AB	30 ea.—6J6	1 ea.—725A
2 ea.—1B22	9 ea.—6VGGT	1 ea.—807
4 ea.—3B24	11 ea.—6AK5	1 ea.—VR105
2 ea.—3FP7	4 ea.—6SL7GT	4 ea.—VR150
3 ea.—5U4	2 ea.—724A	

(govt. acquis. cost over $4,000.00). Ship. wt. 431 lbs. W/operating instructions.
Your special price $69.50

Write for flyer.

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Each announcement represents a current Want or Offering of an organization or individual in the field. Some have money-saving possibilities, others are opportunities for more business; many are employment opportunities; still others offer equipment—used or surplus new.

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MICAFIL

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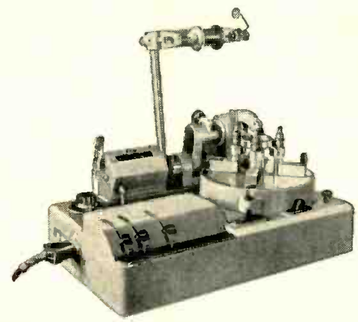
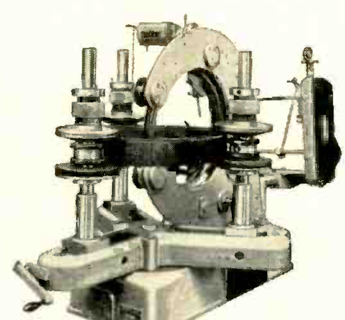
- Minimum Wire Breakage
- Large or Small Coils
- Continuous or Sector



Micafil RW-P. A high precision toroidal coil winding machine for potentiometers, the RW-P will wind perfect layers to a finished I.D. of .25″ to 4″. It is the only toroidal coil winder capable of successfully winding #45 AWG copper wire down to such a small finished I.D. Core rotation can be varied by a 600 step planetary gear box. Winding speeds—up to 100 r.p.m. Optional winding head for speeds up to 400 r.p.m. An automatic turns counter stops the machine automatically after a pre-set number. Core holder for continuous winding over 360°; sector holder for angles up to 330°.



Micafil RW-III. This machine winds large, heavy coils from a minimum I.D. of 1¾″ to a maximum O.D. of 27″. Maximum coil height is 4½″. A two-shuttle type, the RW-III will wind tightly without damaging insulation—with wire up to #10 AWG. Maximum winding speed is 100 r.p.m. Sector holder for 330° winding. Special design for winding Variac Transformers.

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COSA CORPORATION
405 Lexington Ave., New York 17, N.Y.

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FREED MAGNETIC AMPLIFIERS *and* SATURABLE TRANSFORMERS FOR IMMEDIATE DELIVERY

FAST RESPONSE MAGNETIC AMPLIFIERS
2∿ response — Phase reversible

Cat. No.	Supply Freq. C.P.S.	Power Out. Watts	Volt. Out. V. AC	AC or DC signal voltage req'd for full output.	
MAF-1	60	13	110	1.0	—
MAF-6	400	5	57.5	1.2	0.4
	400	10	57.5	1.6	0.6
MAF-7	400	15	57.5	2.5	1.0

SINGLE ENDED MAGNETIC AMPLIFIERS

Cat. No.	Supply Freq. C.P.S.	Power Out. Watts	Sig. req'd for full outp. MA-DC	Total res contr. wdg. K Ω	Load res. ohms
MAO-1	60	4.5	3.0	1.2	3800
MAO-2	60	20	1.8	1.3	700
MAO-4	60	400	9.0	10.0	25
MAO-5	60	575	[illegible]	10.0	25

PUSH-PULL MAGNETIC AMPLIFIERS
Phase reversible

Cat. No.	Supply Freq. C.P.S.	Power Out. Watts	Volt. Out. V. AC	Sig. req'd for full outp. MA-DC	Total res. contr. wdg. K Ω
MAP-1	60	5	115	1.2	1.2
MAP-2	60	15	115	1.6	2.4
MAP-3	60	50	115	2.0	0.5
MAP-3-A	60	50	115	7.0	2.9
MAP-4	60	175	115	8.0	6.0
MAP-7	400	15	115	0.6	2.8
MAP-8	400	50	110	1.75	0.6

SATURABLE TRANSFORMERS
Phase reversible

Cat. No.	Supply Freq. in C.P.S.	Power Out. Watts	Volt. Out. V. AC	Sig. req'd for full outp. MA-DC	Total res. contr. wdg. K Ω
MAS-1	60	15	115	6.0	27
MAS-2	400	6	115	4.0	10
MAS-5	400	2.7	26	4.0	3.2
MAS-6	400	30	115	4.0	8.0
MAS-7	400	40	115	5.5	8.0

All units designed for 115V-AC operation

Write for detailed listing, or special requirements, and copies of complete Transformer and Laboratory Test Instrument Catalogs.

FREED TRANSFORMER CO., INC.
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Brooklyn (Ridgewood) 27, New York

CIRCLE 168 READERS SERVICE CARD

TEXAS INSTRUMENTS
P-N-P germanium
90MC alpha cutoff
NEW T/I diffused base transistors

Your orders for TI silicon and germanium transistors are filled immediately, off-the-shelf at factory prices when you order from your most convenient source . . .

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AT ANY OF THESE FIVE CONVENIENT LOCATIONS

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WRITE OR CALL DEPARTMENT E FOR CATALOG AND PRICE LIST. WE ARE AS CLOSE AS YOUR TELEPHONE.

CIRCLE 175 READERS SERVICE CARD

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F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

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NEW P-N-P germanium 90 MC alpha cutoff T/I diffused base transistors

In a JETEC TO-5 Package!

POWER GAIN VS. FREQUENCY

Now for your television IF's, VHF oscillators and amplifiers plus high speed computer applications . . . new round welded 2N623 diffused-base germanium transistors give you 200 mc typical maximum frequency of oscillation, 90 mc alpha cutoff, plus a 25 mμsec typical total non-saturated switching time.

Check the specifications and application notes below — see how the TI 2N623 can help you with your next high gain/high frequency or ultra high speed switching application.

Write today to your nearest T/I sales office for Bulletin DL-S 904

maximum ratings at 25°C

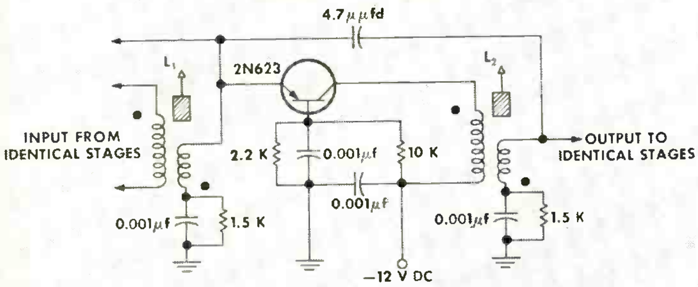
collector to base	—30V
collector to emitter	—15V
emitter to base	—1V
total dissipation	40mW

typical design characteristics at 25°C

	(conditions)		
collector reverse current	$I_E = 0$	$V_{CB} = -20V$	2μA
emitter reverse current	$I_C = 0$	$V_{EB} = -0.5V$	0.5 μA
forward current transfer ratio	$I_C = -2mA$	$V_{CE} = -6V$	35
current transfer ratio cutoff frequency	$I_C = -2mA$	$V_{CB} = -6V$	90 mc
max. frequency of oscillation	$I_C = -2mA$	$V_{CB} = -6V$	200 mc
frequency where h_{fe} is unity	$I_C = -2mA$	$V_{CB} = -6V$	60 mc

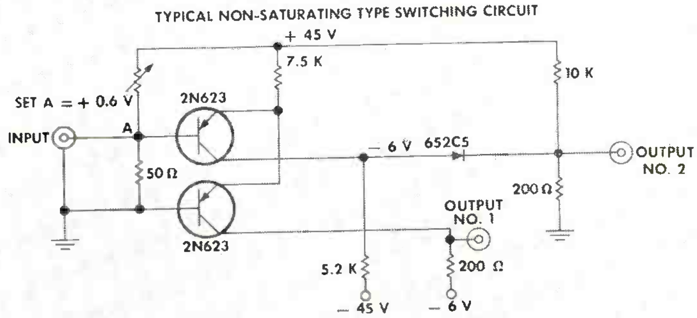
APPLICATION NOTES

TYPICAL 43 MC IF AMPLIFIER



TYPICAL VALUES — AVAILABLE POWER OUTPUT 20 mW (PEAK)
NOISE FIGURE 6 db • POWER GAIN 15 db • BAND WIDTH, ONE STAGE 11 mc
APPROX. IMPEDANCE LOOKING INTO PRIMARY 56 Ω • LOAD ON SECONDARY 3000 Ω

TYPICAL NON-SATURATING TYPE SWITCHING CIRCUIT



TYPICAL SWITCHING TIMES OBTAINED IN ABOVE CIRCUIT
t_{on}: 14 mμsecs t_{off}: 14 mμsecs
(INCLUDES OSCILLOSCOPE RISE TIME)

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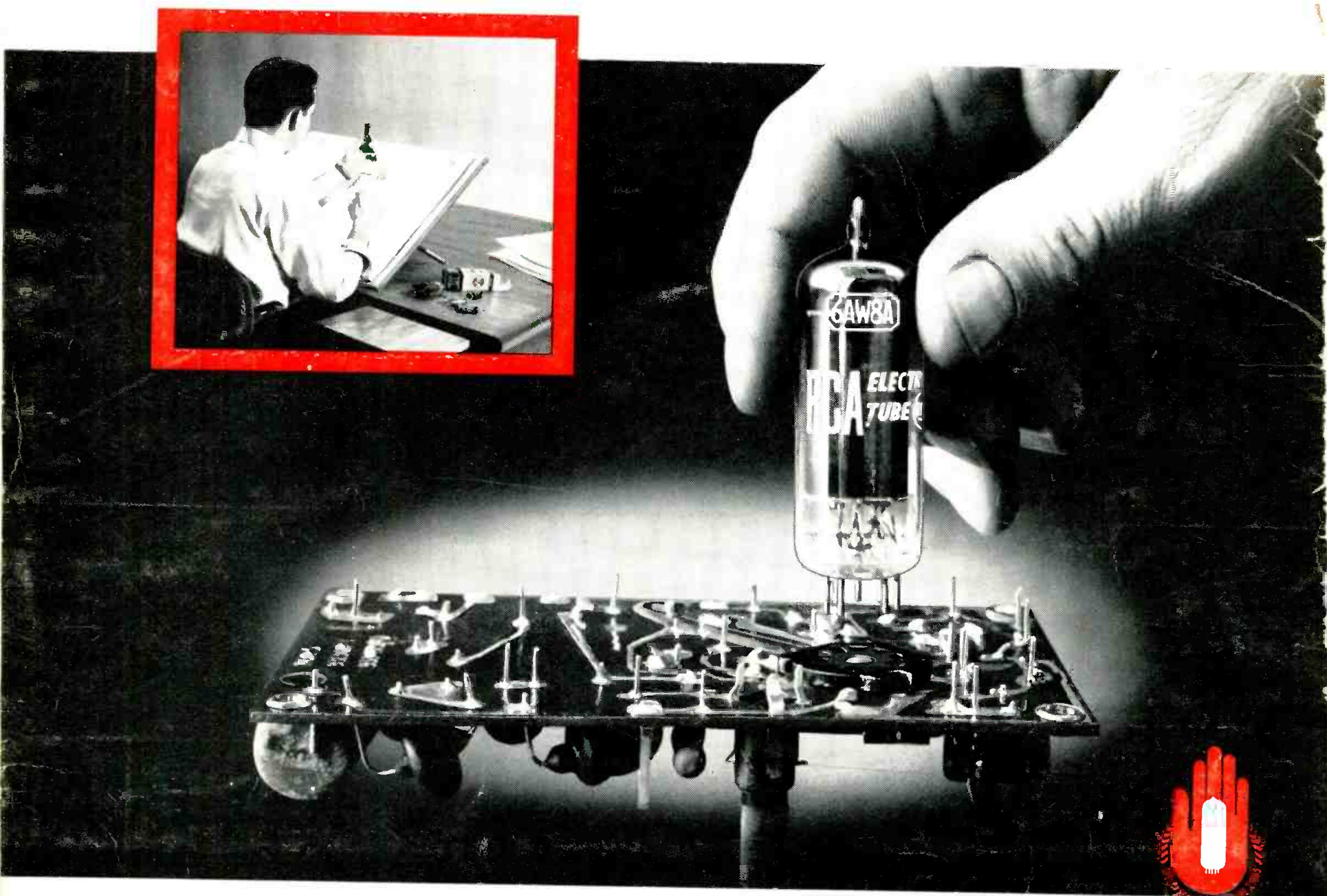
RCA-6AW8-A

—Preferred Tube Type— Offers You Extended Life, Improved Performance



The popular RCA-6AW8-A features highly improved performance and longer life in video-amplifier service —improvements resulting directly from RCA's Preferred Tube Types Program!

THESE IMPROVEMENTS WERE MADE TO THE RCA-6AW8-A

Precise control of heater coatings eliminates "thin spots"—assures durable heaters which minimize heater-cathode leakage and heater-cathode shorts. Special-alloy cathodes offer better cathode activation which reduces slump and assures stable operation. A new cathode design reduces the number of welds—minimizing handling and contamination.

Heat dissipation is improved by the use of heavier side rods on pentode grid #1. Pure nickel pins reduce pin-contact noise and facilitate insertion and removal of the tube. From tip to stem, the glass is controlled for stress and strain to assure durability under wide variations in temperatures. Final test procedures include cycled operational life tests to simulate "on-off" usage in the home.

Result: the highly reliable RCA-6AW8-A for superior video amplifier performance. By designing your circuits "around" proved-in-service Preferred Tube Types, such as the 6AW8-A, you take advantage of the benefits of lower tube costs, more uniform tube quality and better tube availability.

There's a Preferred Tube Type to meet virtually all of your TV, AM and FM receiver requirements. Ask your RCA Representative for the up-to-date list of 62 Preferred Types. Or, write Commercial Engineering, Section F-19-Q-1, Harrison, N. J.

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