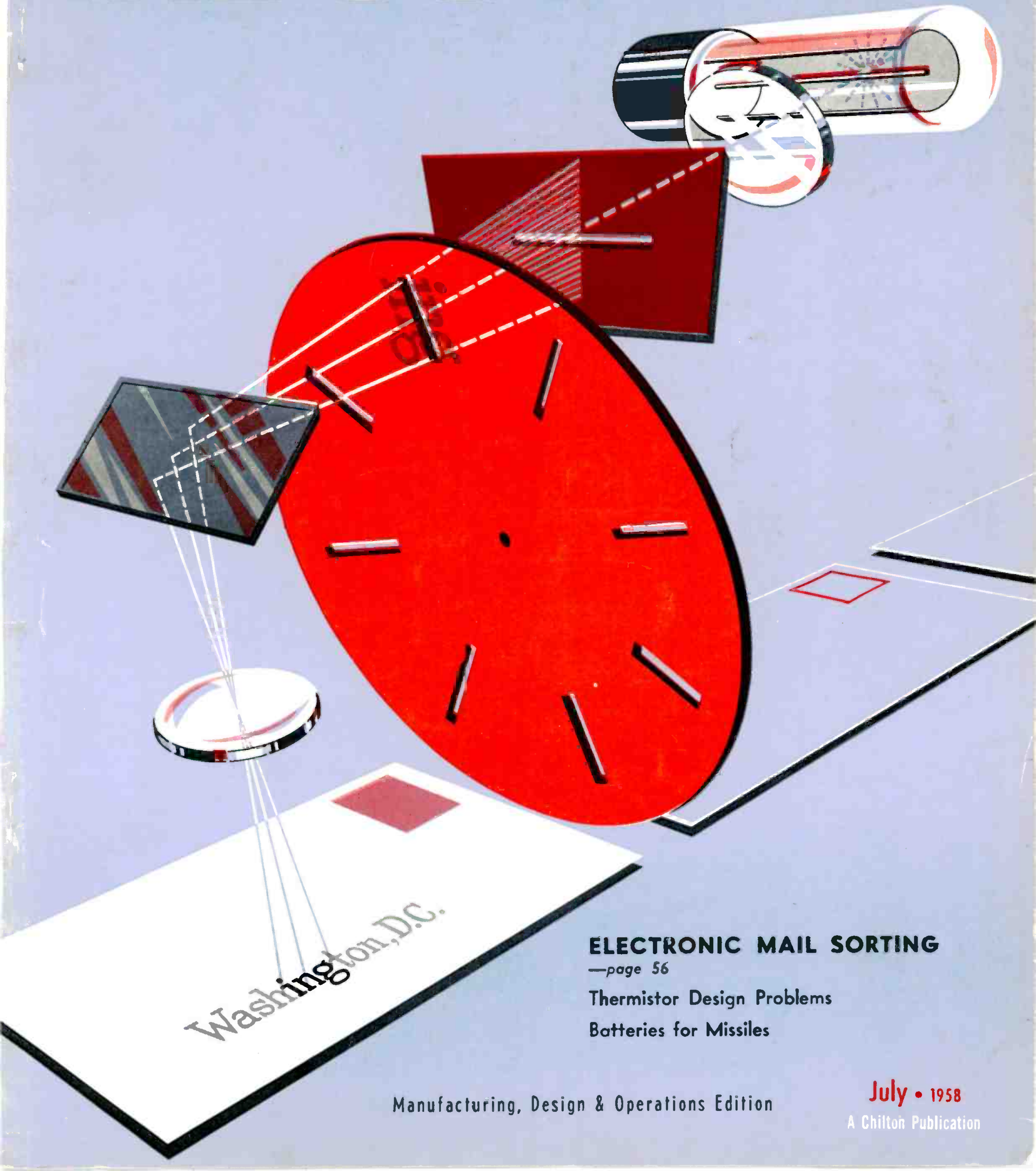
ELECTRONIC INDUSTRIES



ELECTRONIC MAIL SORTING
—page 56

Thermistor Design Problems

Batteries for Missiles

Manufacturing, Design & Operations Edition

July • 1958

A Chilton Publication

so small in size

SO BIG IN PERFORMANCE

RMC Type SM DISCAPS

These truly miniature ceramic capacitors are manufactured with the built-in quality and dependability inherent in all RMC DISCAPS.

SM DISCAPS are available in capacities between 800 and .02 and meet or exceed the EIA RS-198 standard for Z5U capacitors.

If you require small ceramic capacitors, write on your letterhead for samples of RMC's Type SM DISCAPS.

SPECIFICATIONS

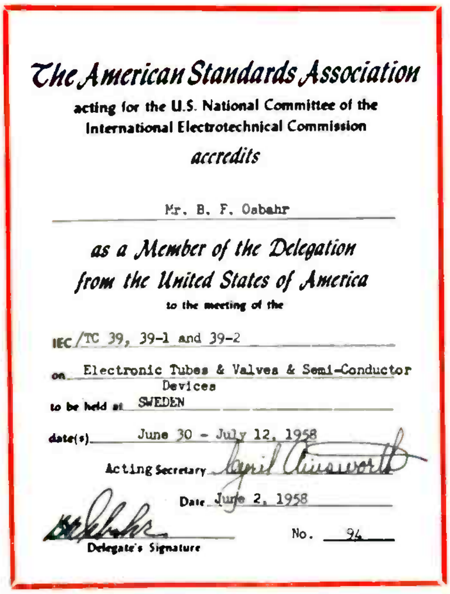
POWER FACTOR: 1.5% Max. @ 1 KC (initial)
WORKING VOLTAGE: 500 V.D.C.
TEST VOLTAGE (FLASH): 1000 V.D.C.
LEADS: No. 22 tinned copper (.026 dia.)
INSULATION: Durez phenolic (1/8" max. on leads)—vacuum waxed
STAMPING: RMC—Capacity—Z5U
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS COMPANY
A DIVISION OF P. R. MALLORY & CO., INC.
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Circle 1 on Inquiry Card, page 83



The American Standards Association

acting for the U.S. National Committee of the International Electrotechnical Commission

accredits

Mr. B. F. Osbahr

as a Member of the Delegation from the United States of America

to the meeting of the

IEC/TC 39, 39-1 and 39-2

on Electronic Tubes & Valves & Semi-Conductor Devices

to be held at SWEDEN

date(s) June 30 - July 12, 1958

Acting Secretary [signature]

Date June 2, 1958

[signature] Delegate's Signature

No. 94

ELECTRONIC INDUSTRIES

R. E. McKENNA, Publisher • B. F. OSBAHR, Editor

Needed:

International Technical Representation

Dear Reader:

This month, Bernie Osbahr your editor who normally writes this page is in Europe attending the meetings of the International Electrotechnical Commission. Bernie is serving as a U. S. delegate on TC-39 and SC 39-1 and 39-2. These committees are concerned with international manufacturing standardization of electronic tubes and valves and semiconductor devices.

In earlier editorials (October 1957, page 51—Electronic Industries in 1958; November 1957, page 53—"Sputnik"—Guide for the U. S.!; February 1958, page 49—Expanding International Electronic Sources; February 1958, page 145—A Look at The International Electrotechnical Commission) we have voiced our interest in the electronic industries on an international as well as on a purely national basis. It is our desire to provide editorial services that will be of interest and benefit to electronic engineers in all countries. Our "International Electronic Sources" form that we have published each month over the past two years, and which abstracts all foreign and domestic electronic articles of import, has already drawn wide reader acclaim. The rise of "Sputnik I" clearly indicates that there is no monopoly on brains and that international technical reporting is a mandatory rather than an optional editorial activity.

The importance of having greater U. S. engineering participation on international technical committees has also been pointed out. In general, foreign delegates are subsidized by their respective governments. This contrasts to our own "free-enterprise" system where individual participants have to sell their own management on their own abilities and on the importance of the occasion. Our "free-enterprise" system thus sometimes puts the U. S. at a disadvantage because some of the more qualified highly technical people are unable to obtain the necessary funds to attend.

Incidentally, in this latter connection, an interesting effort is now being made by the U. S. Committee for the first International Computer Conference sponsored by UNESCO and to be held June 13-31, 1959, in either Paris or Rome. Here the effort is to obtain only the highest possible American technological participation in order to maintain our stature in the eyes of the world. The financial underwriting involved is being treated as a separate problem. This we believe is as it should be!

Above is a reproduction of Bernie's ASA's credentials. As far as we know we are the *only* American publisher participating in these activities, and in a subsequent issue we shall be reporting the happenings at this Stockholm event. Some 1400 delegates from all over the world including the Iron Curtain countries are expected to attend. We hope too, that through our own support of international technical activities, other organizations will become aware of the significance and importance to the United States and that they too will ultimately follow suit.

In closing, Bernie's trip will take him to Sweden, West Germany, France, and England. During his visits he will be looking for items of editorial interest to report to you on his return and he will be establishing editorial contacts with which to assure you of a continued supply of such information in the future. If you as the reader have any especial technological needs of an international character we will be happy to hear from you and to cooperate with you in any way that we can. It has always been our policy and it will continue to be our policy to provide EI readers with only the finest, most up-to-date, and comprehensive editorial material available anywhere in the world.

Sincerely,

[signature]

R. E. McKenna
Publisher

ELECTRONICS INDUSTRIES, July, 1958. Vol. 17, No. 7. A monthly publication of Chilton Company, Executive, Editorial & Advertising offices at Chestnut & 56th Sts., Phila., Pa. Accepted as controlled circulation publication at Phila., Pa. 75¢ a copy; Directory issue (June), $3.00 a copy. Subscription rates U. S. and U. S. Possessions: 1 yr. $5.00; 2 yrs. $8.00. Canada 1 year, $7.00; 2 yrs. $11.00. All other countries 1 yr. $18.00, 2 yrs. $30.00.

ELECTRONIC INDUSTRIES

Vol. 17, No. 7 July, 1958

MONTHLY NEWS ROUND-UP

NEW PRODUCTS & TECH DATA

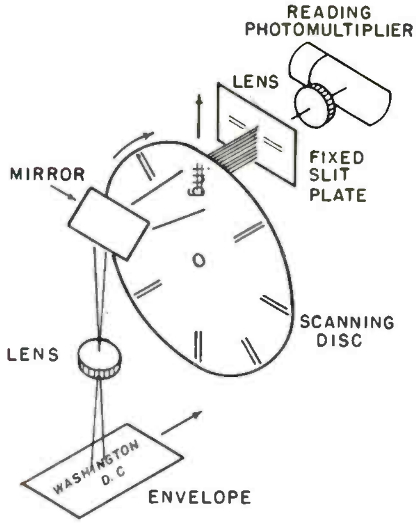
DEPARTMENTS

BPA NBP

Highlights

Of This Issue

The Automatic Post Office! — page 56

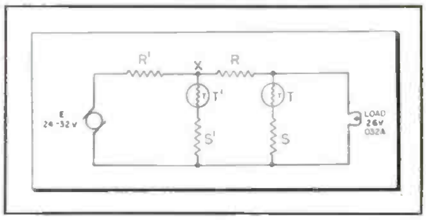


Automatic character sensing equipment is being developed and tested for the Post Office Department to automatically read and sort mail at high speed. The techniques being developed to read standard letters also has many advantages as an automatic input for data processing systems.

A Look At Silver-Zinc Batteries — page 61

In eight short years the silver-zinc battery has evolved from a laboratory unit to a sophisticated item used in missiles, rockets and other rugged applications. One of the most significant developments has been a new high-speed method of automatic activation which makes a primary battery completely interchangeable with silver-zinc rechargeable batteries.

The Germanium Photo-Tetrode — page 64



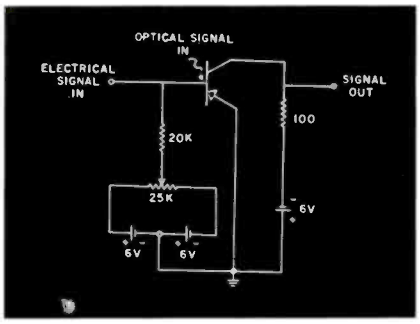
Light can give control characteristics analogous to those resulting from the emitter in the grounded-base transistor. Likewise, a light-controlled tetrode-equivalent is possible, and has been designed. The effective operating point and bias are varied in accordance with the light intensity incident on the base region.

Integrated Aircraft Instrumentation — page 68

Adequate human response in modern closed-loop man-machine systems requires simplified integrated display of command data. A method of generating such a display is developed and the specific techniques for simplifying the instrumentation of jet aircraft are described.

Thermistor Design Problems — page 51

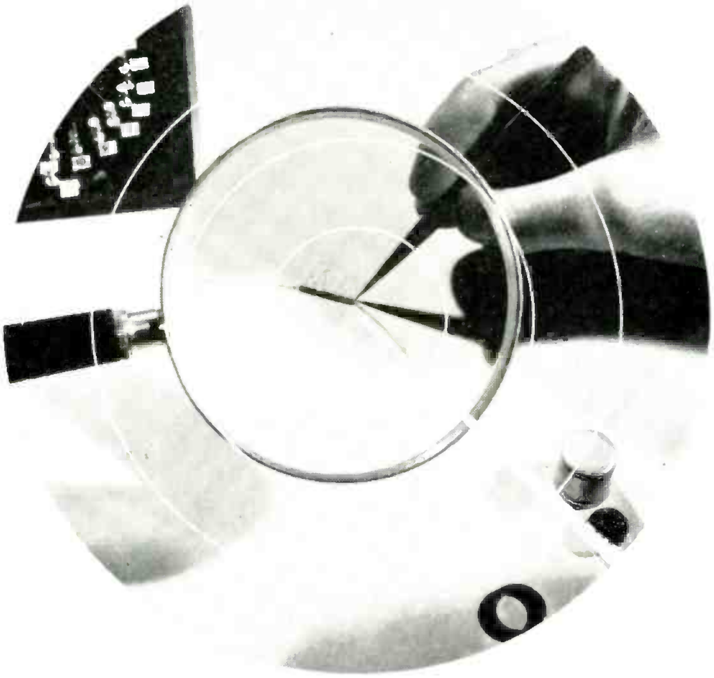
The mathematical expression of all the electrical characteristics of a thermistor, in terms of its mechanical structure, is extremely complicated and involves a large number of independent parameters. It is preferable to use a trial-and-error method. Here is an approach to solving practical thermistor problems, with a wide variety of typical applications.



COMING NEXT MONTH—EI's 7th ANNUAL WEST COAST ISSUE

Timed to appear just before the West Coast's mammoth WESCON Show, this latest and biggest report on the products and doings of West Coast electronic manufacturers will feature top-level technical descriptions of late engineering developments, a full program and preview of the products to be seen at WESCON and the technical papers program, and a number of articles by top-ranking West Coast engineers. DON'T MISS IT!

RADARSCOPE



"SEMICONDUCTOR CIRCUIT"

RCA's new experimental shift register transistor is expected to perform all the functions of a circuit comprising 20 transistors, 40 resistors and 20 capacitors. The laboratory device is only ½-in. long and .004 in. thick.

SOLAR POWER TV CAMERA has been developed by CBS Hytron Div. of CBS, Inc., for use in satellites.

RADIO CONTROLLED TRAFFIC LIGHTS will get an extensive trial in a new experiment in Wayne County, a suburb in Detroit. The installation, by Motorola's Communications & Electronics Div. will involve 10 traffic lights, all incorporating frequency selective receivers and being controlled by a central station. The system, says Motorola spokesman, uses four audio frequencies, and can be expanded to control as many as 1,000 intersections.

JAPAN now has 24 TV stations, with plans for a total of 72 by 1959. There are approximately 1,000,000 sets in use.

THE CAA will spend $1,027,000,000 during the next 5-year period on airways modernization. The primary emphasis is on radar to bring about a semi-automatic air traffic control system. Plans call for a total of 60 additional long range radar installations including those that will be used jointly with the various military services, making a total of 100 in the system. There will also be added 76 new airport surveillance radar units to supplement the 62 already financed for terminal use. All CAA air route traffic control centers will be employing computers for flight data processing by 1963.

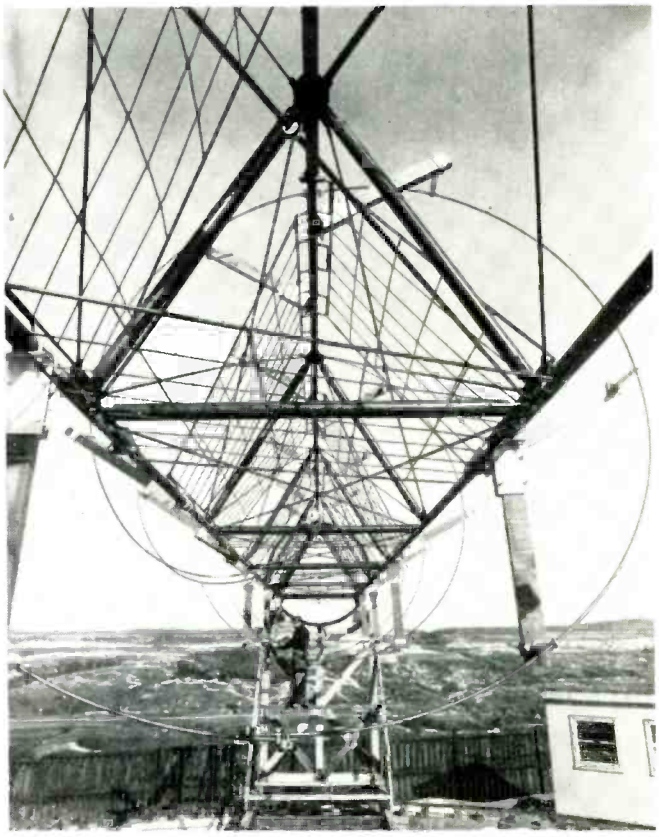
ULTRA-MINIATURE TRANSISTOR being developed at RCA's David Sarnoff Research Center will lead to still smaller, simpler circuits. The shift-register transistor is half an inch long, only .0004 of an inch thick. Describing its function, RCA scientists say it is expected to perform the functions of 20 transistors, 40 resistors, and 20 capacitors. See pix (1).

THE EIA's Consumer Products Div. Executive Committee and Tax Committee will sponsor an all-out campaign for reduction of the excise tax on radio, TV sets and phonographs from 10% to 5%.

AN ENGINEER'S RIGHT to bar the Atomic Energy Commission from disclosing secret data until his patent and other rights are adequately protected is being considered by the U. S. Court of Appeals at the request of the Supreme Court. The test case, which concerns a member of the American Institute of Chemical Engineers and which is being pushed by the Engineers Joint Council will apply broadly to all inventions used by the United States under classification.

ANTENNA TEST SITE

GE took the wraps off its new TV broadcast antenna test site, disclosing this new low-channel, VHF helical antenna that wraps around the antenna supporting towers. The new antenna site is located atop a 1,350 ft. hill at Casanovia, N. Y., near Syracuse.



SMALL BUSINESS SUBCONTRACTORS took more than 267,000,000 of the $1,000,000,000 paid to subcontractors of the aircraft industry engaged in ballistic missiles during 1957. This amounts to approximately 21% of the total.

"COMPUTER OBSOLESCENCE" is the bugaboo that influences so many users to lease instead of buying, but these fears are groundless, says Burroughs' James R. Bradburn. "Significantly advanced computer systems will not be available for another seven to ten years," he says, "therefore management should plan a data processing installation for that period. The chance of it becoming obsolete sooner is negligible. Pointing out the financial advantages he said that on a one shift operation for any given application purchase as opposed to lease may yield a net annual savings equaling 10% of the money invested, and the prevailing fast tax write off sweetens the purchase cup all the more. As of this time a majority of computing users (about 4 to 1) continue to lease.

MISSILE RELIABILITY is highlighted in latest reports that describe large missile systems as containing more than 1½ million parts.

VERY HIGH VOLTAGE POWER TRANSMISSION on a large scale may be available soon throughout the U. S., according to power authorities at the American Power Conference in Chicago. A number of European countries, notably Sweden, France, and Germany, and also Russia, already have 400 kv systems. The highests voltage installations in the U. S. so far are the 345 kv lines of the American Gas and Electric Co., Bonneville Power Administration System and a New Commonwealth Edison Co. installation. Extra high voltage systems can carry larger amounts of power farther and more efficiently.

THE U. S. CHAMBER OF COMMERCE is recommending a new system of appropriating defense funds that would concentrate on the overall needs of military rather than allocating funds by service. The primary purpose served would be in avoiding duplication and triplication of activities by the various services.

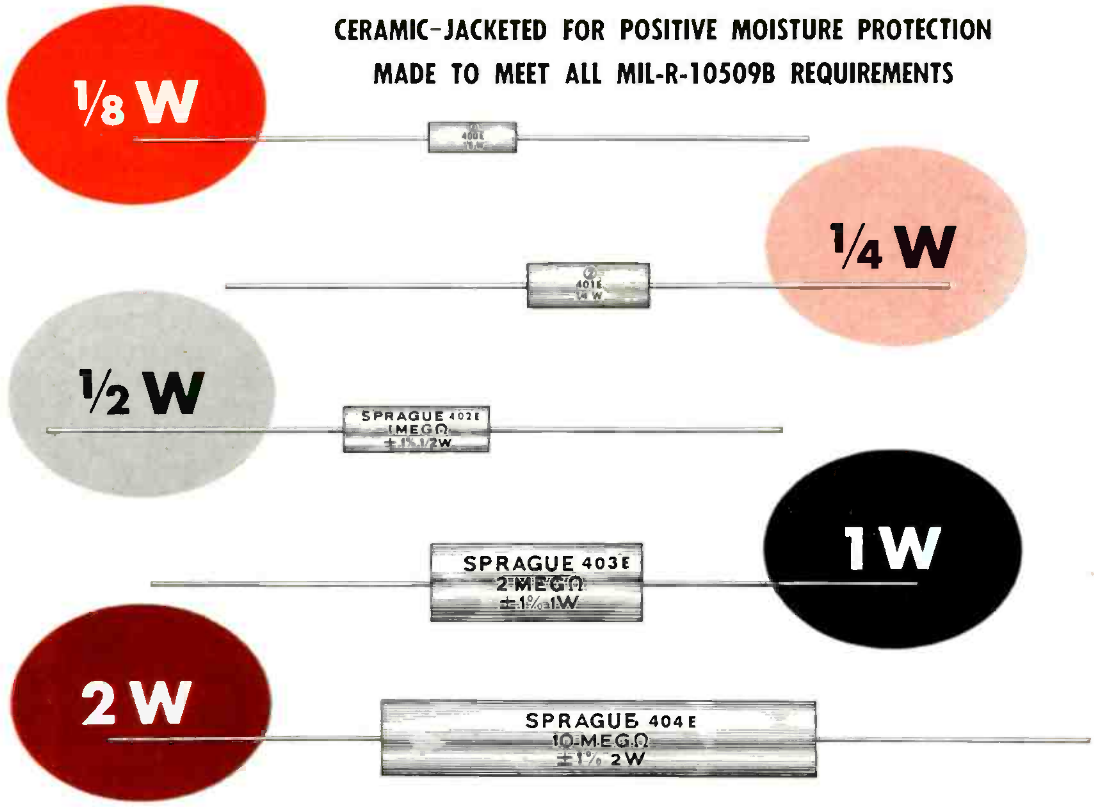
NARROW BAND TV may be the answer to providing additional closed-circuit TV links. General Electric Co. study points out that for full TV band width, the annual cost for transmission facilities over a 500-mile run might come to about $400,000. In contrast the pick-up and display equipment used might cost less than 1% of that figure. GE has developed and is experimenting with a narrow band TV system which they hope will lead to relatively inexpensive TV transmission.

PAY TV PICTURE remains confused. In Bartlesville, Okla., the country's first large scale experiment with closed-circuit pay TV reluctantly discontinued operation. Company officials admitted that the operation, which depended entirely on exhibition of first run movies, had been a financial disappointment. Among the lessons learned, they said, was that "the concept of the package of pictures for a fixed price is wrong. Subscribers must be charged by the picture using a metering device." Company president Henry Griffing added that "no adequate meter is now available in quantity for immediate delivery." But as the Bartlesville experiment folded, International Telemeter Corp. was jumping in with plans for three experimental pay TV operations to go into operation next year. The company, which is owned by Paramount Pictures, is designing their system around a coin box-control system which will be attached to TV sets. Though the exact communities were not disclosed, it was announced that one will be close to New York, a second in the West Coast and a third in Canada. In addition to movies, Telemeter will also arrange to televise sports and other live entertainment attractions.

COIL FOR MISSILE TESTER

Huge inductance coil, built by Westinghouse for the Gas Dynamics Facility at Arnold Engrg. Dev. Center, is the largest ever built. Measuring 119 in. diameter, the coil will create temperatures near 40,000°F. and pressures to 30,000 psi for wind tunnel testing.

CERAMIC-JACKETED FOR POSITIVE MOISTURE PROTECTION
MADE TO MEET ALL MIL-R-10509B REQUIREMENTS



FILMISTOR☆

CARBON FILM RESISTORS IN RATINGS FROM 1/8 TO 2 WATTS PROVIDE THE STABILITY YOU WANT UNDER THE TOUGHEST LOAD AND HUMIDITY CONDITIONS

WRITE FOR BULLETIN NO. 7010A • SPRAGUE ELECTRIC COMPANY
233 MARSHALL STREET • NORTH ADAMS, MASSACHUSETTS

SPRAGUE®
THE MARK OF RELIABILITY

☆ TRADEMARK REG.

SPRAGUE COMPONENTS: RESISTORS • CAPACITORS • MAGNETIC COMPONENTS • TRANSISTORS
INTERFERENCE FILTERS • PULSE NETWORKS • HIGH TEMPERATURE MAGNET WIRE • PRINTED CIRCUITS

Circle 2 on Inquiry Card, page 83

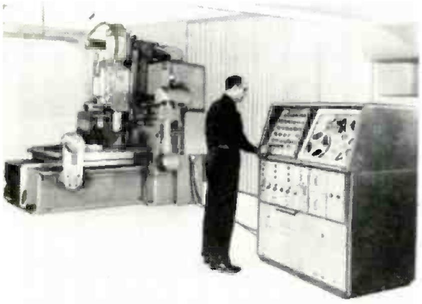
As We Go To Press . . .

Automatic Machine Tool for Small Shop

The first of a new type of numerically controlled machine tool suitable in size and price for "job shop" use by smaller plants was announced by the Morey Machinery Co., of New York City, and Stromberg-Carlson's Electronic Control Systems Division, in Los Angeles, Calif.

Utilizing the DIGIMATIC numerical control system, the new tool is impressive for its relatively small size, high performance and simplicity of operation. Typical contoured parts are "programmed" in the morning directly from blueprints, utilizing only typical machine shop personnel, and automatically machined by lunch time.

The DIGIMATIC Control Unit is exceptionally compact, occupying less than 12 square feet of space, yet it has full capability to run the 4 ft x 4 ft bed-type machine, including its heavy-duty 30 horsepower spindle, in a full 3 axis



Numerically controlled machine tool will be suitable for even small job lot operations.

capability, including lines and circles. Self-checking features and modular design packaging principles make the control console simple to use and maintain under tape control. Cutting speeds up to 100 ips are available, with tolerances down to 0.001 in. The machine is also equipped with micro-dials for positioning and push-buttons which enable the operator to use it as a conventional milling machine.

Using economical half-inch magnetic tape operating at a speed of only 7½ in. per second, a full hour of machining can be accommodated on a 2400 ft roll of tape, which constitutes a full tooling record.

JET LINER

North American's new Sabreliner jet executive transport was rolled out ahead of schedule.

Moon Can Serve As SW Reflector

Research at the University of Michigan indicates that very short wave radio or radar signals, which can be used in voice transmission, bounce off the moon without appreciable loss in quality.

It has been known for several years that voice communication using the moon as a reflector was possible when long wave length signals were utilized. But the University investigators have found that very short wave lengths of about an inch give such improvement in clarity that it now is commercially feasible to set up a world-wide network of stations using this technique.

The U-M scientists met success in developing the reflection theory when, in checking reports by other researchers throughout the nation, they found certain incorrect conclusions had been drawn. One of these was the assumption that, because of the jagged mountains and craters which are known to exist on the moon, the moon would appear rough to a radar signal.

But a short wave signal only requires an area of a few square feet to be reflected. The moon has such areas that are smooth and as a result the radar signals are reflected without a loss in quality.

Army Teletypewriter Is World's Fastest

The world's fastest message printer and code puncher was officially unveiled for public demonstration at the Armed Forces Communications and Electronics Association convention in Washington, D. C. It is the first in a new family of super-speed combat teletypewriter units.

The new device was developed for the U. S. Army Signal Corps, by Kleinschmidt Laboratories, Inc., a subsidiary of Smith-Corona. It pounds out messages at 750 words a minute.

The device has no ordinary typing keys. Instead, a whirling wheel rimmed with letters prints the high-speed messages. It spins at 3,750 revolutions a minute — as

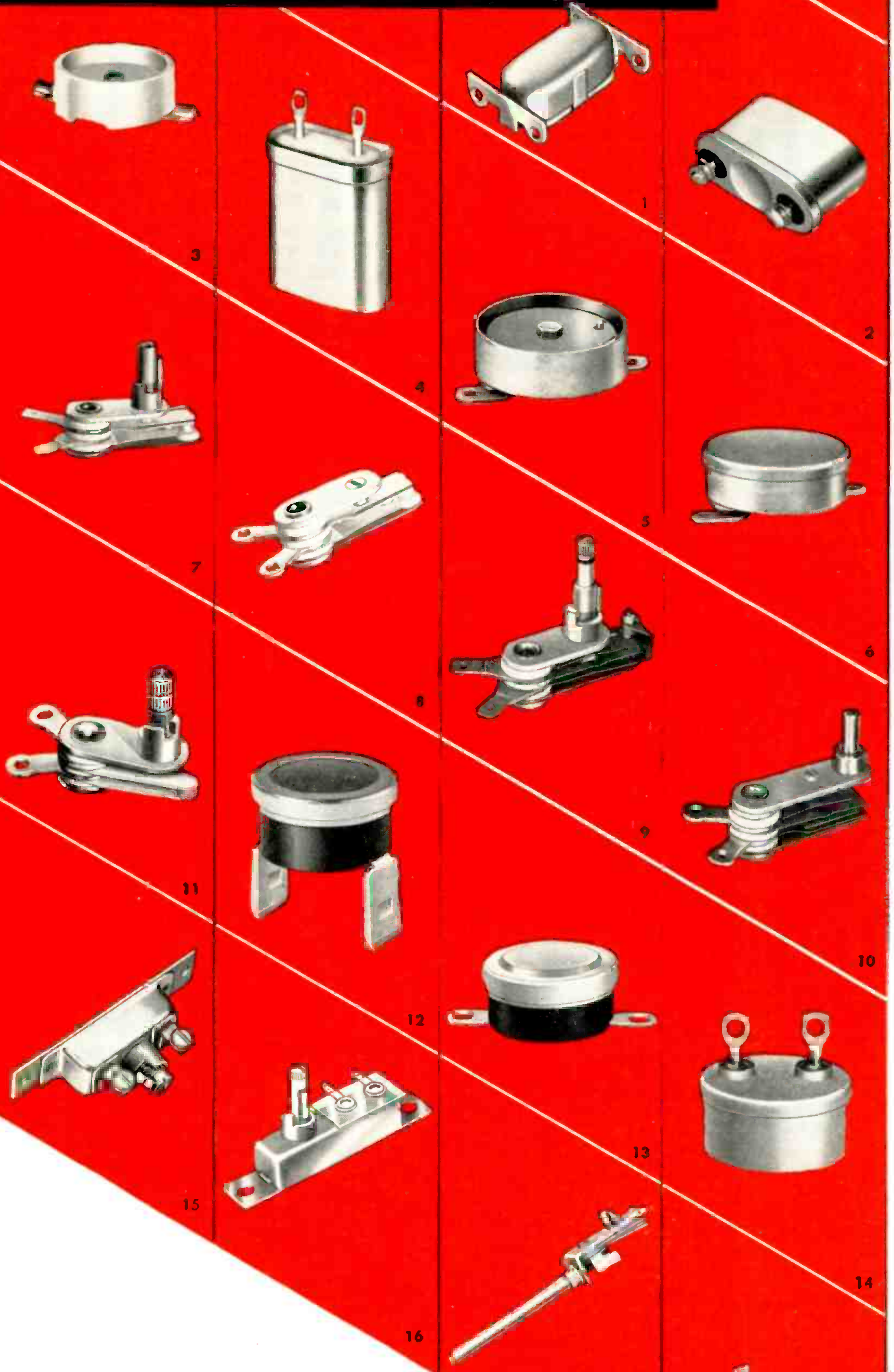
Signal Corps' new high speed teletypewriter stamps out messages at 750 words per minute.

fast as the wheels on a car going 500 miles an hour. At the precise instant the correct letter comes into position, a tiny hammer slaps the paper against the type wheel. Perfection of this technique represents a major breakthrough in the field of mechanical printing.

It types out messages on ⅞-in. paper tape, at the same time punching out coded holes. Tape spews from the printer at 7½ in. per second. These tape messages can be relayed rapidly to other points. Or they could be printed on the spot in page form by automatic typewriters.

MORE NEWS ON PAGE 12

STEMCO THERMOSTATS
for precise, sensitive temperature control



1, 2, TYPE C ***semi-enclosed*** **(1),** ***hermetically sealed*** **(2).** Small, positive acting with electrically independent bimetal strip for operation from -10° to 300°F. Rated at approximately 3 amps, depending on application. Hermetically sealed type can be furnished as double thermostat "alarm" type. Various terminals and mountings. Bulletin 5000.

3, 4, TYPE M ***semi-enclosed*** **(3),** ***hermetically sealed*** **(4).** Electrically independent bimetal disc types for appliance and electronic applications from -20° to 300°F. Rating: 8 amps at 115 VAC, 4 amps at 230 VAC and 28 VDC. Semi-enclosed with virtually any type terminal; hermetically sealed with pin or solder terminals, wire leads, various mounting brackets. Bulletin 6000.

5, 6, TYPE MX ***semi-enclosed*** **(5),** ***hermetically sealed*** **(6).** Snap acting miniature units to open on temperature rise for missile, avionic, electronic and similar uses. 2° to 6° differentials available. Rated at 3 amps to 1 amp, depending on duty cycle, at 115 VAC and 28 VDC for 250,000 cycles. Semi-enclosed types with metal or ceramic bases; hermetically sealed in circular or CR7 cans. Various terminals, mountings, brackets, etc. Bulletin 6100.

7, 8, TYPE S* ***adjustable*** **(7),** ***non-adjustable*** **(8).** Positive acting with single stud or nozzle mounting. Operation to 600°F. Rated at 15 amps at 115 VAC, 7 amps at 230 VAC. Spade, screw or elevated terminals, various adjusting stems, etc. Bulletin 1000.

9, TYPE SA* ***adjustable*** **(9)** ***or non-adjustable.*** Snap acting with electrically independent bimetal. Also single-pole, double-throw. Single stud or nozzle mounting. Non-inductive-load rating: 15 amps at 115 VAC, 10 amps at 230 VAC. Spade or screw terminals. Bulletin 2000.

10, TYPE SM* ***manual reset*** **(10).** Electrically same as Type SA (above) except for manual reset feature. Bulletin 2000.

11, TYPE B ***adjustable*** **(11)** ***or non-adjustable.*** For uses where heat generated by passage of current through bimetal strip is desirable. Various terminals, single stud or nozzle mounting. Operation to 400°F. Nominal rating: 5½ amps at 115 VAC of 40 cycles and higher. Bulletin 9000.

12, 13, 14, TYPE A* ***semi-enclosed*** **(12, 13),** ***hermetically sealed*** **(14).** Insulated, electrically independent bimetal disc gives fast response and quick, snap action control for appliance, electronic and apparatus applications from -20° to 300°F, or higher on special order. Rating: 3 to 4 amps, depending on duty cycle, at 115 VAC, 2 amps at 230 VAC and 28 VDC. Various enclosures and mountings, including brackets. Bulletin 3000.

15, TYPE R* ***sealed adjustable*** **(15),** ***sealed non-adjustable.*** Positive acting for operation to 600°F. Rated at 15 amps at 115 VAC, 4 amps at 230 VAC. Screw terminals. Bulletin 7000.

16, TYPE W* ***adjustable*** **(16),** ***or non-adjustable.*** Snap action bimetal strip type for operation to 300°F. Rated at 5 amps at 115 VAC, 3 amps at 230 VAC. Screw or nozzle mountings; spade, solder or screw terminals. Bulletin 4000.

17, TYPE H† ***adjustable.*** Positive acting for fry pans, skillets, sauce pans, etc. Fail-safe, open in low to 500°F in high. Rated at 1650 watts at 115 VAC. Bulletin 10,000.

18, TYPE D* ***automatic*** **(18), or** ***manual reset.*** For laundry dryers or other surface and warm air applications. Snap acting disc type U.L. approved for operation to 350°F. Open or enclosed styles. Rated at 25 and 40 amps at 120-240 VAC. Screw or spade terminals. Bulletin 8000.

Illustrations, for general information only, do not necessarily show size comparisons. Fully dimensioned and certified prints on request. Manufacturer reserves right to alter specifications without notice. AA-7230

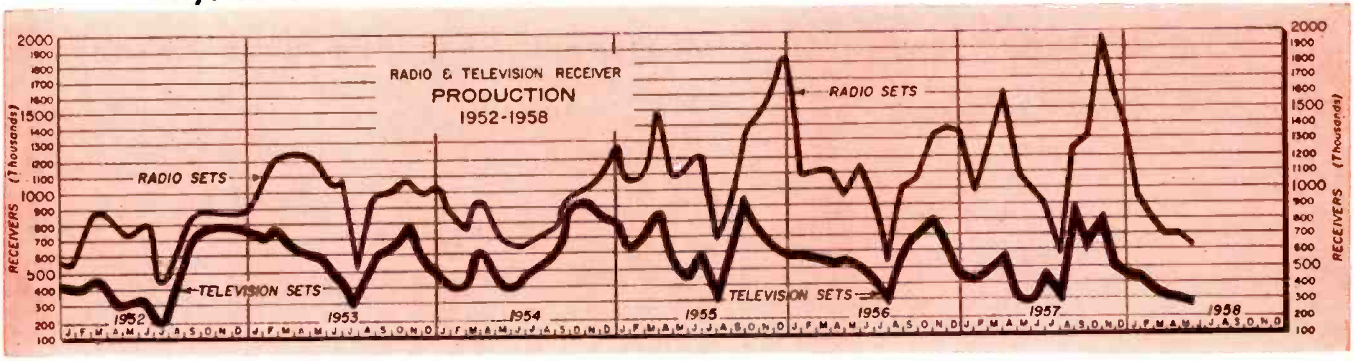
*Refer to Guide 400E0 for U.L. or C.S.A. approved ratings.
†Patent Applied For.

STEVENS *manufacturing company, inc.*
P. O. Box 1007, Mansfield, Ohio

® **STEMCO**
THERMOSTATS

Circle 3 on Inquiry Card, page 83

TOTALS



GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in May, 1958.

Amplifiers	182,202
Antennas & accessories	1,716,215
Batteries, dry	331,604
Beacon equipment, radio	56,311
Calibrators	68,621
Capacitors	104,781
Communication systems	2,750,000
Computers & accessories	901,766
Controls	48,184
Converter equipment	35,346
Countermeasures equipment	660,603
Crystal units	39,000
Delay lines	56,000
Echo box	342,618
Electronic equipment	108,073
Frequency standards	54,406
Generators, speciol electronic	126,506
Generators, signal	612,904
Gyros	52,724
Headsets	632,200
Indicators	266,550
Indicators, radar	164,379
Intercom equipment	25,400
Kits, avionic modification	115,825
Kits, electronic training	36,997
Kits, modification	833,064
Loudspeakers	47,740
Meters	143,025
Meters, field strength	77,550
Meters, ohm	29,084
Meters, volt	46,152
Microphones	370,839
Multimeters	37,250
Navigational systems & equipment	128,970
Oscillographs	75,507
Oscilloscopes & accessories	147,809
Power supplies	146,618
Power supply, dynamotor	25,715
Public address sets	70,433
Radar equipment	1,693,677
Radiac equipment	40,627
Radio direction finders	40,611
Rodio receivers	1,940,138
Rodio sets	1,288,131
Rodio transmitters	1,330,412
Radiosonde equipment	571,380
Radomes	25,740
Recorders & accessories	765,193
Recorders-reproducers	201,973
Rectifiers	37,310
Relay assemblies	62,370
Resistors	63,795
Resolvers	276,150
Semiconductor diodes	170,305
Sonar equipment	356,862
Syncros	81,197
Tape, recording	80,344
Telemetering equipment	388,205
Teletype equipment	8,047,105
Television equipment	60,700
Test equipment (various)	539,858
Testers	536,458
Test sets	65,286
Test sets, radar	544,973
Test sets, radio	114,387
Transducers	149,224
Transformers	65,883
Tubes, electron	7,725,778
Ultrasonic equipment	34,900
Woveguide & occessories	55,157
Wire & coble	2.251 838

EXPENDITURES FOR MISSILE PROCUREMENT

(Millions of Dollars)

Year Ending June 30	DOD Totol	Air Force	Novy	Army
1951	21	16	5	...
1952	169	66	56	46
1953	295	81	95	119
1954	504	176	141	187
1955	718	305	176	238
1956	1,168	641	195	333
1957	2,095	1,417	264	414
1958[E]	2,955	1,970	319	666
1959[E]	3,444	2,166	487	791

E—Estimated

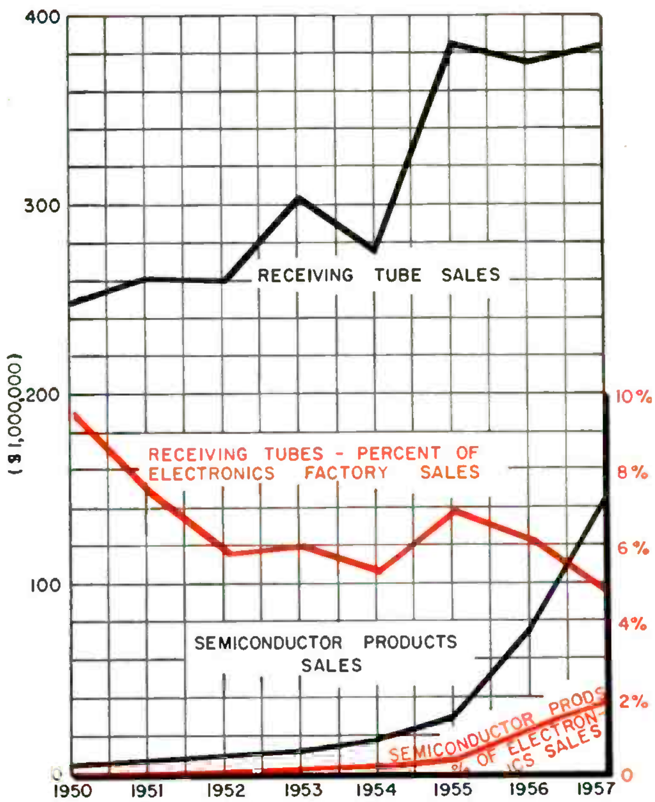
—Aviation Facts and Figures

TRANSISTOR SALES

	1958 Soles (units)	1958 Sales (dollars)	1957 Sales (units)
January	2,955,247	$6,704,383	1,436,000
February	3,106,708	6,806,562	1,785,000
March	2,976,843	6,795,427	1,904,000
April	2,856,234	7,025,547	1,774,000
TOTAL	11,895,032	$27,331,919	6,899,000

—Electronic Industries Association

COMPARISON OF TUBE & SEMICONDUCTOR SALES



—Pacific Semiconductors, Inc.

Never before such capacity in so small

New Adlake little giant

packs 75 amps. into
$4\frac{23}{32}'' \times 2\frac{1}{16}'' \times 2\frac{3}{16}''$

Here is exceptionally high interrupting capacity in the smallest bulk ever achieved—an ingenious design tested and built to serve indefinitely.

Scaled down in everything but performance, all the notable values of Adlake mercury-to-mercury relays are here, including a molded coil, impervious to time and usage.

The Little Giant, Type 1141, offers the long-proved advantages of Adlake design and construction: Perfect snap action without burning, pitting or sticking . . . fixed, tamper-proof time delay characteristics . . . protection from dust, dirt, and moisture in a hermetically sealed case . . . quiet, chatterless operation. Like all the dependable Adlake relays, Type 1141 will require no maintenance.

Our engineers will be happy to help you with your control problems – no obligation. Write The Adams & Westlake Company, 1182 North Michigan, Elkhart, Indiana.

The Adams & Westlake Company

New York . . . ELKHART, INDIANA . . . Chicago

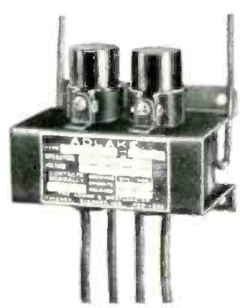
Original and Largest Manufacturer of Plunger-type Relays

Established 1857

Four Popular Models from Adlake's Complete Line

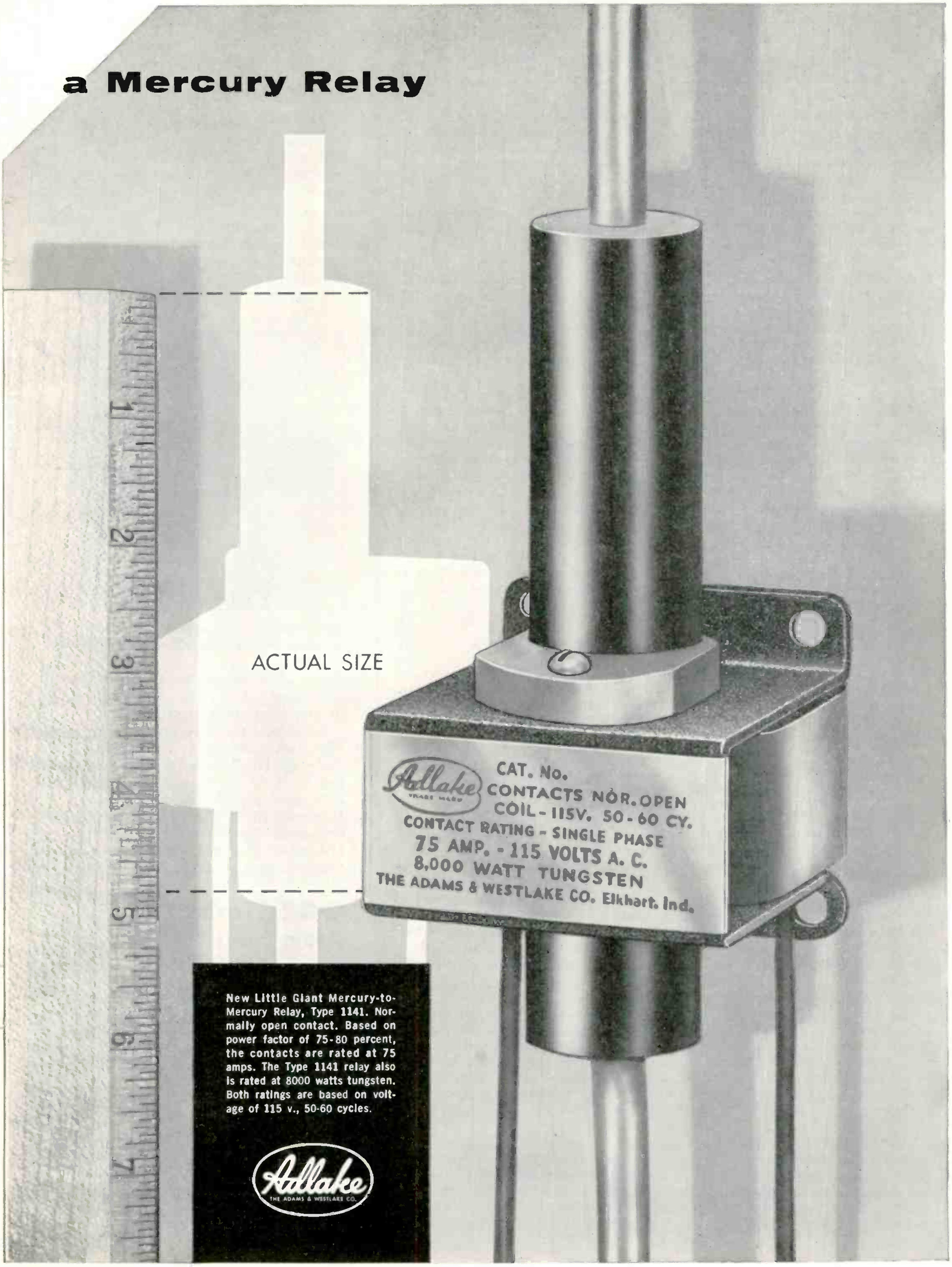
Type 1140

Type 1101



Type 1123

Type 1133


a Mercury Relay
1
2
3
4
5
6
7
ACTUAL SIZE
Adlake
CAT. No.
CONTACTS NOR. OPEN
COIL - 115V. 50 - 60 CY.
CONTACT RATING - SINGLE PHASE
75 AMP. - 115 VOLTS A. C.
8,000 WATT TUNGSTEN
THE ADAMS & WESTLAKE CO. Elkhart, Ind.
New Little Giant Mercury-to-Mercury Relay, Type 1141. Normally open contact. Based on power factor of 75-80 percent, the contacts are rated at 75 amps. The Type 1141 relay also is rated at 8000 watts tungsten. Both ratings are based on voltage of 115 v., 50-60 cycles.
Adlake
THE ADAMS & WESTLAKE CO.

ELECTRONIC SHORTS

▶ The CAA has ordered its 92 aircraft to be distinctively marked with "blaze" orange daylight fluorescent paint to make them more visible in the air, thereby reducing the possibility of mid-air collisions. Besides the wing tips and two wide stripes on the upper and lower wing surfaces, the entire tail assemblies will be painted. Also a wide stripe will be applied along the underside of the aircraft and along the sides of the entire fuselage. Aircraft not carrying airborne radar equipment will be painted on the nose. Radar aircraft will not have fluorescent painting on the nose as it interferes with radar signals.

▶ An advanced flight instrument system for the hypersonic X-15 research aircraft has been developed by Sperry Gyroscope Co. The system's principal function is to help the X-15 pilot control his rocket plane to prevent it from burning up by reentering denser atmosphere too steeply, or "bouncing back" to high from too shallow a trajectory. The system also will feed electronic information into airborne recorders to permanently chart each flight.

▶ A TV set on which father can watch baseball while mother watches drama has been patented by Dr. A. B. Du Mont. The receiver has two picture tubes, one aimed in the usual way and the other pointed upward. One program passes through a semi-transparent mirror and the other is reflected from it. The two programs are superimposed on one screen. Viewing is thru polaroid glasses or polaroid panels. The viewer may make his program choice simply by reversing the glasses or the panels. Individual earphones are used to separate the sound portions of the programs.

▶ Net profits as high as 60.3 cents on the sales dollar have been chalked up by some segments of Puerto Rico's U. S. affiliated electronics-electrical products industry. A recent survey revealed that the industry as a whole is averaging a net profit of 34.9% and a net return on investment of 81.9%. Lowest industry segment on the profit rung was 15.1%.

▶ The Airways Modernization Board has awarded a $57,543 contract to International Business Machines Corp. for studies that may lead to electronic analysis and early correction of some types of flight delay causes. The award calls for trials of air traffic simulation using a SAGE type computer.

▶ First awards of subcontracts to 8 companies totaling approx. $14-million have been made by Sperry Gyroscope Co. The awards are made under the USAF's recently-disclosed electronic countermeasures program for B-52 intercontinental bombers. Subcontracts went to Sylvania Electronic Systems Div.; Federal Telecommunications Laboratories; GE's Power Tube Dept.; Hallicrafters Co.; RCA Electronic Tube Div.; Farnsworth Electronic Co.; Ryan Industries, and Eitel-McCullough, Inc.

▶ The USAF has taken delivery of the first unit of what officials called "A new generation of supersonic jet combat planes that can deliver an atomic weapon at speeds nearly twice that of sound." The Republic F-105 Thunderchief fighter-bomber, brings to America's airborne arsenal "fire-power, versatility and global mobility surpassing any aircraft now flying," said Gen. O. P. Weyland, Commander of TAC.

▶ Coded anti-jam filters which reject interference make the radio-inertial guidance system for the ATLAS ICBM virtually jam-proof. The highly-selective filters of a space, time, and frequency nature make enemy jamming exceedingly difficult since the anti-jam devices are unique for each ICBM. Jamming is made difficult, as well, because radio signals controlling the ATLAS guidance system are only transmitted during the first few minutes of flight, while the missile is over the continental U. S.

▶ The Strategic Air Command is ready to start construction on two ICBM sites, costing $25-million apiece. One will be located in the Offutt AFB, Omaha, area, the other in the Fairchild AFB, Washington, area. Approx. 750 personnel will be assigned in the support and operation of each missile activity. Design and construction will be accomplished through the Corps of Engineers, Dept. of the Army, acting as the USAF construction agency.

Body Heat Keeps Batteries Warm

A battery vest, utilizing human body heat to keep dry cells warm and active for radio operators in extremely cold weather, has been announced by the Department of the Army.

The idea, developed by the U. S. Army Signal Research and Development Laboratory, Fort Monmouth, New Jersey, is to place dry cell batteries in a vestlike garment

Battery vest is worn under a parka so that body heat will keep the chill out of the cells.

worn beneath parkas to capture body heat. A cord is used to plug in standard Army radios.

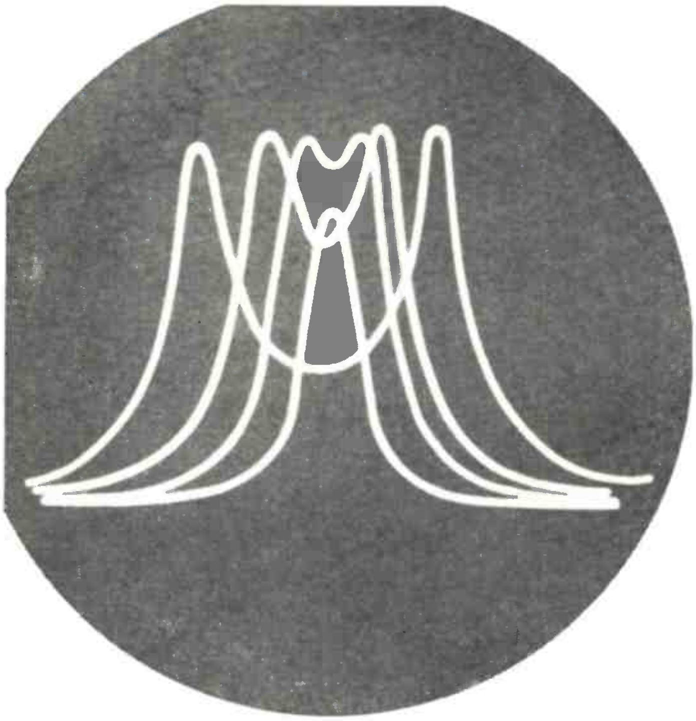
Because batteries go dead rapidly when extreme cold slows down their electrochemical action, keeping them warm is especially difficult when troops are on the move. However, with the vest, batteries developed for low-temperature use are expected to stay in service ten times longer at 40-degrees below.

C-C TV Trains Army Atom Plant Staff

At the Army's first facility for training nuclear power plant operators, at Fort Belvior a closed circuit television system allows a classroom of students to observe intricate maintenance functions or radioactive equipment operation in other parts of the plant.

Designed and built by the Dage Corporation for Alco Products, Incorporated, the AEC's prime contractor on the Army Package Power Reactor, the TV monitor system includes a camera pick-up which can be located inside the plant's "Vapor Container."

MORE NEWS ON PAGE 22



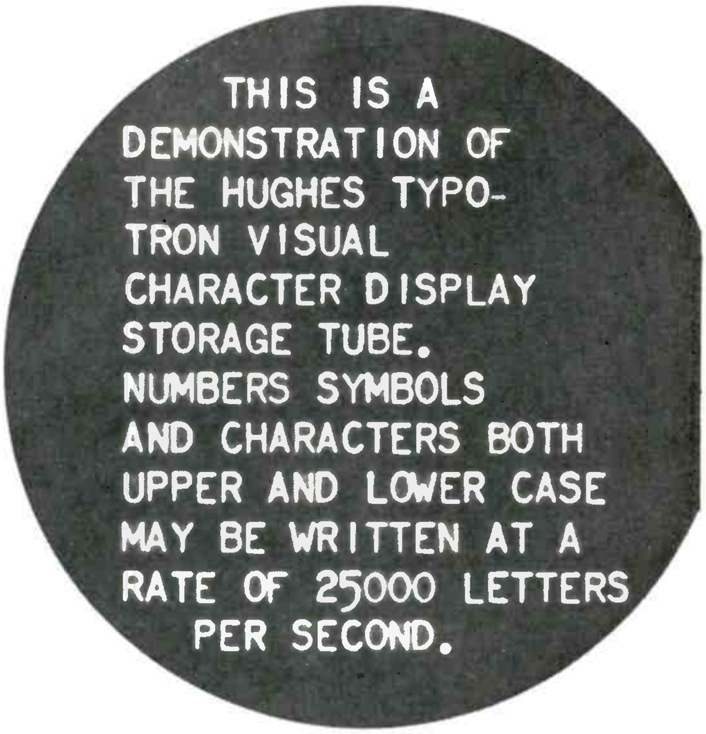
HUGHES . . . pioneer and largest producer of storage tubes

The MEMOTRON®

Type 6498 tube displays successive transient writings until intentionally erased. Careful analysis and comparison of wave forms now becomes possible without photography.

The TYPOTRON®

Type 6577 tube is the first commercially available storage tube which displays until intentionally erased, any combination of 63 symbols or characters at speeds of 25,000 characters per second.



The TONOTRON*

Type 7033 Magnetic Deflection tube at left presents a complete spectrum of gray shades for use in weather radar and PPI information. Tonotron tubes also available in 3 and 5-inch Electrostatic versions, ideally suited for "B" scan projections and complex radar systems.

Currently being widely used in both military and commercial systems, these cathode-ray tubes have established outstanding records of reliability. New storage tubes are under development for an ever-increasing range of applications. Across the country, Hughes engineers are available to discuss the applicability of these tubes to your problems. For further information please write: HUGHES PRODUCTS, Electron Tubes, International Airport Station, Los Angeles 45, California, or contact our local offices in Newark, Chicago or Los Angeles.

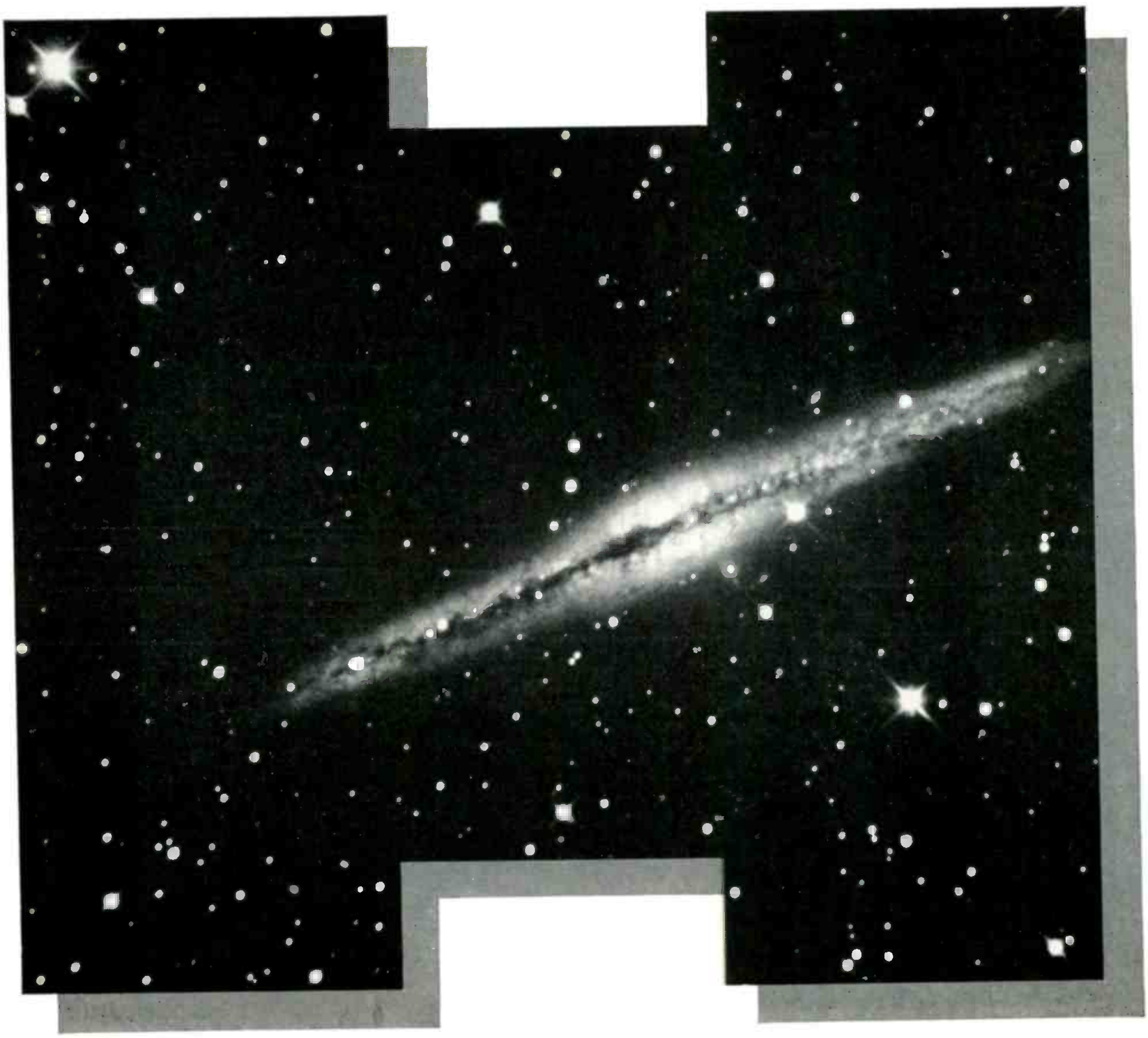
Creating a new world with ELECTRONICS

HUGHES PRODUCTS

*Trademark, H.A.C.

Circle 5 on Inquiry Card, page 33

THE SKY IS



NO LONGER THE LIMIT

Under the water . . . on the water . . . on land . . . in the air . . . and out into space . . . in all these areas Hughes advanced technology is being applied to vital military and commercial electronics projects.

In the space satellite field, for example, Hughes is active in the preliminary design of guidance and control systems, communication and telemetry systems, and sensing devices using infrared, optical and radar techniques.

Responsible for guiding and formulating the advanced systems concepts that make this new product diversification possible is the Systems Analyst. His creative thinking has motivated such new Hughes projects as advanced ballisitic missile guidance, space vehicle systems, and tactical missile systems. Other new programs initiated by Hughes Systems Analysts include advanced radar systems for all areas of military and civilian applications, including AICBM, missile guidance, early warning, air traffic control; and integrated electronics systems for undersea warfare.

Currently the Hughes Research and Development Laboratories are engaged in the greatest expansion in their history. Professional opportunities have never been more promising, especially in the more senior areas such as Systems Analysis.

Other Hughes activities are also participating in the expansion. Hughes in Fullerton is developing and producing advanced three-dimensional radar systems. Hughes Products, the commercial activity of Hughes, is producing an electronics system which automates a complete line of machine tools.

Today Hughes offers Engineers and Physicists the opportunity of locating with an established firm and working in advanced new technical fields.

The wide range of activity at the Hughes Fullerton facility extends from basic data processing and surveillance radar research through final design and packaging.

Ferromagnetic studies conducted by the Hughes Research Laboratories include fundamental research in the physics and chemistry of ferrites, synthesis of ferrite materials and development of ferromagnetic devices.

New commercial and military contracts have created an immediate need for engineers in the following areas:

Circuit Design	Aerodynamics
Reliability	Vacuum Tubes
Communications	Crystal Filters
Microwaves	Systems Analysis
Nuclear Electronics	Computer Engineering

Write in confidence to Mr. Phil N. Scheid, Hughes General Offices, Bldg. 6-N, Culver City, California.

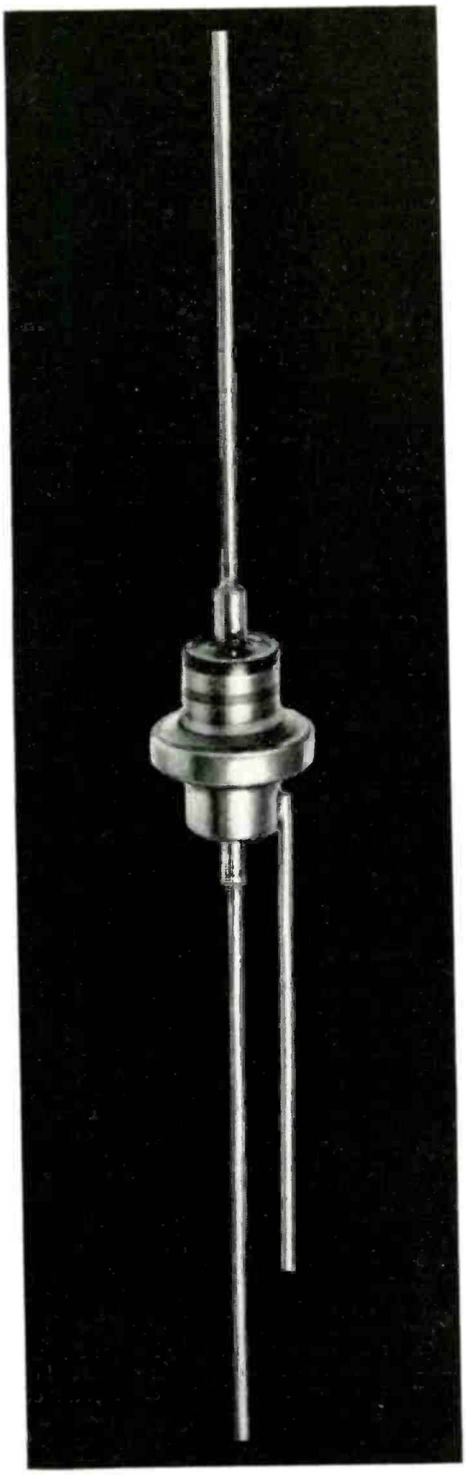
Creating a new world with ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo,
Fullerton and Los Angeles, California
Tucson, Arizona

Circle 501 on "Opportunities" Inquiry Card, page 85

The Hughes HA7500 Series **silicon pnp transistors**



Ideal for:

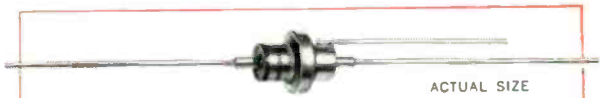
Differential Amplifiers. *Because significantly, the spread for any characteristic of a given type is small, matching becomes easy with this kind of uniformity.*

Low Level Choppers. *Because switching characteristics are excellent, saturation resistances are low; emitter and collector reverse currents are low; emitter to base reverse voltages are high.*

D.C. Amplifiers. *Because variation of characteristics within a type is small, these variations are also little affected by temperature.*

Audio Oscillators, Multivibrators, Flip-Flops. *Because, once again, uniformity becomes significant, as well as the unusual stability of each type, replacement can be accomplished without loss of effectiveness.*

Servo Circuitry, Medium Power Amplification, Phase Detection, Voltage Regulation, Power Control. *Because this series has versatility, both low and high level operation become practical.*



ACTUAL SIZE

These multi-use transistors have the advantages inherent to all silicon devices plus the typical Hughes advantages of ruggedness and reliability. They have a unique coaxial configuration, developed at Hughes to permit the maximum flow of heat from the crystal through the package while providing an extremely sturdy internal structure. Significantly, this configuration is ideal for machine insertion on printed boards. Dimensions: body length, .396 inch; body diameter, .343 inch.

For details of the various types, please write: Hughes Products, Semiconductor Division, International Airport Station, Los Angeles 45, California.

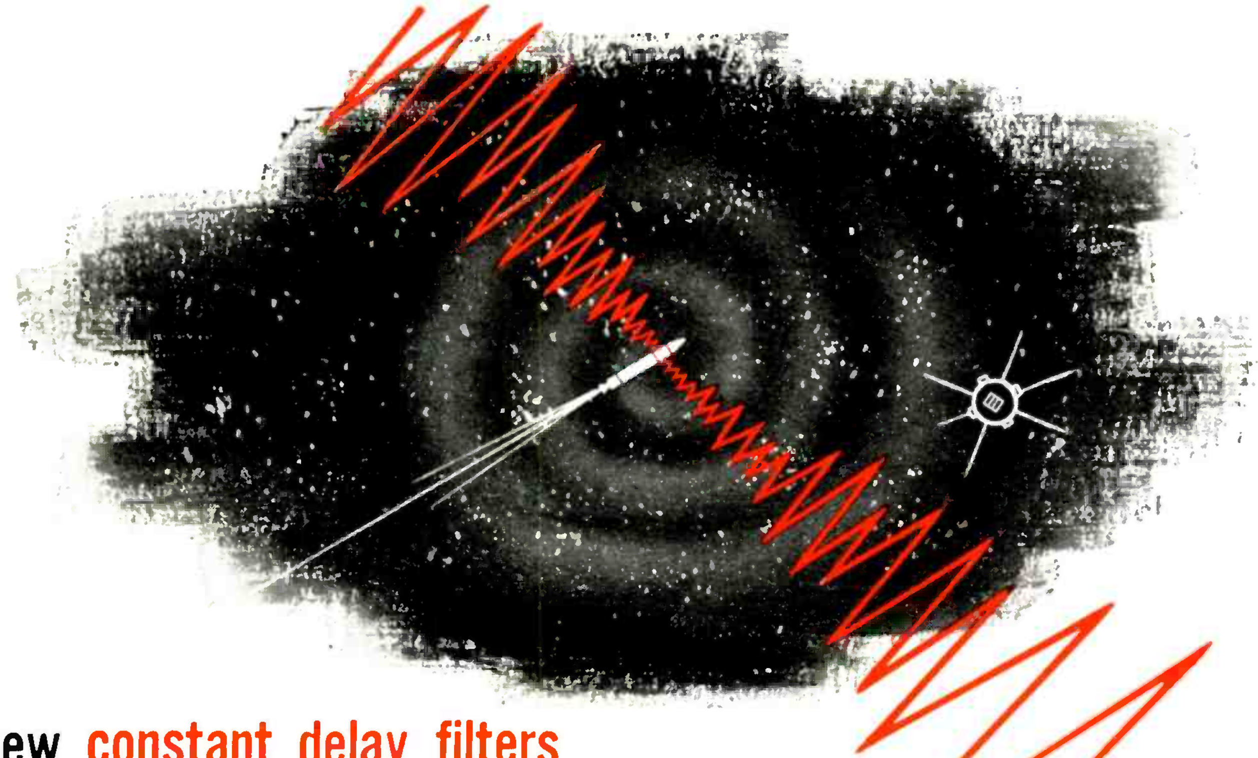
Creating a new world with ELECTRONICS

HUGHES SEMICONDUCTORS

HUGHES PRODUCTS

Circle 6 on Inquiry Card, page 83

Circle 7 on Inquiry Card, page 83 ⟶



new constant delay filters

give minimum intelligence distortion and maximum phase linearity in radar, telemetering and other missile applications

Now . . . Burnell & Co.'s new Type 60051 Constant Delay Filter series provide delay constant to within 5% over the Pass Band — solve troublesome distortion caused by non-linear systems.

It has become apparent that the phase characteristics of telemetering filters are of greater importance than amplitude characteristics in creating intelligence distortion and minimum transient response of frequency modulated signals.

Inasmuch as delay is constant where the derivative of the phase function is truly linear it is an important measure of phase linearity. To obtain constant delay, a complete circuit configuration revision based on a lattice structure is required.

For compactness, a standard type 60051 housing is available. Upon special order JHU-APL housings for circuit replacements can be supplied.

For more detailed information on constant delay filters write for Bulletin CD-051.

BAND PASS FILTERS

Channel	Frequency	Part #	Delay in ms.	B/W
1	.4 KC	S-60051	34.00	15%
2	.56 KC	S-60052	24.30	15%
3	.73 KC	S-60053	18.60	15%
4	.96 KC	S-60054	14.20	15%
5	1.3 KC	S-60055	10.50	15%
6	1.7 KC	S-60056	8.00	15%
7	2.3 KC	S-60057	5.93	15%
8	3.0 KC	S-60058	4.40	15%
9	3.9 KC	S-60059	3.38	15%
10	5.4 KC	S-60060	2.44	15%
11	7.35 KC	S-60061	1.80	15%
12	10.5 KC	S-60062	1.26	15%
13	14.5 KC	S-60063	0.91	15%
14	22. KC	S-60064	0.60	15%
15	30. KC	S-60065	0.44	15%
16	40. KC	S-60066	0.33	15%
17	52.5 KC	S-60067	0.252	15%
18	70. KC	S-60068	0.189	15%
A	22. KC	S-60069	.305	30%
B	30. KC	S-60070	.224	30%
C	40. KC	S-60071	.168	30%
D	52.5 KC	S-60072	.128	30%
E	70. KC	S-60073	.096	30%

CASE SIZE—4 11/16 x 2 x 3 1/2" H (CS-60051)
INPUT IMPEDANCE = 500 ohms
OUTPUT IMPEDANCE = 500 ohms and to grid

LOW PASS FILTERS

Frequency	Part #	Delay in ms
400 cps.	S-60101	2.95 ms
560 cps.	S-60102	2.11 ms
730 cps.	S-60103	1.62 ms
960 cps.	S-60104	1.23 ms
1300 cps.	S-60105	.905 ms
1700 cps.	S-60106	.681 ms
2300 cps.	S-60107	.511 ms
3 KC	S-60108	.392 ms
3.9 KC	S-60109	.302 ms
5.4 KC	S-60110	.218 ms
7.35 KC	S-60111	.160 ms
10.5 KC	S-60112	.112 ms
14.5 KC	S-60113	.0812 ms
22. KC	S-60114	.0535 ms
30. KC	S-60115	.0392 ms
40. KC	S-60116	.0294 ms
52.5 KC	S-60117	.0224 ms
70. KC	S-60118	.0168 ms
22. KC	S-60119	.0738 ms
30. KC	S-60120	.0541 ms
40. KC	S-60121	.0412 ms
52.5 KC	S-60122	.0309 ms
70. KC	S-60123	.0233 ms

CASE SIZE—1 11/16 x 1 9/16 x 2 1/4" H
INPUT IMPEDANCE equals 500/600 ohms
OUTPUT IMPEDANCE equals 500/600 ohms

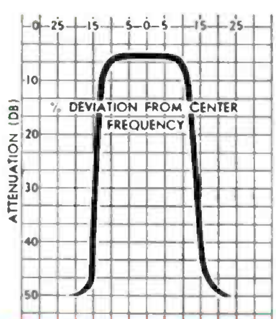
*optional impedance available on special order.

CONSTANT DELAY BAND PASS AND LOW PASS FILTERS ARE AVAILABLE WITH ATTENUATION SLOPES ILLUSTRATED:

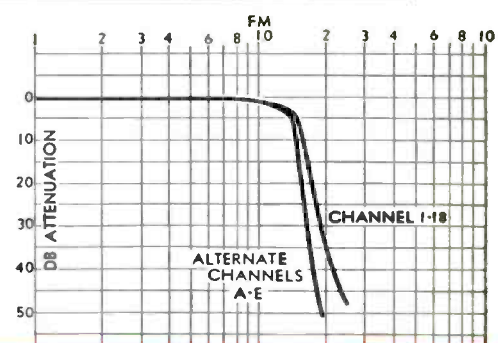
TECHNICAL DATA FOR BAND PASS FILTERS

FOR ± 7½% PASS BAND
1. Flat within 3 db over pass band
2. 21 db at ± 15% of center freq.
3. 40 db at ± 22% of center freq.
4. Time delay over the pass band, constant to ± 5%

FOR ± 15% PASS BAND
1. Flat to 3 db over pass band
2. Flat to 23 db at ± 30% of center freq.
3. Flat to 40 db at ± 44% of center freq.
4. Time delay over pass band constant to ± 7%



Constant Delay Band Pass Filters



Constant Delay Low Pass Filters

Burnell & Co., Inc.

PIONEERS IN TOROIDS, FILTERS AND RELATED NETWORKS

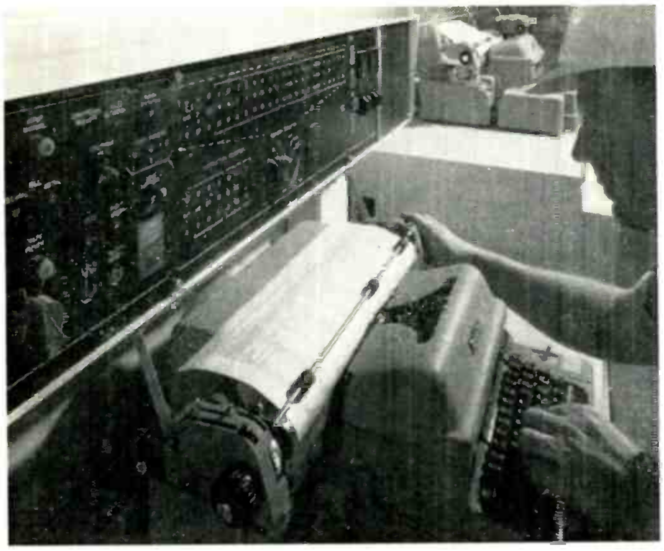
Dept. 1-7

EASTERN DIVISION:
10 PELHAM PARKWAY, PELHAM MANOR, N. Y. • PELHAM 8-5000

PACIFIC DIVISION:
720 MISSION STREET, SOUTH PASADENA, CALIFORNIA • RYAN 1-2841

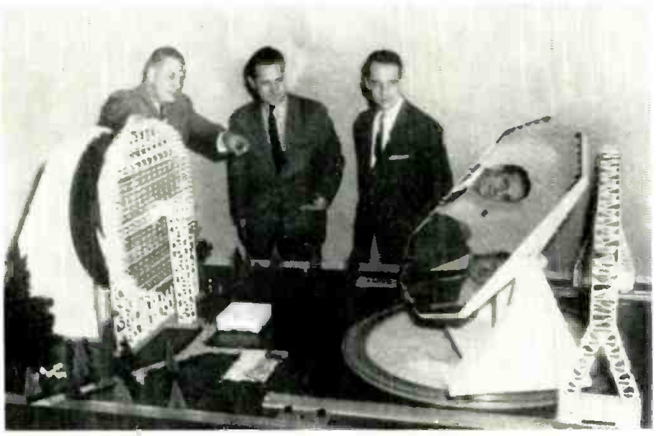
Circle 8 on Inquiry Card, page 83

Snapshots of the Electronic Industries



UTILITY'S COMPUTER

Instructions to the computer are being typed on this control console of the Daystrom transistorized system installed at the new Sterlington Steam Electric Station, Louisiana Power & Light Co., Monroe, La.



SOLAR FURNACE

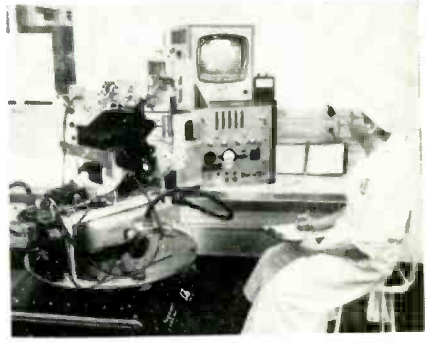
J. Kalla, Pres. of Fecker Inc., engineer P. Kaestner and physicist R. Wight check model of the world's largest solar furnace. Planned for Cloudcroft, N. M., the furnace will develop 7,000°C.

FIRST PRODUCTION MACE

MACE, (left) scheduled to replace the Air Force's TM61C Matador missile, is delivered to Lt. Col. A. Warfield Jr. and Col. F. W. Jetter Jr., by the Martin Co.'s W. F. Sauers at Baltimore, Maryland.

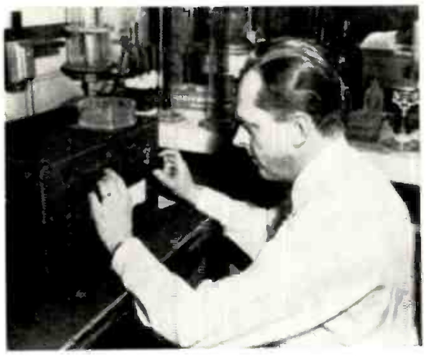
PRODUCTION LINE (below)

Closed circuit television is used to check accuracy of alignment of computing gunsight for F-105 at General Electric LMEE Dept.



AUTOMATIC SORTER

New automatic parcel post sortation system at PRR's 30th St. Sta., Phila. reads labels, sorts packages according to destination.



MEDICAL ELECTRONICS

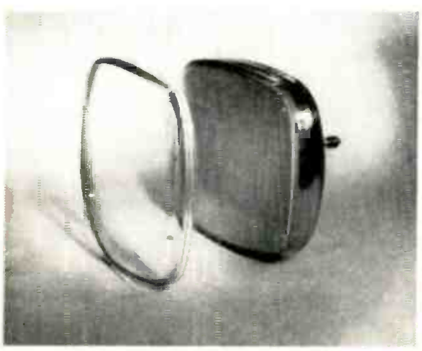
Dr. H. P. Schwan of the Univ. of Penna. has turned Boonton Radio's RX meter to the study of the electrical properties of human tissue.

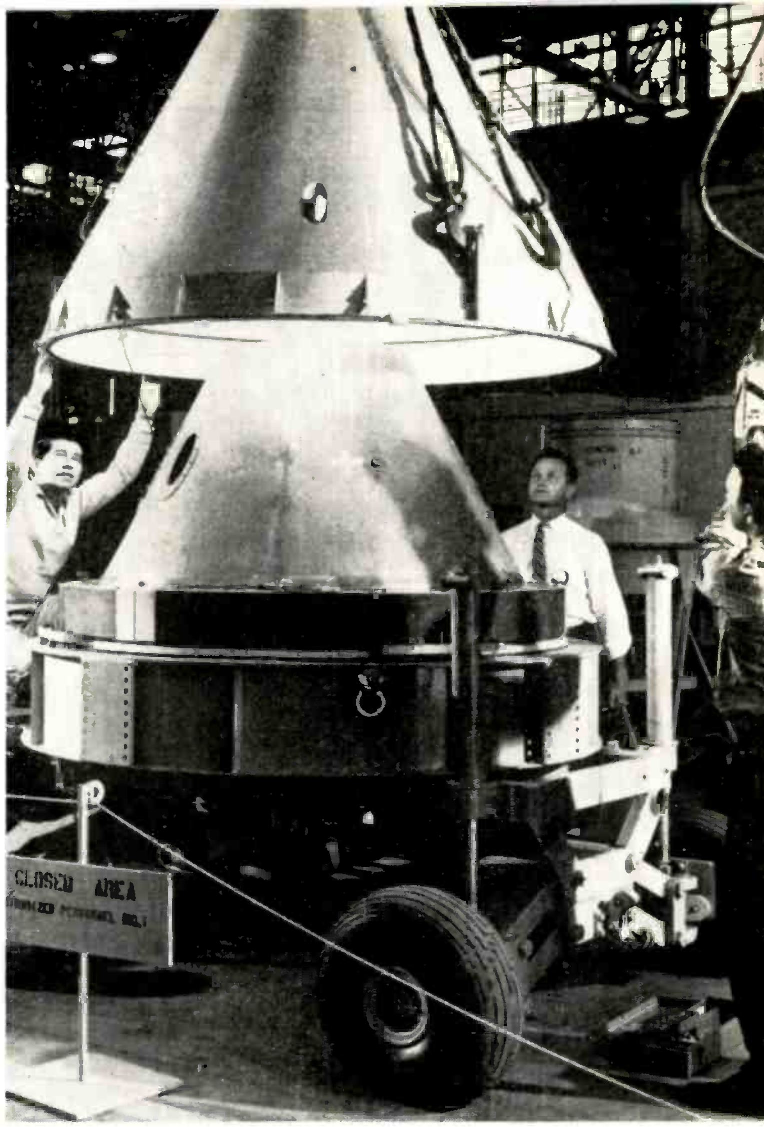
DRONE DIRECTING

Engineers check efficiency of highly advanced microwave command guidance system for controlling missile targets at Sperry Corp.

FACEPLATE, TOO!

Corning Glass Works is sampling to the industry this unique TV picture tube that incorporates a built-in safety faceplate.





MISSILE NOSE CONE

Fully checked out and found operational, the nose cone for the Air Force's ATLAS missile is packed into its carrier case at the Air Force Missile Test Center, Cape Canaveral, Florida.

"PRINTING PRESSES"

Banks of tape recorders are reproducing at high speed an original recorded tape. These tape duplicating facilities are at Magnetic Tape Duplicators in Hollywood, California.

Coming Events

A listing of meetings, conferences, shows, etc., occurring during the period July to October that are of special interest to electronic engineers

July 16-18: 9th Annual National Conf., Forestry, Conservation Communication Assn.; Parker House, Boston, Mass.

July 21-24: Music Industry Convention & Trade Show, Nat'l Assoc. of Music Merchants; Palmer House Hotel, Chicago, Ill.

July 26-29: National Audio-Visual Convention & Exhibit, Nat'l Audio-Visual Ass'n; Morrison Hotel, Chicago, Ill.

July 29-31: Photographic Instrumentation Engineers Symposium, Statler Hotel, Los Angeles, Calif.

Aug. 6-8: Special Technical Conference on Non-Linear Magnetics & Magnetic Amplifiers, AIEE & IRE; Hotel Statler, Los Angeles, Calif.

Aug. 13-15: Conference on Electronic Standards of Measurements, NBS, IRE & AIEE, NBS Boulder Labs; Boulder, Colo.

Aug. 15-17: ARRL National Convention, Washington, D. C.

Aug. 19-22: Wescon, IRE & WCEMA, Ambassador Hotel, Pan Pacific Auditorium; Los Angeles, Calif.

Aug. 19-22: Pacific Meeting, American Institute of Electrical Engrs.; Sacramento, Calif.

Aug. 22-24: Annual Convention & Seminar, Nat'l Alliance of TV & Electronics Service Assn.; Congress Hotel, Chicago, Ill.

Aug. 25-28: Rocky Mountain Electronic Parts Reps Conf., The Representatives; Colorado Hotel, Glenwood Springs, Colo.

Sept. 3-10: 2nd International Congress on Cybernetics, International Assoc. for Cybernetics; Namur, Belgium.

Sept. 8-10: 1st National Conf. & Exhibit on Application of Electrical Insulation, AIEE, Hotel Pick-Carter, Cleveland, O.

Sept. 8-13: First International Congress, Int'l Congress of the Aeronautical Sciences; Palace Hotel, Madrid, Spain.

Sept. 12-13: Communications Conf., IRE; Sheraton Montrose Hotel, Cedar Rapids, Iowa.

Sept. 12-14: 7th Annual Chicago High Fi Show; Palmer House, Chicago.

Sept. 15-17: International Power Industry Computer Application Conf., AIEE; King Edward Hotel, Toronto, Canada.

Sept. 14-19: 13th Annual Instrument & Automation Conference & Exhibit, Instrument Society of America; Convention Hall, Phila., Pa.

Sept. 16-18: Fall Quarterly Conference, EIA; St. Francis Hotel, San Francisco, Calif.

Sept. 22-24: Symposium & Exhibit on Telemetry & Remote Control, IRE; Americana Hotel, & Patrick AFB, Miami Beach, Fla.

Sept. 24-25: Industrial Electronic Conference, IRE & AIEE; Rackham Memorial Bldg., Detroit, Mich.

Sept. 28-Oct. 2: Fall Meeting, Electrochemical Society; Chateau Laurier, Ottawa, Canada.

Sept. 30-Oct. 4: High Fidelity Show, Institute of High Fidelity Mfrs.; New York, N. Y.

Oct.: Western Regional Conference, Nat'l Community TV Ass'n; Portland, Ore.

Oct. 1-2: 4th Conf. on Radio Interference Reduction, Armour Research Foundation; Museum of Science & Industry, Chicago, Ill.

Oct. 2: Section Meetings Calender—Wichita Sect., Institute of Aeronautical Sciences; Innes-Colonial, Room 121 S. Broadway, Wichita, Kans.

Oct. 2: Section Meetings Calendar—Phila. Sect., Institute of Aeronautical Sciences; Penn-Sherwood Hotel, Phila., Pa.

Oct. 2-3: Engineering Writing & Speech Symp., IRE; New York City.

Oct. 6-7: Symp. on Extended Range & Space Communications, IRE & G. Washington Univ.; Lisner, Washington, D. C.

Abbreviations:

ACM: Association for Computing Machinery
AIEE: American Inst. of Electrical Engrs.
ARRL: American Radio Relay League
EIA: Electronic Industries Assoc.
IAS: Inst. of Aeronautical Sciences
IRE: Institute of Radio Engineers
ISA: Instrument Society of America
WCEMA: West Coast Electronic Manufacturers Assoc.

As We Go To Press . . .

AF Tape Recorder Has 28 Channels

Development of a magnetic tape recording system that can simultaneously monitor around-the-clock voice communications on 28 radio frequencies was announced recently by Minneapolis-Honeywell Regulator Company.

The system, known as an Air Traffic Voice Monitor (ATVM), was designed and built by the company's Davies Laboratories Division in Beltsville, Md., for the Flight Test Center at Edwards Air Force Base in California.

The voice monitor, built into five six-foot-high cabinets, has two re-

Airline stewardesses inspect 28-channel air traffic magnetic tape recording system.

corders. Magnetic tape, 1¾ in. wide, on reels 19 in. in diameter, largest ever made for such systems, monitors information fed to any of its 28 channels for 24 hrs. without stopping.

Only one recorder is used at a time. If its tape fails or is used up, an automatic switching device starts up the second recorder to insure continuous monitoring of all communications.

1959 COMING EVENTS

Jan. 12-13-'59: 5th National Symposium on Reliability & Quality Control, IRE, AIEE, ASQC & EJA; Bellevue-Stratford Hotel, Phila., Pa.

Mar. 2-6: Western Joint Computer Conf., IRE, AIEE & ACM; at Fairmount Hotel, San Francisco, Calif.

March 23-26: IRE National Convention, IRE; New York City.

Apr. 5-10: 5th Nuclear Congress, IRE & EJC; Cleveland, Ohio.

May 4-6. National Aeronautical Electronics Conference, IRE; Dayton, Ohio.

If FAST SWITCHING is your need and available germanium types won't meet temperature and reliability requirements . . .

SWITCH to SILICON

MILITARY TYPES

Silicon Computer Diodes | 1N663 1N662 1N643

A definite break-through of the inherent temperature limitations of germanium is provided by these outstanding new Silicon Diffusion Computer Diodes. They switch as fast as the best germanium types...and at temperatures to 150°C!

They combine fast switching with high conductance and high break-down voltage with high temperature operation . . . plus PSI "Built-in-Reliability."

These three related military types can replace all germanium diodes in computers of advanced design where high reliability performance *at high temperatures* must be sustained without compromise.

Look at these outstanding specifications!

		EIA TYPE	Minimum Saturation Voltage (volts) @ 100 μA	Minimum Current Forward @ + 1.0v	Maximum Reverse Current (μA)		Reverse Recovery Characteristics	
					25°C	100°C	Reverse Resistance (ohms)	Maximum Recovery Time (μs)
HI-CONDUCTANCE	Mil-E-1/1140 (Sig C)	1N663	100	100	5(75v)	50(75v)	200K	0.5
GENERAL PURPOSE	Mil-E-1/1139 (Sig C)	1N662	100		1(10v) 20(50v)	20(10v) 100(50v)	100K	0.5
HIGH VOLTAGE	Mil-T-12679/39 (Sig C)	1N643	200	10	.025(10v) 1(100v)	5(10v) 15(100v)	200K	0.3

Detailed specifications, ratings and curves available on request.

Distributors:

ALLIED RADIO
Chicago, Illinois

ALMO RADIO COMPANY
Philadelphia 7, Pennsylvania

CRAMER ELECTRONICS, INC.
Boston 16, Massachusetts

ELECTRONIC SUPPLY CORP.
Pasadena, California

ELECTRONIC INDUSTRIAL SALES
Washington 1, D. C.

PEERLESS RADIO DISTRIBUTORS, INC.
Jamaica 33, New York

PENINSULA TV AND RADIO SUPPLY
San Jose, California

WHOLESALE RADIO PARTS COMPANY
Baltimore 1, Maryland

Write for full information on the entire line of PSI silicon and germanium diodes, silicon rectifiers and PSI voltage-variable capacitors (VARICAP). Production quantity delivery on all types.

Pacific Semiconductors, Inc.

10451 West Jefferson Boulevard, Culver City, California

NEW YORK – 2079 Wantagh Ave., Wantagh, Long Island, N. Y.
CHICAGO – 6957 W. North Ave., Oak Park, Illinois
SEATTLE – Administration Bldg., Boeing Field, Seattle, Wash.
EXPORT DEPARTMENT – 431 Fifth Ave., New York 16, N. Y.

Circle 9 on Inquiry Card, page 83

Electronic Industries' News Briefs

Capsule summaries of important happenings in affairs of equipment and component manufacturers

EAST

PHILCO CORP. and **LEEDS & NORTHRUP CO.** have launched a shared cost program to develop, design and build a digital computer which will have important applications in industrial process control and in scientific and engineering computation, including data processing.

WARD LEONARD ELECTRIC CO. has moved their Pittsburgh District Office to 929 Park Ave., Pittsburgh 34, Pa. Phone: LOcust 1-6405. Manager: Leonard H. Wurzel.

GENERAL ELECTRIC CO. has opened its Northeastern Sales district office for airborne military electronics at 600 Old Country Rd., Garden City, N. Y. Phone: Pioneer 7-6300. Manager, Kenneth T. Casey.

F-R MACHINE WORKS, INC., has been awarded a subcontract from the Sperry Gyroscope Co for the design and manufacture of the Line Type Modulators on the FPS-35 radar system. Amount of contract: $500,000.

CORNING GLASS WORKS has moved its Electronic Components Sales Dept. to Bradford, Pa., site of the department's manufacturing installation.

ELECTRODATA is installing a Burroughs 205 computing system in the Boston Naval Shipyard. First task will be the automatic preparation of thousands of weekly employee paychecks.

SYLVANIA ELECTRONIC SYSTEMS just opened its new 102,000 sq. ft. facility to house the Data Processing Lab. in Needham, Mass. Company's work on the USAF Ballistic Missile Early Warning Systems will be carried on at the new location.

CUTLER-HAMMER, INC., has acquired **AIRBORNE INSTRUMENTS LABORATORY, INC.** AIL will operate as the Electronics Div. of Cutler-Hammer, retaining its name, officers, management.

ACOUSTICA ASSOCIATES, INC., has formed an Electronics Mfg. Div. The division will be housed in a newly-acquired 10,000 sq. ft. plant in Mineola, N. Y.

RAYTHEON MFG. CO. has established 10 pre-doctoral fellowships totaling $30,000 a year at 9 leading universities. The firm will pay the candidate's tuition (averaging $1,200 per year), plus an annual allowance of $1,800.

WESTINGHOUSE ELECTRIC CORP.'s Electronic Div. has received a contract approximating $10-million to develop and test an advanced ground control system to guide the BOMARC missile.

SPRAGUE ELECTRIC CO. has announced a price decrease of approx. 30% in the cost of solid electrolyte tantalum electrolytic capacitors.

SPERRY GYROSCOPE CO. has been awarded a $3-million contract to develop and produce all-attitude flight control systems for the U. S. Navy's F8U-3—a very advanced all-weather fighter now under development by the Chance Vought Aircraft, Inc.

SHALLCROSS MFG. CO. has moved to Preston St., Selma, N. C. Phone: WOodlawn 5-2341. It is maintaining a sales office at Collingdale, Pa. Phone: LUdlow 4-5100.

JERROLD ELECTRONICS CORP. has moved to new and larger quarters at Jerrold Bldg., 15th St. & Lehigh Ave., Philadelphia 32, Pa. Phone: BAldwin 6-3456.

INTERNATIONAL TELEPHONE AND TELEGRAPH CORP. has been awarded $5.6-million USAF contract to build a 300-mile electronic scoreboard for testing anti-aircraft missiles on the gulf coast of Florida.

VITRO LABORATORIES DIV., VITRO CORP. OF AMERICA, has purchased and installed a Bendix Aviation Corp. digital electronic computer for general engineering research and development computations.

ALLEN B. DU MONT LABORATORIES, INC., through DeMambro Sound Equipment Co., Boston, is installing a closed-circuit television system in the new facilities of the Dept. of Nuclear Engineering of MIT. It will allow observation of nuclear experimentation procedures from locations removed from the reactor area.

MID-WEST

HOFFMAN ELECTRONIC CORP., Semiconductor Div., has developed a new line of silicon junction Zener reference elements designed specifically for miniaturized printed circuit systems.

SHURE BROS., INC., has introduced a trade-in plan to stimulate present buying of monaural phonograph cartridges and tone arms which can be converted later to stereophonic units.

FANSTEEL METALLURGICAL CORP. has appointed Slug-Bit Supply Co., 9745-A Hine Blvd., Dallas 20, Tex., as Southwest rectifier capacitor distributor.

CANNON ELECTRIC CO. has introduced an improved redesign of their "XLR" Cannon plug for audio applications. New design offers the ultimate user protection against disagreeable mechanical noise.

BECKMAN PROCESS INSTRUMENTS DIV. has received a USAF contract for $328,000 to cover instrumentation for hazardous vapor and moisture detection systems at the Arnold Engineering Development Center's Supersonic Propulsion Wind Tunnel, Tullahoma, Tenn.

AIR-MARINE MOTORS INC. has appointed G & H Sales Co., Cincinnati, Ohio, to handle sales of the complete line of sub-fractional horsepower motors, blowers, and fans. The territory includes Ohio, West Virginia, Western Pennsylvania and Kentucky.

COOK ELECTRIC CO. has been awarded a U. S. Army service contract for physical and chemical testing of specified materials for the U. S. Quartermaster Corps.

ROHN MFG. CO. now has available mast tubing in a variety of sizes and weights in "ROHNKOTE" enamel.

LOCKHEED AIRCRAFT CORP., Georgia Div., has formed a separate operating branch which is engaged in designing and manufacturing nuclear reactors for the generation of industrial heat.

MINNEAPOLIS-HONEYWELL REGULATOR CO. is developing a new nuclear warhead "package" for the Army's "Honest John" tactical support missile. It will enable a missile to deliver a "massive battlefield punch."

BURROUGHS CORP. recently introduced the series F2000 computer. Because of its simplicity of operation and high degree of reliability it represents a highly practical investment for business firms, banks and governmental agencies.

WEST

ELECTRONIC RESEARCH ASSOCIATES, INC. has formed a new California subsidiary known as ERA Pacific, Inc. It is located in a newly constructed plant at 1760 Stanford St., Santa Monica, Calif. Manager: Robert S. Bowditch.

PACIFIC AVIATION CORP., Pacific Div., reports that the production of components and systems for 20 U. S. missiles will account for more than half of its 1958 sales.

HUMPHREY, INC. has established Humphrey Products Div. The principle function of the new division will be to accelerate new product development and expand sales operations on products already established. The new sales office is located at 3794 Rosecrans St., San Diego 10, Calif.

AEROPHYSICS DEVELOPMENT CORP. has developed a recorder calibrator, designed for checkout and calibration of airborne analog tape recorders used in aircraft and missiles.

CONSOLIDATED ELECTRODYNAMICS CORP. has been awarded a USAF research and development contract totaling $99,000 for a mass spectrometer instrumentation system that will be used in materials research and analysis.

AMPEX CORP. was awarded a $1,238,000 contract to provide the USN's Bureau of Aeronautics with airborne magnetic recorders and spare parts.

PACKARD BELL COMPUTER CORP. has relocated their offices to 1905 Armacost Ave., Los Angeles 25, Calif. Phone: GRanite 3-8667.

NARDA MICROWAVE CORP. has appointed Rush S. Drake Associates, Inc., 1806 Bush Place, Seattle 44, Wash. as sales and technical service representative in Washington, Oregon, Montana, and Idaho.

MAGNETIC RESEARCH CORP. formed the Magnepulse Div. The new division located at 3160 W. El Segundo Blvd., Hawthorne, Calif. will manufacture a new line of magnetic pulsers and related equipment.

U. S. SEMICONDUCTOR PRODUCTS, INC. is considering merger with **U. S. ELECTRONICS DEVELOPMENT CORP.**, Glendale, Calif.

FOREIGN

BURNDY CORP. has opened a branch in Western Europe with headquarters in Antwerp, Belgium. The new branch Manager is Augustin Bouchaert.

KELLOGG SWITCHBOARD & SUPPLY CO., a Div. of International Telephone & Telegraph Corp., recently installed a new 7-3 crossbar switching equipment for the Juneau and Douglas Telephone Co., Juneau, Alaska.

POTTER & BRUMFIELD, INC., has announced plans for a manufacturing facility in Canada. The new operation will be located in Guelph, Ont., and will start manufacturing about August 1, 1958.

NARDA MICROWAVE CORP. has appointed Hayward C. Parish, South and Reddy Sts., Edgecliff, Sydney, Australia, as a sales and service representative for all of Australia.

Circle 10 on Inquiry Card, page 83

NEW DC-to-15 MC OSCILLOSCOPE

. . . with the Tektronix Plug-In Feature

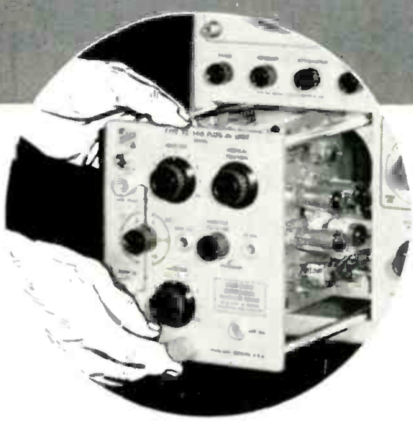
TYPE 533

Special Features

- Wide-band main vertical amplifier—0.022-μsec risetime.
- Nine Plug-In Preamplifiers available for quick conversion to specialized applications.
- Single-Knob selection of 24 direct-reading calibrated sweep rates.
- 2, 5, 10, 20, 50, and 100 times sweep magnification.
- Sweep lockout and 250-cm/μsec writing rate for one-shot recording.
- Fiddle-free triggering.
- Blanking of switching transients in dual-trace operation.
- Warning lights for uncalibrated sweep-rate and magnifier settings.

PRICE, without plug-in units, **$1050**

Prices f.o.b. Factory



ADD SWEEP LOCKOUT *to your Tektronix Type 531 and 541 Oscilloscopes—order Modification Kit*

K531 Sweep Lockout, Tek. 040-118 . . . . $25

for Type 532

K532 Sweep Lockout, Tek. 040-147 . . . . $25

Complete specifications for the Tektronix Type 533 are available. Your Tektronix Field Engineer or Representative can usually arrange demonstrations at your convenience. You can call on them for assistance without obligating yourself in any way. Please take advantage of this Tektronix Service whenever you have an instrument problem.

Tektronix, Inc.

P. O. Box 831 · Portland 7, Oregon

Phone CYpress 2-2611 · TWX-PD 311 · Cable: TEKTRONIX

TEKTRONIX FIELD OFFICES: Albertson, L. I., N.Y. · Albuquerque · Bronxville, N.Y. · Buffalo · Cleveland · Dallas · Dayton · Elmwood Park, Ill. · Endwell, N.Y. · Houston · Lathrup Village, Mich. · East Los Angeles · West Los Angeles · Minneapolis · Mission, Kansas · Newtonville, Mass. · Palo Alto, Calif. · Philadelphia · Phoenix · San Diego · Syracuse · Towson, Md. · Union, N.J. · Willowdale, Ont.

TEKTRONIX ENGINEERING REPRESENTATIVES: Arthur Lynch & Assoc., Ft. Myers, Fla., Gainesville, Fla.; Bivins & Caldwell, Atlanta, Ga., High Point, N. C.; Hawthorne Electronics, Portland, Ore., Seattle, Wash.; Hytronic Measurements, Denver, Colo.

Tektronix is represented in 20 overseas countries by qualified engineering organizations.

RAYTHEON

industrial cathode ray tubes

available in commercial and military types, many having MIL approval

or custom built to your exact requirements

Raytheon Cathode Ray Tubes meet the highest standards of quality and performance. They must pass the most extreme and rigid quality control tests known to the industry.

Design features available for your specific needs include:

- round or rectangular faces
- optical glass faces
- standard or narrow necks
- metal shells
- single or multi-guns
- high resolution guns
- screen persistences for visual or photographic use
- transparent screens
- high altitude anti-corona connectors

Representative applications and some of the Raytheon types include:

- radar indicators (5AHP7A, 7ABP7A, 10UP14A, 12ABP7A, 16ADP7)
- monitors (10SP4)
- oscilloscopes (3UP1, 5ADP7)
- flying spot scanners (5AKP24, 5AUP24, 5BNP16, 5WP15, 5ZP16)
- industrial and military television (17AVP7, 21FP7A)

RAYTHEON®

INDUSTRIAL TUBE DIVISION

Reliable Miniature and Subminiature Tubes • Filamentary Tubes
VR Tubes • Rectifiers • Thyratrons • Cathode Ray Tubes

Newton, Mass.: .... 55 Chapel St., Bigelow 4-7500
New York: .... 589 Fifth Ave., PLaza 9-3900
Chicago: 9501 Grand Ave., Franklin Park, NAtional 5-6130
Los Angeles: 5236 Santa Monica Blvd., NOrmandy 5-4221

Circle 12 on Inquiry Card, page 83

Tele-Tips

SOVIET SCIENTISTS, according to a national columnist, are pilfering writings by U. S. scientists and after translation, signing their own names. The articles are appearing in several top Soviet electronics magazines.

CLOSED-CIRCUIT TV is keeping a minute-by-minute watch on the more than 7,000 buses of the London Transport Co. The cameras installed along the 500 bus routes of the British capital work as well at night as in sunshine, and have even been found effective in fog. A central control headquarters is able to determine whether traffic congestion is holding up the buses.

COMPUTING MACHINES that will not only open the morning mail but will also dictate answers are now in the planning stage, according to one British computer expert. If the machine does not know the answer, it will throw back the letter and say, "This is the one letter that you really have to look at."

FCC ENGINEERS got themselves involved in a marital quarrel in Seattle where a woman complained that her former husband, who lived next door, was intentionally creating interference on her TV receiver. Several neighbors were also complaining. The local power company was unable to place the blame. An FCC engineer then discovered that the real offender was a defective electric thermostat on the complaining woman's own electric blanket.

HIGH SUNSPOT intensity was demonstrated again when the FCC's Hawaii monitoring station heard signals above 40 MC from as far east as Mississippi and as far west as Japan.

FLORIDA BROADCAST station complained that its programs were being smothered by the heterodyne of another station operating off frequency. However, a

(Continued on page 34)

Component Specification: ARNOLD

- ✓ SILECTRON CORES
  Types C, E and O
- ✓ TOROIDAL CORES
  Nylon and Aluminum cased
- ✓ BOBBIN CORES

The ARNOLD LINE-UP includes the TAPE CORES you need

APPLICATIONS

We'll welcome your inquiries on your Tape Wound Core requirements for Pulse and Power Transformers, 3-Phase Transformers, Magnetic Amplifiers, Current Transformers, Wide-Band Transformers, Non-Linear Retard Coils, Reactors, Coincident Current Matrix Systems, Static Magnetic Memory Elements, Harmonic Generators, etc.

ENGINEERING DATA

For data on the various types of Arnold Tape Cores, write for these Bulletins:

SC-107—*Silectron Cores, Types C, E and O*
TC-101A—*Toroidal Cores, nylon and aluminum cased*
TC-108A—*Bobbin Cores*

ADDRESS DEPT. T-87

How to be *sure* of tape core performance and uniformity? Just specify and use *Arnold* Cores in your transformer, magnetic amplifier, reactor and computer assemblies, etc.

Here's why!

To begin with, Arnold is a fully integrated company, controlling every manufacturing step from the raw material to the finished core. Then, modern testing equipment permits 100% inspection of cores before shipment. Finally, you're matching your requirements against the most experienced and complete line of tape cores in the industry. Arnold produces Types C, E and O Silectron cores, nylon and aluminum cased toroidal cores, and bobbin cores to meet whatever your designs may require in tape thickness, material, core size or weight. Wide selections of cores are carried in stock as standard items for quick delivery: both for engineering prototypes to reduce the need for special designs, and for production-quantity shipments to meet your immediate requirements.

Let us help you solve your tape core problems. Check Arnold, too, for your needs in Mo-Permalloy or iron powder cores, and for cast or sintered permanent magnets made from Alnico or other materials.

WSW6447

THE ARNOLD ENGINEERING COMPANY

Main Office & Plant: Marengo, Illinois

Repath Pacific Division Plant: 641 East 61st Street, Los Angeles, Calif.

District Sales Offices:
Boston: 200 Berkeley St.   Los Angeles: 3450 Wilshire Blvd.
New York: 350 Fifth Ave.   Washington, D.C.: 1001-15th St., N.W.

Circle 14 on Inquiry Card, page 83

Non-stop relay station for military messages!

Kleinschmidt equipment receives and instantly re-transmits thousands of printed communications daily at the Army's Switching Center, Davis, California.

At one of the largest installations in the U. S. Army's teletypewriter network, Kleinschmidt reperforator-transmitters, teletypewriters and related equipment, developed in cooperation with the U. S. Army Signal Corps, receive and automatically relay the vast load of military communications for the Pacific overseas area and western United States. With related switching equipment, incoming messages are scanned and re-transmitted without manual handling . . . so rapidly that the first portion of a relayed message is received at its destination before the latter part has been transmitted from point of origin!

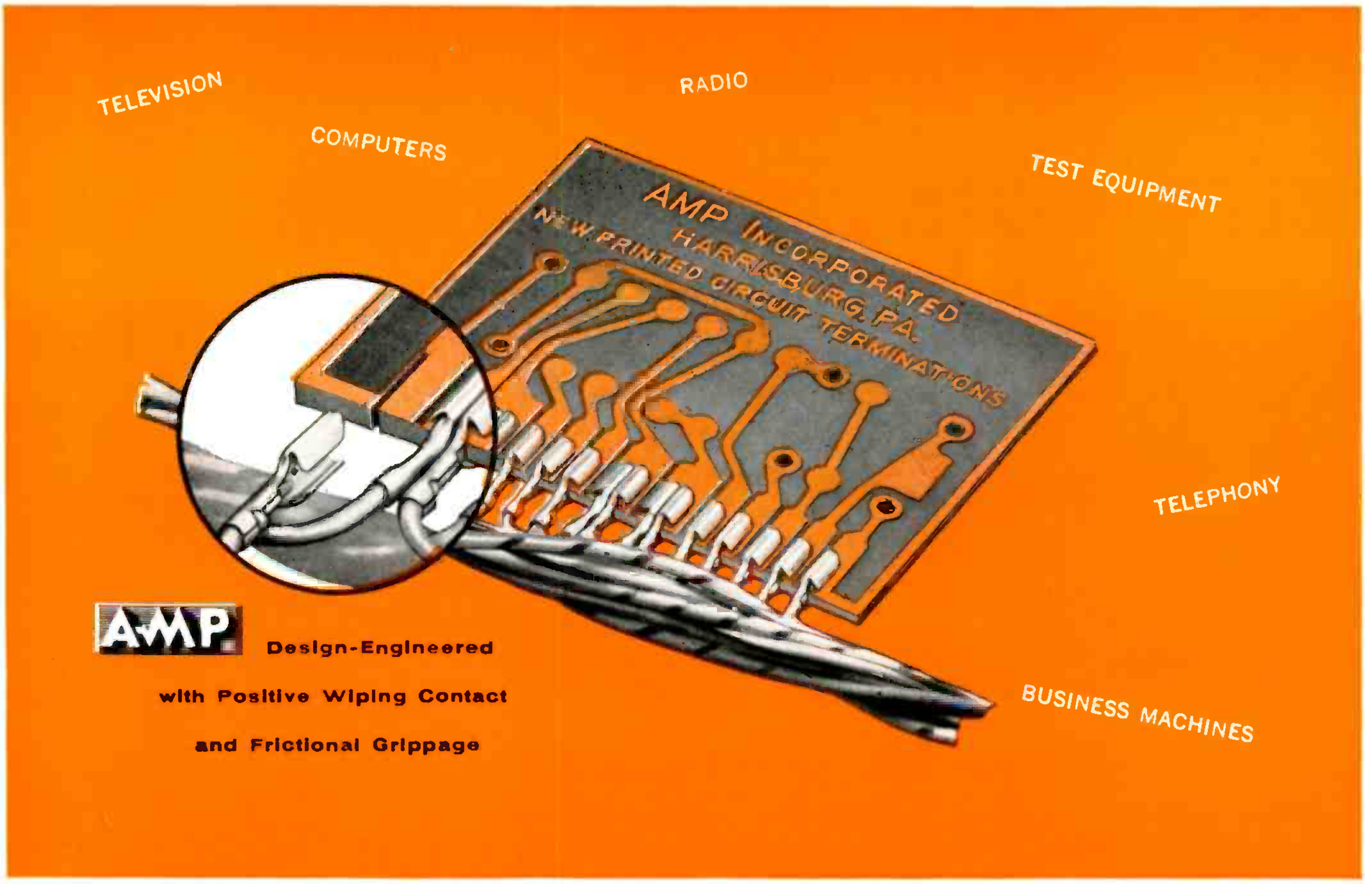
Research and development of equipment for transmitting and receiving printed communications has been a continuing project at Kleinschmidt for almost 60 years. This unparalleled store of experience, now joined with that of Smith-Corona Inc, holds promise of immeasurable new advances in electronic communications.

KLEINSCHMIDT

KLEINSCHMIDT LABORATORIES, INC., DEERFIELD, ILLINOIS

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

AMP-EDGE HAS THE EDGE ON PRINTED CIRCUITS



The new AMP-Edge Connector gives you . . .

greater flexibility— your printed circuit area and completed unit are not limited by the size of connection, as found in alternate methods of edge connection.

greater design versatility— they can be applied in any arrangement to any section of the perimeter of the printed circuit.

two-way cost reduction— production time and material costs are reduced through solderless termination of the connector to the wire (4,000 terminations per hour) and the ease of applying the Edge Connector to the printed circuit without molded parts.

Additional information is available upon request.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

 Circle 16 on Inquiry Card, page 83

Just ONE of the Reasons

for the Increase in

ELECTRONIC INDUSTRIES Advertising

in THE FIRST SIX MONTHS OF 1958

OTHER REASONS:

- Editorial content of Highest Engineering Interest.
- Tangible Evidence of Readership Thru Hundreds of Requests for Reprints from every issue.
- More Quality Inquiries for Technical Data from Advertisers.
- First—by Thousands—in O.E.M. Circulation.
- First in U. S. Circulation.
- Unequalled Marketing Assistance Program.
- Published by CHILTON COMPANY—an Experienced, Respected Pioneer in the Business Paper Field.
- Editorial Treatment in Depth—by Engineers—for Engineers.
- Reference Type Information on a Monthly Frequency Provides More Exposure to Advertising; Gives More Selling Impressions.

Tele-Tips

(*Continued from page* 28)

frequency measurement showed that the complainant's own station was the one that was off frequency. Its red-faced engineer promptly corrected the error.

YOUNG RADIO ENTHUSIASTS in a Massachusetts town were found operating a neighborhood broadcast "network" with "wireless broadcast" equipment purchased through a magazine advertisement. The boys said they were misled by the ad to believe that a license was not needed. They promptly went out of business when the FCC warned them of the consequences that could result from illegal operation.

ADDITIONS to our bookshelf:

"Bartenders Guide to Boolean Algebra"
"How to Tell a Kilocycle from a Motorcycle"
"Distortion, Extortion and You"
"How to Check Your Frequency"

SMALL BOAT OWNERS who are complained of as using indecent and profane language over their radio transmitters should take warning from the case of a shrimp fishing boat owner who pleaded guilty as a result of a trial in the Federal court at Tampa, Fla., and received a 2-year probationary sentence. Four more were fined or sentenced in other cases.

COLOR TV, provided by General Electric, is being used at Cape Canaveral to bring the picture of Jupiter firings to missile scientists and Army technicians huddled in the nearby blockhouse. Color enables the missile-team audience to check on such factors as the successful ignition of propulsion fuels.

THE BIG STORMS of the past winter were a godsend to at least one segment of the industry, the manufacturers of gasoline-motor generating units. Onan, for one, was deluged with orders, and many units were being flown in to hard hit areas.

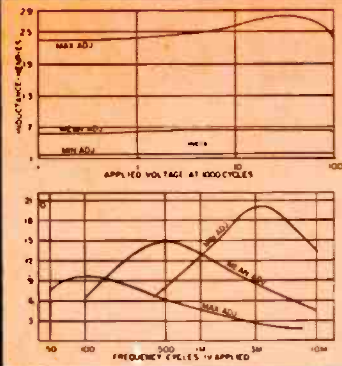
Hi-Q Inductors . . . . FROM STOCK

As largest producers in this field for over two decades, UTC inductors cover virtually every need for both fixed and variable units of exceptional stability. Hermetic units have been proved to MIL-T-27A, eliminating costs and delays of initial MIL-T-27A testing.

For complete listing of our 700 stock items (300 hermetic) write for catalog.

HVC Hermetic Variable Inductors

A step forward from our long established VIC series. Hermetically sealed to MIL-T-27A...extremely compact...wider inductance range...higher Q...lower and higher frequencies...superior voltage and temperature stability. Case 25/32 x 1⅛ x 1 7/32, 2 oz.

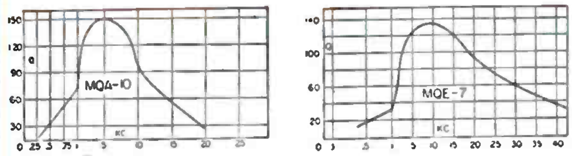


Type No.	Min. Hys.	Mean Hys.	Max. Hys.
HVC-1	.002	.006	.02
HVC-2	.005	.015	.05
HVC-3	.011	.040	.11
HVC-4	.03	.1	.3
HVC-5	.07	.25	.7
HVC-6	.2	.6	2
HVC-7	.5	1.5	5
HVC-8	1.1	4.0	11
HVC-9	3.0	10	30
HVC-10	7.0	25	70
HVC-11	20	60	200
HVC-12	50	150	500

HVC

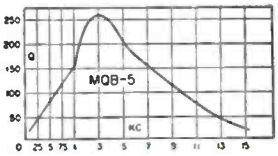
MQ drawn case structure

	Length	Width	Height	Oz.
MQE	1/2	1-1/16	1-7/32	1.5
MQA, MQD	11/16	1-9/32	1-23/32	4
MQB	1-5/16	2-9/16	2-13/16	14



MQA
19 stock values from 7 Mhy. to 22 Hy.

MQE
15 stock values from 7 Mhy. to 2.8 Hy.



MQB
12 stock values from 10 Mhy. to 25 Hy.

MQD

New extreme stability inductors for 12KC to 130KC range. Typical Q is 170 @ 50KC. 6 stock values from 2 mhy. to 20 mhy.

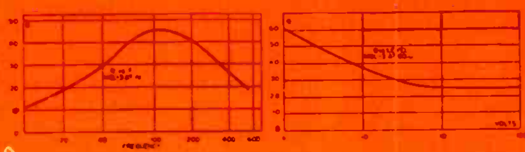
MQ Series Compact Hermetic Toroid Inductors

The MQ permalloy dust toroids combine the highest Q in their class with minimum size. Stability is excellent under varying voltage, temperature, frequency and vibration conditions. High permeability case plus uniform winding affords shielding of approximately 80 db.

MQL Low Frequency High Q Coils

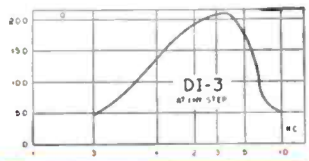
The MQL series of high Q coils employ special laminated Hipermalloy cores to provide very high Q at low frequencies with exceptional stability for changes of voltage, frequency and temperature. Two identical windings permit series, parallel, or transformer type conections. 1-13/16 dia. x 2½" H.

MQL-0	.25/1 Hys.
MQL-1	2.5/10 Hys.
MQL-2	5/20 Hys.
MQL-3	50/200 Hys.
MQL-4	100/400 Hys.
MQL-5	625/2500 Hys.



DI Inductance Decades

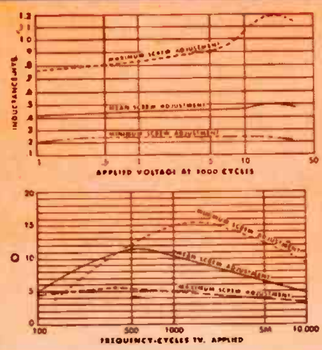
These decades set new standards of Q, stability, frequency range and convenience. Inductance values laboratory adjusted to better than 1%. Units housed in a compact die cast case with sloping panel ideal for laboratory use . . . 4½ x 4⅜ x 2⅜ high.



DI-1	Ten 10 Mhy. steps.
DI-2	Ten 100 Mhy. steps.
DI-3	Ten 1 Hy. steps.
DI-4	Ten 10 Hy. steps.

VIC case structure

Length	Width	Height	Oz.
1-1/4	1-11/32	1-7/16	5-1/2



Type	Mean Hys.	Type	Mean Hys.
VIC-1	.0085	VIC-12	1.3
VIC-2	.013	VIC-13	2.2
VIC-3	.021	VIC-14	3.4
VIC-4	.034	VIC-15	5.4
VIC-5	.053	VIC-16	8.5
VIC-6	.084	VIC-17	13.
VIC-7	.13	VIC-18	21.
VIC-8	.21	VIC-19	33.
VIC-9	.34	VIC-20	52.
VIC-10	.54	VIC-21	83.
VIC-11	.85	VIC-22	130.

VIC Variable Inductors

The VIC Inductors have represented an ideal solution to the problem of tuned audio circuits. A set screw in the side of the case permits adjustment of the inductance from +85% to −45% of the mean value. Setting is positive.

Curves shown indicate effective Q and L with varying frequency and applied AC voltage.

SPECIAL UNITS TO YOUR NEEDS
Send your specifications for prices.

UNITED TRANSFORMER CORPORATION

150 Varick Street, New York 13, N. Y.

PACIFIC MFG. DIVISION: 4008 W. JEFFERSON BLVD., LOS ANGELES 16, CALIF.
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "ARLAB"

Letters

to the Editor

"Automatic Checkout"

Editor, ELECTRONIC INDUSTRIES:

I have just finished reading the article on automatic check out equipment published in your April issue. In my opinion, this is a very excellent presentation and Mr. Klivens should be complimented for the manner in which he handled the subject.

In contacting the airlines, we notice that there is an ever increasing amount of interest in equipment for the flight control systems which will be delivered on the jet aircraft. At the present time, no less than three major airlines are thinking in terms of automatic check out not only for overhaul facilities, but also for use at line stations where servicing time is very limited.

ROBERT W. HALLAM
Eclipse-Pioneer Div.
Bendix Aviation Corp.

"A Less-Than-Minimum Phase Shift Network"

Editor, ELECTRONIC INDUSTRIES:

This letter is in reference to the article, "A Less-Than-Minimum Phase Shift Network," by R. F. Destebelle, C. J. Savant, and C. J. Savant, Jr., published in the September 1956 issue of ELECTRONIC INDUSTRIES AND TELE-TECH.

It may seem surprising that you should receive a commentary on an article which appeared more than 18 months ago. I happened to find the article while doing some research on nonlinear compensation of feedback control systems.

There appears to be an error in the basic reasoning presented, in showing that one obtains a slope of 12 db per octave with a total phase shift of 90°, rather than 180°.

If a suppressed carrier modulated input $(\cos w_m t)(\cos w_o t)$ is applied to the tuned amplifier discussed in the article, the output is found as follows:

$$(\cos \omega_m t)(\cos \omega_o t) = \tfrac{1}{2}\left[\cos(\omega_o + \omega_m)t + \cos(\omega_o - \omega_m)t\right]$$

The input contains the radian frequencies $\omega_o + \omega_m$ and $\omega_o - \omega_m$. The tuned circuit is centered at ω_o. At the frequency $\omega_o \pm \omega_m$ the phase shift is $\mp\phi$ where $\phi = \tan^{-1} 2Q\sigma$. The output of the tuned amplifier is:

(Continued on page 40)

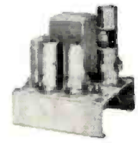
FREQUENCY STANDARDS

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 *NEW*
TYPE 2007-6
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

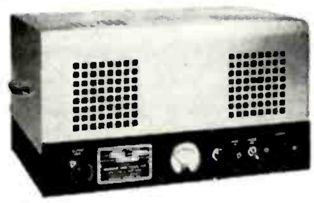
Size
8¾" x 19" panel
Weight, 25 lbs.
Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)

FREQUENCY STANDARD
TYPE 2001-2

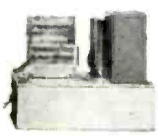
Size 3¾" x 4½" x 6" H., Wght. 26 oz.

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.**

Circle 21 on Inquiry Card, page 83

Facts You Can Use to Identify and Sell Your Electronic O.E.M. Market

WHAT'S THE DIFFERENCE BETWEEN ELECTRONIC O.E.M. AND ELECTRONIC END-USER MARKETS?

The end-user market is where electronic Original Equipment Manufacturers (O.E.M.'s) *sell* their military, industrial and commercial products. It is an "after market," entirely distinct from the original market where O.E.M.'s *buy* their materials, components, and subsystems.

End-users—commercial, industrial and government—buy finished electronic products like broadcast transmitters, industrial controlling equipment, radar systems, computers, and missile guidance systems. The original equipment (O.E.M.) market buys tubes, semiconductors, wire, solder, plastics, pre-assembled circuits and subsystems, power supplies, relays, etc.—in production quantities—for assembly and resale to end-users.

Although these "before" and "after" electronic markets are sometimes lumped into one, the people in them differ in buying motive, selling technique, and personal identity. *The O.E.M.'s are in the market for "producers goods"; the end-users are in the market for "capital goods."*

O.E.M. MARKET RESEARCH WITH THE NEW E.I.C. CODE

The government's Standard Industrial Classification (S.I.C.) fails to distinguish electrical from electronic manufacturers. For years this has forced manufacturers relying on S.I.C. market data to promote electronic components to electrical and electronic markets which cannot buy them in production quantities.

Now a new Electronic Industries Classification, the E.I.C. Code, has been developed to provide 101 major classifications for electronic products only. Data from an independent census of original equipment builders and suppliers are being punched on the IBM cards according to the E.I.C. Code.

Now you will be able to identify and measure your electronic O.E.M. market potentials using the E.I.C. Code, and ELECTRONIC INDUSTRIES IBM facilities. For more information contact your EI representative.

CAN ELECTRONIC O.E.M. MARKETS BE ECONOMICALLY REACHED THRU ROCKET AND MISSILE, AUTOMATION, AVIATION, AND OTHER END-USER PUBLICATIONS?

Electronic engineers working for aircraft, missile and industrial control manufacturers continue to submit most of their declassified theory and technique for publication in electronic—not end-user—magazines. Here, they know, is where fellow specialists working for other aircraft, missile, and control builders will be looking for electronic progress in these fields.

You will see over 80% of the contributed articles on missile electronics, electronic controls, and avionics in ELECTRONIC INDUSTRIES, Electronics engineering edition, Electronic Design, Electronic Equipment Engineering, and Proceedings of the IRE. Each one of these magazines alone reaches more electronic engineers in missile, industrial control, and aircraft activities than any TWO of the fourteen end-user publications aimed at these fields.

. . . . and ELECTRONIC INDUSTRIES delivers you more electronic O.E.M. subscribers in missile, aircraft, and control fields than any THREE end-user magazines.

ARE ELECTRONIC O.E.M. BUYING INFLUENCES REACHED BY "TECHNICAL MANAGEMENT" WEEKLIES, OR BY ENGINEERING MONTHLIES?

Original electronic manufacturers and end-users need to interweave both engineering and cost judgments in order to buy intelligently. These cost judgments involve management participation, obviously, when the product is purchased as capital equipment. Typical examples are the financial and labor-saving calculations necessary in the purchase of electronic automation equipment by industrial and commercial enterprises.

But with the exception of such capital goods as test instruments and light production equipment, the original electronic manufacturer buys only for assembly and resale to end-users. Here cost engineering is largely outside the scope of management decision. *Cost evaluation of alternate electronic subsystems and components is accepted as a problem only for working engineers—engineers conversant with the latest ideas in the monthly technical literature.*

For these reasons, electronic ads in missile, electronic and aircraft weeklies are sometimes logical for finished electronic systems sold to end-users as capital (or military) goods. But when selling "producers goods" to original electronic manufacturers for assembly, system incorporation, and resale, engineering monthlies are the only realistic, and economical, advertising media.

WHY ELECTRONIC INDUSTRIES IS — NOW — THE MOST IMPORTANT PUBLICATION SERVING THE ORIGINAL ELECTRONIC MARKET

FIRST—by thousands—in O.E.M. circulation (see S.R.D.S. listings)
FIRST in missile electronic and avionic circulation (see S.R.D.S. listings)
FIRST in number of letterhead requests for article reprints
FIRST with new ideas in a depth usable to engineers (send for details)
FIRST in market research services (send for details)

ELECTRONIC INDUSTRIES

Chilton Company Executive Offices:
56th & Chestnut Sts., Phila. 39, Pa.

AND, DEFYING INDUSTRY TRENDS, ELECTRONIC INDUSTRIES GAINED IN ADVERTISING IN THE FIRST HALF OF 1958

BPA NBP

FOTOCERAM circuit board blanks are made photographically. All holes and shapes are produced by simple exposure to light, heat, and an etching operation.

This is a FOTOCERAM printed circuit

... an unusual new type of printed circuit board

Reliable through-plate holes • The good adhesion of the circuit runs applies also to the through-plate holes because both are produced with one plating operation.

Excellent resolderability • We have removed and resoldered components over twenty times on a FOTOCERAM board without damage to circuit runs or through-plate holes. And this is *without* using adhesives to bond the copper to the board.

Dimensional stability • Rigid structure of FOTOCERAM prevents unusual design considerations—eliminates problem of warp and twist.

Good adhesion • It takes 12-25 pounds to peel a one-inch copper strip from a FOTOCERAM board.

Exceptional pull strength • 1400 pounds per square inch.

No water absorption • FOTOCERAM'S nonporous—zero water absorption.

Non-flammable

No blisters • FOTOCERAM never blisters. We put it through repeated 15-second cycles of copper metallizing at 500°F. and could not find a single blister or sign of peeling or failure.

Other properties:

Dissipation factor	1mc @	20°C.	0.006
	@	200°C.	0.014
Dielectric constant	1 mc @	20°C.	5.6
	@	200°C.	6.3
Loss factor	1mc @	20°C.	0.034
	@	200°C.	0.088

For more information, write for our Data Sheet on FOTOCERAM.

Corning means research in Glass

CORNING GLASS WORKS, Bradford, Pa.

Electronic Components Sales Department

Circle 22 on Inquiry Card, page 83

Letters

to the Editor

(*Continued from page 36*)

$$\frac{A}{\sqrt{1+4Q^2\sigma^2}}\ \tfrac{1}{2}\left\{\cos\left[(\omega_o+\omega_m)t-\phi\right]+\cos\left[(\omega_o-\omega_m)t+\phi\right]\right\}$$

$$=\frac{A/2}{\sqrt{1+4Q^2\sigma^2}}\cos\omega_o t\cos(\omega_m t-\phi)$$

The suppressed carrier modulated wave has its modulating frequency component shifted by ϕ; but there is no carrier phase shift. Therefore, the equation $K = K_o \cos\phi$ used by the authors for the demodulator transfer function does not apply.

To find the actual demodulator output it is best to think of the demodulator as ideal, i.e., the demodulator input is multiplied by $\cos \omega_o t$ to produce the process of demodulation.

The demodulator output is then:

$$\frac{A/2}{\sqrt{1+4Q^2\sigma^2}}\cos\omega_o t\cos(\omega_m t-\phi)\ (\cos\omega_o t)$$

$$=\frac{A/2}{\sqrt{1+4Q^2\sigma^2}}\cos^2\omega_o t\cos(\omega_m t-\phi)$$

$$=\frac{A/2}{\sqrt{1+4Q^2\sigma^2}}\left[\left(\tfrac{1}{2}+\tfrac{1}{2}\cos 2\omega_o t\right)\cos(\omega_m t-\phi)\right]$$

$$=\frac{A/2}{\sqrt{1+4Q^2\sigma^2}}\left\{\tfrac{1}{2}\cos(\omega_m t-\phi)+\tfrac{1}{4}\cos\left[2\,\omega_o t+(\omega_m t-\phi)\right]+\tfrac{1}{4}\cos\left[2\,\omega_o t-(\omega_m t-\phi)\right]\right\}$$

In a servo system the higher frequency terms will be filtered out. The demodulator output is:

$$\frac{A/4}{\sqrt{1+4Q^2\sigma^2}}\cos(\omega_m t-\phi)$$

The above expression indicates that the entire transfer function of the demodulator and tuned amplifier is:

$$\frac{A/4}{1+j\,\tau\,\omega_m}\quad\text{where } \tau = 2Q/\omega_o$$

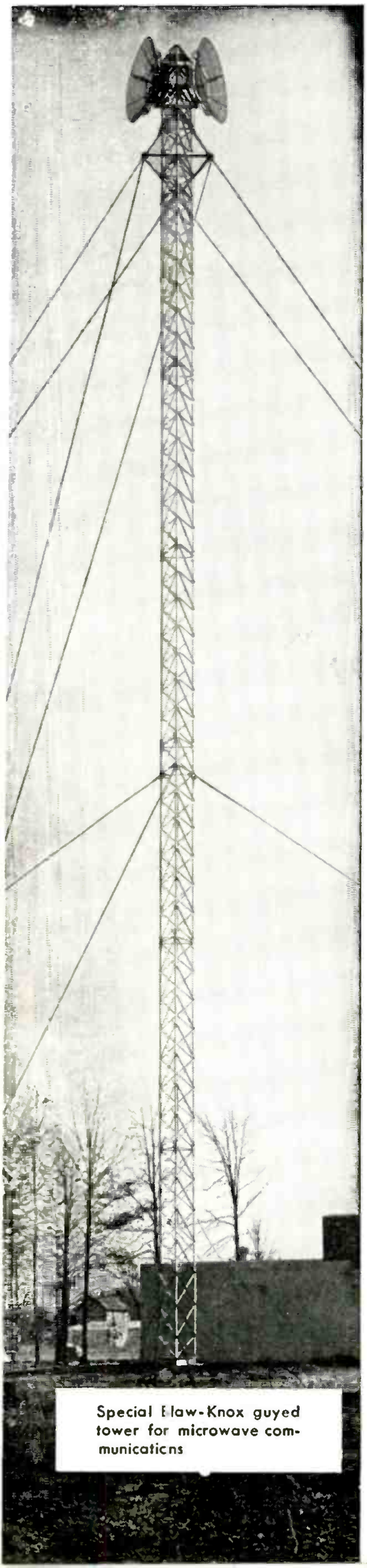
The break point is at $1/\tau$ with a high frequency asymptote of 6 db per octave and a total phase shift of 90°. The less-than-minimum phase shift network the authors discuss is not realized.

JULES H. LEVINE
Senior Engineer

Guided Missile Laboratory,
Federal Telecommunication Labs,
Nutley 10, N. J.

Planning better communications?

Microwave may be the answer ...and Blaw-Knox has the towers



Special Blaw-Knox guyed tower for microwave communications

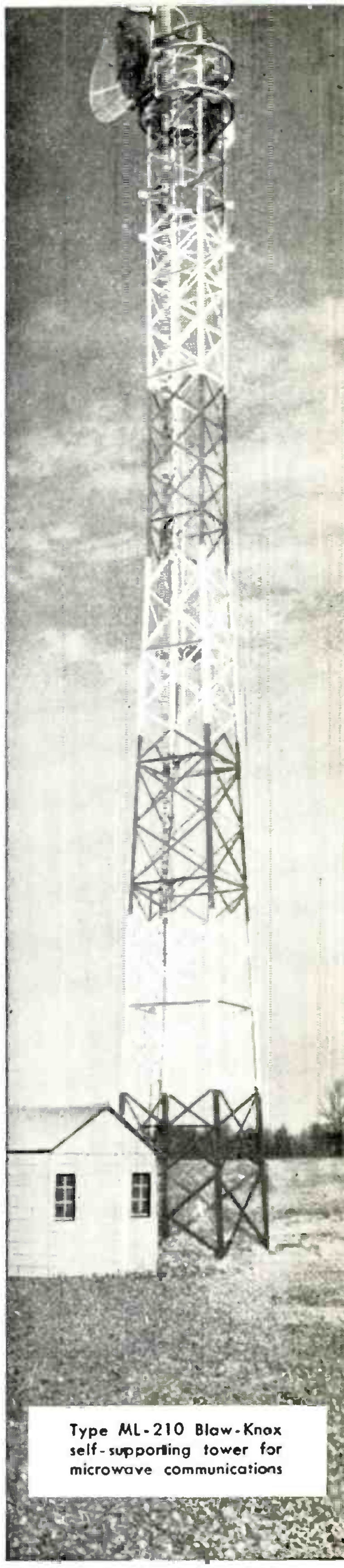
Improved service, reduced maintenance, and economy records of pioneer microwave installations are responsible for many companies planning new communications paths through the sky. Quite possibly, microwave can best answer your growth problems, and Blaw-Knox can best answer your tower questions.

Blaw-Knox Microwave Tower designs are based on more than 40 years of experience in building towers. For example:

- The first Blaw-Knox Towers, four 300′ self-supporting towers erected over 40 years ago in Alaska, still stand in good service.
- The world's first atom bomb was supported by a Blaw-Knox Tower, ushering in the Atomic Age at Alamogordo, New Mexico, in 1945.
- First electronic contact was made with outer space by a radar signal to the moon, beamed from a Blaw-Knox Tower.

From such varied experience as this, Blaw-Knox engineers are well qualified to design and engineer the type of tower system that will best meet your present and future requirements. Blaw-Knox Microwave Towers meet or surpass government standards and recommendations of the Radio-Electronics-Television Manufacturers Association for safety, wind loading and quality of construction.

Get the full story of Blaw-Knox Tower design, engineering and fabrication services. Write today for your free copy of new Bulletin 2538.



Type ML-210 Blaw-Knox self-supporting tower for microwave communications

BLAW-KNOX

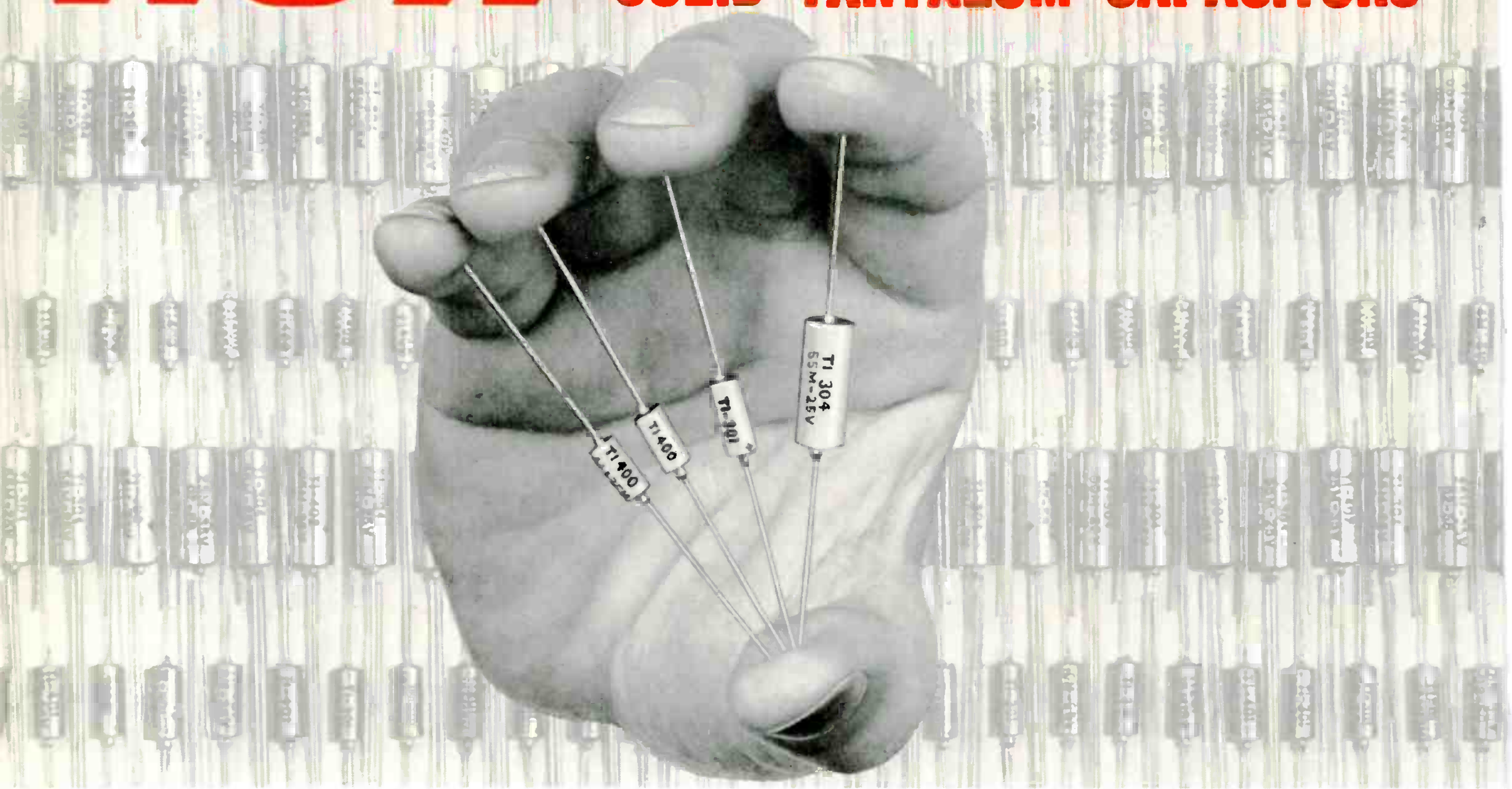
BLAW-KNOX COMPANY
Equipment Division
Pittsburgh 38, Pennsylvania

MICROWAVE TOWERS
Guyed and self-supporting Microwave Towers, custom-built for each installation ... and Transmission Towers ... Antenna Towers—guyed and self-supporting for AM-FM-TV, Radar ... parabolic antennas and other special structures

Circle 25 on Inquiry Card, page 83

NOW tan-TI-cap*

SOLID TANTALUM CAPACITORS

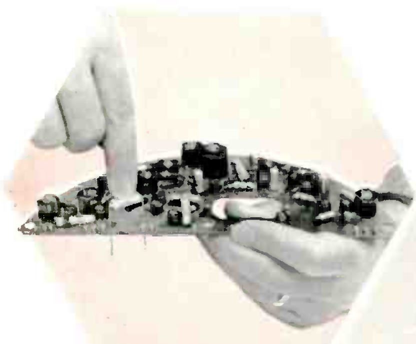


...immediately available in production quantities!

YOU get precision performance, tough mechanical construction and clean, compact design when you specify *tan-TI-cap* solid-electrolyte tantalum capacitors — *available immediately in production quantities!*

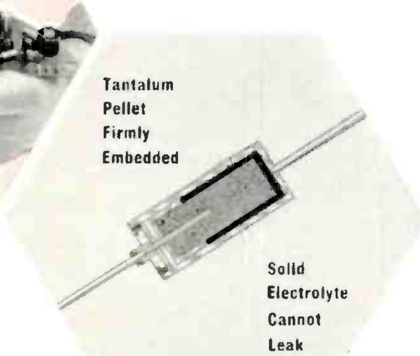
YOU are assured of the stability your high reliability applications require with *tan-TI-cap* capacitors. Capacitance and impedance parameters remain within 5% of rating throughout entire temperature range . . . from –80 to +85°C . . . *and stable throughout extra-long shelf and service life!*

Solid, no-leak construction of *tan-TI-cap* capacitors provides pellet with a hard surrounding foundation of high temperature solder that resists high impact and vibration. You simplify printed circuit assembly with *tan-TI-cap* capacitors . . . firmly anchored leads can be bent sharply *close to the case* for easy mounting in subminiature circuits.



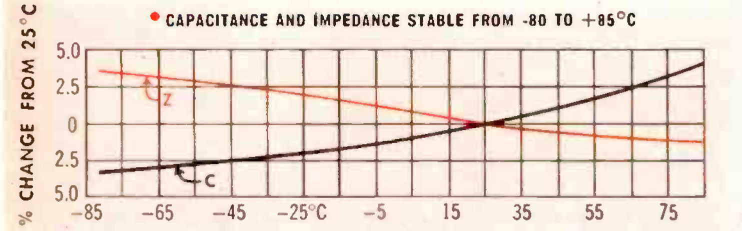
• EASY MOUNTING

you get these proved benefits!



• BUILT FOR TOUGH DUTY

• CAPACITANCE AND IMPEDANCE STABLE FROM -80 TO +85°C



SELECT FROM 18 RATINGS –

6-Volt	22 µf	33 µf	47 µf	60 µf	200 µf
15-Volt	10	15	22	33	100
25-Volt	5	10	15	35	55
35-Volt	4	8	25		

ASK YOUR NEAREST TI SALES OFFICE FOR BULLETIN DL-C 859

*Trademark of Texas Instruments Incorporated

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SEMICONDUCTOR-COMPONENTS DIVISION
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How You Can Cut Product Costs With Indox V Ceramic Magnets

Experience in the design and production of Indox V, for such products as the loudspeaker below, points the way to substantial savings in manufacturing costs for other products using permanent magnets.

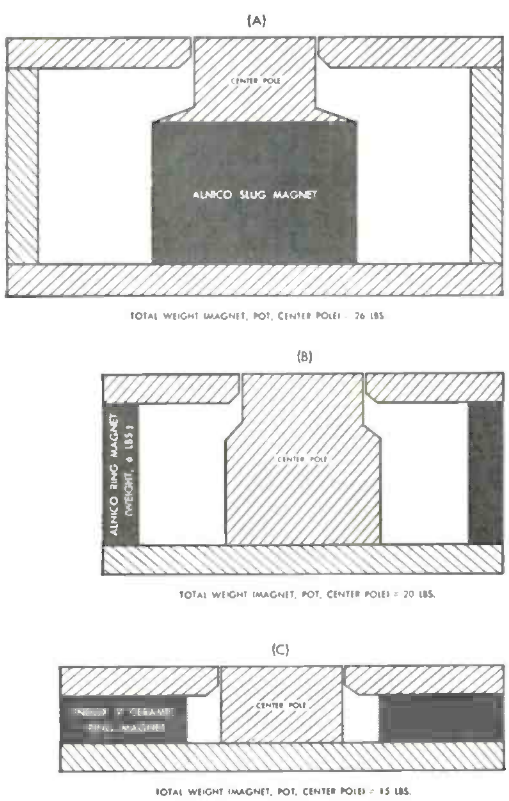
WHAT IS INDOX V

Indox V is a highly oriented barium ferrite material. Its energy is comparable, on an equivalent weight basis, to that of Alnico V—the most powerful permanent magnet material available. Indox V magnets possess unique advantages — light weight, high-electrical resistivity, great resistance to demagnetization, and inexpensive, non-critical raw materials — plus an energy product over three times that of non-oriented ceramic magnets.

NEW INDOX V LOUDSPEAKER DESIGN...

• Cuts magnet cost 20% • Saves 25% on weight • Reduces length 46%

High fidelity, permanent magnet loudspeakers normally use an Alnico slug (A) or ring (B) magnet. Assembly (C) illustrates how one loudspeaker was redesigned to use Indox V, with the results indicated. Assemblies shown in proportion.



APPLICATIONS

Indox V's excellent magnetic qualities and special properties suggest wide usage in many applications.

Among them:

D. C. Motors of Medium Size with Indox V fields have a high efficiency and show high starting and stall torques characteristic of series wound motors.

Holding Devices can take advantage of Indox V's total potential energy which, per pound of magnet weight, is appreciably higher than that of Alnico V.

Torque Drives using Indox V discs can be magnetized with multiple-pole faces.

The list of other promising applications is growing.

WHO MAKES INDOX V

Only Indiana Steel Products makes this oriented ceramic magnet, with an energy product of 3.5 million B_dH_d. And, because Indiana also produces Alnico and all other permanent magnet materials, it is uniquely qualified to recommend the *one* best material for your design. You are invited to consult with Indiana's design engineers for expert help on any application involving permanent magnets.

SEND FOR FREE LITERATURE

Write for your copy of the bulletin "Indox V Ceramic Permanent Magnets," describing magnetic properties, design considerations, and sizes and shapes available from stock for experimental work. Ask for Bulletin No. N-7.

THE INDIANA STEEL PRODUCTS COMPANY
VALPARAISO, INDIANA

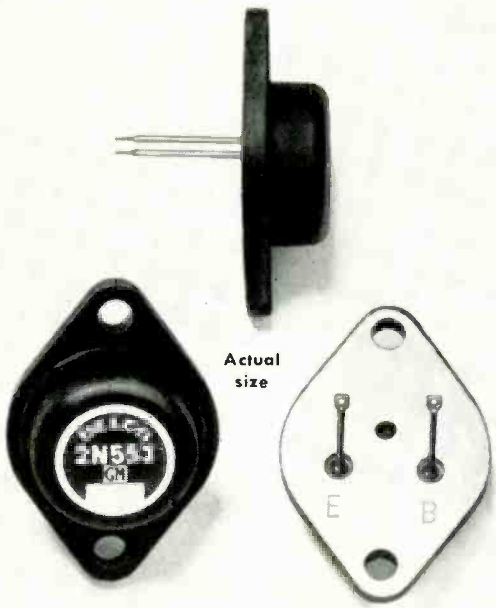
WORLD'S LARGEST MANUFACTURER OF PERMANENT MAGNETS

INDIANA PERMANENT MAGNETS

IN CANADA: The Indiana Steel Products Company of Canada Limited, Kitchener, Ontario

← Circle 26 on Inquiry Card, page 83

Circle 27 on Inquiry Card, page 83



ANNOUNCING...

the newest addition to the Delco family of PNP germanium transistors! It's ideally suited for high-speed switching circuits and should find wide use in regulated power supplies, square wave oscillators, servo amplifiers, and core-driver circuits of high-speed computers. It's the 2N553!

NEW HIGH-FREQUENCY POWER TRANSISTOR BY DELCO

No other transistor offers so desirable a combination of characteristics for applications requiring reliability and consistency of parameters.

TYPICAL CHARACTERISTICS T = 25°C unless otherwise specified

Collector diode voltage V_{CB} ($V_{EB} = -1.5$ volts)	80 volts maximum
Emitter diode voltage V_{EB} ($V_{CB} = -1.5$ volts)	40 volts maximum
Collector current	4 amps. maximum
Base Current	1 amp. maximum
Maximum junction temperature	95°C
Minimum junction temperature	−65°C
Collector diode current I_{CO} ($V_{CB} = 2$ volts)	12 μa
Collector diode current I_{CO} ($V_{CB} = -60$ volts)	0.5 ma
Collector diode current I_{CO} ($V_{CB} = -30$ volts, 75°C)	0.5 ma
Current gain ($V_{CE} = -2$ volts, $I_C = 0.5$ amp.)	55
Current gain ($V_{CE} = 2$ volts, $I_C = 2$ amps.)	25
Saturation voltage V_{EC} ($I_B = 220$ ma, $I_C = 3$ amps.)	0.3
Common emitter current amplification cutoff frequency ($I_C = 2$ amps. $V_{EC} = 12$ volts)	25 kc
Thermal resistance (junction to mounting base)	1° C/watt

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

 Circle 28 on Inquiry Card, page 83

How the man from Tensolite cuts assembly costs

Westinghouse Aero 13 Armament Control System, mounted in nose of Navy F4D Douglas carrier-based interceptor, is typical of systems using FLEXOLON *wire for faster assembly, lower production costs.*

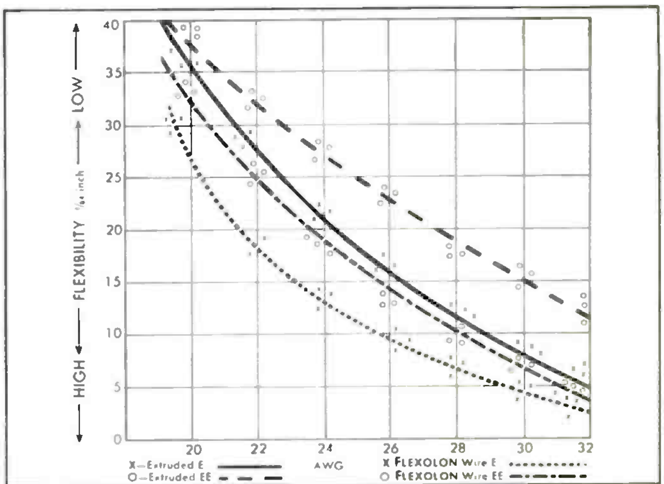
FLEXOLON hook-up wire with Raybestos-Manhattan RM "Teflon" tape proves most flexible

Developed and manufactured to answer industry's demands for increased wire flexibility, new FLEXOLON high temperature hook-up wire meets with ease the extra-flexibility requirements of today's most intricate circuit layouts.

FLEXOLON wire's greater flexibility was proven in a recent series of tests on the new hook-up wire and wires of other construction. In test after test FLEXOLON wire, insulated with Raybestos-Manhattan "Teflon" tape, proved consistently more flexible than all other high temperature hook-up wires tested.

The flexibility advantage of FLEXOLON wire is cutting assembly costs for many manufacturers. At Westinghouse, for example, the new hook-up wire makes an easier job of wiring intricate harnesses for armament control systems . . . assuring faster assembly and production.

Surpassing the requirements of MIL-W-16878C . . . and providing greater dielectric strength and higher average concentricity . . . new FLEXOLON hook-up wire is another example of Tensolite's continuous leadership in miniature wire development.



FLEXIBILITY COMPARISON OF FLEXOLON WIRE AND EXTRUDED WIRE

Plot of flexibility as recorded in tests proves greater flexibility of FLEXOLON *wire with R/M "Teflon" tape insulation. For complete testing data, call the man from Tensolite, or write for free* FLEXOLON *hook-up wire bulletin.*

Tensolite INSULATED WIRE CO., INC.

West Main Street, Tarrytown, N. Y. • Pacific Division: 1516 N. Gardner St., Los Angeles, Calif.

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Books

The Encyclopedia of Radio and Television, 2nd Edition

Published 1958 by Philosophical Library, Inc., 15 E. 40th St., New York 16. 736 pages. Price $12.00.

Among the subjects this encyclopaedia covers are the fundamentals of radio; transmitting and receiving theory and practice, including broadcasting; television techniques; radar; communication systems; components; measuring instruments; electrical machinery and power supply. A separate reference section contains a number of abacs, a wide range of formulas with work examples, and other data.

Throughout, mathematic explanations have been reduced to a minimum and the treatment is as simple and as straightforward as possible, but none the less accurate and authoritative.

The Science of Engineering Materials

Edited by J. E. Goldman. Published 1957 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 528 pages. Price $12.00.

Based on the proceedings of the Carnegie Conference on the impact of solid state science on engineering education, held at Carnegie Institute of Technology in 1954, the book reflects the accelerating trend toward applying tools of basic science to the solution of engineering problems.

Recent insight into the basic nature of atoms in atomic aggregates have brought into use a revolutionary new materials and improvements in many of the standard materials. This book aims to give the engineer a feel for these advances in materials technology and how they have come about.

Feedback Theory and its Applications

By T. H. Hammond. Published 1958 by The Macmillan Co., 60 Fifth Ave., New York 11. 363 pages. Price $7.00.

This book presents well tried methods of linear and non-linear feedback system analysis and illustrates their application to a variety of engineering devices which incorporate feedback in some form. The book is intended for postgraduate engineering and physics students and others who require an introduction to the subject and a view of its scope and future. Some familiarity with the Laplace or Heaviside operational method is assumed.

Mathematics for Science and Engineering

By Philip L. Alger. Published 1957 by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36. 360 pages. Price $6.95.

This book enables one to find, understand, and use with ease and quickness the various mathematical methods useful to an engineer or scientist. For almost any technical problem one meets on the job, here is found a clear guide to the proper mathematical tool for solving it.

Here one gets the benefit of the famous, clear explanations of complex quantities originated by Dr. Charles P. Steinmetz, so useful in developing equivalent circuits to represent all sorts of physical phenomena. In addition the noted tensor theory of Gabriel Kron (a generalization of complex number theory) used in solving modern problems with electronic computers is given.

Advances in Electronics and Electron Physics, Volume IX

Edited by L. Marton. Published 1957 by Academic Press, Inc., Publishers, 111 Fifth Ave., New York 3. 357 pages. Price $9.00.

This volume groups the contents of the whole volume around one main theme instead of attempting to take a cross-section of various aspects of electronics and of electron physics. The main theme is geophysical and originates from the dedication of this year as the International Geophysical Year.

The Theory of Networks in Electrical Communication and other Fields

By F. E. Rogers. Published 1958 by E. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. 560 pages. Price $11.50.

In this comprehensive volume the author makes a clear and thorough analysis of the subject and the work should become standard. There are many illustrations and numerical examples, together with original work.

Russian-English Electronics and Physics Glossary

Published 1957 by Consultans Bureau, Inc., 227 W. 17th St., New York 11. 360 pages, paper bound. Price $10.00.

This glossary is a compilation of Russian terms used in the various specialized fields of electronics. It includes terms from thousands of pages of the most recent issues of Soviet journals. To this has been added an appendix containing circuit notation, U. S. equivalents for vacuum tubes, and other useful information not found in other technical dictionaries. This glossary which includes more than 22,000 Russian terms, while incorporating all previously published electronics glossaries, eliminates duplications, and adds thousands of new terms including idioms and selected general vocabulary.

Television Interference, Its Causes and Cures

By Phil Rand. Published 1958 by The Nelson Publishing Co., P. O. Box 36, Readding Ridge, Conn. 56 pages, paper bound. Price $1.75.

Coming as it does when so much emphasis is being placed by the military on a reduction of all types of interference, this book is indeed timely. The book is profusely illustrated with actual interference diagrams of suggested circuits and cures.

Circle 30 on Inquiry Card, page 83

Personals

Leonard G. Walker, Marketing Manager, Microwave and Industrial Control Dept., Motorola Inc., was appointed Chairman of the Microwave Section, EIA Technical Products Div.

William C. Boese has been reappointed Assistant Chief Engineer and Chief of the Technical Research Div. of the FCC.

Gerald M. Henriksen has been elected Director and Vice President of Acoustica Associates, Inc. Mr. Henriksen, who joined Acoustica recently, was formerly Director of Research and Engineering for the Turbo Div. of American Machine and Foundry Co. in Pacoima, Calif.

G. M. Henriksen

W. O. Faith

Winston O. Faith has assumed the position of Director of Advanced Engineering with the Varo Mfg. Co. Prior to assuming his present position, he was Group Engineer at Tempo Aircraft in the field of automatic controls and at Chance Vought in servomechanisms.

Robert E. Moody has been Chief Project Engineer for Beckman/Scientific Instruments Div., Fullerton, Calif. He will direct research and design work on ultraviolet spectrophotometers and accessories.

Dr. Nicholas A. Begovich, a specialist in electronic scanning radar and landing and approach systems, has been appointed Director of Engineering of Hughes Aircraft Company's Ground Systems.

Dr. Louis Malter is now Director of Central Research for Varian Associates. He was formerly Chief Engineer of the Semiconductor and Materials Div. of the Radio Corp. of America.

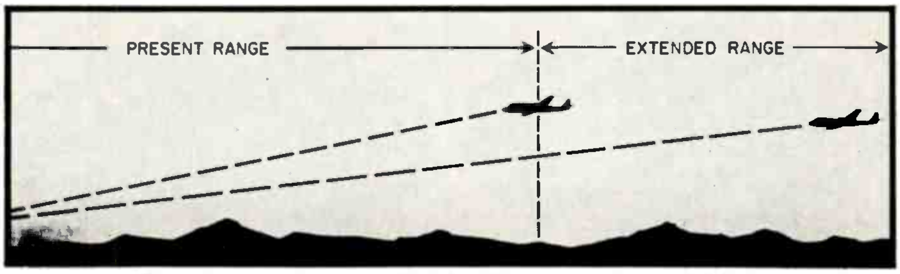
Joseph J. Sinacore has been appointed Resistor Project Engineer for the General Transistor Corp. He was formerly Production Manager at Eastern Precision Resistor Corp.

Dr. Joseph M. Denney, solid state physicist and metallurgist, has joined the Nuclear Electronics Dept. at Hughes Aircraft Co. He was formerly with Aeronutronic Systems.

MICROWAVE AND SPECIAL TUBE NEWS from SYLVANIA

New Mixer Diodes can extend Radar Range by 18%

Premium 1N78B, 1N26A and 1N53B improve new and existing radar with unmatched ease and economy



How radar range increases with Sylvania's new premium crystal diodes

Three new microwave diodes covering applications from 13,000 mc to 35,000 mc are now available from Sylvania. The new mixers, types 1N78B, 1N26A and 1N53B, have improved overall noise figures, more uniform RF impedance, and two of the types have greater resistance to burnout. They can extend radar coverage by as much as 18 percent*, provide more uniform performance from system to system, and increase operational reliability. An equivalent upgrading of equipment by any other means would demand a twofold increase in power.

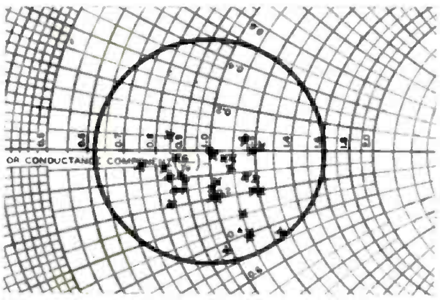
The new crystals are exact retrofits of preceding types and are comparable in price. Each type is available in matched pairs to Sylvania's specification, which has recently been accepted as the industry standard by JETEC 14.7.

*2.8 db improvement in overall noise figure of 1N53B yields 18% increase in range.

Type 1N78B—Used in applications from 13,000 mc to 16,500 mc, the diode has an overall noise figure of 8.8 db, an improvement of 3 db over the 1N78 and 1 db over the 1N78A. It is being used extensively in doppler navigation equipment and in fire-control radar.

Type 1N26A—Designed for use as a mixer in superheterodyne radar receivers in the 24,000 mc region, the type is primarily used in airport traffic control equipment and in air-to-air missiles. Its 11.3 overall noise figure is a 1.8 db improvement over the 1N26. Its burnout resistance rating has been increased threefold to 0.3 erg.

Type 1N53B—This miniature coaxial type point contact silicon diode is designed for use as a mixer in the 35,000 mc region. Its major application is in Terrain Avoidance and Mapping Radar. The burnout resistance rating of the 1N53B is double that of the 1N53 and its overall noise figure has been reduced from 13.14 to 10.3. It is tested for a band width of 12 percent to assure good performance in any application in its frequency range. The new diode can also be used as a harmonic generator for very short wave-lengths.


VSWR measurement of a random selection of 1N78B's indicates the positive control over RF impedance of new Sylvania crystal mixers. The circle shows a VSWR of 1.6

New Edition—Complete up-to-date technical information on Sylvania's full line of Microwave Crystal Diodes is contained in a new revised edition of the 8-page booklet "Ratings and Characteristics of Microwave Crystal Diodes." Write Sylvania direct or call your Sylvania representative for a free copy of the new booklet.

Electrical Characteristics & Ratings

	IN78B	IN26A	IN53B
Conversion Loss (db) max.	6.5	7.5	6.5
Output Noise Ratio max.	1.3	2.0	2.0
IF Impedance (Ohms)	365-565	300-600	400-800
RF Impedance (VSWR) max.	1.6	1.6	1.6
Burnout (erg)	0.3	0.3	32.8-37.0
Frequency (kmc)	16	24	0.3

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Circle 33 on Inquiry Card, page 83

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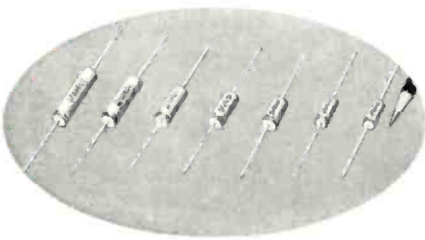
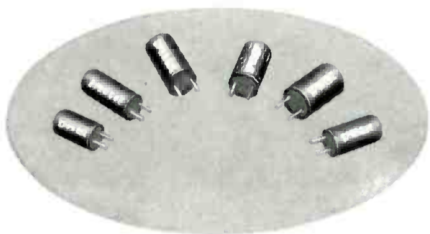


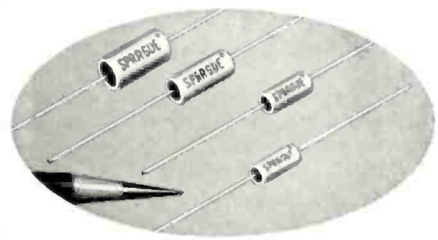
LITTL-LYTIC* CAPACITORS

Sprague's new Type 30D hermetically-sealed aluminum-encased capacitors are the *tiniest* electrolytic capacitors made to date . . . and their performance is better than ever. Their remarkable reliability is the result of a new manufacturing technique in which *all the terminal connections are welded. No pressure joints . . . no "open circuits" with the passage of time.* And check this for ultra-low leakage current: for a 2 µf, 6 volt capacitor . . . only 1.0 µa max.; for a 300 µf, 6 volt capacitor . . . 3.5 µa max.! Engineering Bulletin No. 3110 gives the complete story. 85°C standard.



VERTI-LYTIC* CAPACITORS

These space-saving Type 89D 'lytics are designed for easy manual upright mounting on printed wiring boards. Keyed terminals assure fast mounting and correct polarity. No reworking on the assembly line. Sturdy pre-molded phenolic shell with resin end-fill gives excellent protection against drying-out of the electrolyte or the entry of external moisture. The phenolic case eliminates the necessity for additional insulation. Reasonably priced for mass production receivers. Engineering Bulletin No. 3060 lists standard ratings with performance data.



Cera-lytic* CAPACITORS

The ideal capacitor for applications where low cost is the primary consideration is Sprague's new Type 31D. Capacitor sections are housed in a dense steatite tube with resin end-fill to provide protection against mechanical damage and atmospheric humidity. This construction results in excellent capacitor performance for all miniature electronic circuits. Size for size, they're the smallest the industry has produced in a ceramic-cased aluminum electrolytic. Engineering Bulletin No. 3010 details standard ratings and gives performance data.

*Trademark

FOR ENGINEERING BULLETINS on the industry's first complete line of subminiature aluminum electrolytic capacitors, write Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

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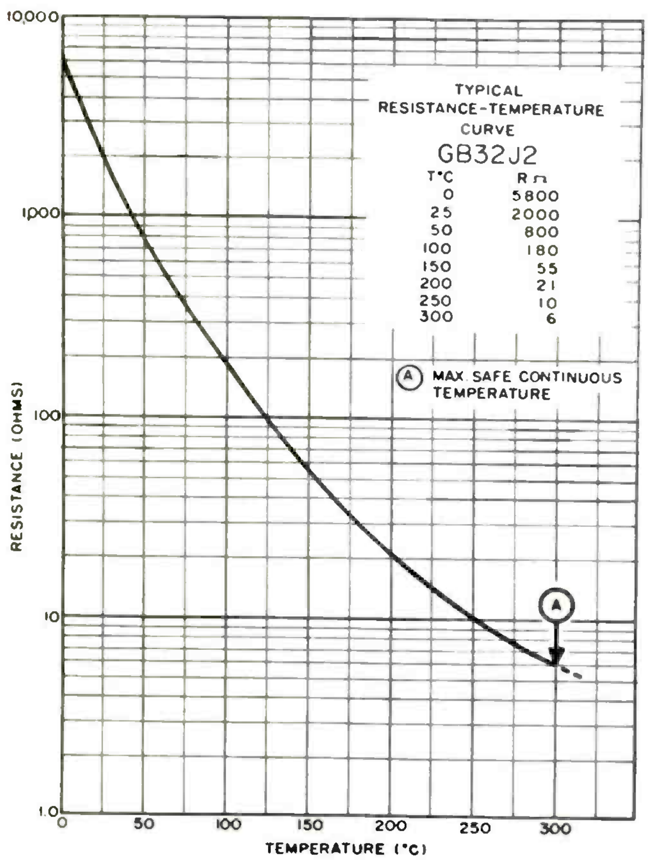
A Practical Approach to

Solving Thermistor Problems

Much has been written concerning the general characteristics and applications of thermistors, but little on how-to-solve actual problems. Three application problems, each highlighting a different major characteristic, are solved here.

By ROBERT S. GOODYEAR
President, Fenwal Electronics, Inc.
Mellen St., Framingham, Mass.

Fig. 1: Relationship of thermistor resistance to the temperature.



ALTHOUGH "thermistor" means "thermal resistor" and applies to devices with a positive or a negative temperature coefficient of resistance, the latter is the major thermistor industry today. We will limit our discussion to that field. The same techniques, slightly modified, may be used to solve problems involving thermistors with positive coefficients.

Thermistors really do only one thing; they change their electrical resistance with absolute temperature. Those we are discussing, reduce resistance as temperature increases. The curve which represents this relationship is called the R-T (Resistance-Temperature) curve and is usually plotted in terms of the logarithm of resistance vs. temperature, Fig. 1.

Another common way of presenting this information is in tabular form where the ratio of the resistance at any temperature to the resistance at 25°C is tabulated against various temperatures, Table 1. This is the characteristic which is used in temperature measurement, temperature control, and temperature compensation.

Background Data

Most thermistors are rather small, ranging from tiny beads, a few thousandths of an inch in diameter, to washers about 1 in. in diameter and ½ in. thick.

If a very small voltage is applied, a small current, not sufficient to heat the thermistor measurably above its surroundings, will flow. Under these circumstances, Ohm's Law will be followed and the current will be proportional to the applied voltage.

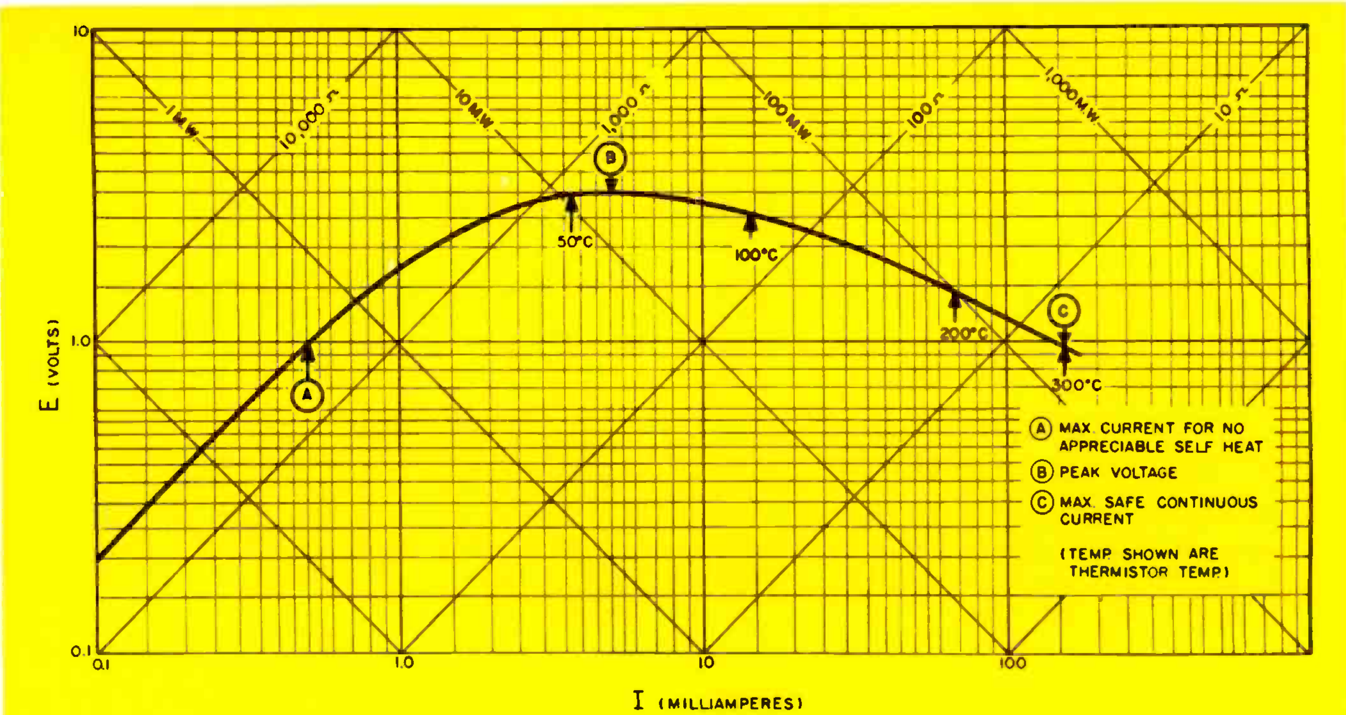


Fig. 2: The major thermistor industry is concerned with that portion beyond "B"—the negative temperature coefficient.

Thermistor Problems *(Continued)*

However, if the voltage is gradually increased, the current will increase and the heat generated in the thermistor will finally begin to raise its temperature above that of its surroundings. The resistance will consequently be lowered and more current will flow than if the resistance had remained constant.

The curve which shows this characteristic is called the E-I (Voltage-Current) curve and is usually plotted in terms of the logarithm of the voltage vs. the logarithm of the current, Fig. 2. The advantage of this type of curve is that the thermistor power and resistance may also be read on the diagonal logarithmic scales. Fig. 2 shows that the voltage drop across a thermistor increases with the current until it reaches a peak value at "B" beyond which the voltage drop decreases as the current increases. In this portion of the curve, the thermistor is exhibiting a negative resistance characteristic.

Power Considerations

Thus, under any fixed ambient conditions, the resistance of a thermistor is a function of the power being dissipated within itself, provided there is sufficient power to raise its temperature considerably above ambient. Under normal operating conditions, the temperature may rise 200° or 300°C and the resistance may be lowered to 0.001 of its value at low current. This characteristic is used in such devices as voltage regulators, microwave power meters, gas analyzers, and automatic volume and power level controls.

If a voltage is applied to a thermistor and resistor in series, a current will flow which is determined by the voltage and the total circuit resistance. If the voltage is high enough, some heat will be generated in the thermistor, lowering its resistance and permitting more current to flow. This, in turn, will heat the thermistor still more and lower its resistance further. The process will continue until the thermistor reaches the maximum temperature possible for the amount of power available in the circuit, at which time, a steady state will exist. The E-I curve described represents only these steady state conditions.

Fig. 3 shows the "current-time" or "dynamic" characteristic of a thermistor in a fixed circuit in which

Table 1

Material		No. 2	No. 2	No. 2	No. 1	No. 1
Type units		Discs Washers	Rods	Glass coated beads	Discs Washers Rods	Glass coated beads
Codes prefixed by:		KB, LB, WB	QB, RB	GB	KA, LA, QA, RA, WA	GA
β in °K		3400 ± 80	3450 ± 80	3495 ± 175	3900 ± 55	4115 ± 150
Ratio R_0 @ 0°C to R_0 @ 50°C		6.95 ± 4.5%	7.10 ± 4.5%	7.27 ± 10%	9.11 ± 3%	10.33 ± 8.5%
Ratio test limits		6.63 — 7.26	6.79 — 7.43	6.56 — 7.99	8.83 — 9.39	9.45 — 11.20
α @ 25°C		−3.9%/°C	−3.9%/°C	−3.9%/°C	−4.4%/°C	−4.6%/°C
°F	°C	A	B	C	D	E
−76	−60	73.04	77.0	81.6	145.2	200.
−58	−50	38.95	40.2	42.5	68.88	92.0
−40	−40	21.51	22.0	23.3	34.28	45.5
−22	−30	12.33	12.5	13.2	17.92	22.0
−4	−20	7.307	7.42	7.85	9.792	11.6
14	−10	4.476	4.54	4.70	5.560	6.30
32	0	2.825	2.85	2.90	3.274	3.55
50	10	1.830	1.84	1.85	1.992	2.09
68	20	1.216	1.22	1.22	1.250	1.27
77	25	1.000	1.00	1.00	1.000	1.00
86	30	.8267	.825	.827	.8053	.800
104	40	.5742	.570	.566	.5316	.513
122	50	.4067	.402	.396	.3595	.340
140	60	.2937	.289	.286	.2482	.231
158	70	.2160	.212	.210	.1747	.162
176	80	.1615	.157	.156	.1252	.114
194	90	.1229	.119	.117	.09126	.0816
212	100	.0946	.0910	.0900	.06754	.0600
230	110	.0740	.0705	.0696	.05076	.0454
248	120	.0585	.0552	.0550	.03867	.0343
266	130	.0471	.0437	.0428	.02988	.0264
284	140	.0382	.0350	.0341	.02327	.0208
302	150	.0314	.0285	.0273	.01843	.0165
320	160	.0259	.0240	.0222	.0147	.0132
356	180	.0180	.0169	.0152	.0097	.0087
392	200	.0130	.0121	.0106	.0066	.0058
428	220	.0098	.0090	.0077	.0047	.0040
464	240	.0076	.0069	.0058	.0035	.0028
500	260	.0060	.0054	.0045	.0026	.0020
536	280	.0048	.0044	.0037	.0021	.0015
572	300	.0040	.0037	.0031	.0017	.0011

voltage is varied. Fig. 4 shows the same characteristic in which the voltage is fixed and the series resistance is varied. This is the function of thermistors normally used for time delay and surge suppression applications.

Specific Problems

Now that we have discussed the data normally published by manufacturers, let us solve a few specific problems. It would be very nice, if we could write a series of precise mathematical equations, with instructions to put in a few conditions, and solve for the answers. Unfortunately, this is not the case.

A thermistor appears to be a simple device, but the mathematical expression of all its electrical characteristics, in terms of its mechanical structure, is extremely complicated and involves a large number of independent parameters.

If you have tried to solve a thermistor problem by trial and error, do not be ashamed. It is still the easiest and quickest way to get an answer.

Temperature Compensator

Let's design a temperature compensator for a copper relay coil, 5000 Ω at 25°C, that pulls in at 1 ma. The relay should operate in a voltage regulation circuit where it must pull in at a constant voltage from 0° to 60°C.

For a copper coil, $R_t = R_o (1 + 0.0039\ t)$. R_t at 25°C equals 5000 Ω so R_o at 0°C = 4555 Ω. Every 10°C, the resistance will increase about 178 Ω. The coil resistance vs. temperature is tabulated in Table 3, Column a.

Since the relay pulls in at 1 ma, it will require 4.56 v. at 0°C and 5.62 v. at 60°C to pull in. We know that the thermistor will have to be shunted and will be some resistance considerably lower than the coil resistance. Assume a value between 1000 and 4000 Ω. Assume also that we are short of space and would like to bury the thermistor right in the relay coil. A small glass coated bead or ¼ in. long glass probe would be convenient. Looking in a catalog, we find that such beads and probes are available in this resistance range and their R-T curve is the one shown in Fig. 1 and Table 1. Thermistor ratios have been added in Table 3, Column b.

If we subtract the last ratio from the 50° ratio, we get .110 which is the amount of resistance change a 1 Ω thermistor would give between 50° and 60°C. We need 178 Ω change so by dividing 178 by .11, we find we need a 1600 Ω thermistor at 25°C. We make this calculation at the highest temperature end of the chart because the thermistor has the least sensitivity here. Also, we want to be sure to have enough thermistor to give the resistance change required. When the thermistor is shunted, at low temperature, the shunt will control the resistance; at high temperatures, the thermistor will control the resistance.

First Attempt

If we use a 1600 Ω thermistor, we can multiply the ratio at 50° and 60°C by 1600 and find the thermistor resistance values will be 633 and 457 Ω respectively. The difference is very close to the 178 Ω required. The unshunted thermistor would compensate very nicely between 50° and 60°C but, of course, would way over-compensate at lower temperatures.

When we add the shunt, we will reduce the thermistor value about 50% to make up for this loss. Therefore, we want to try a thermistor of 1600 × 1.5 or 2400 Ω at 25°C. Thermistor resistance values, Table 3, Column c are obtained by multiplying 2400 by the thermistor ratios.

By the time we shunt the thermistor at 60°C, the compensation resistance will be in the order of 500 Ω which added to 5623 will give about 6100 Ω. This is about the value we should have at 0°C also. Therefore we must shunt the 6950 Ω thermistor to produce 6100-4555 or 1545 Ω. The shunt resistance will be

$$\frac{R_t\ R_{st}}{R_t - R_{st}} \text{ or } \frac{6950 \times 1545}{6950 - 1545}$$

which equals 2000 Ω, where R_t is the thermistor resistance, S is the shunt resistance, and R_{st} the shunted thermistor resistance. We can now add two more columns to our chart, the compensator resistance, Table 3, Column d, which is the value of the thermistor shunted by 2000 Ω, or $\frac{S\ R_t}{S + R_t}$, and the total

Table 2

I_t	E_t	E_s	$E_t + E_s$
20 ma.	2.38 v.	.35 v.	2.73 v.
25	2.22	.44	2.66
30	2.09	.53	2.62
35	1.98	.62	2.60
40	1.88	.70	2.58
45	1.80	.79	2.59
50	1.72	.88	2.60
55	1.65	.97	2.62
60	1.58	1.06	2.64
65	1.53	1.15	2.68
70	1.48	1.23	2.71

Table 3

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
			First Try: R_t = 2400 Ω at 25°C			Second Try: R_t = 3100 Ω at 25°C		
	Coil Resistance	Thermistor Ratio	Thermistor Resistance Unshunted	Thermistor Resistance w/2000 Ω shunt		Thermistor Resistance Unshunted	Thermistor Resistance w/2040 Ω shunt	
Temp.	R_c	ρ	R_t	R_{st}	$R_c + R_{st}$	R'_t	R'_{st}	$R_c + R'_{st}$
0°C	4555 Ω	2.90	6950 Ω	1555 Ω	6110 Ω	8980 Ω	1662 Ω	6217 Ω
10	4733	1.85	4440	1380	6113	5730	1506	6239
20	4911	1.22	2930	1190	6101	3780	1325	6236
25	5000	1.00	2400	1090	6090	3100	1231	6231
30	5089	.827	1985	998	6087	2565	1136	6225
40	5267	.566	1360	810	6077	1755	943	6210
50	5445	.396	950	644	6089	1230	767	6212
60	5623	.286	687	511	6134	886	618	6240

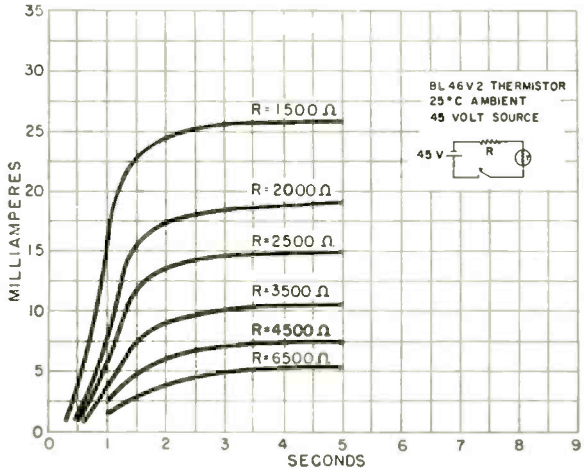


Fig. 3 (above): When the voltage is varied and circuit components fixed, the dynamic characteristics of the thermistor is obtained.

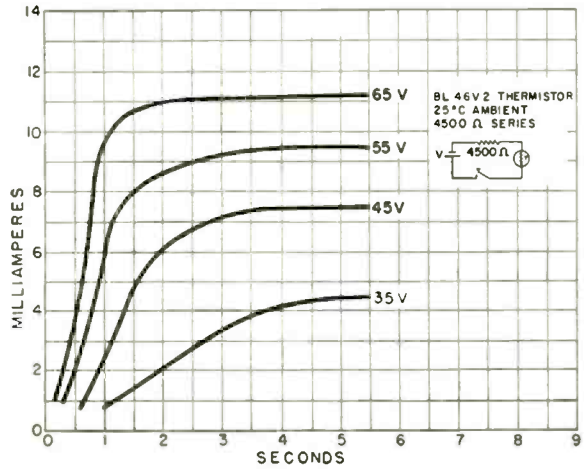


Fig. 4 (above): Here the voltage is fixed, resistance is varied.

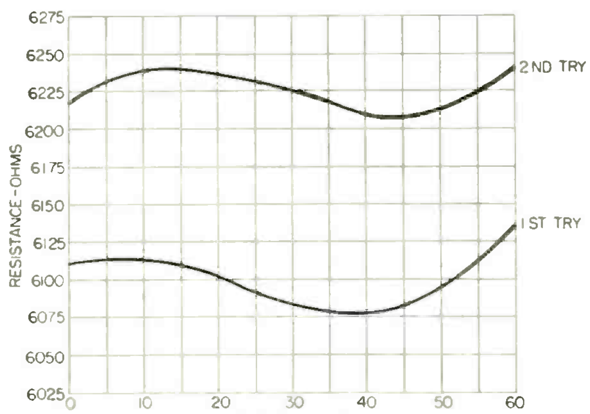


Fig. 5 (above): Compensation brings coil resistance variation within ±0.24% on just two trys. Uncompensated coil variation was ±10.5%.

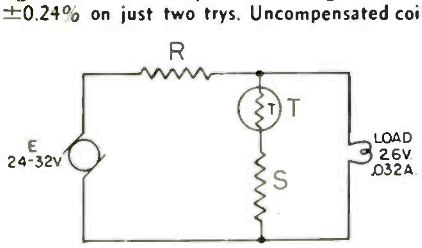


Fig. 6: Current through the thermistor circuit varies widely, but the voltage across it remains constant.

Thermistor Problems *(Continued)*

circuit resistance, Table 3, Column e, which is the copper coil resistance plus the compensation resistance.

Without compensation, the coil resistance is within ± 10.5% of a nominal. On the first try, we have brought the variation down to 6106 ± 28 or ± 0.46%, Fig. 5.

Second Attempt

For a second try, we see that we need more negative resistance between 50° and 60°C to reduce the positive slope in that range. Let's try about a 30% larger thermistor. Instead of a 2400 Ω unit, we will try a 3100 Ω unit. Column f is added to Table 3 by multiplying 3100 by the thermistor ratios. To get the best compensation, the peak point at 10°C must equal the peak point at 60°C. If we use a 2000 Ω shunt with our 886 Ω thermistor at 60°C, we get a total circuit resistance of 613 + 5623 or 6236 Ω. To get this same value at 10°C which is where our curve in Fig. 10 peaks, we must make the shunt and 5730 Ω thermistor equal 6236-4733 or 1503 Ω. Therefore, the shunt must be 2040 Ω. Columns g and h can now be added to Table 3. Plotting this curve in Fig. 5, we see the total circuit is 6225 ± 15 Ω or ± .24%. This is about the best compensation we can get without using a double or triple compensation network. This is more than 40 times as good as the uncompensated relay!

Power in Thermistor

Maximum power exists when the thermistor and the shunt are of equal value, about 35°C. A max. current of 0.5 ma flows which approximates 0.5 mw in 2040 Ω. A small glass probe embedded in the coil has a dissipation constant of about 1 mw/°C. So 0.5 mw raises the thermistor temperature about 0.5°C. This lowers its resistance 1.7% or about 35 Ω. Instead of a 2040 Ω shunt and a 2040 Ω thermistor, we have a 2040 Ω shunt and a 2005 Ω thermistor because of self heat. This makes a compensator of 1012 Ω instead of 1020 Ω. This 8 Ω lower resistance increases the overall error from ± 0.24% to ± 0.30%.

We now have the final answer. A bead type, glass probe thermistor, ¼ in. long, with a standard β value of 3495, buried in the coil, and shunted by a 2040 Ω resistor will do an excellent job.

Voltage Regulator Problem

For an automatic camera, a constant light source is needed as a reference for an automatic iris adjuster. The light is to be a 2.6 v., 32 ma bulb operating from a generator. The voltage varies from 24 to 32 v., depending upon load and speed of rotation.

In a voltage regulator circuit, Fig. 6, E is the supply voltage, R a series resistance for control, T the thermistor and S a series resistor with the thermistor. A thermistor voltage control works just like a gas tube control; current through the thermistor circuit varies widely but the voltage across it remains substantially constant. The voltage drop in R always balances out the variation in source voltage.

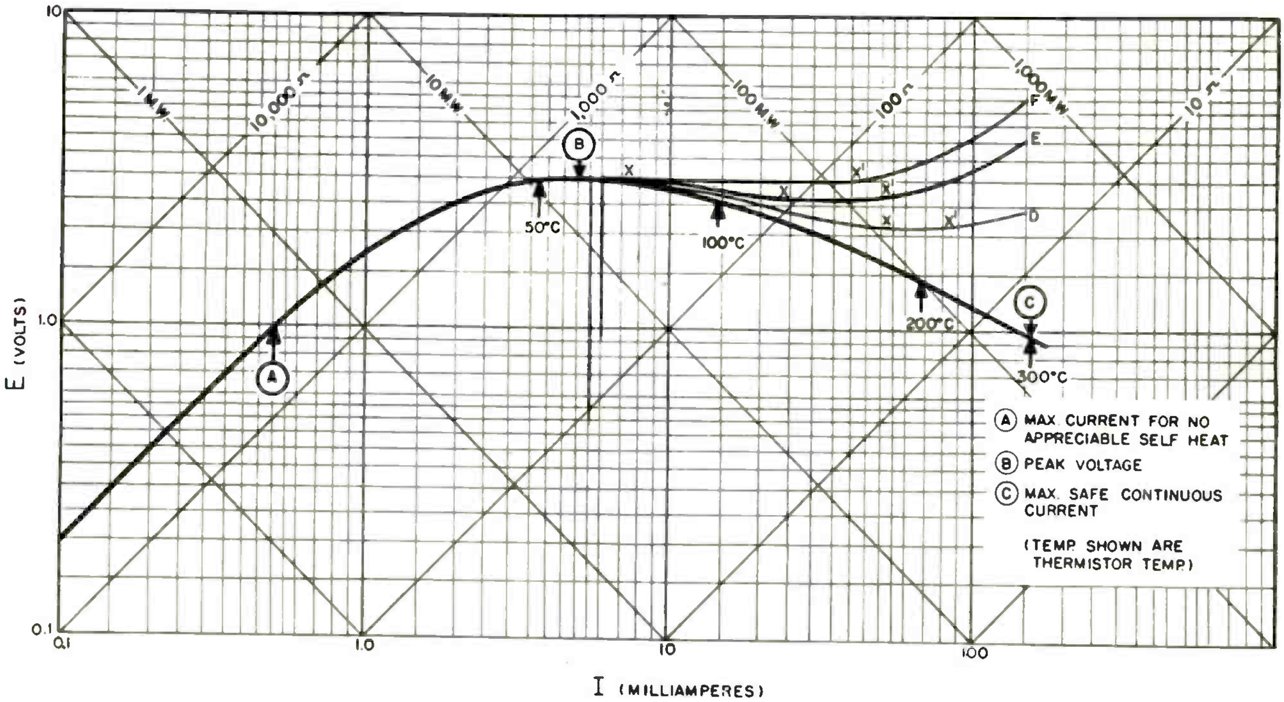


Fig. 7: Curves D, E, and F show the effect of adding series resistance to thermistor used to produce Fig. 2.

Looking at Fig. 2 we see a typical E-I curve of a thermistor. There is a short flat part to this curve at the peak, "B." This would give some voltage regulation but would not cover a very broad range of load or source variation. If we put a 10 Ω resistor in series with the thermistor and plot a new E-I curve including this resistor, we get curve D, Fig. 7. If we do the same with a 20 Ω resistor, we get curve E. A 30 Ω resistor gives curve F. In all 3 curves we find an extended flat section of the curve between X and X^1.

Curve Selection

We want a curve which has a peak slightly above the 2.6 desired controlled voltage. The heavy curve Fig. 7, (similar to Fig. 2) should be about right. First make up a chart, Table 2, showing thermistor current in 5 ma steps from 20 ma to 70 ma. Then read the voltages across the thermistor from the curve.

At some nominal point like 50 ma what value of S do we need to make load voltage 2.6 v.? Thermistor voltage is 1.72 so we need 2.60-1.72 or .88 v. across S. Therefore, S must be

$$\frac{0.88}{0.050} \text{ or } 17.6\ \Omega.$$

Multiplying 17.6 by various values of current, we can write down the voltage developed across S. Adding the thermistor and S voltage we get the total values.

The flattest part of the curve is between 30 and 55 ma. What value of R do we need to put 30 ma in the thermistor circuit when our source is minimum (24 v.)? The load current will be 32 ma, the thermistor current will be 30 ma so the total current through R will be 62 ma. The load voltage will be 2.6 v. so we must drop 21.4 v. in R.

$$R = \frac{21.4}{0.062} = 345\ \Omega.$$

What current will the thermistor take at maximum supply voltage? Load voltage of 2.6 means 29.4 v. must be dropped in R.

$$I = \frac{29.4}{345} = 85 \text{ ma.}$$

Therefore the thermistor must take 85-32 or 53 ma.

Without voltage control, the load variation would be 28±4 or ±14.3%. With voltage control, the max. load voltage, between 30 and 55 ma, in the thermistor circuit is 2.62 and the min. is 2.58. This is a variation of 2.60 ±0.02 or ±.77% which is about 19 times as good. This could be improved by making a two stage regulator as shown in Fig. 8. Here let thermistor T be the same circuit we just worked out and thermistor T^1 another one which would control point X to constant voltage of about 4 v. ±2%. With no more than this variation applied to our circuit T, we could control output voltage to 2.60 ±0.005 or about ±0.2%.

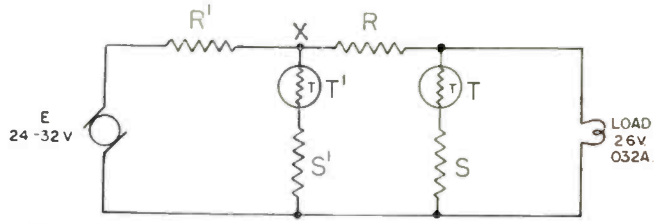


Fig. 8: This two-stage regulator gives very close voltage control.

Thermistor Mounting

Since this E-I curve is data on a small bead thermistor suspended in air, we would want to have it in a small air filled container like a glass bulb or a crystal can for easy mounting. Our thermistor is operating at about 50 ma and 1.7 v. or 34Ω. The 25°C resistance of this unit is 2100Ω therefore the ratio

(*Continued on page* 118)

Electronic Reader Sorts Mail

Automatic character sensing equipment is being developed and tested for the Post Office Department. It will automatically read and sort mail at a high speed. This equipment can also be used as an automatic input for data processing systems.

By A. I. TERSOFF
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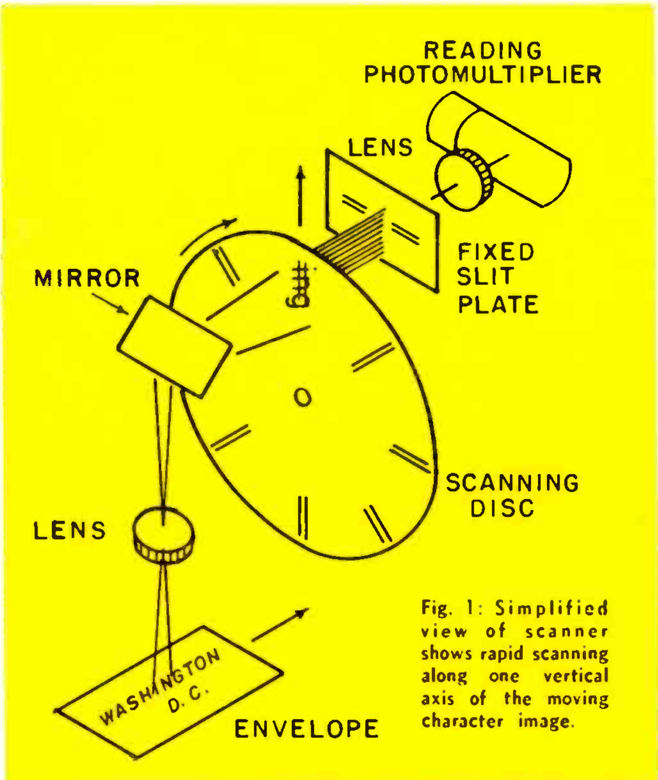

Fig. 1: Simplified view of scanner shows rapid scanning along one vertical axis of the moving character image.

OPTICAL character sensing, or the automatic reading by machines of information visible to the human eye, has many apparent advantages as an automatic input for data processing systems. Over the years, a number of research groups have worked to develop just such a replacement for the human operators normally required to translate data into machine language.

To date, this work has led to the development of a small but significant group of optical character sensing machines. Intelligent Machines Research Corporation already has eight machines of four different models of Analyzing Readers[1] in use in the field processing ordinary business documents. These machines have accumulated a total of eleven machine years of field use to date. However, while the different models read different documents prepared in various type faces, the information to be read by any one model is typewritten or imprinted in a specified manner in a given type face.

For all practical purposes, the reading machine described in this article is the first one developed with the ability to read alphabetic characters in many styles and sizes of type without change of program. However, for the sake of economy, this ma-

[1] Trademark, Registered U. S. Patent Office.

chine recognizes only enough information to identify given cities and states, and does not completely identify each character by itself.

Scanning the Document

The type size normalization technique described is currently employed in an Analyzing Reader being developed for the Post Office Department. This Reader presently scans a 1¼ inch zone on envelopes fed past it, and sorts them according to the city-state address read on the bottom line. The envelope speed during this reading operation is 30 ips, representing a character rate of 360 characters per second for standard elite type. Reading is accomplished using a high resolution mechanical scanner and photomultipliers to convert the optical image received from the envelope into electrical signals. As each envelope is moved past a reading station, an image of the address is focused onto a high speed scanning disc containing 0.010 in. wide radial slits. (See Fig. 1.) Immediately in back of the scanning disc, and swept by light projected through the radial slits, is a fixed plate containing a slit 0.010 in. wide. As the envelope is moved past the reading station, an image of the information on it moves across the system of intersecting slits. A two dimensional scan of the address is obtained by a beam of light passed by what is effectively a "flying aperture."

The moving spot of light passed by the intersecting slits is projected onto a photomultiplier. Here it is converted into an electrical signal whose amplitude is proportional to the intensity of the spot of light. Since the length of the fixed slit is made slightly less than the chord between adjacent radial slits at that point, each scan across the fixed slit will produce a "black pulse" in the photomultiplier output at the point where light is completely blocked from the fixed slit. (See Fig. 2.) During the remainder of each scan, pulses will occur only when the scanning of a line element of a character produces a substantial decrease in the intensity of the light passed by the intersecting slits. This photomultiplier output is then fed to a video channel, where it is amplified and clipped at the voltage levels (+15 and —25 volts)

Table 1

	0	1	2	3	4	5	6	7	8	9
LONG VERTICAL LEFT	+		–	–	–	–	+	–		–
LONG VERTICAL RIGHT	+	+	–	+	+	–	–	+		+
HORIZONTAL TOP	+	–	+	+	–	+	–	+	+	+
HORIZONTAL MIDDLE	–	–	+	+	+	+	+	–	+	+
HORIZONTAL BOTTOM	+	+	+	+	–	+	+	–	+	–
SHORT VERTICAL UPPER LEFT & LOWER RIGHT	+	–	–	–		+	+	–	+	+
SHORT VERTICAL UPPER RIGHT & LOWER LEFT	+	–	+	–	–	–	–	–	+	–
SHORT VERTICAL LEFT & RIGHT SIMULTANEOUSLY	+	–	–	–		–	+	–	+	+
SHORT VERTICAL UPPER LEFT				–	+					
LONG VERTICAL LEFT & RIGHT SIMULTANEOUSLY	+								–	
MIDDLE PROJECTING RIGHT					+					–

+ : CONDITION MUST BE DETECTEO
— : CONDITION MUST NOT BE DETECTED

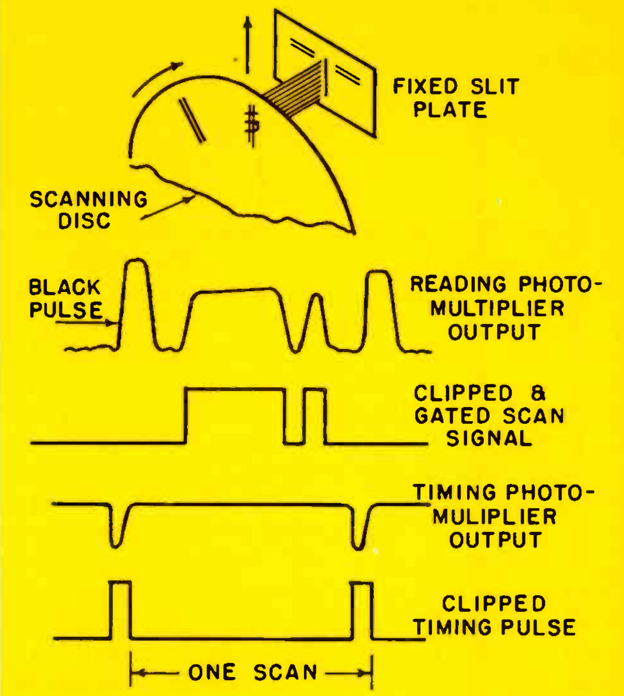

Fig. 2: Development of a clipped scan signal and timing pulse.

used in subsequent logical units. Also developed in the video channel is a feedback voltage which holds the amplitude of the "black pulse" constant, compensating for variation in document reflectivity and photomultiplier sensitivity.

A second photomultiplier and an exciter lamp, placed on opposite sides of the scanning disc, are used to produce a tinning pulse at the end of each vertical scan. (See Fig. 2.)

Logic of Character Analysis

The scan signals obtained from each envelope are analyzed in a small, special purpose computer called the interpreter. This interpreter is made up of an assortment of modular logical units which operate on signals clipped at +15 and —25 volts. By properly combining the inputs and outputs of these logical units, the interpreter is programmed to distinguish between characters on the basis of the presence or absence of significant character strokes.

The most common logical units are the primer ("P") unit, the inverter ("I") unit and the measuring ("M") unit. As for the function of these units:

1. The primer is essentially a storage unit with a four-input AND gate. Its output is up (at +15 volts) from the time pre-determined requirements are satisfied until it is reset by the reset ("Z") unit. Its output then goes down (to —25 volts).

2. The inverter is most commonly used to provide an output signal which is the exact inverse of its input signal.

3. The measuring unit's basic function is to provide an output signal which differs from its input signal only in that the leading (or positive going) edge is delayed a known, controlled amount. No out-

Electronic Reader Sorts Mail

(Continued)

put pulse is obtained when the input pulse is shorter than the established delay interval. This measuring unit's delay is obtained through the use of an adjustable R-C input network to generate a sawtooth timing signal of controlled slope. The setting of the R-C network, and the resultant slope of the sawtooth timing signal, establishes the delay which a measuring unit will provide.

Among the other logical modules in the interpreter are some locator units. Their function is to automatically register in a known manner on the characters to be read, and to do so with sufficient precision to permit an analysis of the various strokes comprising the characters. This registration on a selected point within the scan cycle is indicated by switching of the locator unit's output. Switching occurs at the earliest point in the scan cycle at which specified information has been detected. In the case of the mail sorter, programming considerations make it desirable that we be able to register on the bottoms of the various characters in the bottom line, as with locator "P" in Fig. 3. Since the rate of upward drift of the reference level can be controlled, locator "P" is permitted to drift up quickly in order that it may follow closely the bottoms of those characters in the bottom line. However, it is not permitted to drift more than a specified distance above locator "Q," which is made to drift up relatively slowly. This prevents locator "P" from erroneously drifting up to the line above and confusing it with the bottom one.

An example of the general manner in which characters are distinguished from each other in a typical Analyzing Reader is shown in Table 1. In this case, eleven different stroke criteria are employed to provide a minimum of two differences between any pair of numbers in the indicated type face. The lower, middle and upper portions of the characters are identified by a locator unit in conjunction with measuring units. The presence or absence of specific strokes or combinations of strokes in certain portions of the various characters is established largely through the use of primer and inverter units.

Reading Intermixed Type

The character identification logic described above is straightforward, and easily applied to the usual character sensing application where but one type face is to be read. However, in the case of the automatic mail sorter presently under development, it is not possible to control the preparation of input documents. Here the type styles and sizes to be read vary over too wide a range to permit the use of a fixed set of standards for the analysis of stroke length and location. This was proven by an analysis of 352 cancelled envelopes addressed to nine destinations. The height of each character in the city-state address on

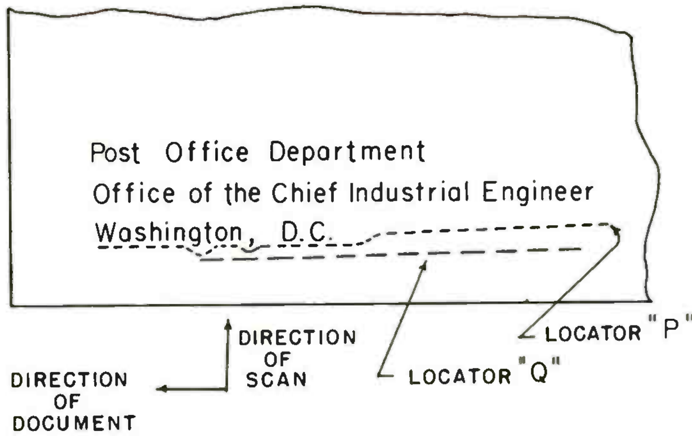

Fig. 3: Locator circuits with slow and fast reference level drift.

these envelopes was measured optically, and the results recorded. The overall variation in height of individual characters was determined to be approximately ±16%.

It was then decided to take the first character in the bottom line as an arbitrary (but pertinent) measure of height and compute the height of all lower case characters relative to it. The variation in this "adjusted" height of individual characters, which is due to differences in style, was only ±5.5%, or one-third of the actual variation. On the basis of these findings there was developed a Comparator circuit which adjusts itself, for each envelope scanned, according to the height of the first character read on the bottom line. This is presumed to be a capital letter in every case. Thus, despite a variation in type size from envelope to envelope, the Comparator provides, for each envelope, a "proportioned yardstick" to be used in the analysis of all characters after the first one.

Comparator Circuit Operation

The function of the Comparator is to provide the charging voltage for the R-C input networks of selected measuring units. The magnitude of this voltage is established, for each envelope, by the height of the first character read. Further, the greater the height of this character, the smaller the Comparator output voltage. Thus the measuring units connected to the Comparator will provide delays which vary in proportion to the height of the first character read. These proportional delay times provide precisely the "proportioned yardstick" desired.

The general operation of the Comparator circuit can be analyzed with the aid of Fig. 4, the Comparator control program. The output of primer P1, the Comparator's locking signal, will be up only during the time that the first character on the bottom line is being read. It is during this time that the Comparator setting is established. The output of P2, the Comparator's reset signal, will get up at the same time and remain up until reading of the document is completed. This serves to hold the Comparator setting at its established value for the remainder of the document. Since the scan signals are gated by the outputs of M1 and I1, the Comparator setting is established only by signals received after the output of M1 becomes positive and before the output of M2 becomes positive. Any scan signal generated by information more than M2's delay time (roughly 4 µsec) above the Comparator setting marked by M1 is blanked out by I1.

Referring to the circuit diagram of Fig. 5, we find that when P1 and P2 are both down, diode D2 conducts until the potential at point (A) is —25 volts. Under these circumstances V2 will conduct lightly, V3 will conduct heavily, and the potential at point (B), the proportional voltage output, will be roughly + 150 volts. At the moment that reading of the first character of an address is begun, the outputs of P1 and P2 go to +15 volts. Under these circumstances, D1 and D2 can have no effect other than to prevent the potentials at points (A) and (D) from rising above +15 volts. The locator unit meanwhile tracks the bottom of the bottom line in the address, due to the fact that envelopes are scanned from bottom to top. With the proportional voltage still up at its maximum possible potential, M1 will get up slightly above the bottom of the bottom line in the address. We see then that whenever a scan signal is detected just after M1 gets up, the potential at point (C) will be forced to +15 volts. Under these circumstances the potential at (A) will be less than that at (D) and V1B will charge capacitor C1 through

proportional voltage must be, in order that M1 shall get up just above the characters in the bottom line. It is this feedback which is the heart of the Comparator's operation, causing the delay in M1 to always equal the height of the first character.

When reading of the first character has been completed, P1 will be reset and its output reduced to —25 volts. From this time until all reading has been completed, the potential at point (A), which controls the output proportional voltage, must be held as constant as possible. One possible obstacle to the attainment of this goal is the slight current drawn by V1B even when it is "cut off." This obstacle is overcome by the insertion of isolating diode D3. With point (A) established at some potential between +15 and —25 volts, and point (D) held at —25 volts by D1, V1B finds it much easier to draw its minute current through D1 than through the back resistance of D3. The second possible obstacle to the attainment of a stable potential at point (A) is the tendency of V2's grid current to slowly drive point (A) negative. This obstacle is overcome by the use of V4 and the 50 megohm resistor between its plate and point (A) to leak electrons off C1 at approximately the same rate that grid current from V2 puts them there. As the potential at point (A) rises, the potential at point (E) drops, the potential at point (F) rises, and the rate at which electrons leak off through the 50 megohm resistor remains approximately equal to the grid current.

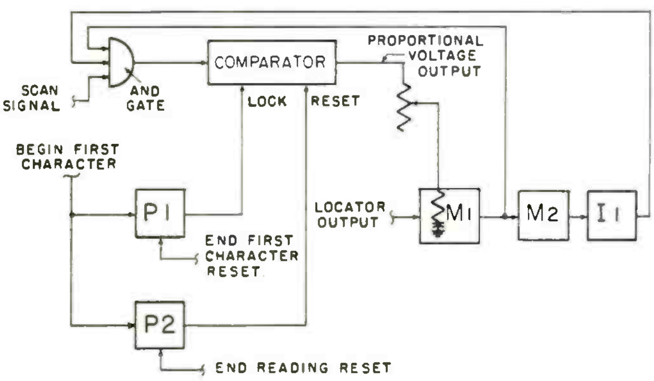

Fig. 4: Diagram shows control program for comparator circuit.

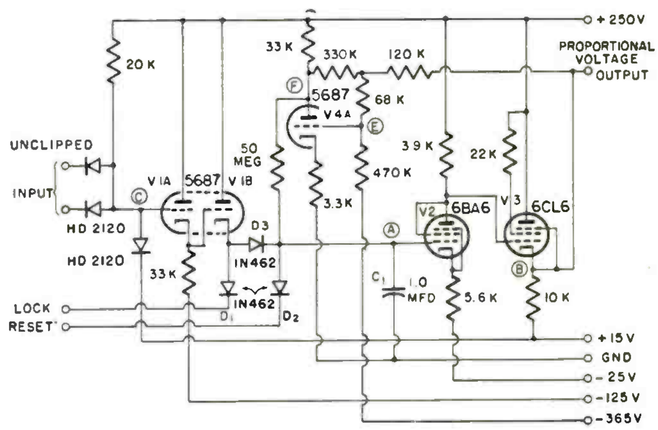

Fig. 5: Comparator circuit generates voltage for measuring units.

D3. Point (A) will then rise, V2 will conduct more heavily, V3 will conduct less heavily, the proportional voltage will be less positive, and M1 will get up slightly later than before. This process continues until the potential at (A) is high enough, and the proportional voltage low enough, to cause M1 to get up just above the characters in the bottom line. With M1 getting up at this point, the AND gate will only be enabled in the space between the lines. Since no scan signals will be detected there, charging of capacitor C1 will cease. It can be seen that the taller the type face read, the more positive the potential established at point (A) must be, and the lower the

Comparator Operation Evaluation

To evaluate the accuracy of the Comparator circuit, its operation was tested by taking four measurements on each of 112 envelopes. These envelopes were selected at random from a supply of cancelled mail bearing a variety of addresses. Since the Comparator is supposed to set so that M1 comes on just above the top of the first character in the bottom line, the time measured by M1 (equivalent to a distance above the locator unit's setting) was used to represent the setting of the Comparator circuit. As indicated by the curve of Fig. 6, the height of the first character was

Electronic Reader Sorts Mail

(Concluded)

between 98 and 100% of the Comparator circuit setting for 392, or 87%, of the measurements. Less accurate measurements were obtained where poor character quality deprived the Comparator circuit and/or locator unit of reasonable input signals.

Conclusions

Designing a reading machine for use as an automatic mail sorter poses some unusual problems, for the Post Office Department handles mail addressed by virtually countless typewriters and imprinters. The most practical approach was deemed to be incorporation in the machine of sufficient flexibility to enable it to read intermixed type faces with a single logical program. Flexibility was achieved, in part, through the development of a Comparator circuit. This circuit makes it possible to measure typographic features of the characters on an envelope relative to the height of a selected character on that envelope. Investigation has proven the advantage of such relative measurements in the reading of intermixed type faces.

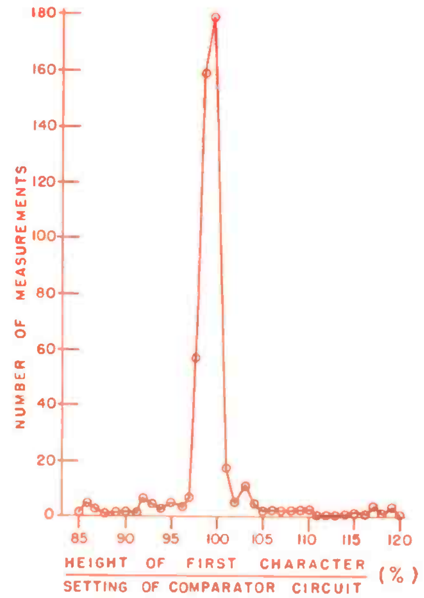

Fig. 6: Comparator circuit provides an accurate measure of type size.

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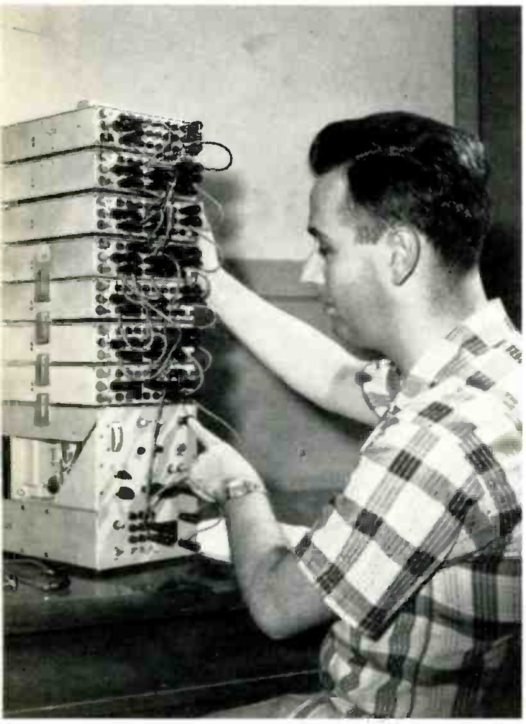
2. "A Reliable Character Sensing System for Documents Prepared on Conventional Business Devices." D. H. Shepard, P. F. Bargh, and C. C. Heasly, Jr., *1957 IRE WESCON Convention Record*, Part 4, pp. 111-120.
3. "Automatic Registration in High Speed Character Sensing Equipment." A. I. Tersoff, *Proceedings 1957 Eastern Joint Computer Conference*.

Computer Circuit Simulator

A new digital computer circuit simulator, developed at SRI, eliminates the need for complex test or pilot models.



CONSIDERABLE savings in the cost of developing electronic computer circuits are possible through use of a new digital computer circuit simulator developed at Stanford Research Institute, Menlo Park, California.

The device in many instances eliminates the need for large and complex test or pilot models of computer circuits and related components. Building these models is expensive and time-consuming. In addition, they are usually limited to a one-time use and are not flexible enough for application to other computer circuitry problems.

With the simulator, or "basic universal relay programmer," a wide variety of digital networks can be set up economically under conditions particularly suitable and convenient for detailed study. Just one wiring configuration, for example, can be used to simulate over 1,000 circuit conditions. An unlimited number of other configurations can be similarly set up to obtain different results.

The major components of the programmer are several electronic memory units that function as basic digital computer circuit elements. Each unit includes a plugboard which permits rapid and easy "plug-in" interconnection or disconnection with "patch-cords," similar to those used on telephone switchboards.

Timing and counting units are provided to expedite the testing and running through of calculation sequences without constant attention. The programmer is compact, easily handled, and relatively inexpensive to construct.

The memory units can also be connected to function as a small calculator. This particular capacity has been especially useful in the solution of unconventional mathematical problems that have arisen in the development of systematic design techniques for digital computers.

The new programmer, designed by Senior Research Engineer W. H. Kautz and constructed in the SRI Computer Laboratory, is intended primarily for solving numerous design problems related to computer research.

Fig. 1: Used in telemetering equipment, this cell weighs 1/7 oz.

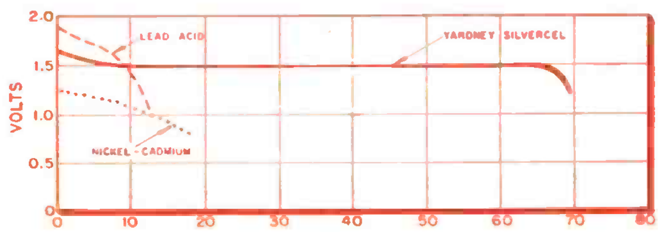
New Developments are

Improving Performance of Silver-Zinc Batteries

Developments, materials, and techniques that offer the most promising prospects for this powerful cell are presented. Some of the more prominent applications are recalled.

By **DR. PAUL L. HOWARD**
Director of Technical Operations
Yardney Electric Corp.
40 Leonard St., New York 13, N. Y.

Fig. 2: Characteristics of high-rate silver-zinc compared with equal weight lead-acid and nickel-cadmium delivering the same current.



IN eight short years, the silver-zinc battery has evolved from a laboratory unit with simple cellophane separators and powdered electrodes to a sophisticated item. It is used in missiles, rockets, aircraft, torpedoes, portable power sources, and radio control applications.

To those aware of the efficiency of the silver-zinc couple, the reasons are clear. Foremost is its output per unit of weight and space—up to 6 times greater than that of lead-acid or nickel-cadmium couples. Silver-zinc batteries can supply 5 or 6 times more power than standard batteries of equal size; or they can supply the same at times, even more—power than standard batteries that are 5 or 6 times larger and heavier.

They are capable of extremely high rates of discharge—up to 20 times their rated capacity. The voltage, shown in Fig. 2 after an initial peroxide level which is of great advantage when high initial loads are required, is level ±3%.

Miniaturization and special projects have demanded higher and higher rates of discharge. The role of the silver-zinc battery has therefore come in for greater attention and closer scrutiny.

With reduced size and weight and increased power outputs, we now have highly-sophisticated applications. These include data-recording systems, complex telemetering instruments, and mobile, long-range missiles.

Applications which, up to now, had been considered impossible have become feasible, thanks to design developments in this new battery. The silver-zinc

Silver-Zinc Batteries *(continued)*

battery, new as it is, has seen many recent developments, which have led to great improvements.

Primary Batteries

A most significant development has been a new high-speed method of automatic activation. This results in a primary battery completely interchangeable with silver-zinc rechargeable batteries.

Because silver-zinc primaries utilize the full capacity of the battery, they can provide, in a smaller volume, power output equal to that of a rechargeable battery. Including separate gas and electrolyte tanks, they become equivalent to secondaries in weight and volume as well as output. See Fig. 3.

The importance of this development, activation and operation of the primary in any position, is obvious. To the missile design engineer, e.g., this means that he can use rechargeable units for exercise and test runs, keeping a check on reliability; and a primary battery for tactical end use, for long shelf life and economy.

The new automatic activating mechanism takes only split seconds to activate the primary, and ready it to provide 100% of its power.

Fig. 3: A new automatic activation system lends itself to compact arrangements. Capable of being activated and operated in any position, it is used in ICBMs.

It consists of 3 basic components which may be placed in whatever arrangement will best fit space requirements.

This type of construction lends itself to circular and odd-shaped configurations. The separate system for remote activation reduces further the weight of the battery in missiles by eliminating the inclusion of an activating unit.

As Fig. 4 indicates, when the spring-loaded plunger is triggered it breaks the gas tank seal. Gas inflates the bladder of the hermetically-sealed electrolyte cylinder. The displaced potassium hydroxide electro-

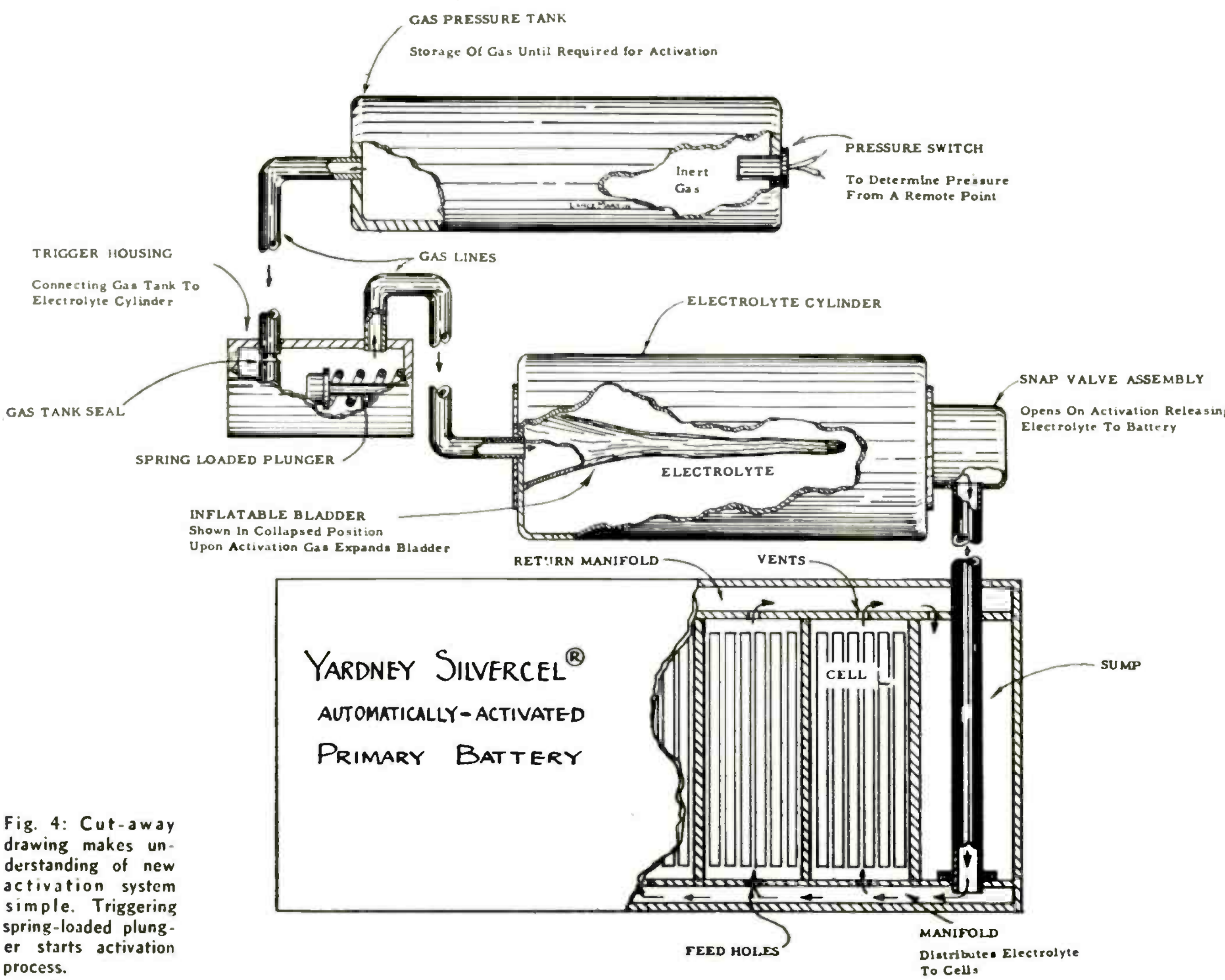


Fig. 4: Cut-away drawing makes understanding of new activation system simple. Triggering spring-loaded plunger starts activation process.

lyte then forces open a snap valve at the other end and flows through the feed tube to the manifold.

The snap valve assembly has been made shock resistant, so that the battery can be subjected to severe shock and vibration without fear of inadvertent activation.

In the manifold, the electrolyte is evenly distributed through feed holes into the individual cells, special vents allowing the surplus electrolyte, gas and vapors to escape through a return manifold into a sump. This venting system also permits operation of individual cells without high internal pressure, making the battery more reliable and saving additional weight.

Since the electrolyte does not contact the electrodes until the battery is activated, the battery may be stored dry indefinitely.

Rechargeable Batteries

Of great importance in secondary batteries has been the adoption of interference fit, Fig. 5, to monobloc rechargeable batteries.

The intercell connectors have eliminated threaded terminals and hardware—saving not only assembly, weight and space, but providing electrical contact between individual cells more reliable than any other means, short of fusion.

New Materials

Development of the silver-zinc battery is also being carried on continuously through research in new materials and techniques.

New types of negative plates have been developed to improve dry charged rechargeable batteries, and increase the efficiency of primaries.

In this list of developments are dry charged negatives that use special shape and surface treatments to maintain their capacity and activate more rapidly; combined dry charged and active reserve negatives that employ such refinements as "forge welding" for longer cycling; the introduction into high rate and low rate negatives of conducting alloys that will not form chemical couples with active materials; special additives, including active and non-active oxides and salts for pasted negatives, improving capacity and charging characteristics; and, laminated negatives, used in dry-charged, long life cells.

During research on positive plates Yardney Electric developed the first self-supported sintered electrodes; special construction of imbedded conductors for high-rate applications; and new "forge welding" techniques permitting fabrication of specially-large positives for extra-size cells.

A number of new types of cellulosic and non-cellulosic separators have also been developed which have increased the cycle life of silver-zinc rechargeable batteries as much as four-fold. These improved materials are used to meet the demands of high-rate or low-rate discharges, extremes of temperature, etc. Developments in this branch of the art have been especially marked in primaries, where there have been great advances in quick activation and long wet stand life performance.

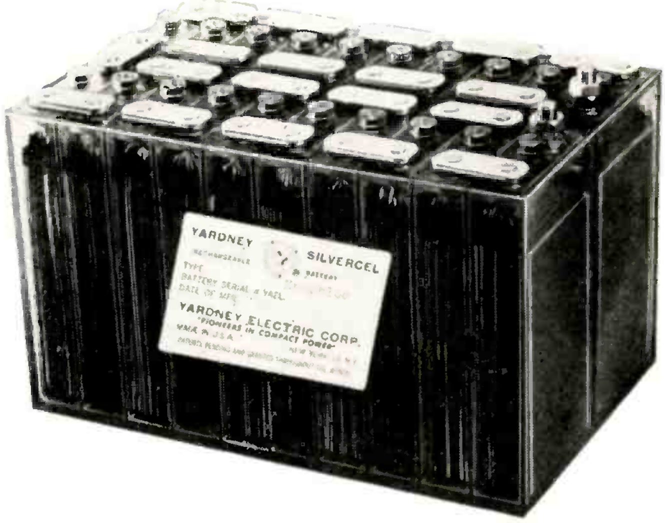


Fig. 5: Interference fit has helped replace the threaded terminals and hardware on this battery with new intercell connectors.

New Technique

Advanced molding techniques have been developed by Yardney Electric with the Rolle Mfg. Co. in the production of specially-cast metal trays for assembly of primary and rechargeable batteries. Of light metal alloys, including magnesium and hot-hard alloys, these trays are unique in the fact that the normal tolerances for the draft of the case have been greatly reduced. This decreases the volume required for the case and assembled cells.

Battery cases and covers cast from HK 31, a new magnesium alloy containing thorium and zirconium have been introduced. Used with batteries employed in the Bomarc IM-99 interceptor missile, this rugged alloy proved to be even better than stainless steel in its ability to withstand the severe shock and vibration requirements. At 600° F, it showed even greater mechanical strength than at room temperature.

There have been other developments: special shock-resistant mountings and constructions, including unitized and sintered electrodes, for withstanding high accelerations and vibrations up to and including white noise; special initial charging techniques and treatments to insure uniform and dip-free discharge characteristics, etc.

Prospects

Many more improvements are in the offing, not only in terms of size, weight and power output, but—just as important—in terms of reliability and performance.

That the silver-zinc battery has come as far as it has in eight short years is an impressive fact. But that its continuous development implies possible applications in many more commercial and military fields is more significant.

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Light can give control characteristics analogous to those resulting from the emitter in the grounded-base transistor. Likewise, a light-controlled tetrode-equivalent is possible, and has been developed.

The Germanium Photo-Tetrode

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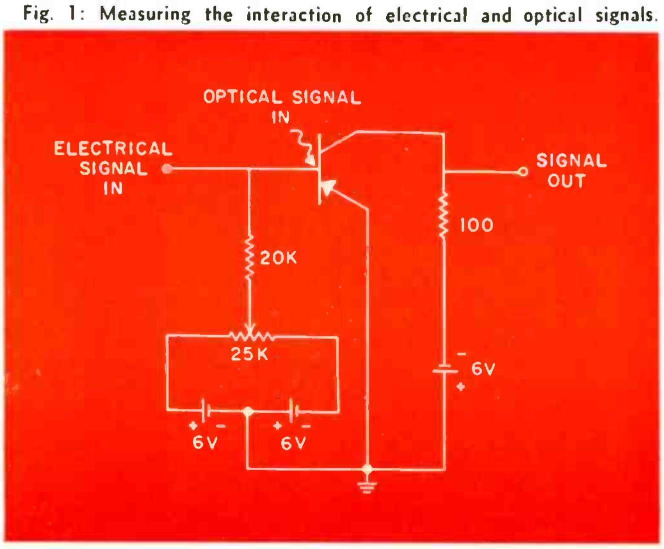
THE electrical behavior of semiconductors in the presence of suitable light has served both as a source of information on fundamental phenomena and as the basis for the development of transducer devices.

The conductivity modulation effected by light in a semiconducting crystal is well known, and the term "phototransistor" was first applied to the diode controlled by incident illumination.[1] The control characteristics thus achieved were entirely analogous to those produced by the action of the emitter in the grounded-base transistor.

Fig. 1: Measuring the interaction of electrical and optical signals.

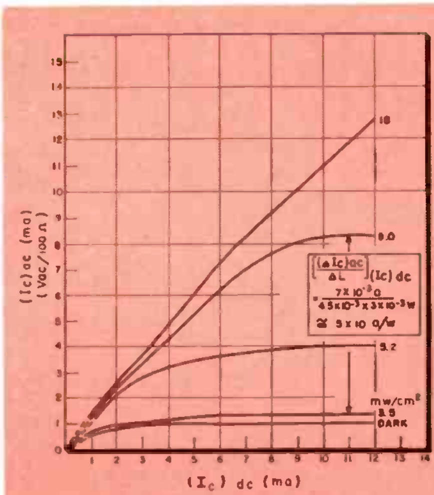


Early Forms

Early work on a light-controlled three-element transistor-type unit concerned itself principally with the floating-base, two-terminal connection.[2] Many current applications utilize a transparently encased junction transistor in this configuration, in which the collector photosensitivity is multiplied by the emitter-to-collector gain factor of the transistor.

For other applications, it is advantageous to use such a phototransistor as a light-controlled tetrode-equivalent, in which the effective operating point and bias are varied in accordance with the light intensity incident upon the base region. The *2N318* phototransistor is assembled as a normal *PNP* alloyed-junction germanium transistor, mounted in a glass envelope to enable light to impinge on the inter-junction region. In the absence of light, the short-circuit current gain (α_{cb}) for the grounded-emitter connection is constant with I_e up to 20 ma. With constant ambient illumination, α_{cb} is substantially unchanged, but the electrical characteristic is observed to shift so that higher values of cutoff bias are required on the base.

When the light is chopped to supply the signal and the base-to-emitter voltage is used as the compensat-



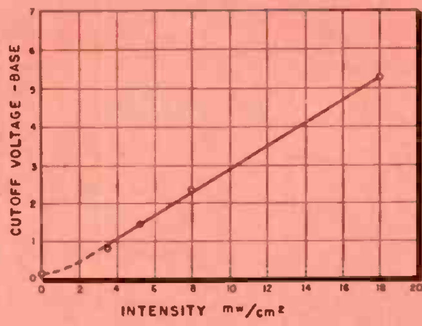
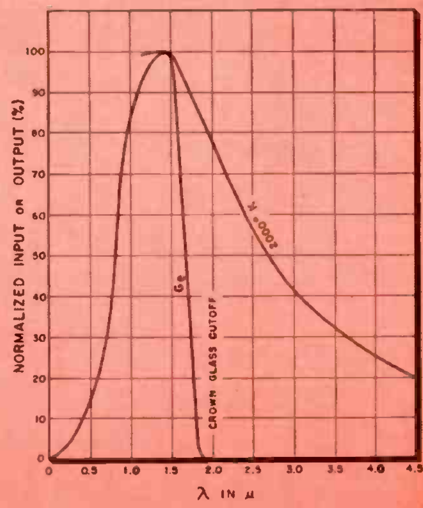


Fig. 2 (left): Signal current vs dc I_c.

Fig. 3 (above): Cutoff vs optical input.

Fig. 4 (right): Comparison, spectral sensitivity Ge devices and 2000°K black body.



ing bias, a different behavior is observed. Here the output signal current increases with increasing I_c to a saturation at much higher values than that required in darkness. Fig. 2 illustrates these characteristics. This effect indicates an increase in dynamic photoresponse with increasing emitter current. Fig. 1 is a schematic diagram of the circuit used throughout.

The interaction of the two biases may be observed in the variation of the electrical cutoff of I_c with light intensity. Fig. 3 is a graph of cutoff base bias versus incident intensity for cutoff current. The residual value of current, however, increases with increasing intensity because of the photovoltaic effect.

ments, the interposition of a crown glass lens between the lamp and the thermopile effectively eliminated the need to correct the thermopile readings for that portion of the black-body spectrum which would not produce photoconductivity in the germanium. In subsequent operation, the lens substantially reduced spurious heating of the transistor. Fig. 5 is a schematic representation of the optical system, and Fig. 7 is the output calibration at the image plane for this system.

The radiant source was a 500-watt G.E. projection lamp, which has a very compactly wound filament. The calibration was made with a 12-junction bismuth-silver thermopile.

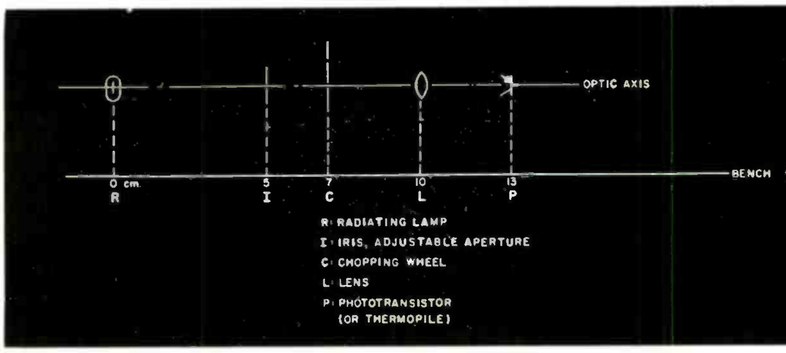


Fig. 5: Measuring total radiation sensitivity of the phototetrode.

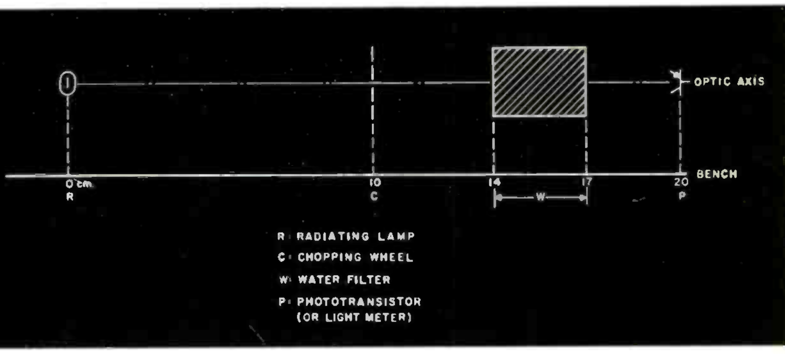


Fig. 6: Measuring the visual sensitivity of the Ge phototetrode.

Units

It will be noted that the light intensity is expressed in terms of energy density rather than in photometric units. The spectral sensitivity of germanium devices is known to be greatest in the near infrared region. The comparative characteristics of a germanium receiver and of a black-body emitter at 2000°K are illustrated in Fig. 4. The wavelength identified as the spectral cutoff for crown glass shows that for engineering use at moderately high intensities, crown glass optical elements are adequate.

In fact, for purposes of measuring the available radiation of a tungsten source for these measure-

Dynamic Sensitivity

The average dynamic sensitivity of this type of phototransistor may be computed from the curves of Fig. 2 by taking the ratio $\left[\frac{(\Delta I_c)\ ac}{\Delta L}\right] (I_c)\ dc.$ The effective area of the unit is an annulus surrounding the optical shadow of the emitter of about 3×10^{-3} cm². Thus the total radiation input is the measured intensity multiplied by this area. A change of 4.5 mw/cm² in intensity becomes a change (ΔL) in total effective light input of 14 μw. With $(\Delta I_c)_{ac} = 7$ ma, the resultant sensitivity is 5×10^2 μa/μw. The transistor gain factor, α_{cb}, for the typical unit illustrated here was measured in darkness and

Photo-Tetrode

(Concluded)

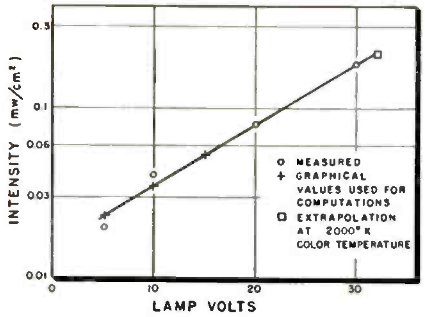
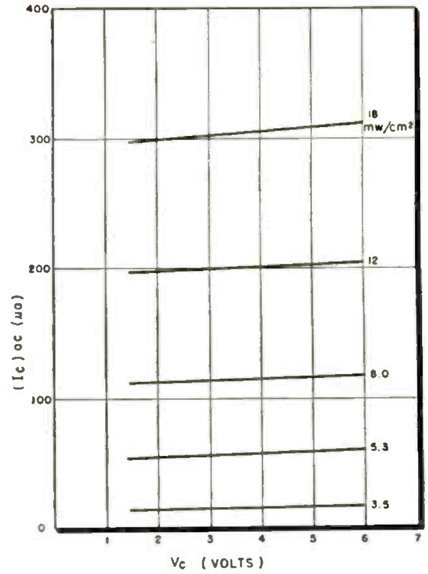


Fig. 7 (above): Calibration of 500-watt projection lamp through crown glass optics.

Fig. 8 (right): Photo-sensitivity of the collector alone, operated as a diode.



found to be 80, so that the net photosensitivity of the collector region is about 6 μa/μw. By comparison, the sensitivity of the collector junction alone may be computed from the data of Fig. 8, and is found to be 6 μa/μw. These nominal values are representative of units selected at random from several production lots.

Visible Range

For work in the visible range, an order-of-magnitude conversion may be made with the factor 6×10^2 lumens/watt. This value is taken from the average sensitivity curve of the human eye. The conversion factor actually varies with wavelength, and its maximum, at the maximum sensitivity of the eye (5560A) is 621 lumens/watt. Averaged over the narrow range of overlap of the human eye and the germanium spectral response characteristics, the value 600 is sufficient for engineering requirements provided no infrared energy is permitted to reach the germanium. With this provision in mind, the sensitivity of 500 μa/μw is translatable to 0.8 μa/μ-lumen.

To test the validity of this conversion, the lamp was operated at 90 volts to produce the photometric color temperature standard of 2870°K. No lens could be used with the intensities thus generated. A 3-cm. thickness of water was introduced into the optical path to filter out the infrared, yielding a net spectrum which is a good approximation to the response of the eye. A photographic light-meter was used for intensity readings.

At an intensity level of 1000 ft-candles, which is about 1 lumen/cm², the effective input to the phototransistor was 3×10^{-3} lumen. The output signal current was 2.4×10^{-3} amp, confirming the value of 0.8 μa/μ-lumen. The optical system for this measurement is schematically shown in Fig. 6.

The relative spectral ranges of the total and the visible-only inputs for the 2870°K system may be inferred from the fact that the output reading with the water filter removed was 2.7 volts. The corresponding difference in the light-meter readings was some 50%; the meter contains a selenium cell and a filter to correct it to eye-sensitivity. Thus, while many control applications employ visual light sources and photometric comparisons, the greater utility of the germanium phototransistor lies in the near infrared.

The sensitivity defined here has been a signal rating, as it would most conveniently be obtained in actual use. The light levels were direct, but the signal was alternating. The chopped waveform was square, and the duty cycle was 50%. The effective value is therefore 50% of peak, and the true sensitivity, based on dc values, would be doubled.

In the region marked on the graph of Fig. 2, the increments show that the variation of photocurrent with light is linear up to the point where the device becomes current-limited. The intensity region in this investigation is defined as the high-light range,[3] that in which the photocurrents are of the same order of magnitude as the dark currents. In germanium and silicon of transistor-quality purification this range is readily attained, in contrast with other photoconductive substances, in which it is relatively difficult to generate such photocurrents because of the higher probability of carrier recombination. The behavior of *NPN* germanium units is qualitatively similar to that of the *PNP*, and these measurements will be followed for *NPN* cells.

Applications

Suggested types of applications for this device are those in which a light beam may be used to actuate a gating circuit, or the converse, where a gated bias circuit serves to switch the photosignal on and off.

The authors wish to thank their colleague, Sherman Gross, for supplying the phototransistors used in this study. In addition, they express their appreciation to Dr. Frédéric Fua of Standard Electronics Research Corporation for his advisory discussions on radiometry.

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2. Stahl, F. A. *Elec. Eng.*, 70, 518 (1951).
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For Designers . . .

Using Self-Resonant Frequency

Increasing demands for circuit simplicity, reliability, and economy suggest re-evaluation of the r-f coil. Self-resonant frequency characteristic offers unique design features.

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ALL coils exhibit a self-resonant frequency (SRF) characteristic. The inductance of a coil, together with the inherent distributed capacitance in parallel, form a parallel tuned resonant circuit. The resulting characteristic may be utilized for many circuit functions.

Proper control of the SRF characteristic and connected reactive circuit constants must be assured before the equipment manufacturer can fully exploit these circuit design potentialities.

Circuit Design

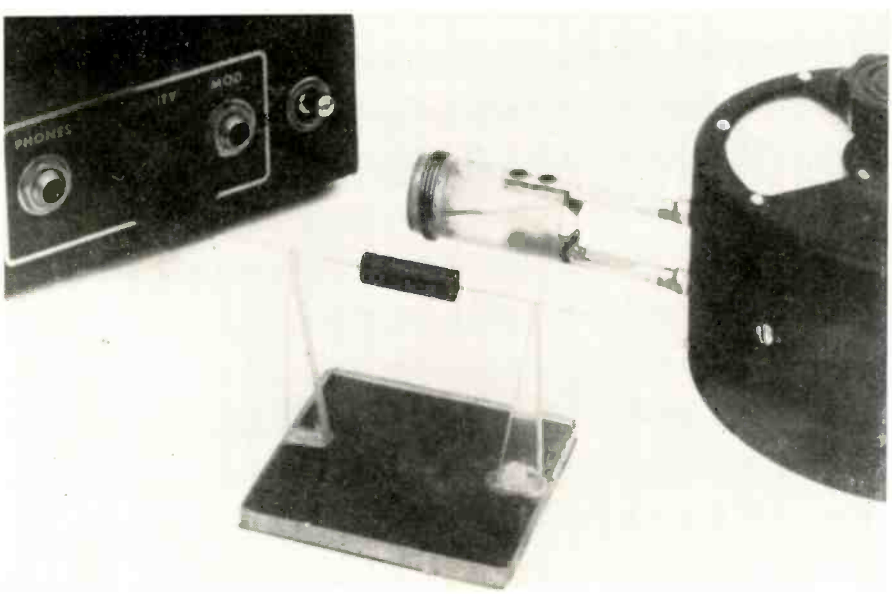
For most applications, the only requirement for SRF is that it be considerably above the operating frequency. This assures uniform circuit impedance. A specified SRF minimum is an accurate and convenient method of specifying the distributed capacitance of a coil. Any further requirements on this parameter for general applications could result in unnecessary restrictions on the coil design, which might add to the cost.

Although a coil possesses both inductance and inherent distributed capacitance, the reactance of these at SRF completely cancel out, thereby providing a resistive impedance. Such a resistive impedance is useful in many circuits wherever a large matching or blocking impedance is required providing other reactive circuit elements have been balanced or compensated for.

A coil operating at its SRF can be very useful in filter applications. A single coil connected in series will serve as a bandstop filter. Similarly, a single coil connected in parallel will serve as a simple bandpass filter.

A coil functioning at its SRF can also serve as a "stand off" terminal mount. Such "mounts" offer an impedance at a particular frequency comparable to that of a good quality insulator. Other frequencies and dc are readily passed.

Fig. 1: Grid dip meter readings should be taken with a minimum of inductive coupling.



Measurement of SRF

It is difficult to over-emphasize the importance of good measurement techniques in any program of close SRF control. For small r-f solenoid coils with axial leads from 0 to 0.5 in. long and with inductance values up to a few μh, a typical distributed capacitance would be 0.3 μμf.

However, this does not mean

(*Continued on page* 100)

A REPRINT
of this article can be obtained by writing on company letterhead to
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ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

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Adequate human response in modern closed-loop man-machine systems requires simplified integrated display of command data. A method of generating such a display is developed, and the specific techniques for simplifying the instrumentation of jet aircraft are described.

Man-Machine Systems Call for

Displaying Integrated

THE instrument panel of a modern jet aircraft illustrates a situation that has its counterpart in many industrial applications: many separate indicators show components of an over-all situation that must be integrated in the mind of the human controller (the pilot).

The integration process requires a finite time, and a point is soon reached at which the number of independent data inputs cannot be integrated within the over-all response time required of the man-machine system.

A jet pilot, flying on instruments, might very easily find himself in a fatal situation, through a pilot error that occurred as a result of the delay between the time at which he began making his last survey of the instruments and the time at which he initiated the corrective action.

Over-all response time consists of data acceptance time plus reaction time required to initiate corrective action. Reaction time is a property of the individual, and cannot be much decreased once the individual is selected and trained. The data acceptance time, however, depends on (1) the number of separate inputs and (2) the time required for their integration. Both of these factors can be decreased by the application of the concept known as integrated instrumentation.

Contact Analog

In the integrated-instrumentation system, the number of separate inputs is effectively decreased by presenting all of the information on a single display. Moreover, the integration time is decreased by presenting the information in a form that has some

Representation of Aircraft Attitudes

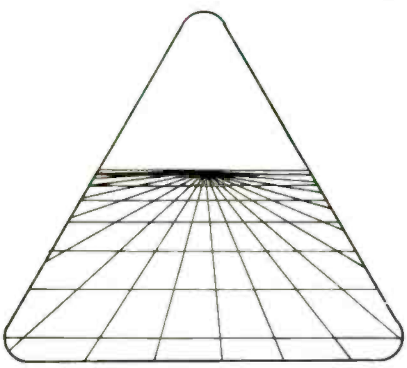

Fig. 1: Level flight, plane on heading.

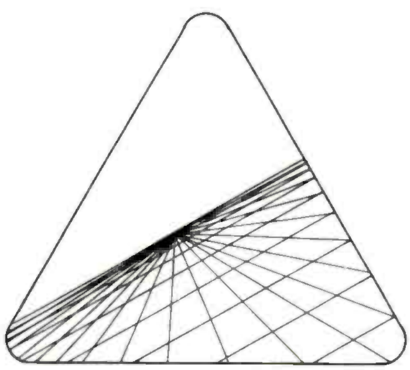

Fig. 2: Aircraft is now in a right bank.

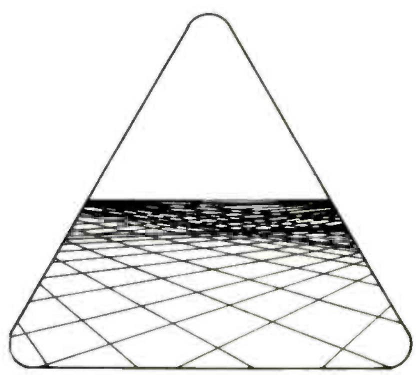

Fig. 3: Level flight, on cross heading.

D. G. Aid

Dr. C. Süsskind

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DR. CHARLES SÜSSKIND is also Asst. Prof. of Electrical Engineering, Univ. of Calif., Berkeley, Calif.

Mockup of cockpit shows thin, flat plate, transparent screen called contact analog.

Instrumentation by Means of the Contact Analog

relation to the manner in which the human controller is accustomed to accepting it in the real world. For instance, an indication of an increase in altitude is much better related to the real world if it is presented in the form of an apparent contraction of a textured surface than in the form of a dial reading.

These concepts are obviously applicable to any man-machine system, although the present description is limited to the case of integration of flight information. The data representing an aircraft's speed, altitude, and attitude (i.e., heading, roll .and pitch) are combined into a single display. This display is related to the real world in a simple way, and is known as the contact analog. The method is utilized in an actual display generator designed and developed at the Kaiser West Coast Electronics Laboratory in Palo Alto, Calif.

In a typical presentation, Fig. 1, the contact analog consists of a perspective representation of a set of grid lines that appear to converge toward a point on the horizon. When the aircraft goes into a roll, the entire presentation tilts, Fig. 2. A change in heading shifts the picture as in Fig. 3. A change in pitch changes the perspective: a vertical dive is illustrated in Fig. 4. A change in altitude at level flight is illustrated in Figs. 5 & 6, which show the apparent expansion in the texture gradient as the aircraft goes from a high altitude, Fig. 5, to a low altitude, Fig. 6.

A representation of speed is obtained by causing the entire display to give the impression of forward motion to the observer. In the level-flight, on-heading case, Fig. 1, for example, the horizontal lines appear to be generated in the horizon, move continually

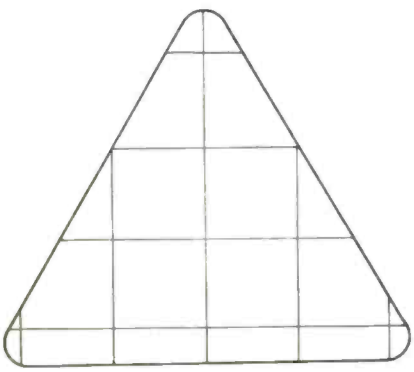


Fig. 4: Perfect grid means vertical dive.

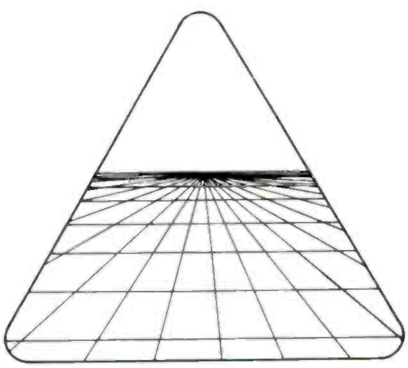


Fig. 5: Plane flying at high altitude.

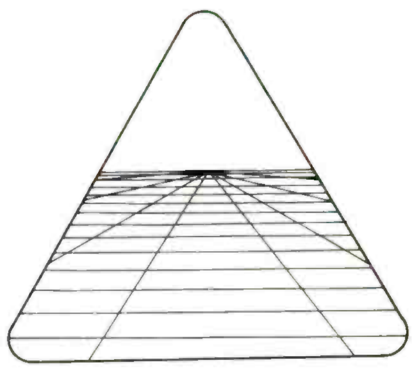


Fig. 6: Plane operating at low altitude.

Displaying Instrumentation

(Continued)

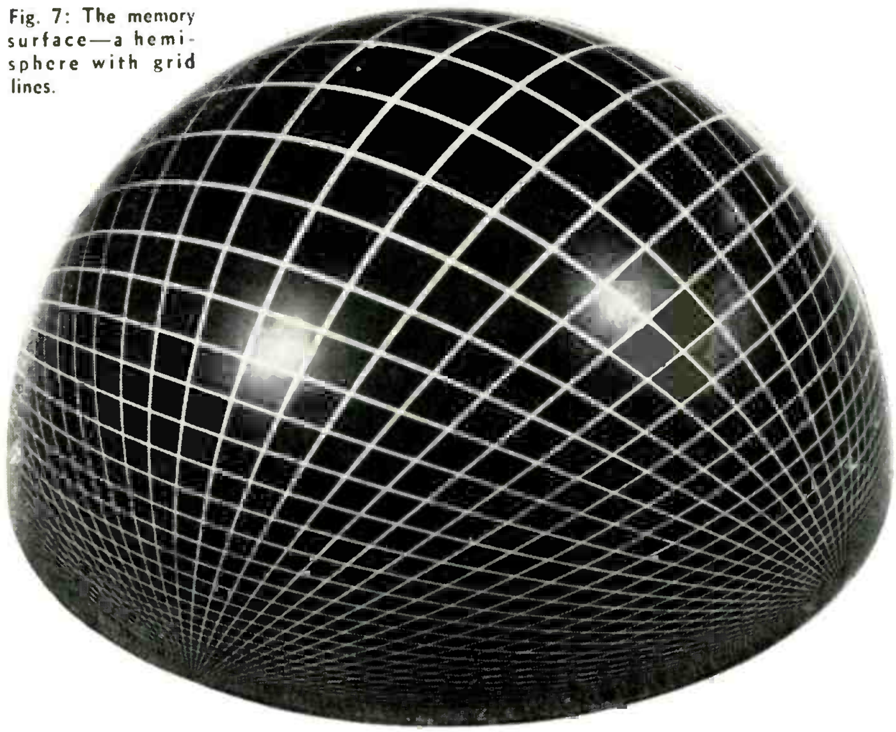


Fig. 7: The memory surface—a hemisphere with grid lines.

downward, and disappear from view at the bottom of the display. In fact, the contact analog of a moving aircraft is always a dynamic display with complete continuity of motion—a characteristic that cannot be readily represented by drawings or photographs.

The contact analog thus satisfies both the requirement for a reduced number of separate inputs, by combining several into a single display; and the requirement for reduced integration time, by presenting the information to the pilot in a manner similar to that in which he is accustomed. The grid-line representation is seen to be very much like the actual picture observed by the pilot of an aircraft flying over flat farmland sectioned into regular, square lots.

The Hemisphere

The basic information to be displayed is contained on the surface of a hemisphere, Fig. 7. A pattern of lines is mechanically inscribed on a hollow aluminum surface that has been anodized black and covered with an acid-resistant film; immersion in an etching vapor bath then produces the contrasting pattern shown. An examination of this pattern reveals that all of the configurations illustrated in Figs. 1 to 4 can be derived by viewing a portion of the hemisphere—a procedure that is actually accomplished by an electronic camera. The edge of the hemisphere corresponds to the horizon. The lines converge toward four singularities on the horizon, representing the cardinal points of the compass. The thickness of each line varies, decreasing toward the horizon to strengthen the impression of linear perspective.

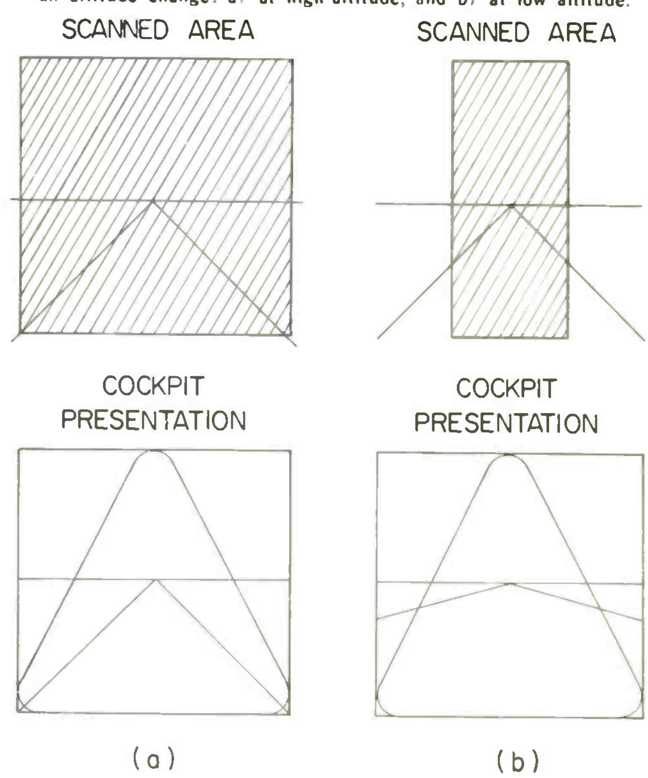
To obtain a display like that of Fig. 1, the camera views a small area surrounding one of the cardinal points; Fig. 3 corresponds to an area half way between cardinal points; and Fig. 4, which does not contain the horizon at all, corresponds to the apex of the hemisphere. The motions necessary to produce the changes in heading and pitch are accomplished in the present device by moving the hemisphere with respect to a stationary camera. The hemisphere is supported by a two-axis gimbal and is moved by two servo repeaters actuated by electrical signals from the vertical and directional gyros of the aircraft.

Camera

The camera serves two purposes: (1) to read out the positioning information; and (2) to transform this information in accordance with additional information pertaining to altitude and speed.

In practice, the camera comprises a flying-spot scanner and photomultiplier. The moving light "spot" on the face of the scanner is optically focused onto the surface of the hemispherical memory. The reflected light is collected and amplified by the photomultiplier. The flying spot produces a uniformly bright rectangular area on the scanner face. The differences in the amount of light reflected from the white lines and from the dark background on the hemisphere are translated into a video pulse train (by means of the photomultiplier) that is amplified

Fig. 8: Relation between the size of camera raster and display in an altitude change: a) at high altitude, and b) at low altitude.



by a video amplifier and forms the input to the display tube. The sweeps of the display tube are, of course, synchronized with those of the camera tube, by means of a central timing and sweep generator.

To introduce altitude information, the size and shape of the raster of the camera tube are adjusted, as follows. To indicate a decrease in altitude, the texture of the display must be made coarser, Fig. 6. This change is accomplished by making the camera-tube raster smaller along the horizontal, Fig. 8.

To introduce speed information, the display must appear to expand continuously from the impact point. The impact point is defined as the intersection of the flight path with the surface of the earth; in level flight, the impact point lies in the horizon. The nature of the display pattern is such that this continuous expansion can be accomplished by a repeated expansion and collapse, since the action is repeated as soon as a horizontal line reaches the position initially occupied by the preceding line. To accomplish this action, it is thus only necessary to apply a cyclic signal that contracts the size of the camera raster, and then permits it to expand to its initial size almost instantaneously. This operation is illustrated in Fig. 9.

It is seen that in both the altitude and speed transformations, it is necessary to perform an operation on the camera raster that is the inverse of that required on the display. The over-all size of the display raster remains constant.

It should be noted that the flight path may not always coincide with the physical heading of the aircraft, e.g., when the aircraft is "slipping" or "settling." Here, the impact point lies off center, or not on the horizon, or both, but the display pattern must still appear to expand from that point. A special circuit is employed to shift the display raster accordingly.

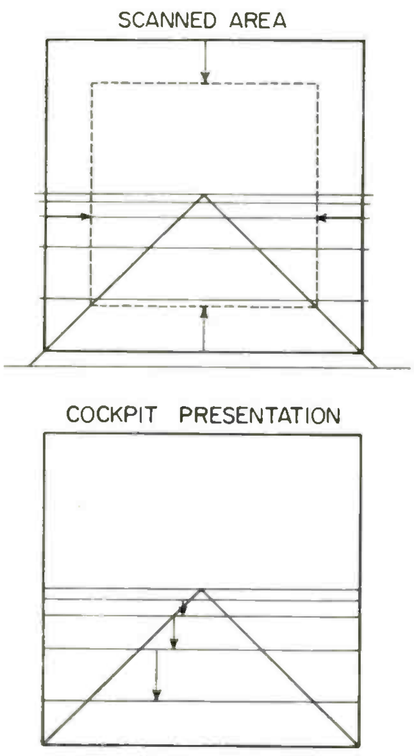


Fig. 9: Method of contracting camera raster periodically to obtain periodic expansion of display presentation.

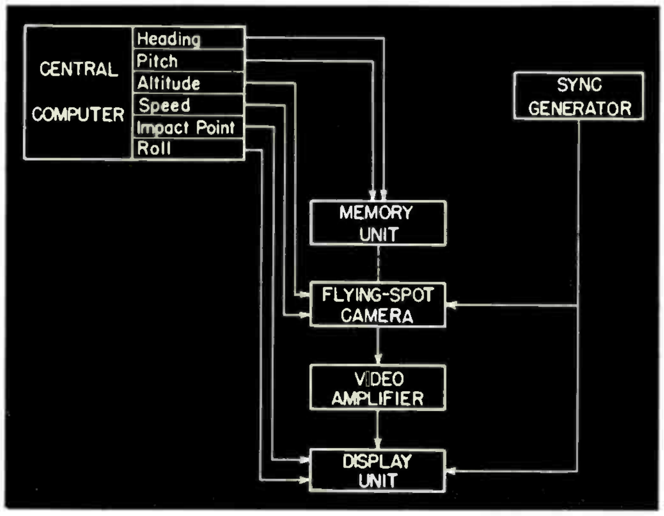


Fig. 10: Contact analog system can introduce roll electronically.

Roll

The operations described above thus accomplish a representation of all the elements needed to describe the aircraft's speed, altitude, and attitude, with the exception of roll. This information can be introduced in a number of ways, all aiming at rotating the display in accordance with the roll of the aircraft. Perhaps the simplest method is to cause the deflection fields of the display tube to rotate about its axis, either by physically rotating external magnetic deflection yokes, or electronically, by using resolved signal components on the windings of a double yoke.

Possible Extensions

If roll is introduced electronically, the system, Fig. 10, operates entirely electronically, with the exception of the two servo repeaters used to move the hemispherical memory. In an alternate version, now under development, even this moving part is eliminated (by the use of advanced electronic storage techniques), so that an "all-electronic" system results.

The system is by no means limited to the display of the information described above. Additional information, e.g., air temperature, could, of course, be included by the use of appropriate symbols, and the versatility of the system could be further increased by the use of a color display tube. Even the present system contains additional features omitted for the sake of clarity and other reasons. One such feature is the addition of a second hemisphere, carrying a contrasting pattern to represent the "sky." This prevents the display from becoming blank during a steep climb.

Acknowledgment

Much of the work toward the development of the system described was carried out under the Army-Navy Instrumentation Program (ANIP), coordinated by Douglas Aircraft Co. under Prime Contract Nonr 1076(00). This system constitutes the first known method of presenting an integrated display of the several information signals on an electronic display screen. A more advanced system is currently under development at Kaiser's Palo Alto laboratory.

Examining the significant operational characteristics of delay lines and how they influence design. Covers: delay time, carrier frequency, voltage attenuation, bandpass characteristics and spurious response.

Designing

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THE primary consideration with regard to delay time is the physical size of the final package. Since delay time is basically a function of path length and shear velocity in the transmission medium (.01234 ft./μsec. in Code 7940 C.G.W. Fused Silica), the size of the delay line is determined by the reflection pattern selected.

Three typical reflection patterns yield cased line sizes shown in Table I.

These three patterns cover the range of delay time in common use today. However, numerous other patterns, with varying degrees of reflection pattern compression, have been developed to meet specific size requirements and other performance characteristics.

Design Capabilities

The upper limit of the delay time, for any given single plane pattern, is fixed by the maximum diameter of available ultrasonic quality fused silica. These limits are those shown in Table I for Patterns I and II.

Beyond the limit of 3300 μsec., it is necessary to resort to a more compressed pattern or a multi-plane configuration.

The lower limit is imposed when the reflecting and transducer facets become too short to accommodate an effective acoustic beam width on any given reflection pattern. It then becomes necessary to employ a less compressed pattern to provide the desired transducer areas. Generally, this is more of an economic consideration than a design problem.

Related Characteristics

Voltage attenuation, carrier frequency, terminal capacity, and, in particular, spurious response and third time reflection, are all related to delay time and thereby physical size. Each of these characteristics are treated individually later and are mentioned here only to emphasize their interrelationship.

Carrier Frequency

The major factor related to carrier frequency is silica loss. Silica loss increases rapidly with frequency. This becomes an important consideration from the standpoint of voltage attenuation characteristics as the delay time (path length) increases.

To compensate for increased silica loss at higher frequencies, it becomes necessary to increase the transducer crystal frequency. For long delay times, the total silica loss becomes so great that large increases in transducer crystal frequency are required. For example, a 2100 μsec. delay line with a carrier frequency of 35 MC requires 60 MC crystals to obtain minimum attenuation at carrier frequency. Since 60 MC is the highest frequency of crystals available in commerical production and suitable for delay line use, this constitutes a design limit. Fig. 1 illustrates the practical limit of carrier frequency as related to delay length, for fundamental mode operation.

At lower frequencies, silica loss is no problem. However, transducer efficiency (referred to unit driven area) decreases with frequency; consequently, larger driving areas must be used. The problem then becomes one of obtaining a geometric configuration with large enough crystal and reflecting facets to accommodate an effective transducer, yet small enough to satisfy the requirements of the application.

Voltage Attenuation

The voltage attenuation of a signal through a delay line results from the sum of the losses in:

1. The transducers.
2. The fused silica.
3. Beam collimation, reflecting apertures and coatings used for secondary control.

Of these three losses, the transducer and fused silica losses are most significant.

The transducer losses:

1. Decrease with increasing frequency (area constant).
2. Decrease as active area is decreased.
3. Increase with off-resonance operation of the crystal.

acteristics. Note the effect of increasing silica loss with increasing frequency in shifting the peak frequency lower, and skewing the resultant response curve.

Fig. 2 also demonstrates the mechanism by which carrier frequency is limited by delay time or total silica loss.

Smoothness of Response

Regular high frequency variations in voltage attenuation in the pass band (ripples) are primarily a function of transducer design. Ripple can be con-

Ultrasonic Delay Lines

Since losses in the fused silica increase with increasing frequency, a complex relationship exists between voltage attenuation, carrier frequency, and delay time. Thus, it is necessary to consider each of these factors simultaneously in the design phase and summarize the effect of each in predicting voltage attenuation.

Typical values of voltage attenuation are given in Table 2.

This demonstrates the absence of a simple relationship among delay time, carrier frequency and voltage attenuation parameters.

trolled to negligible amplitudes with design and process techniques.

Irregular variations (jags) are primarily a function of material quality and can be controlled only to a limited extent by design technique.

The design most commonly employed provides a theoretical maximum bandwidth of 77% of center frequency. This is a theoretical value, and has not been achieved in practice. Practical values obtainable in quantity production range up to 50% of center frequency. Better than 60% bandwidth has been achieved occasionally with laboratory controlled conditions.

Other factors which affect bandwidth are silica

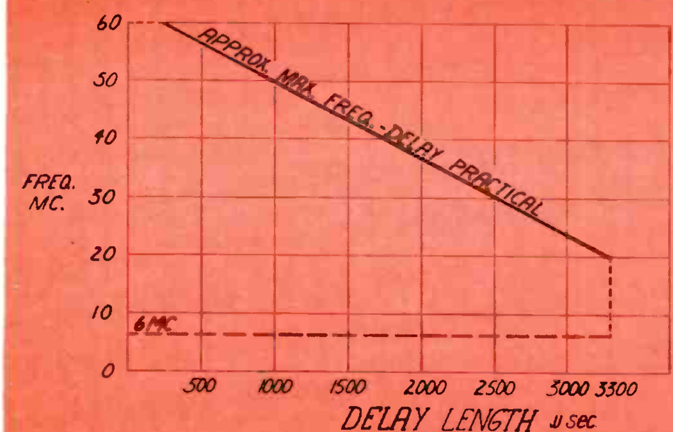


Fig. 1: Practical limit of carrier frequency vs. delay length.

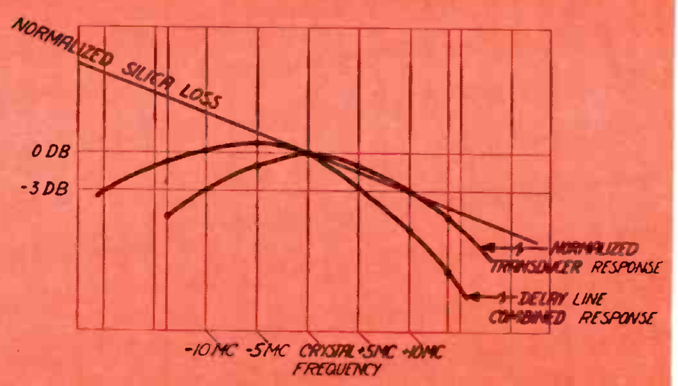


Fig. 2: Increasing silica loss lowers the peak frequency.

Band Pass Characteristics

The acoustic bandwidth of a delay line is primarily related to carrier frequency and transducer design.

Theoretically, bandwidth bears a percentage relationship to carrier frequency, hence wider bandwidths result with higher carrier frequencies. The transducer design, including both configuration and materials used in the assembly, are very significant factors in determining bandwidth.

Fig. 2 shows the effect of silica on band pass char-

quality, absorbers used to control secondaries, and delay length.

It is of interest to note that by transducer design variations, it is possible to reduce voltage attenuation moderately at the expense of reduced bandwidth.

The relationship is similar to those existing in the case of loaded resonant circuits. Ripple within the band pass can be controlled to 1 db. peak to peak without difficulty. Lesser values become an economic consideration.

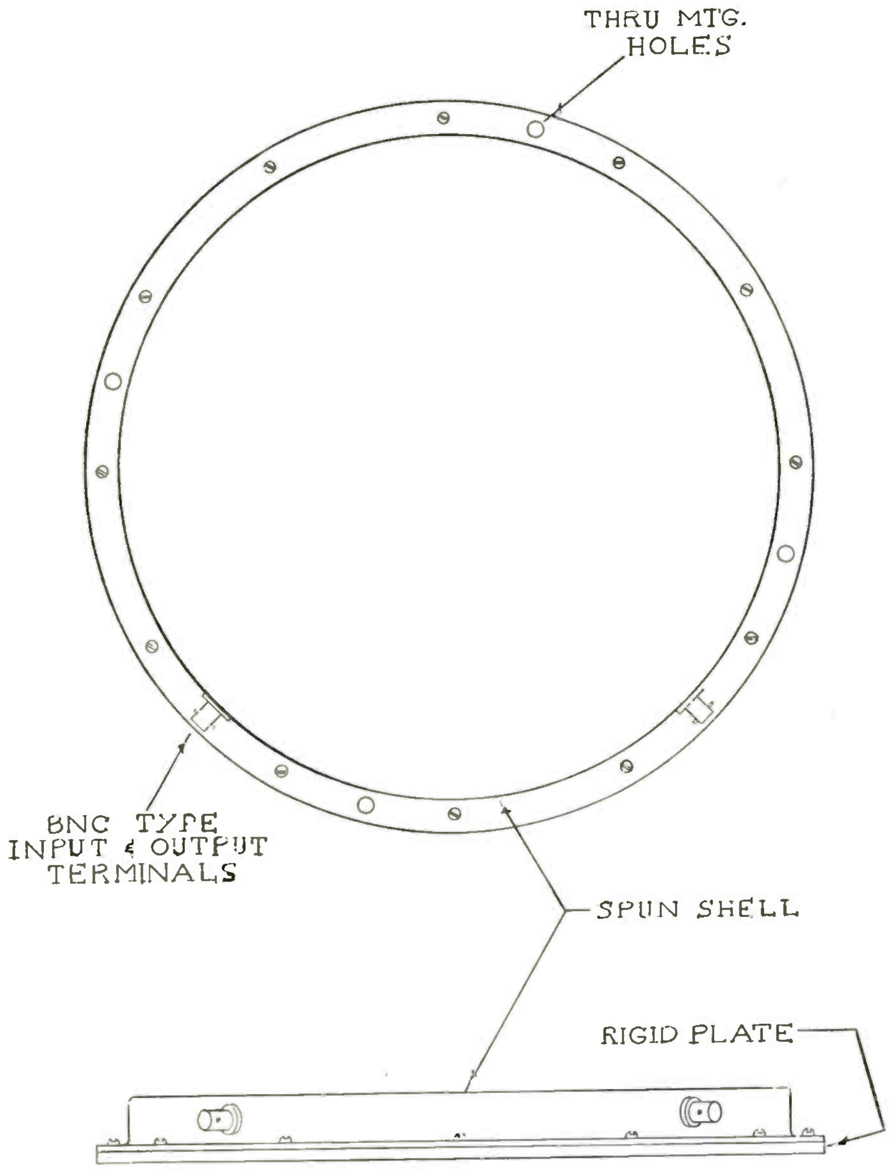


Fig. 3: "Hat" design is simple to assemble and minimizes feedthrough and shielding problems.

Table 1—Typical Reflection Patterns

Pattern	Delay Range (μ sec.)	Simple Case Dia. & Thickness (inches)
I	1000 to 3300	7¼ D. x 1⅛ to 20 D. x 1¼
II	500 to 1790	7 D. x 1⅛ to 20 D. x 1¼
III	240 to 1400	3⅛ D. x 1 to 17¾ D. x 1¼

Table 2—Typical Voltage Attenuation Values

Delay (μ sec.)	Frequency (mc.)	Voltage Attenuation (Ave. db. into 50 ohms)
250	40	60
250	11	72
2778	20	72
2778	9	80
3333	10	78
3333	15	68
1559	35	56
2053	35	77

Ultrasonic Delay Lines

(Continued)

Spurious Responses

Spurious signal levels are closely associated with reflection pattern compression. Generally, as pattern compression increases, spurious level capabilities of the delay line degrade.

Within this general capability area established by a particular pattern, other factors influence spurious levels in practical design.

Any single spurious signal is simply energy from the main beam, or its side lobes which reaches the output transducer by way of a path other than the desired one, therefore the best spurious performance requires minimum beam spreading and low side lobe energy content. These factors are controlled largely by transducer design.

Beam control is, to a considerable degree, a function of the dimensions of the active area of the transducer, measured in wave length units. Thus, in a practical sense, this consideration is closely allied with carrier frequency, delay time and actual physical dimensions of the delay line pattern required.

Absorber coatings are normally applied to portions of the reflector facet not used to reflect energy. The uncoated portions of these facets in effect are reflecting apertures, tending to limit the energy to the desired reflection path. These so called "absorber stops" reduce the energy content in the inevitable spurious signals impinging on these absorber areas.

Problems of spurious control become magnified on compressed patterns where multiple main path reflections are required on nearly every facet.

The nominal spurious performance ranges of three commonly used patterns is shown in Table 3.

Third Time Reflection

This spurious signal occurs at three times the design delay of the main delayed signal, as the name implies. It is present at some amplitude in all ultrasonic delay lines. This amplitude varies widely with delay time and frequency.

The phenomenon accounting for third time response is that of reflection of a portion of the main signal energy from the output transducer back along the main beam path, reflected again at the input transducer, then returning to the output transducer to produce the spurious response. Higher order multiple responses are possible as well, under certain conditions.

The factors affecting the ultimate amplitude of the third time signal, and most significantly, the signal level when referred to the main delayed signal, are:

1. Total loss of the acoustic transmission medium which acts *once* on the main delayed signal, and three times on the triple pass reflection.

2. The reflection coefficient of the transducers.

Since the loss per unit length of path of fused silica varies with frequency, it is apparent that the relative amplitude of third time signal will be a delay length and frequency dependent variable.

Control of reflection coefficient is primarily a function of transducer design. Transducer design can be used to control third time reflection signal level within reasonable limits. However, as design carrier frequencies are reduced and delay times decreased, the third time response becomes increasingly difficult to reduce.

Somewhat limited experience with short delay low frequency lines indicates that a 250 μsec.-20 MC line, assembled with optimum standard techniques will have a third time response of about 40 db below the main delayed signal. If the same line is assembled to operate at 10 MC, it is estimated that the third time response will be approximately 30 db below the main delayed signal.

All delay line transducers are simple two-plate capacitors. The standard method of computing capacity applies, utilizing the electrode area, crystal thickness and dielectric constant to yield quite accurate end cell design values. Build out capacity of wiring, connectors, etc. usually adds 5-7 micro-microfarads in uncomplicated assemblies.

The design capabilities are limited only by the compromises necessary in consideration of the performance characteristics dependent on tranducer design. Most important of these are:

1. Band pass characteristics (ripple).

2. Spurious performance.

3. Voltage attenuation.

It follows that where terminal capacity is limited by specification, performance characteristics must be compromised. Thus it is mutually advantageous to avoid finalizing the capacity specification until prototype delay lines have been designed, assembled, and tested. At this point, the capacity specification can be safely finalized, and tolerances assigned.

Mechanical Characteristics

Table 1 shows typical case dimensions for a range of delay times. Case design generally preferred by us is what is commonly referred to as a *"hat"* and *"plate"* design. This is shown in Fig. 3.

This design has two primary advantages as follows:

1. It provides a simple and effective package because
   (a) It is easy to assemble in production
   (b) terminal arrangement minimizes feed through problems and the necessity for internal shielding
   (c) the proximity of terminals to transducer minimizes variations in *terminal* capacitance
   (d) a convenient mounting arrangement is provided by flange
   (e) tight closure is provided, yet critical tolerances are not required.
2. It is easily and readily obtainable
   (a) can be procured without costly tooling
   (b) delivery can be obtained in minimum time.

Possible disadvantages are:

1. Overall diameter is increased by the flange.
2. Terminal arrangement may not be convenient in the equipment.

Internal Package Design

Internal package design, including materials used, meet most military requirements. Materials are not fungus nutrients. The delay line is encapsulated or potted in Dow Corning's RTV Silastic compound. This method is preferred over hermetic sealing because it combines shock and absorption characteristics with effective internal sealing.

Weight

Table 4 shows weights for typical assemblies of various time delays.

Terminals

BNC or similar types are preferred terminals because:

Table 3—Spurious Performance

Pattern	Delay Range (μ sec.)	Compression (dia. μ sec.)	Nominal Spurious Levels 9–20 mc		Over 20 mc	
I	1000–3000	.0055	−30	−40 db	−40	−45 db
II	500–1790	.0102	−45	−50 db	−50	−55 db
III	240–1400	.0127			−44	−60 db

Table 4—Typical Delay Times and Weight

Delay (μ sec.)	Approx. Weight (lbs.)
250	.9–1.5
850	9–10
1100	8–10
1400	9–11
2200	12–15
2600	14–16
2780	14–16
3300	24–48

Table 5—Variations In Delay Time With Operating Frequency

Nominal Delay Time (μ sec.)	Carrier Frequency (mc)	Normal Bandwidth (mc)	Variations in Time Delay over Bandwidth (μ sec.)
2778	9	3	1.34
2778	20	6	0.18

Ultrasonic Delay Lines

(Continued)

1. They are standard throughout the industry and generally acceptable to the military.
2. Availability is good.
3. When required, internal (base) shielding is uncomplicated.

Operational Factors

Two major operational factors influence delay line performance and thus must be given design consideration. They are (1) operating frequency, and (2) temperature.

The characteristics which are affected by variations in operating frequency are delay time and spurious response, including third time around. Variations in delay time with operating frequency are small as shown in Table 5 for a 2778 μsec. delay line, hence are not considered to be too important in most applications.

Note that for a given delay time the variation per megacycle decreases with higher carrier frequency. Also, since this is a vertical geometry phenomenon, the variation varies directly with delay time (path length).

A complex relationship exists between spurious signal level and operating frequency. From consideration of the factors influencing spurious signal levels

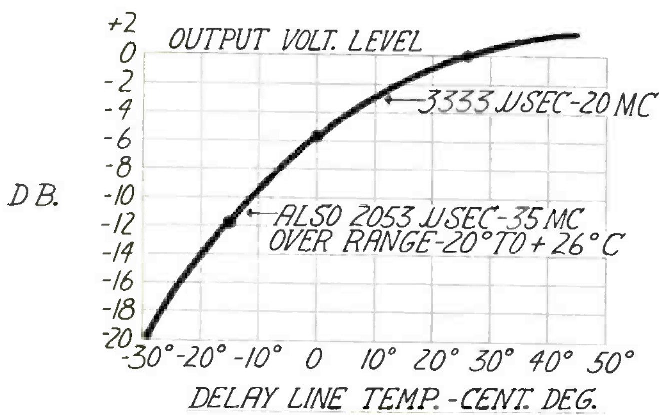


Fig. 4: Voltage attenuation increases with decrease in temp.

it follows theoretically that spurious signals cannot remain constant over a frequency range. This is best demonstrated by considering the affect of one factor, glass loss, in the case of a single spurious arriving at the output transducer at 50% of the delay time. At any given operating frequency, the spurious signal will have a given amplitude relative to the main delayed signal. At some higher operating frequency the difference in amplitudes will become less. This is true because

1. the glass loss is greater at the higher frequency, and
2. the main delayed signal travels twice as far as the spurious signal.

From this it can be seen that the greater the difference in time delay between the spurious signal and the main delayed signal, the greater will be the difference in amplitudes with changes in operating frequency. This is particularly significant in the case of the third time around whose path length is three times that of the main delayed signal.

Silica loss is only one of the factors contributing to variations in spurious signal level with changes in operating frequency. Other factors include transducer design, reflecting aperture design, carrier frequency, reflecting pattern design, and path length.

Temperature Variations

Delay line performance is influenced by temperature primarily through two characteristics which vary with temperature. They are:

1. shear velocity
2. silica loss

Change in shear velocity with temperature produces a temperature coefficient (T.C.) of time delay. In Code 7940, C.G.W. Fused Silica, the T.C. of time delay is nominally —77 ppm/°C. The magnitude of the effect of temperature change on delay time may be readily computed from the relationship.

Δ Time Delay = Time Delay (μsec.) x 77 x 10^{-6} x Δ Temp. (°C)

For a 2778 μsec. delay line the change in time delay is —.214 μsec. for 1°C temperature change.

While an exact tolerance is not given for the value of T.C. of time delay for C.G.W. Fused Silica, practical experience has shown that the deviation or variation from —77 ppm/°C is very small—probably less than ±5 ppm/°C. In actual applications, consideration of the variation of T.C. is usually insignificant. Since 1°C temperature difference represents a .214 μsec. change in time delay, a variation of ±5 ppm would result in a variation of ±.014 μsec. time delay. The value .014 μsec., however, is also equivalent to a temperature difference of only .06°C (.014 μsec. — 2778 μsec. x 77 x 10^{-6}). Thus, the effect of variation of T.C. is negligible in considering the overall problem of temperature control.

Silica loss varies inversely with temperature. The affect of change in silica loss has been treated in detail in previous portions of the presentation; therefore, at this point it is necessary to simply summarize the affect of changes in silica loss as a function of temperature variations.

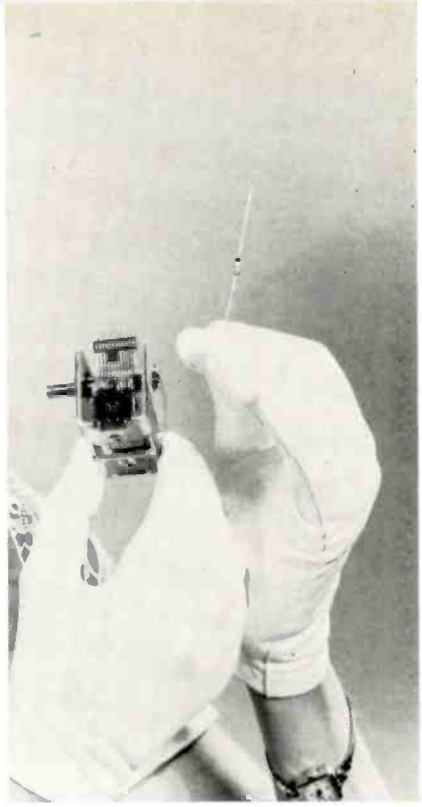
Voltage attenuation—increases with a decrease in temperature. Fig. 4 shows voltage attenuation vs. temperature for a 3333 μsec. —20 MC delay line. This curve also applies for a 2053 μsec. —20 MC delay line.

Band pass characteristics—peak response frequency shifts to lower frequency, bandwidth becomes narrower, and band pass becomes more skewed with decrease in temperature. Refer to Fig. 2. The overall affect on band pass characteristics may be visualized if a new normalized curve of silica loss, representing higher loss and thus having a steeper slope is inserted, and combined with the transducer response curve.

Spurious response level—spurious signals with delay time less than the main delayed signal have greater relative amplitude with decrease in temperature; spurious signals with delay time greater than the main delayed signal (third time around included) have

(*Continued on page* 117)

The design engineer now has a unique new component for electronic equipment. Here are the design characteristics of the new electronically variable, solid state capacitor.



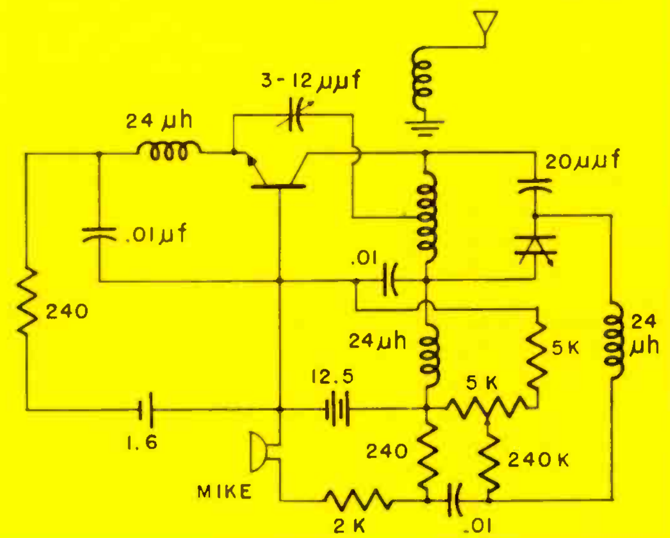
With the tiny new Varicap, the engineer can make an entirely new approach to variable capacitance circuits.

A Voltage Variable Capacitor

By GENE F. STRAUBE
Pacific Semiconductors, Inc.
1041 West Jefferson Blvd.
Culver City, California

Part Two of Two Parts

Fig. 13: A simple FM transmitter with Varicap modulation circuit.



FM

Frequency modulation is achieved by voltage-modulating a Varicap in the resonant tank of an FM oscillator. Such an FM transmitter has been designed and constructed by PSI and is schematically depicted in Fig. 13. The Varicap serves to modulate the transistor oscillator center frequency of 100 MC in accordance with the signals applied to it from the microphone input. The transistor used in this transmitter is a high-frequency silicon transistor developed by PSI under contract to Sandia Corporation and the U.S. Army Signal Supply Agency.

Voltage-controlled oscillators using Varicaps have been designed and constructed. The Varicap offers quite a simple and effective means of voltage tuning by varying the resonant frequency of an oscillator tank circuit. It can be used to provide remote tuning or replace mechanical systems now in use. A commercial transistor portable receiver has been modi-

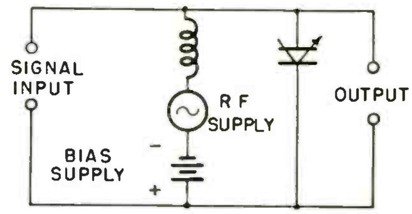


Fig. 14: Resonant slope dielectric amplifier using a Varicap.

fied at PSI to provide Varicap r-f input and local oscillator tuning in the broadcast band replacing variable ganged air capacitors.

Varicap Amplifier

Varicaps may also be used as resonant slope dielectric amplifiers. In such a circuit (Fig. 14) the RF input and bias are set such that the Varicap and inductor will operate on one side or the other of the resonant frequency, *f*. Variations in the input will then tend to vary the capacitance and resonant frequency and, hence, vary the r-f output as shown in Fig. 15. Resonant curve *1* is the Varicap-inductor resonance curve with zero signal. Curve *2* is the resonance curve resulting from the input signal going positive, reducing the total voltage on the Varicap, thereby increasing the capacitance and decreasing the resonant frequency. Conversely, curve *3* results from a negative going signal which tends to decrease the capacitance and increase the resonant frequency. The output therefore is amplitude modulated in accordance with the input signal strength.

An amplifier following this principle has been designed and constructed by Dill and Depian[9] and is schematically represented in Fig. 16. C∆ and L_1 are the resonant tank, L_0, is an r-f choke, C_0, an r-f bypass, and the diode, C_f, and load combination a half-wave rectifier circuit. Stable voltage gains of over 30 and up to 5 KC signal frequency were reported using an 800 KC r-f supply and a 20 K load.

Variable Filter

Another interesting application of Varicaps is their use in voltage-controlled variable filter circuits. Varying the voltage bias will vary the pass band of the filter. An example of this application is the *T* section of Fig. 17a. With its associated bias network, this low pass filter employing a Varicap is depicted in Fig. 17b. The frequency-voltage dependence may be derived as follows:

$$Z_T = \frac{1}{2} Z_1 + \frac{(\frac{1}{2} Z_1 + Z_T)\, Z_2}{\frac{1}{2} Z_1 + Z_T + Z_2}$$

$$Z_T = \frac{\frac{1}{4} Z_1^2 + \frac{1}{2} Z_1 Z_T + \frac{1}{2} Z_1 Z_2 + \frac{1}{2} Z_1 Z_2 + Z_T Z_2}{\frac{1}{2} Z_1 + Z_T + Z_2}$$

which simplified, yields

$$Z_T = \sqrt{Z_1 Z_2 + \frac{1}{4} Z_1^2}$$

at cutoff

$$\frac{1}{4} Z_1^2 = - Z_1 Z_2$$

$$\frac{1}{4} Z_1 = - Z_2$$

substituting from Figure 19b.

$$\frac{1}{4} \alpha\, 2 \pi f_{co} L = - \frac{1}{2 \pi f_{co} C}$$

$$f_{co} = \frac{1}{\pi \sqrt{L C}} \qquad (22)$$

since

$$C = \frac{K}{\sqrt{V}}$$

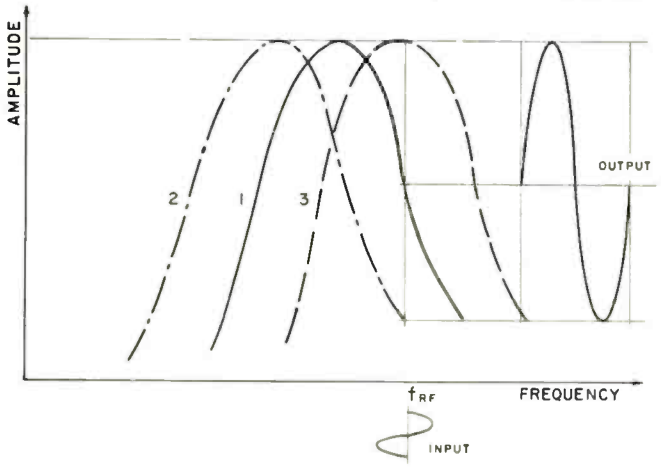
$$f_{co} = R^4 \sqrt{V} / \pi \sqrt{L} \qquad (23)$$

Therefore a variation in bias voltage from one to five volts would increase the highest frequency transmitted in an ideal loss-free filter by roughly 50%. Other types of low pass, high pass, and band pass filters could similarly employ Varicaps as variable voltage capacitor sections.

Measurement Techniques

Measurements have been made on Varicaps using the Boonton Model 250A RX Meter, General Radio Type 821-A impedance meter, Tektronix Model 130 LC meter, and various other instruments. Since the measurements of leakage resistance and maximum operating voltage are quite straightforward, only the capacitance and *Q* instrumentation will be discussed in this section.

Fig. 15: These curves illustrate resonant slope dielectric operation.



Capacitance

A simple means of obtaining a fairly accurate capacitance reading is through the use of the Tektronix Model 130 LC meter with external bias supply. This meter measures full scale capacitance from 3 to 300 μμf at 150 KC. The Varicap bias is adjusted to the desired value by means of the external bias supply. The instrument operates by measuring the change in frequency caused by the Varicap when it is added to a resonant tank circuit. An ac voltage of up to one volt is applied across the Varicap during this measurement. Due to the non-linear capacitance-voltage characteristic this ac voltage modulation will tend to cause the LC meter to read slightly higher than the true value of the capacitance. The total error is normally less than 5%, however, and the instrument offers an efficient and simple means of capacitance measurement.

$$Q = \frac{1}{\omega R_s C} \qquad (25)$$

V series Varicaps from PSI are measured in this meter at a bias of 4 volts to determine capacitance, R_s and Q.

The model 250 RX meter used at PSI has been modified to minimize error due to the magnitude of signal voltage, to extend the capacitance range and to provide a variable bias to the Varicap. The first objective is obtained by lowering the level of applied r-f voltage to about 50 mv by reducing the oscillator output. This is accomplished by supplying the oscillator *B*+ through a 50,000 ohm potentiometer, thereby reducing the plate voltage on the oscillator tube. The capacitance range extension and bias supply is achieved by means of a test jig as shown in Fig. 20. The battery voltage-divider arrangement supplies a controllable bias to the Varicap as read on the VTVM. The inductance is determined by the amount of inductive reactance required to shift the null of the bridge to the end of the C_p scale as follows:

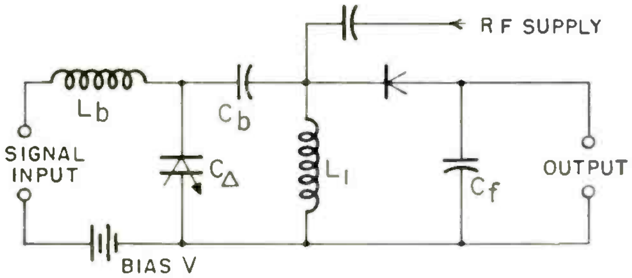


Fig. 16: A variable capacitor amplifier using Varicap.

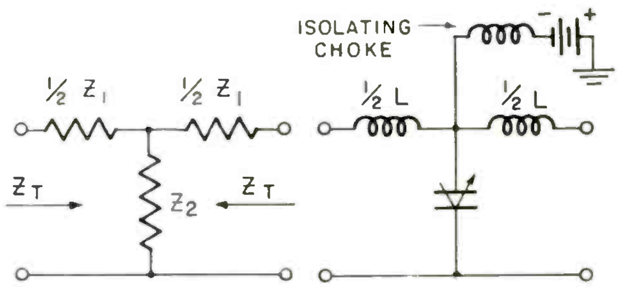


Fig. 17: Simple schematic of voltage controlled T section.

Reactance

A wider range of tests may be performed using the Boonton Model 250A RX meter. This meter determines the equivalent parallel resistance and parallel reactance of a two-terminal network at frequencies between .5 and 250 MC. The instrument consists of a Schering bridge with its associated oscillator, detector, amplifier, null detector, and power supply. Bridge balance is observed on a null meter by adjustment of two calibrated dials which indicate parallel resistance and parallel capacitance of the two-terminal component. This meter will transform the equivalent circuit of the Varicap in Fig. 18a into its equivalent parallel resistance-reactance network of Fig. 18b. The equivalent parallel resistance, R_p, has no physical reality in the Varicap and is merely a measurement of the magnitude of the series resistance, R_s. The value of R_s may be determined as follows:

$$R_s = \frac{R_p}{1 + R_p^2 \omega^2 C^2} \qquad (24)$$

For convenience it may be determined from Fig. 19, which is merely a chart of Eqn. 24 at 50 MC. The figure of merit, Q, is then easily calculated as follows:

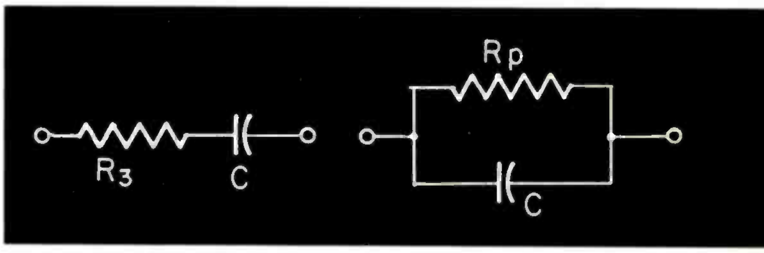


Fig. 18: Transformation of Varicap equivalent into parallel form.

$$L = \frac{1}{4 \pi^2 f^2 \sqrt{C}} \qquad (26)$$

where C = maximum capacitance to be measured
f = operating frequency

At C = 100 μμf and f = 50 MC the inductance becomes 0.1 μh, which is the value used in production testing of *V* series Varicaps. With these modifications, the Boonton Model 250A RX meter serves as

Varicap *(Continued)*

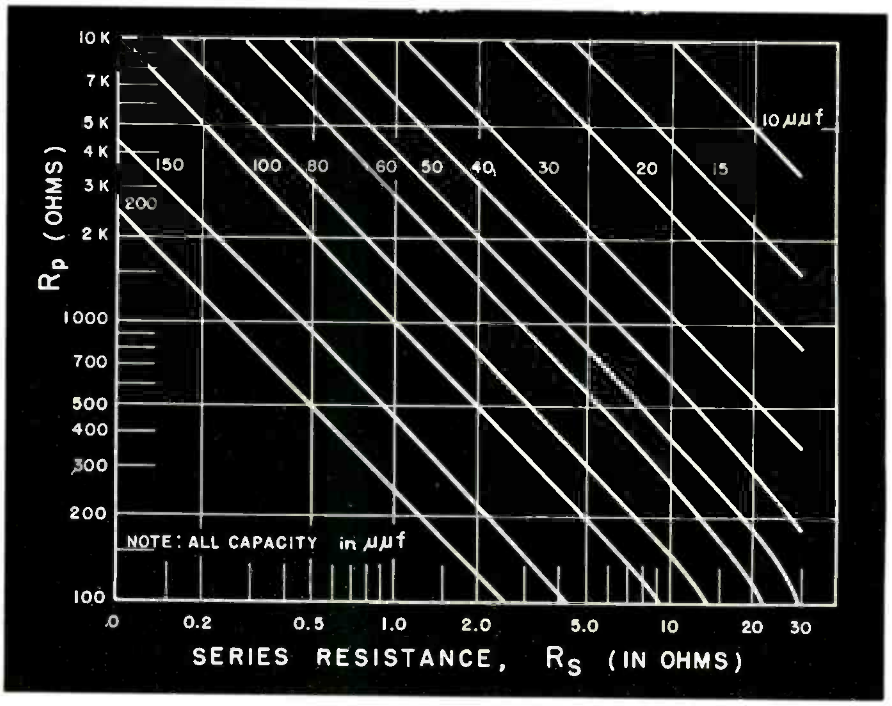


Fig. 19: Parallel resistance vs series resistance at 50 MC.

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The Editor
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a very useful instrument for measuring C_p and R_p of Varicaps.

Another instrument that has been successfully employed is the General Radio Type 821A Impedance meter. This instrument transforms a two-terminal network into its parallel admittance components, susceptance and conductance, over the frequency range from 470 KC to 30 MC. The dials are calibrated, however, directly in capacitance and conductance. It is very effective equipment for determination of C, R_s, and Q and is particularly useful because of the extended range of capacitance, up to 1000 μμf, which it is capable of measuring.

Conclusions

Varicaps have many advantages over reactance tubes, mechanical tuning capacitors, and barium titanate capacitors. They offer great reduction in size and weight, significant improvement in service reliability, and stability of capacitance with temperature variations. Compared to reactance tubes, they are much smaller and lighter, require no filaments and associated filament circuitry, operate to much higher frequencies, are considerably more reliable, and eliminate the need for sockets, shields, and other vacuum tube accessories. Varicaps offer simpler remote tuning, less maintenance, and faster operation than mechanical tuning capacitors. They have a very significant advantage over barium titanate capacitors in that these are quite temperature sensitive whereas Varicaps have practically no capacitance variation with temperature over most of their operating range.

The introduction of commercially available Varicaps with controlled characteristics not only provides the circuit designer with an improved substitute for previously existing devices but with a new design element that should broaden the scope of electronic circuitry.

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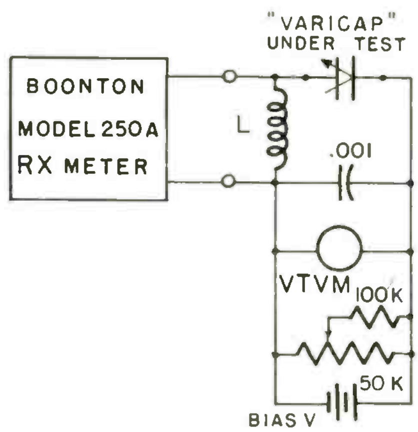

Fig. 20: Test setup for finding Varicap C and R_p.

Circle 47 on Inquiry Card, page 83

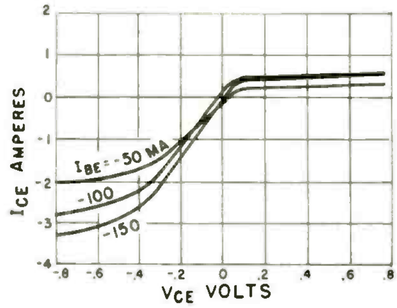

Fig. 1: Typical example of a power transistor with incomplete symmetry.

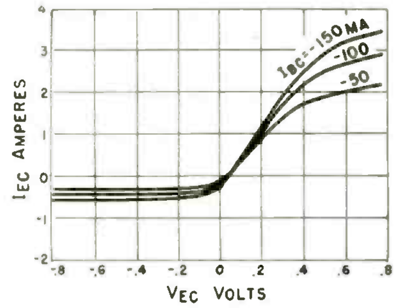

Fig. 2: Connections to the emitter and collector have been interchanged.

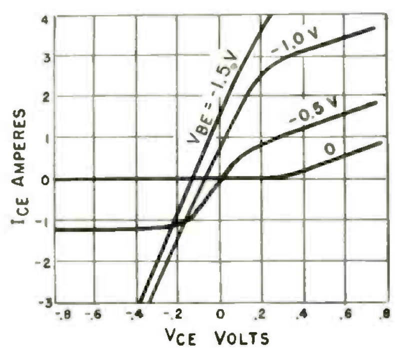

Fig. 3: Base-emitter voltage, instead of current, is held constant here.

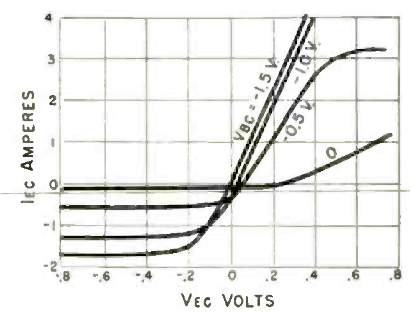

Fig. 4: Connections interchanged as in Fig. 2, but with voltage constant.

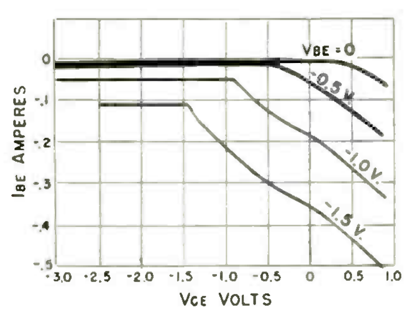

Fig. 5: Base current rises as collector voltage enters positive region.

Bilateral Conductivity in Power Transistors

This similarity of positive and negative portions of collector current curves, base voltage constant, is treated for the first time. The property, most useful in horizontal deflection output stages, appears in most junction triode p-n-p power transistors.

By DR. IOURY G. MALOFF
Advanced Development,
RCA Victor TV Division
Camden 8, New Jersey

ONE very important application of power transistors is in the output stages of horizontal deflection in television receivers.[1] In general, during the scanning trace the collector of the output transistor swings from a fraction of a volt positive to a fraction of a volt negative. At the same time, the collector current swings from a large value of several amperes positive to an even larger value of negative current at the end of the trace period.

The sign convention that is used throughout this article is: Positive currents flow toward the base and collector, while negative currents flow away from these electrodes. In the figures, the positive sense is to the right and up, while negative sense is to the left and down from the origin; the quadrants are numbered in a conventional counterclockwise direction.

New Characteristic

This ability of p-n-p power transistors of carrying large collector currents of nearly equal magnitude in either direction is realized with

(Continued on page 88)

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23 Cannon Electric Co.—Audio plugs

47 Cinch Manufacturing Corp.—Heat dissipating shield insert

42 Connecticut Hard Rubber—Pressure sensitive TEFLON tape

50 Conrac, Inc.—TV monitors & receivers

22 Corning Glass Works—Ceramic printed circuit board

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36 Dale Products, Inc.—Wire-wound subminiature resistors

17 Deutsch Company, The—Miniature connectors

28 Delco Radio Division of General Motors —High-frequency power transistor

31 Dilectrix Corp.—Cast TEFLON film

72 DuMont Laboratories, Inc., Allen B., Instrument Div.—Sensitive oscilloscope

509 Farnsworth Electronics Co., Div. of I T & T—Engineering personnel

67 Film Capacitors, Inc.—Precision film capacitors

13 Fluocarbon Products, Inc. — TEFLON tube insulators, tube sockets & transistor sockets

74 Freed Transformer Co., Inc.—Telemetering components

52 Gates Radio Company — General electronic catalog

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510 General Electric Co., Missile Guidance Sect.—Engineering personnel

65 General Electric Co., Apparatus Sales Div.—Brushless voltage regulator

68 General Electric Co., Apparatus Sales Div.—Temperature compensated voltage regulator

70 General Electric Co., Apparatus Sales Div.—Drift-free voltage regulator

38 General Transistor Corp.—Bobbinless resistors

60 General Transistor Corp. — "Factory fresh" diodes

45 Gertsch Products, Inc. — Ratio transformer

48 G-V Controls, Inc. — Thermal timing relays

63 Graphic Systems, Inc.—Visual control board

39 Howard Industries, Inc.—Servo motor

51 Houston Fearless Corp.—TV pedestal

5 Hughes Products—Storage tubes

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69 Johnson Co., E. F.—Pilot lights

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213 Calibrator, resistance — International Resistance Co.
226 Camera heads, ITV—The Houston Fearless Corp.
215 Computer, analog—Donner Scientific Co.
200 Connectors, miniature—The Deutsch Co.
231 Control, temperature—Arnoux Corp.
197 Counter, frequency time—Potter Instrument Co.
219 Couplers, coaxial — Narda Microwave Corp.
229 Diode radiator—The Britcher Corp.
221 Dry cell, long life—P. R. Mallory & Co.
214 Fasteners—Tinnerman Products, Inc.
217 Ferrites—Kearfott Co.
218 Ferrite slugs — Ferroxcube Corp. of America
223 Jack, high-temp—Raytheon Mfg. Co.
225 Measuring instrument — Lavoie Labs. Inc.
209 Orthicon orbiter—Foto-Video Labs.
202 Oscillator, sweeping—Kay Electric Co.
230 Oscillators, telemetering—Dorsett Labs.
222 Potentiometers — Osborne Electronics Corp.
216 Potentiometers, vernier—Rinco, Inc.
201 Power supplies — Chicago Condenser Corp.
210 Recorder-reproducer—Magnecord
227 Rectifier, power—Fansteel Metallurgical Corp.
198 Rectifiers, silicon—Audio Devices, Inc.
207 Resistors, precision—Allen-Bradley Co.
205 Resistors, wire wound—General Transistor Corp.
212 Television camera, small—Dage Television
203 Terminals for missiles—AMP Inc.
228 Time delay—G-V Controls, Inc.
208 Time delay relays—Tempo Instruments, Inc.
232 Transistor bases—Electrical Industries
220 Transistor mounting—Delbert Blinn Co.
224 Tubing—The Zippertubing Co.
211 Turntable—QRK Electronic Products
199 VTVM, sensitive dc—Millivac Instruments
204 Wiring harness—Methode Mfg. Corp.

NEW TECH DATA

172 Antennas, communication—Ward Products Corp.
178 Cameras & recorders—Berndt-Bach, Inc.
177 Capacitor catalog — Illinois Condenser Co.
187 Capacitors, computer—General Electric Co.
165 Capacitors, phase-shifting—Nilsen Mfg. Co.
161 Capacitors, stable—Sprague Electric Co.
185 Circuits, packaged—Centralab
166 Connector chart—The Deutsch Co.
191 Diode, microwave silicon — Microwave Associates, Inc.
186 Electronic instruments—Millivac Instruments
174 Electronic instruments catalog — Kay Electric Co.
170 Electro-mechanical assemblies—Spectrol Electronics
183 Electro-mechanical facilities — Benrus Watch Co.
184 Galvanometers—Consolidated Electrodynamics Corp.
167 Leads & harnesses—General Laboratory Assoc.
173 Microphone guide — Radio Corp of America
180 Modules — Associated Missile Products Co.
179 Motors & generators—Instrument Motors
175 Multimeter, dc—Belleville-Hexem Corp.
196 Pilot lights—Dialight Corp.
176 Potentiometer glossary — Bourns Labs Inc.
190 Power supplies—The Varo Mfg. Co., Inc.
181 Power supply catalog — Perkin Engineering Corp.
182 Rectifier listings, silicon — Automatic Mfg.
195 Relays, sub-miniature—Filtors, Inc.
169 Scientific instruments—Electro-Measurements, Inc.
168 Staff & facilities—Electro Development Corp.
192 Television equipment, industrial—General Precision Labs.
163 Terminals, high temperature—AMP Inc.
162 Transformer catalog—Freed Transformer Co.
193 Transformer catalog, variable—The Superior Electric Co.
194 Transistor list — Industro Transistor Corp.
160 Tubes, electron—Bendix Aviation Corp.
188 Tubes, reliable—Sylvania Electric Products, Inc.
189 Waveguide bends—Microwave Development Labs.
171 Waveguide components—D. S. Kennedy & Co.
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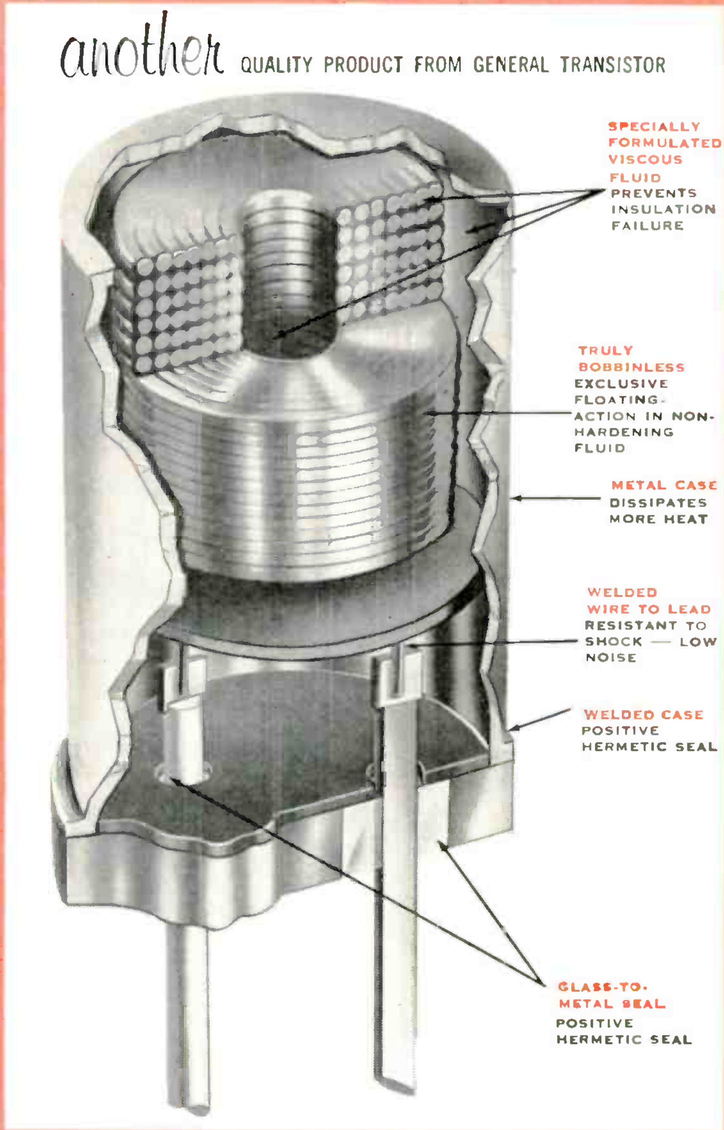

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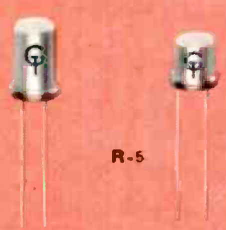
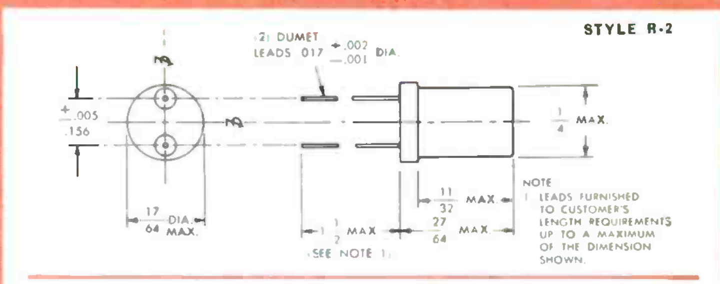
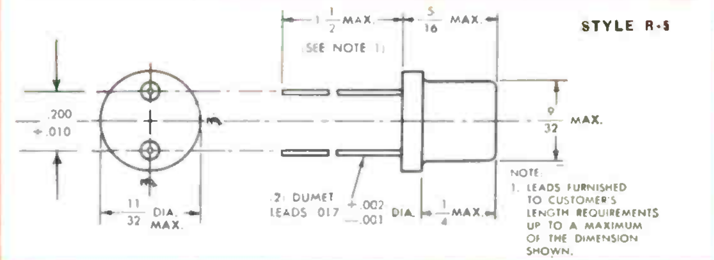
Power Rating	¼ watt continuous in free air (increased dissipation possible with heat sink)	⅓ watt continuous in free air (increased dissipation possible with heat sink)
Temperature Range	−65°C to +125°C	−65°C to +125°C
Maximum Operating Voltage	250V, DC	500V, DC
Temperature Coefficient of Resistance	±20 parts per million/°C	±20 parts per million/°C
Dielectric Strength	500V rms, winding to case	1000V rms, winding to case

Construction — Terminations: — Welded



R-2 R-5 ACTUAL SIZE





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Bilateral Conductivity *(Continued)*

a constant negative voltage bias on the base in a common emitter circuit. This property is tentatively termed "bilateralism," to distinguish it from "symmetry"[2] in power transistors; the latter, perfect or otherwise, refers to constant base current condition.

In the simplest form of transistorized horizontal deflection, during the positive portion of the trace, the energy stored in the load is returned to the low voltage supply, thereby reducing the drain on the power supply. In the meantime, it provides damping action furnished by the damping diode in vacuum tube deflecting circuits. To repeat: It is essential to the whole operation of the circuit that the base-to-emitter voltage (not the current) is kept at an approximately constant negative value. This is generally higher than either the negative or the positive peak collector-to-emitter voltage.

This article presents the experimental and theoretical data on the mechanism of the operation of power transistors under the rather unusual voltage and current conditions stated.

Symmetry and Bilateralism

Most junction transistors will carry controllable currents to and from the collector to the emitter. When applied to transistors the term "symmetry," or "degree of symmetry," refers to similarity, or degree of similarity, between the characteristic curves of the collector-to-emitter currents in the first and third quadrants at constant base currents.

For complete symmetry, these characteristics are alike except for the sense or sign. In the case of incomplete symmetry the curves appear as in Fig. 1. These curves are for an experimental type RCA power transistor. With the connections to the emitter and collector interchanged, a similar set of curves is obtained except that it is rotated 180° about the origin as in Fig. 2.

If, instead of keeping the base-emitter current constant, the base-emitter voltage is kept constant, an entirely different set of curves, like those in Fig. 3, is obtained. It shows that, in the region of collector voltage between a few tenths of a volt positive to a few tenths of a volt negative, with negative base bias higher than the collector voltage, a linear transition of collector

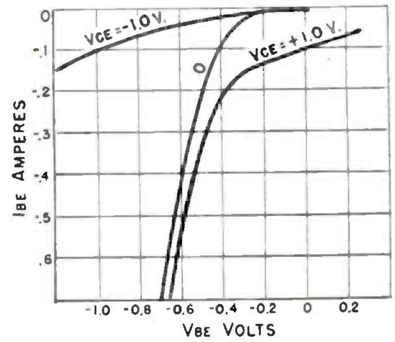


Fig. 6: Input impedance drops as collector becomes positive with respect to emitter.

current from a high positive value to a high negative value can be obtained.

This property of constant conductivity in the region stated makes the power transistor a nearly perfect bilateral switch. It is extremely useful in transistorized horizontal deflecting circuits and has been tentatively termed "bilateral conductivity" or "bilateralism" to distinguish it from the term "symmetry."

When base voltage is kept constant and the connections to the collector and emitter are reversed, a set of curves is obtained as in Fig. 4. It has no similarity to the characteristics for the normal circuit shown in Fig. 3. There appears to be no direct connection between symmetry and bilateralism. A transistor may have little symmetry, Fig. 1, and perfect bilateralism, Fig. 3.

Mechanism of Bilateralism

Bilateralism is confined to a relatively small operating region in the vicinity of zero collector voltage and with the base at a constant negative potential. The latter is generally higher than either the positive or negative values of the collector voltage. As the collector voltage is moved from a small negative value through zero into the positive region, the base current, heretofore constant, begins to rise rather rapidly. In Fig. 5 this phase of transistor characteristics is shown. The increase in the base-to-emitter current causes an increase in the collector-to-emitter current and a sharp upturn in collector current characteristics that finally produces the family of curves shown in Fig. 3.

It follows that the input impedance of the transistor (base-to-emitter), while nearly constant and relatively high (of the order of 10 Ω) with the collector negative, drops to a fraction of an ohm when the collector becomes positive with respect to the emitter. In Fig 6 this effect is shown in terms of variations of base-to-emitter current vs. base-to-emitter voltage at three values of collector-to-emitter voltage.

Transistorized Horizontal Deflection

One of the most useful applications of bilateralism is in the output stage of horizontal deflection in a television receiver or camera. The transistorized horizontal output stage is an active pulse generator. It produces the scan while acting as a diode during the first part of the scan, quadrant 1 in Fig. 3: completes the scan by transistor action, quadrant 3 in Fig. 3; and, produces a sharp pulse for retrace. This pulse can be utilized for gen-

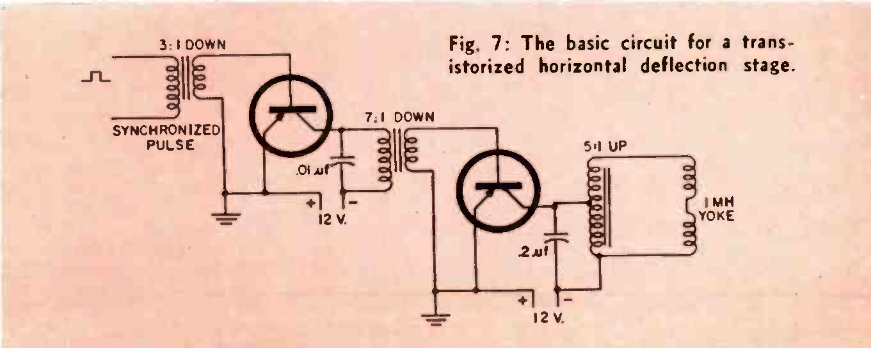


Fig. 7: The basic circuit for a transistorized horizontal deflection stage.

eration of the +B supply for the video amplifier, kinescope screen, and the ultor voltage as described in reference 1. The basic circuit of such a stage is shown in Fig. 7. It is preceded by a driver stage which is also a pulse generator driven in turn by pulses from a blocking oscillator, not shown.

The output circuit is driven by a stepdown transformer which holds the base at approximately constant negative voltage during the trace period. The leakage reactance of the transformer has been minimized by multifilar windings. There is no fixed bias on the base of the output transistor, making the circuit self-protecting.

For drive failure, the collector current in the output stage merely goes to zero. The output transistor works into an effective load of 40 μh tuned to 55 KC by a capacitance of .2 μf. When the output stage is fed with sharp, narrow, positive pulses from the driver stage, the load current and voltage waveforms appear as in Figs. 8 and 9. The collector current and voltage waveforms appear as shown by oscillograms in Figs. 10 and 11. In these diagrams the time duration of one complete deflection cycle is that of one scanning line (trace and retrace) or 63.5 μsec.

In analyzing the mechanism of operation of a transistorized horizontal output stage, a diagram of collector current, Fig. 12, has been found useful.

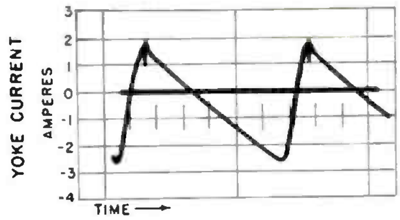


Fig. 8: Load current waveform; output stage fed with sharp, narrow, positive pulses from driver.

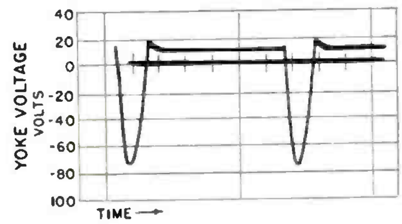


Fig. 9: Load voltage waveform; same conditions as Fig. 8.

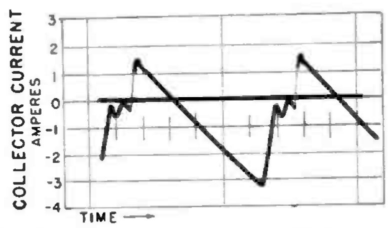


Fig. 10: Collector current waveform; same conditions.

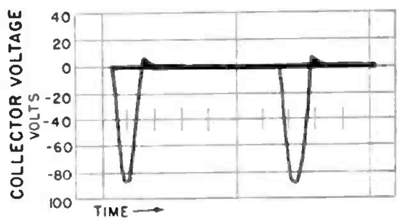


Fig. 11: Collector voltage waveform; same conditions.

If the starting point is taken when the electron beam is undeflected, the current through the load is zero and so are the collector current and voltage. This condition is indicated by "O". Since the system is reactance controlled and a constant negative bias voltage on the base is maintained, the whole supply voltage is across the load; the collector voltage rises linearly in the negative direction to "A," which is the end of the trace.

At this point a steep positive pulse is delivered to the base by the driver stage. This positive pulse drives the base into the positive or cut-off region and the operating point moves from "A" to "B." The solid line from "A" to "B" indicates an instantaneous cut-off of collector current which would take place in an idealized case. Actually, with the existing transistors, a finite time is required for cutting off large currents and the transition takes place along the broken line to "C." Incidentally, most of the power loss in power transistors, p r e s e n t l y available takes place during this transition from A to C.

Collector Current Collapse

The sudden collapse of the collec-

(*Continued on page* 122)

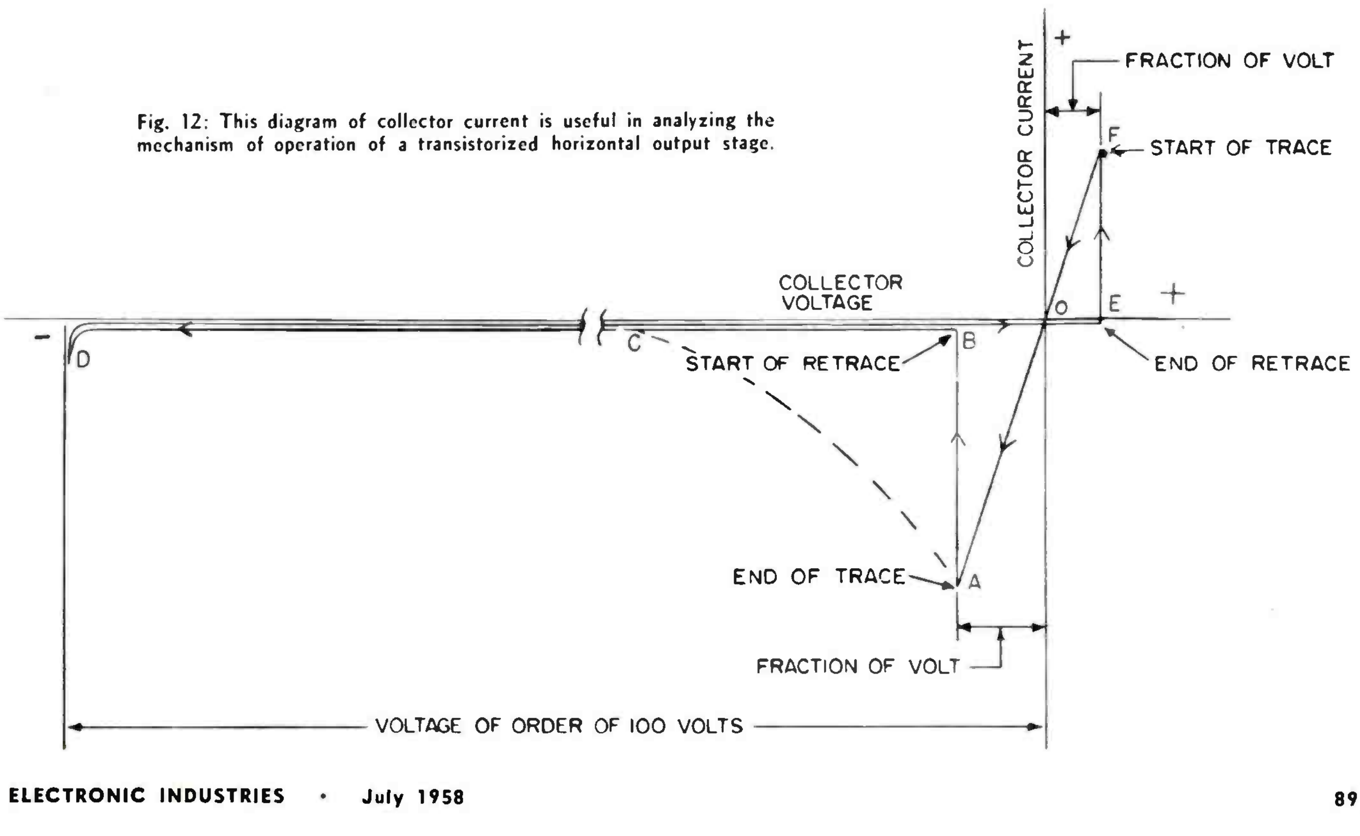
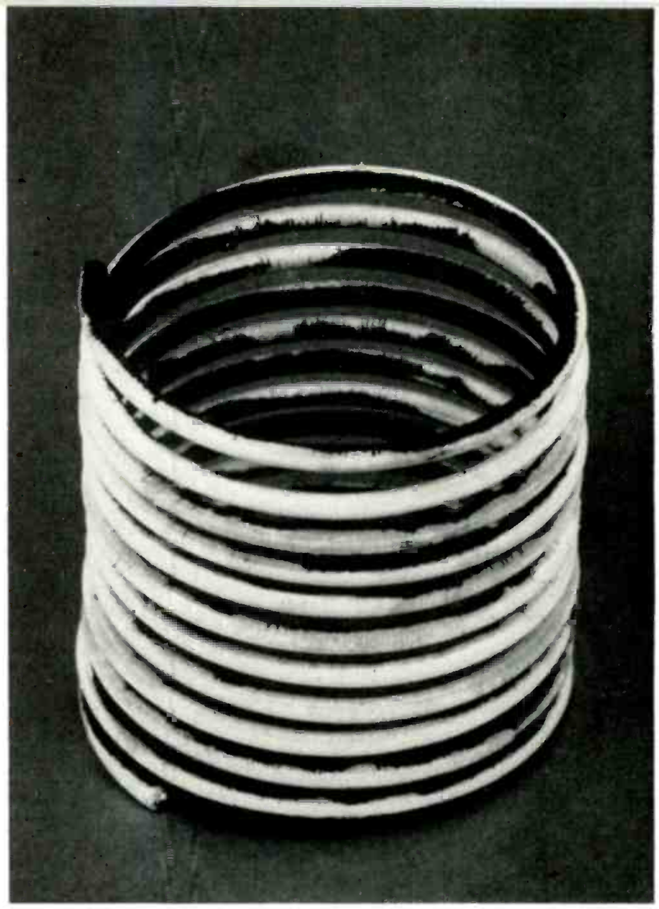


Fig. 12: This diagram of collector current is useful in analyzing the mechanism of operation of a transistorized horizontal output stage.

What's New . . .

Where Is It?



(Left) Under white light, areas inside this potentiometer coil where varnish-like bonding cement still remains are practically invisible.

(Right) Under ultra-violet light, the areas still containing the bonding cement are brightly fluorescent.

WITH the increasing demand for small precise electronic components and assemblies, there are new problems in applying cements, bonding compounds, and plastic coaters with a minimum of labor in the way of production and inspection.

Take precision potentiometers, for example. Some of these are produced by winding the fine resistance wire on an enameled copper wire mandrel. The resistance wire is then bonded to the mandrel by means of a varnish-like cement. There are at least two ways of doing this. One method involves applying the cement to only one side of the mandrel, leaving the other side clean and available for electrical contact. The second method involves coating the entire wound mandrel, and subsequently removing the surface cement from one side by a form of fine sand-blasting.

In either of these methods there is a very real problem of quality control, since if the cement creeps over contact areas of the winding, or is not perfectly cleaned off, the potentiometer will be noisy. It takes only a few molecules of insulating cement to create objectionable noise in low level, high gain circuits.

From the standpoint of the production operator the problem is mainly one of fatigue, since even though the cements are strongly colored, by red dyes for example, the cement deposits are very dif-

(Continued on page 127)

"Sandblasting"

A SEMI-AUTOMATIC process for stripping off wiping contact path on precision potentiometer windings now offers faster production, maximum control and safety for resistance wire and mounts.

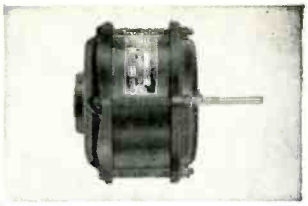
Controlled stripping of organic coatings from potentiometer windings in a semi-automatic operation is handled by a form of precision "sandblasting" at the Gamewell Co., Newton Upper Falls, Mass. The work is done by a process using a gas-propelled abrasive moving at high speed in a controlled pattern. The stripping operation exposes the wiping contact surface needed for potentiometer control action.

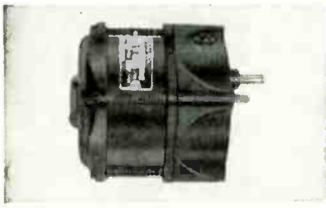
Controlled stripping of the organic coatings on the potentiometer windings at the Gamewell plant is handled by an industrial Airbrasive unit made by The S. S. White Industrial Division, New York. This unit concentrates a stream of sodium bicarbonate particles travelling at high speed through a small-orifice nozzle, permitting controlled removal of material to the desired pattern. The cutting action is fast, cool and without shock.

A gas-propelled abrasive removes the organic coating from this potentiometer winding.

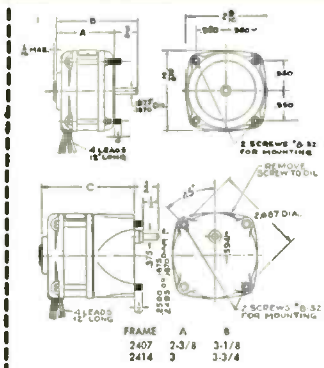
For Servo Applications

HOWARD MODEL 2400





CAPACITOR OR 2 PHASE TYPE SERVO MOTOR



This four pole motor is designed for servo applications. Low inertia rotor provides quick response and high impedance stator windings can be matched to vacuum tube plate circuits. Center topped windings can be provided. As a 2 phase motor, the speed can be varied by varying the phase angle. Responds to a wide range of frequencies. Gear units are available with ratios from 2½ :1 to 3600:1. For complete data, write today.

HOWARD INDUSTRIES, INC.
1730 State St.
Racine, Wisconsin
Divisions: Electric Motor Corp.
Cyclohm Motor Corp.
Racine Electric Products

Circle 39 on Inquiry Card, page 83

TROUBLED WITH TRANSIENTS?

HERE'S THE ANSWER!

Unsuspected high voltage peaks can upset the most carefully designed equipment. They can cause erratic behavior of electronic circuits or even bring about out and out malfunction. These unwanted "transients" can completely upset your calculations.

For the laboratory technician, missile circuit designer or other electronic engineer interested in detecting such important variables, our Model PTM-7 Peak-Meter supplies the answer.

NOW AVAILABLE WITH 3000 VOLT FREQUENCY COMPENSATED PROBE, the Peak-Meter features a retentive memory for these elusive "transients."

Write for literature.

CONTROL DEVICES, INC.
8299 East Nine Mile Road
Warren, Mich.—SLocum 8-4444

Circle 40 on Inquiry Card, page 83

MILITARY CIRCUITS by METHODE

NOW, a special division for this high precision work:

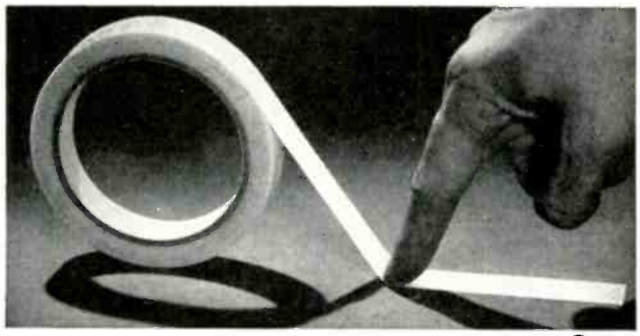
★ Separate management and operating team specializing in reliable production of precision printed circuits
★ Special facilities for accurate and uniform short run punching and fabrication of printed circuits
★ Complete precious metal electroplating department to handle all finishes
★ The newest in equipment with the industry's largest manufacturing capacity devoted to printed circuitry
★ A number of important projects for missiles, radar and airborne ordnance continuously in production

METHODE also offers film insulated wiring harness and connectors for printed circuit applications. Write for bulletin.

Address:
Military Contracts Coordinator

METHODE Mfg. Corp.
7447 W. Wilson Ave., Chicago 31, Ill.

Circle 41 on Inquiry Card, page 83



New TEMP-R-TAPE® C

.002" thick, 2750 v/m pressure sensitive TEFLON* tape For -100°F to 500°F applications

TEMP-R-TAPE® C, CHR's newest pressure-sensitive tape, is made of ultra-thin, high dielectric, cast Teflon film to which a silicone polymer adhesive has been applied. Both pressure-sensitive and thermal curing, the adhesive sticks well to any surface over a −100°F to 500°F (−70°C to 260°C) temperature range. Providing an easy-to-apply, extremely thin, high dielectric insulator (2750 volts/mil), TEMP-R-TAPE C was designed for and is now being used in the manufacture of miniature electronic units to withstand Class H and higher temperature requirements. *Send for data on TEMP-R-TAPE C and CHR's other extreme temperature, electrical and mechanical pressure-sensitive tapes.*

CONNECTICUT HARD RUBBER

NEW HAVEN 9 CHR CONNECTICUT

**du Pont TM.*

Circle 42 on Inquiry Card, page 83

Fig. 1: Cross sections of various types of insulation are shown. Notice that Flexolon insulation runs parallel to wire.

What's New . . .

Miniature High Temperature Wire

IN response to industry demand, a new miniature high temperature wire has been developed.

"Flexolon" wire, a product of Tensolite Insulated Wire Co., Inc., differs from the usual taped wire in that the "Teflon" tapes are applied longitudinally rather than spiralled helically. Fig. 1 compares cross-sectional views of the various types.

Increasing the number of layers of tape on the new wire diminishes the probability of an individual tape flaw influencing the final performance.

Flexibility

"Flexibility" as applied to wire has almost as many definitions as users. A good definition is: The ability to adapt readily to the bends and turns met in normal circuit construction.

To illustrate this definition, a test was devised which pictures it graphically.

The test consists of suspending a 25 gram weight from an 8-in. length of wire and measuring the deviation from the center line of a ½-in. round peg to the free curve of the wire as suspended from the peg. Fig. 3 shows a plot of flexibility in terms of 1/64 in. deviation from the peg center line by AWG.

Dielectric Strength

Sample lengths, selected at random from extruded and "Flexolon" wire production, were cut into 10 ft. lengths. Each section was immersed in a water bath containing a suitable wetting agent for a period of 4 hrs. Each piece was next subjected to a high potential test. The voltage was increased from 0, at the rate of 3000 v. per 10 sec. interval, until breakdown. The voltage at breakdown was recorded and summarized.

The new wire showed a marked increase in average dielectric breakdown voltage. More important, variation of breakdown voltage is considerably less. The performance of this new wire can therefore be predicted with a high degree of reliability, whereas other wires exhibiting relatively wide variations are less liable to prediction.

Concentricity

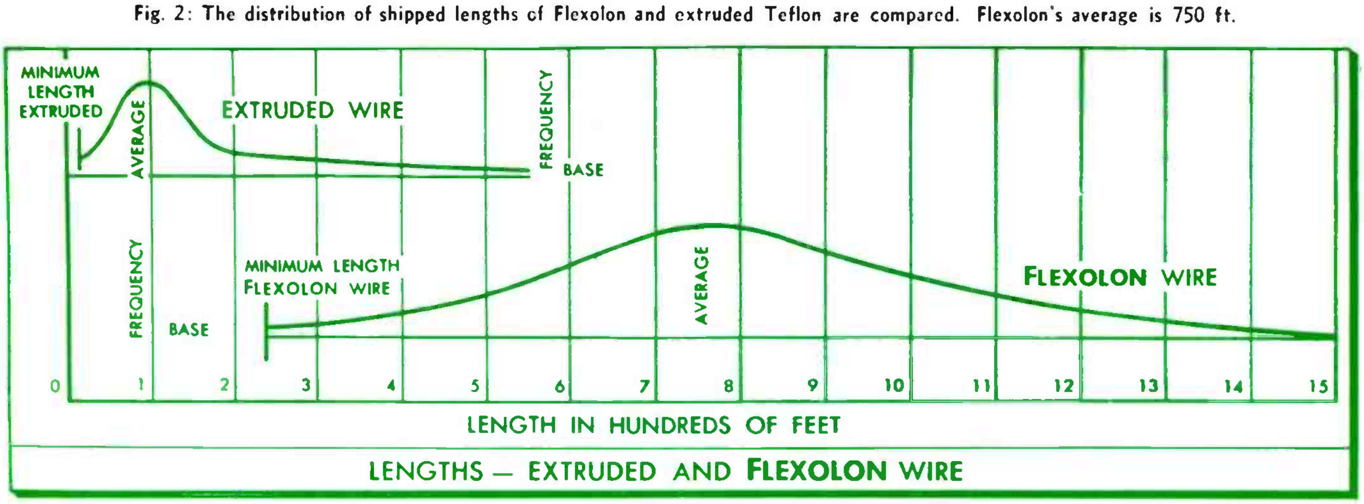
The insulation of random samples was stripped and prepared in cross-sectional slices. The test consisted of measuring wall thicknesses using a 50X Portman optical comparator and mathematically calculating concentricity.

"Flexolon" wire has a higher percentage concentricity and the variation of percentage concentricity is reduced to a more reliable level than with other wires.

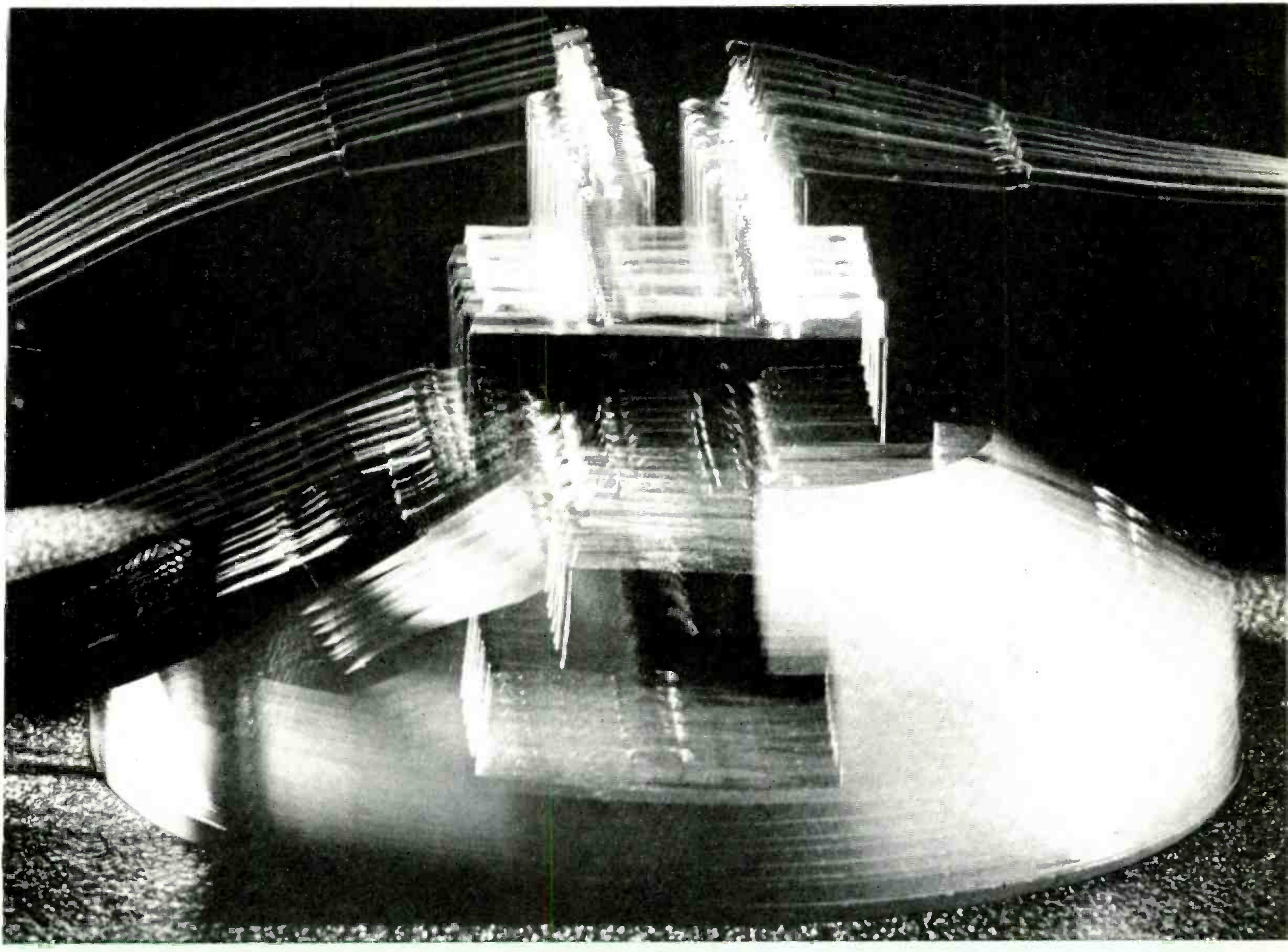
Higher concentricity and smaller deviation from average assure easier stripping, cleaner cuts and protection against conductor damage.

(*Continued on page* 130)

Fig. 2: The distribution of shipped lengths of Flexolon and extruded Teflon are compared. Flexolon's average is 750 ft.



Circle 37 on Inquiry Card, page 83 →



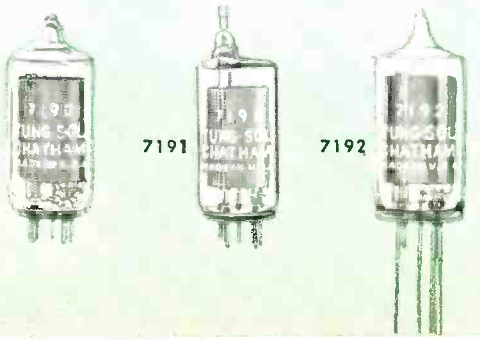
Two Type 7191's receive special "D.C. hold-off" vibration test. *All* Tung-Sol/Chatham miniature hydrogen thyratrons — 7190, 7191, 7192 — must "hold off" while subject to 15G vibration, swept from 50 to 2,000 cps in 4 minutes. Tubes also are shocked at 48° hammer angle in Navy high-impact flyweight shock machine, equal to 720G/1 millisecond shock.

Tung-Sol/Chatham miniature hydrogen thyratrons supply test-proved ruggedness for missile use!

Extensive in-factory tests assure designers Tung-Sol/Chatham miniature hydrogen thyratrons — 7190, 7191, 7192 — can withstand the severe shock and vibration met in missile flight. Performance of these tubes in several operational missiles gives in-use proof of their ruggedness.

In radar modulators and tracking beacons, these compact tough tubes supply 10 KW, replace bulkier types. Broad range of pulse repetition rates widens design choice . . . zero bias simplifies circuitry and triggering requirements. Tubes hold off high voltage, pass high peak current with low tube voltage drop. Three types available: 7190 — pin base, 7191 — top anode connector, 7192 — flexible leads.

Tung-Sol, only producer of miniature hydrogen thyratrons for missiles, can supply you immediately. For complete data on these types . . . on special-purpose tubes of all types, phone or write. Tung-Sol Electric Inc., Newark 4, New Jersey. Commercial Engineering Offices: Bloomfield and Livingston, New Jersey; Culver City, California; Melrose Park, Illinois.



7190 7191 7192

TUNG-SOL®

WASHINGTON

News Letter

CATV IMPACT ON TV BROADCASTING—Though it has probably more investigations on its hands than at any other time in its 24-year history, the FCC has launched a new and highly controversial inquiry proceeding with a call for comments concerning the "impact" of Community Antenna TV Systems, and television translator, satellite, and booster operations on the "orderly development of television broadcasting." The written comments are to be submitted by June 27 on a list of 14 FCC inquiry questions. The Commission pointed out that "CATV systems are reported to be serving half a million homes" and that "about 1,000 so-called 'booster' TV stations are said to be in operation," but it made no estimate as to the number of satellite and translator TV stations.

EXPAND MOBILE SPECTRUM—Since UHF television is not utilizing satisfactorily its portion of the spectrum from 470 to 890 MC, the Electronic Industries Association's Land Mobile Communications Section has asked the FCC to add fixed and mobile radio service designations for the frequencies in this band. The EIA group informed the Commission that the present anticipated growth rate of mobile services will produce in the next decade a minimum requirement of 41 additional megacycles, or approximately 1200 new voice channels, of new spectrum space. The FCC's mid-April spectrum reallocation, changing the division of frequencies for government and non-government use, the EIA cited, "made it unlikely that additional mobile space will ever be available in the spectrum immediately below 450 MC."

TWO-BILLION DOLLAR AIRWAYS PROGRAM—An expanded modernization program for the nation's air traffic control and navigation systems, developed by the Civil Aeronautics Administration and submitted to Congress by Commerce Secretary Weeks, calls for procurement of new electronics, communications, air traffic control, and air navigation equipment during the next five fiscal years totaling an estimated $1,027,000,000. Maintenance and operation will add another $1,756,000,000 to the cost. Primary emphasis in this five-year program is placed on radar. The plan calls for a total of 60 additional long-range enroute radar installations, 76 new airport surveillance radar units, 30 surface detection equipment units for radar control of aircraft on the ground and 289 air traffic control radar beacons.

CONSIDERING MODIFICATION—The fifth section of the 1956 Bell System antitrust consent decree—prohibiting non-regulated services such as lease-maintenance, mobile radio, paging systems and wired music—is being considered by the Justice Department for the possibility, "if feasible," of seeking modification or interpretation by the federal court, Judge Victor R. Hansen, Assistant Attorney General in charge of the Antitrust Division, recently informed the House Judiciary antitrust subcommittee. He stated that it was his intention "to do everything within my means" to enforce this section of the consent decree and prohibit the Bell System "from engaging in any business which is clearly not a common carrier communications activity." He pointed out to the House subcommittee that he had authorized Justice Department intervention in the FCC private mobile communication system hearings.

LOCAL GOVERNMENT RADIO—A new local government radio service, open to states, counties, cities, towns and other governmental subdivisions for radio communications "essential to their official activities" was made effective by the FCC June 30. The local government service began functioning with 15 frequency assignments in the 40 MC band, picked up on a reserve basis in previous rulemaking, and 38 channels in the 450 MC band available on a shared basis with all public safety services, together with five 27 MC assignments, three "narrow-band" segments in the 150 MC area for developmental work, and access to shared operational fixed frequencies above 890 MC.

NEW AVIATION RESEARCH PLAN—Aeronautical Radio, Inc., because of increased requirements for communications between "jet" aircraft and ground traffic control centers, is establishing a new research organization, known as "Arinc Research Corporation." The new Arinc service will concentrate on reliability research and, as announced by Arinc president John S. Anderson, will "accommodate a growing interest" in this field. Reliability research has been carried on by Arinc, in addition to its radio station operations and its service as a technical meeting center for aviation communications, for over ten years for the airlines and under military contracts since 1951.

National Press Building
Washington 4

ROLAND C. DAVIES
Washington Editor

Circle 36 on Inquiry Card, page 83 ⟶

New Tech Data for Engineers

Electron Tubes

The Bendix Aviation Corp., Red Bank Div., Eatontown, N. J., has just issued a 6-page booklet which lists and describes various types of receiving tubes, microwave tubes, gas and special purpose tubes, gas noise source tubes, spark gaps and other types of tubes.

Circle 160 on Inquiry Card, page 83

Stable Capacitors

Engineering Data Sheet 2073 describes, with complete specifications, a new type of stable capacitor. This new line of Isofarad capacitors do not change capacity with temperature changes and are ideal where excellent stability is required. Sprague Electric Co., North Adams, Mass.

Circle 161 on Inquiry Card, page 83

Transformer Catalog

A new fully illustrated 48-page catalog listing a complete line of transformers is available from the Freed Transformer Co., Inc., 1726 Weirfield St., Brooklyn, N. Y. Described in this booklet are a complete line of audio transformers, discriminators, filters, high Q reactors, magnetic amplifiers, power components, pulse transformers and ultrasonic components.

Circle 162 on Inquiry Card, page 83

High Temperature Terminals

AMP Inc., Harrisburg, Pa., has just issued Catalog HT describing a complete line of terminals and connectors for high temperature applications. The 16-page multi-colored booklet contains drawings, tables and illustrations of a complete line of terminals and connectors along with precision engineered tooling for use with these.

Circle 163 on Inquiry Card, page 83

Fine Wire

An 8-page booklet issued by Nesor Alloy Products Co., 282 Halsey St., Newark 2, N. J., describes a complete line of very fine wire made of precious metals, alloys and steels that are available. Complete technical and electrical data is included.

Circle 164 on Inquiry Card, page 83

Phase-Shifting Capacitors

A 36-page hand book of capacitor phase-shifting transducers is available from the Nilsen Mfg Co., Addison, Ill. The first half of the handbook contains technical information on phase-shifting networks and the use of phase-shifters and the second half describes the various products available under the trade name of Variogon.

Circle 165 on Inquiry Card, page 83

Connector Chart

A readily used wall-chart for specifying AN connectors is offered by The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif. This colorful 22 x 28 in. chart graphically provides a simple method for selecting the proper AN connector for an application.

Circle 166 on Inquiry Card, page 83

Leads and Harnesses

A 4-page, 2-color bulletin issued by General Laboratory Assoc., Inc., Norwich, N. Y., describes the facilities available by this company for manufacturing leads and wiring harnesses for the electrical and electronic fields.

Circle 167 on Inquiry Card, page 83

Staff and Facilities

Electro Development Corp., 3939 University Way, Seattle 5, Wash., has just issued a 12-page booklet describing their development and manufacturing facilities and gives a complete rundown on their staff.

Circle 168 on Inquiry Card, page 83

Scientific Instruments

A 12-page, 2-color booklet has been issued by Electro-Measurements, Inc., 7524 S. W. Macadam, Portland, Ore. Catalog A-26 lists bridges and accessories, voltage dividers, decade capacitors and decade resistors. Catalog is complete with electrical and mechanical specifications, photographs, line drawings and schematic drawings along with tables.

Circle 169 on Inquiry Card, page 83

Electro-mechanical Assemblies

Spectrol Electronics, 1704 S. Del Mark Ave., San Gabriel, Calif., has just issued an 8-page booklet entitled *Spectrol "In-Line" Mechanisms*. The booklet describes with photographs and drawings a new approach to subsystem module design of electromechanical systems.

Circle 170 on Inquiry Card, page 83

Waveguide Components

A 4-page, 2-color brochure issued by D. S. Kennedy & Co., Cohasset, Mass. describes their line of waveguide components. Specifications are listed for two of the more popular sizes of components.

Circle 171 on Inquiry Card, page 83

Communication Antennas

A 16-page, 2-color catalog describing a complete line of mobile antennas and mounts by the Ward Products Corp., 1148 Euclid Ave., Cleveland 15, Ohio along with mechanical and electrical specifications and photographs. A price list is included.

Circle 172 on Inquiry Card, page 83

Microphone Guide

A new booklet "Select-a-Guide" has just been issued by the Sound Products Section, Radio Corporation of America, Bldg. 15-1, Camden 2, N. J., which gives complete details on the application, range, impedance, characteristics, advantages and special features for each of 15 microphones. Additional specification information is provided on microphone stands.

Circle 173 on Inquiry Card, page 83

Electronic Instruments Catalog

Kay Electric Co., Dept. EI, Maple Ave., Pine Brook, N. J., has just released its new 1958-59 catalog of precision electronic instruments, test equipment, and related accessories. The new catalog lists 75 instruments on 52 pages, all completely and accurately cross-indexed alphabetically and by instrument function for rapid reference.

Circle 174 on Inquiry Card, page 83

DC Multimeter

A 4-page bulletin issued by the Belleville-Hexem Corp., 638 University Ave., Los Gatos, Calif., contains photographs, specifications and descriptive material on their new model 110 E-I-R meter. The portable battery-powered meter measures dc voltage, current and resistance.

Circle 175 on Inquiry Card, page 83

Potentiometer Glossary

Bourns Laboratories, Inc., P. O. Box 2112, Riverside, Calif., has just issued a glossary which contains a definition of terms used in describing potentiometers.

Circle 176 on Inquiry Card, page 83

Capacitor Catalog

A new catalog featuring subminiature electrolytic capacitors has just been issued by the Illinois Condenser Co., 1616 N. Throop St., Chicago 22, Ill. The multi-colored literature gives complete data on the type SMT tubular electrolytic capacitors including voltage range and temperature range. Listed in simple chart form, the information is easy to use for reference.

Circle 177 on Inquiry Card, page 83

Cameras & Recorders

Berndt-Bach Inc., 6900 Romaine St., Hollywood 38, Calif. Has just issued a 74-page booklet which describes in complete detail their line of Auricon 16 mm sound-on-film cameras and recorders. Booklet is well illustrated, contains all technical information and has prices.

Circle 178 on Inquiry Card, page 83

New Tech Data for Engineers

Motors & Generators

A 20-page, 2-color booklet has been issued by Instrument Motors, 375 Coit St., Irvington, N. J., which describes their complete line of motors, tach generators and special purpose motors and generators. Booklet contains photographs, outline drawings, electrical and mechanical specifications and tables.

Circle 179 on Inquiry Card, page 83

Modules

Associated Missile Products Co., 2709 N. Garey Ave., Pomona, Calif. has just issued a 4-page brochure describing automatic test system modules for "go, no-go" testing. The various modules available are described.

Circle 180 on Inquiry Card, page 83

Power Supply Catalog

Catalog No. E-58 illustrating and describing a complete line of dc power supplies, ac line regulators, and static inverters is available from Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

Circle 181 on Inquiry Card, page 83

Silicon Rectifier Listings

A 4-page, 2-color brochure has been issued by Automatic Mfg., 65 Gouverneur St., Newark 4, N. J. Specifications for silicon rectifiers are contained in the brochure in an easy-to-follow tabular form along with outline drawings.

Circle 182 on Inquiry Card, page 83

Electro-Mechanical Facilities

A new brochure describing equipment, processes, techniques and abilities available at the Benrus Watch Co., 30 Cherry Ave., Waterbury, Conn. is available. Brochure also describes the type of work that is being done on a sub-contract basis, such as electronic assemblies, electro-mechanical assemblies and mechanical assemblies, in addition to components, parts fabrication, engineering research and product development.

Circle 183 on Inquiry Card, page 83

Galvanometers

Bulletin 1528A is a 12-page, 2-color booklet issued by Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif. which describes their galvanometers. Booklet contains descriptions of the principal of operation, construction features, galvanometer characteristics, photographs, and schematic drawings along with charts and graphs.

Circle 184 on Inquiry Card, page 83

Packaged Circuits

P.E.C. Guide No. 4 is a 12-page, 2-color booklet which is a packaged electronic circuit guide. The guide contains part listings, schematics and test data for the various component circuits. Centralab, 938Y E. Keefe, Milwaukee 1, Wis.

Circle 185 on Inquiry Card, page 83

Electronic Instruments

Millivac Instruments, 2315 Second Ave., Carman, Schenectady 3, N. Y. has just issued a series of bulletins describing their latest line of electronic instruments. These new bulletins describe such items as their post-amplifier which is used to increase power signal generators and sweep generators, precision DC VTVM, electronic RMS millivoltmeters and a sensitive DC VTVM microvoltmeter as well as other equipment manufactured by them.

Circle 186 on Inquiry Card, page 83

Computer Capacitors

Bulletin GEA-6819, 6-pages, gives detailed information on the description, operation and application of filter capacitors designed for computer circuits where high reliability and long operating life is required. General Electric Co., Schenectady 5, N. Y.

Circle 187 on Inquiry Card, page 83

Reliable Tubes

Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y. has just issued a 34-page, 2-color booklet which describes their Gold Brand line of reliable electron tubes. Booklet contains complete electrical and mechanical specifications, tables, outline drawings, photographs, and other information concerning these reliable grade tubes.

Circle 188 on Inquiry Card, page 83

Waveguide Bends

A 12-page catalog, No. C-158, just released by Microwave Development Laboratories, Inc., 92 Broad St., Babson Park 57, Wellesley, Mass. provides an up-to-date guide for the selection of precision cast bends and formed waveguide bends.

Circle 189 on Inquiry Card, page 83

Power Supplies

The Varo Mfg. Co., Inc., 2201 Walnut St., Garland, Tex. has just issued a booklet describing a series of their specialized power supplies. Complete information and photographs are given in this series.

Circle 190 on Inquiry Card, page 83

Microwave Silicon Diodes

A 24-page brochure describing microwave silicon diodes has been issued by Microwave Associates, Inc., Burlington, Mass. Catalog includes up-to-date technical data and receiver design information for low noise mixer and video diodes for applications in the 300 MC to 70,000 MC frequency range. A recently developed diode for test equipment applications is also described. Performance curves, nomographs, outline drawings, and photographic illustrations are included.

Circle 191 on Inquiry Card, page 83

Industrial TV Equipment

An 8-page illustrated brochure entitled "How Many Jobs" covers a complete line of industrial television equipment for business and industry. It shows different types of cameras, control units, monitors, accessories, and projection systems. General Precision Laboratory, 63 Bedford Rd., Pleasantville, N. Y.

Circle 192 on Inquiry Card, page 83

Variable Transformer Catalog

The Superior Electric Co., Bristol, Conn. has just issued a 100-page, multi-colored catalog describing their complete line of Powerstat variable transformers. The multi-colored catalog contains photographs, tables, charts, mechanical and electrical specifications, outline drawings, and all other necessary information. It is profusely illustrated.

Circle 193 on Inquiry Card, page 83

Transistor List

A 4-page, 2-color brochure has been issued by Industro Transistor Corp., 35-10 36th Ave., Long Island City, N. Y. describing their line of transistors. Transistors are listed in tabular form. Also included is an interchangeability guide for transistors.

Circle 194 on Inquiry Card, page 83

Sub-miniature Relays

A 20-page, 3-color catalog issued by Filtors, Inc., Port Washington, N. Y. describes their line of hermetically sealed micro and sub-miniature relays. Catalog contains complete engineering specifications and operational data plus illustrations and detailed drawings for all major types.

Circle 195 on Inquiry Card, page 83

Pilot Lights

Information on a new pilot light with built-in resistor that uses high-brightness neon glow lamp NE-51H is available from the Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.

Circle 196 on Inquiry Card, page 83

New Products . . . for the Electronic Industries

FREQUENCY TIME COUNTER

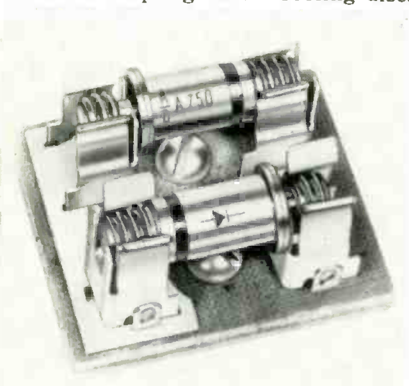
Featuring preset interval generating, timing, and counting functions in a compact package; the Model 860, Frequency Time Counter is a completely transistorized instrument with

unobscured, visual, in-line readout. It contains the shaping, gating, switching, counting and crystal-controlled time base circuitry required to perform counting, timing, frequency measuring, and interval generating functions. The use of a variable time base permits direct reading of results without considerations of transducer conversion factors. Potter Instrument Co., Inc., Sunnyside Blvd., Plainview, L. I., N. Y.

Circle 197 on Inquiry Card, page 83

SILICON RECTIFIERS

The Model A-750 is used in radio, TV, and electronic devices where low cost is a very important requirement. These units are applicable to series operation up to 20 kv. Parallel units for higher currents is possible with the use of balancing resistors. These units may be clip mounted as shown or screwed together with the aid of threaded coupling units. Cooling discs

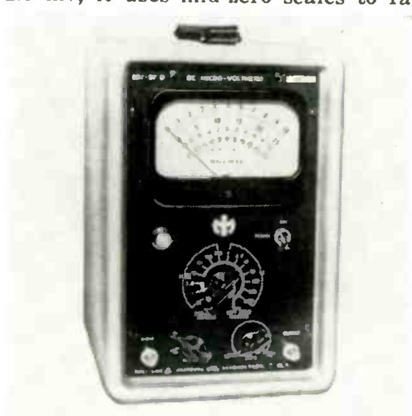


are available for use with the coupling units. The rectifiers may also be mounted directly to the chassis. Audio Devices, Inc., 620 E. Dyer Rd., Santa Ana, Calif.

Circle 198 on Inquiry Card, page 83

SENSITIVE DC VTVM

The MV-27D DC microvoltmeter has 250 µv full scale sensitivity, its highest range being 0-1 kv. On its three lowest ranges, 250 µv, 1 mv and 2.5 mv, it uses mid-zero scales to fa-

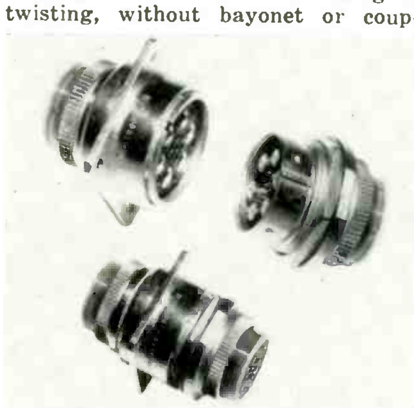


cilitate null-indicator operation in bridge circuits. All other ranges are left-zero for maximum scale length and highest reading accuracy and convenience. Housed in a modernized cabinet with recessed front panel, it has a larger indicating meter and is polarized, thereby eliminating "needle fold-over" under negative overloads on the mid-zero ranges. Millivac Instruments, 2315 Second Ave., Carman, Schenectady 3, N. Y.

Circle 199 on Inquiry Card, page 83

MINIATURE CONNECTORS

A specially designed, environmental connector utilizing 6 coax contacts and thirteen #20 contacts is available. Available in 6 alternate insert positions, the push-pull, quick disconnect connector features either standard or special coupling rings that lock and unlock in the direction of plug travel without lockwiring or twisting, without bayonet or coup-



ling-nut. Coax contacts will accept RG-196/U cable. Pins or sockets are available in either the plug or the receptacle. The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif.

Circle 200 on Inquiry Card, page 83

POWER SUPPLIES

A new line of miniaturized power supplies for dc is available. These hermetically sealed units are lightweight and compact. They are available with 5 ma. output at the follow-

ing voltages: 2, 5, 10, and 15kvdc. High quality selenium rectifiers and capacitors are used. The line is engineered for reliability and oil impregnated for stability. Ripple is 1%. Positive or negative terminal can be grounded to case, standoff high voltage terminals are designed for safe operation. The heavy steel cases are plated and painted. Chicago Condenser Corp. 3255 W. Armitage Ave., Chicago 47, Ill.

Circle 201 on Inquiry Card, page 83

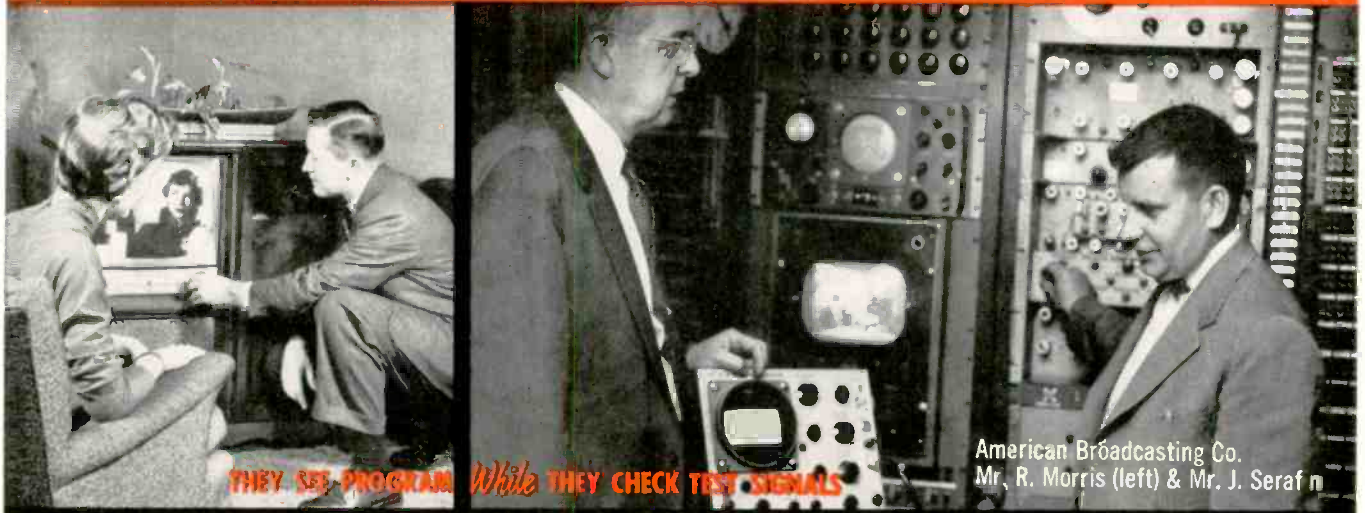
SWEEPING OSCILLATOR

The Vari-Sweep Model 400 has been added to a line of precision all-electronic sweeping oscillators. With the sweep off, it will also serve as an accurately calibrated, continuously tuned CW signal source with the high level output AGC'd constant over the frequency band. It has a continuous frequency coverage from 15 to 470 MC. It provides frequency sweeps

that are flat, wide, and linear. Its r-f output voltage is high enough for testing lossy networks without using additional amplifiers. Kay Electric Co., Maple Ave., Pine Brook, N. J.

Circle 202 on Inquiry Card, page 83

New — SEND TEST SIGNALS DURING PROGRAMMING



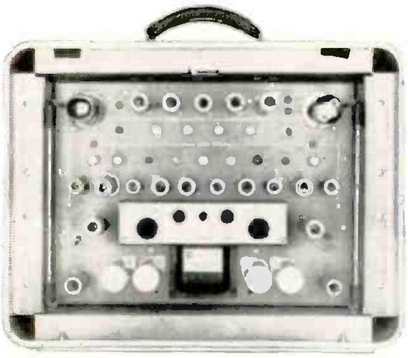
TELECHROME MFG. CORP.

VERTICAL BLANKING INTERVAL TEST SIGNAL KEYER

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.

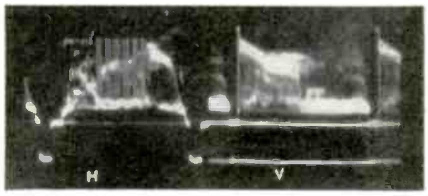
MODEL 1008-A



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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Self-Resonant Frequency

(*Conitnued from page* 67)

that accuracy of measurement is not readily possible. With a properly calibrated stable grid-dip meter and proper coil mounting fixture, readings can be made in a matter of seconds on a production basis. A proper holding fixture can be of any design that adds a minimum of capacity to the coil. Accuracy of measurement is usually limited only by the readability of the meter scale.

A proper mounting fixure may consist of two upright supports of polystyrene extending at least 2½ in. from a base, Fig. 2. The supports should be tapered to a knife edge at the top. The supports should be arranged so that the coil can be supported with a lead on either knife edge. Grid-dip meter readings of SRF should then be taken with a minimum of inductive coupling, Fig. 1.

The lead length of the coil is a very important factor in any accurate determination of the SRF of a coil. For this reason, it is necessary either to make all such measurements with the same lead length for each coil type or to apply a suitable correction factor.

Factors Influencing SRF

The SRF characteristic of a small r-f solenoid coil and the factors affecting it are well defined mathematically. Since the constants of a coil form a parallel tuned resonant circuit, SRF is given by the following formula:

$$\text{SRF} = \frac{159.2}{\sqrt{LC}} \quad (1)$$

where SRF is in MC
C is in μμf (at SRF)
L is in μh (at SRF)

The inductance L of a coil can be readily determined; the distributed capacitance C of the coil is less obvious. For coils on forms with axial leads, the C of a coil is made up of the following factors:

1. Capacitance due to the coil form;

2. Capacitance due to coil form leads;

3. Capacitance betwen the turns in the coil winding;

4. Capacitance due to any insulating material over the winding.

For any small well designed solenoid coil wound on a phenolic coil form, all of the above factors will be essentially constant for coils within a group of a given design.

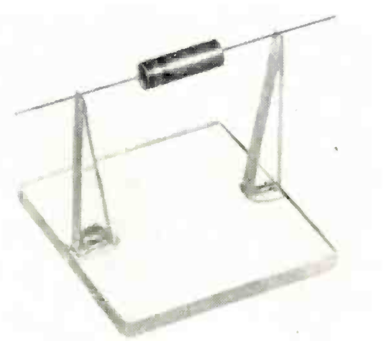


Fig. 2: Polystyrene supports taper to a knife edge; leads are supported on edges.

The total value of C for a coil on a phenolic form is small, approximately 0.3 μμf, with the lead capacitance constituting an appreciable portion of the total. For this reason, any change in lead length results in an appreciable percentage-wise effect on both C and SRF.

For a small r-f coil wound on a powdered iron coil form, the capacitance due to the coil form alone may be 1.0 μμf or more, with an appreciable variation within coil form lots. This resulting variation in C gives rise to a variation in SRF that is comparable to, or larger than the variations in SRF due to an inductance tolerance of 10 to 20%. For coils on powdered iron forms, any change in lead length results in a relatively small percentage change in C and SRF because of the larger total value for C.

Some typical SRF values obtained for several coils with various lead lengths are shown in Fig. 3.

Shortening the coil leads not only raises the SRF nominal, but also increases the percentage variation of SRF values in any lot of coils. Consequently, a larger percentage SRF tolerance, as well as a higher nominal SRF value, may be required after the leads are shortened.

The relationship between small changes in the variables shown in Eq. 1 can be represented to a close practical approximation in terms of the following expressions:

$$SRF = \frac{-(\Delta L + \Delta C)}{2} \qquad (2)$$

where Δ represents a small percentage change (10% or less) from the nominal value. It can be noted from Eq. 2 that the sum of any small percentage changes L and C will shift the SRF by approximately one-half this amount in the opposite direction.

This method can be used to establish a realistic SRF tolerance in those applications where such control is required. A variation in C of up to $\pm 10\%$ and more can be expected for small r-f solenoid coils wound on phenolic coil forms. Similar coils wound on powdered iron coil forms may exhibit a variation in C of up to $\pm 25\%$. Because of the variable C factor, it is impossible to maintain SRF tolerances closer than those derived by Eq. 2, without resorting to a control or adjustment technique.

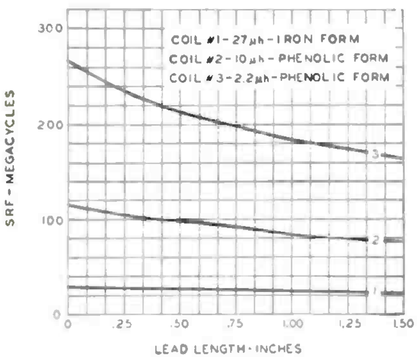


Fig. 3: Relationship between SRF and lead length for 3 different types of coils.

Control Techniques

Special techniques can be utilized to achieve a very close control of SRF for applications where the tuned circuit features of a coil operating at its SRF are desired. For all practical purposes the actual degree of control possible is limited only by the economics involved. Close control of the SRF may be achieved through the use of one or more of the following methods:

1. Holding c l o s e r inductance tolerances (for most coils).

2. Adjusting the inductance to control SRF (this method may require a rather broad inductance tolerance).

3. Sorting of the powdered iron forms to minimize variation in the coil form capacitance.

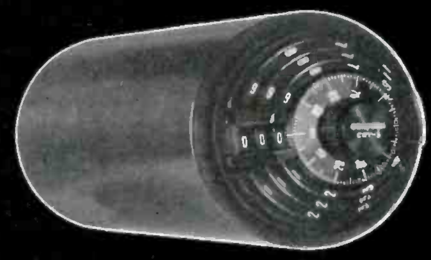
4. Adding capacitance to the coil in the form of a conductive paint on the winding, so as to minimize the percentage variation in the distributed capacity of the coil. This method can reduce the SRF nominal appreciably.

* * *

"Noise Nomograph"

A production error on the nomograph of "Calculating Noise in Electrical Resistors" in the March, 1958, issue of ELECTRONIC INDUSTRIES resulted in Scale "F" being left out.

Scale "F" should be drawn as a straight vertical line placed 1/8 in. to the right of, and parallel to, Scale "E." This is the "Reference Scale" referred to, but not shown, on the graph.



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Tele-Tech's

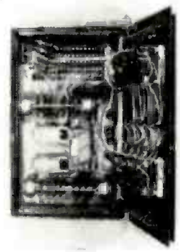
ELECTRONIC OPERATIONS

The Systems Engineering Section of ELECTRONIC INDUSTRIES • July 1958

In This Issue:

Transistorized Mobiles 02

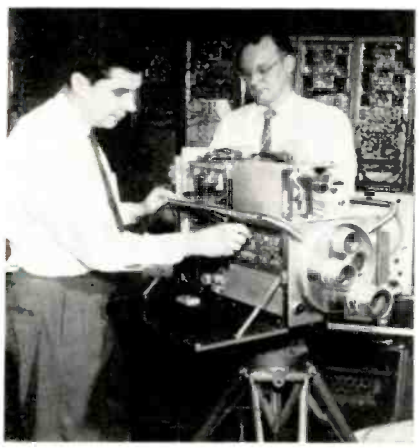
The latest in the line of Signal Corps receiver-transmitters is an almost completely transistorized miniature double-conversion superhetrodyne receiver designed for the reception of FM signals and tunable over a 20 to 70 MC range.



Patchable Time Sequence System 08

A new time sequence system permits patching a number of control functions, both turn-on and turn-off to a precision of 0.1 seconds throughout a sequence period of 15 seconds. A signal generator eliminates roller-type switches and motor driven cams.

SYSTEMS—WISE . . .



NEW TV CAMERA

GE engineers W. L. Shepard and W. Smithies make adjustments on GE's new partially transistorized monochrome camera. New design eliminates microphonics.

▶ **KOTV, Tulsa, and WTAR-TV, Norfolk, Va., have just taken delivery on Ampex VR-1000 videotape recorders.**

▶ Radio Board of the National Association of Broadcasters elected its new officers: J. Frank Jarman, vice-pres. and general mgr. of Station WDNC, Durham, N. C., to chairman, and Robert T. Mason, pres. and general mgr. of Station WMRN, Marion, Ohio, to vice chairman.

▶ **One hundred mobile radio units designed by GE are being used along a 150-mile stretch of the Massachusetts Turnpike. The 2-way radio ties into the turnpike microwave system, also manufactured by GE.**

▶ "Operation Upturn" is being launched by GE to focus effort on better service and better values for GE customers. Plans include an "expedited shipment" procedure which is being put into operation immediately to assist users of 2-way radio equipment where early delivery is extra-important. L. W. Goostree will head the campaign.

▶ **Radechon storage tubes, used for storing information in computers are now going into production at Westinghouse electronic tube division.**

▶ RCA's 2-way radio units will be installed in the buses of the United Transit Co., Providence, R. I. This is the first installation of its kind in the country; other transit companies in Cleveland and Rochester, N. Y., are experimenting with similar installations.

▶ **Conference on Electronic Controls and Highway Safety, sponsored by the Safety Education Institute, Teachers College, Columbia Univ. saw a report by Bendix on an automobile radar that automatically warns the driver of traffic hazards. With an antenna mounted in the front radiator grille the radar would warn the driver if he is closing the gap too rapidly between his car and the one in front, also if cross traffic threatens collision.**

▶ Total of 533 member radio stations of the National Association of Broadcasters have signed pledges of adherence to the Radio Standards of Good Practice.

▶ William Hatton, a veteran of 37 years in the communications field, was designated Assistant Director of the Communications Industries Div. of the Business and Defense Service Administration, U. S. Dept. of Commerce.

Finest line of High Frequency Cables in the communications field!

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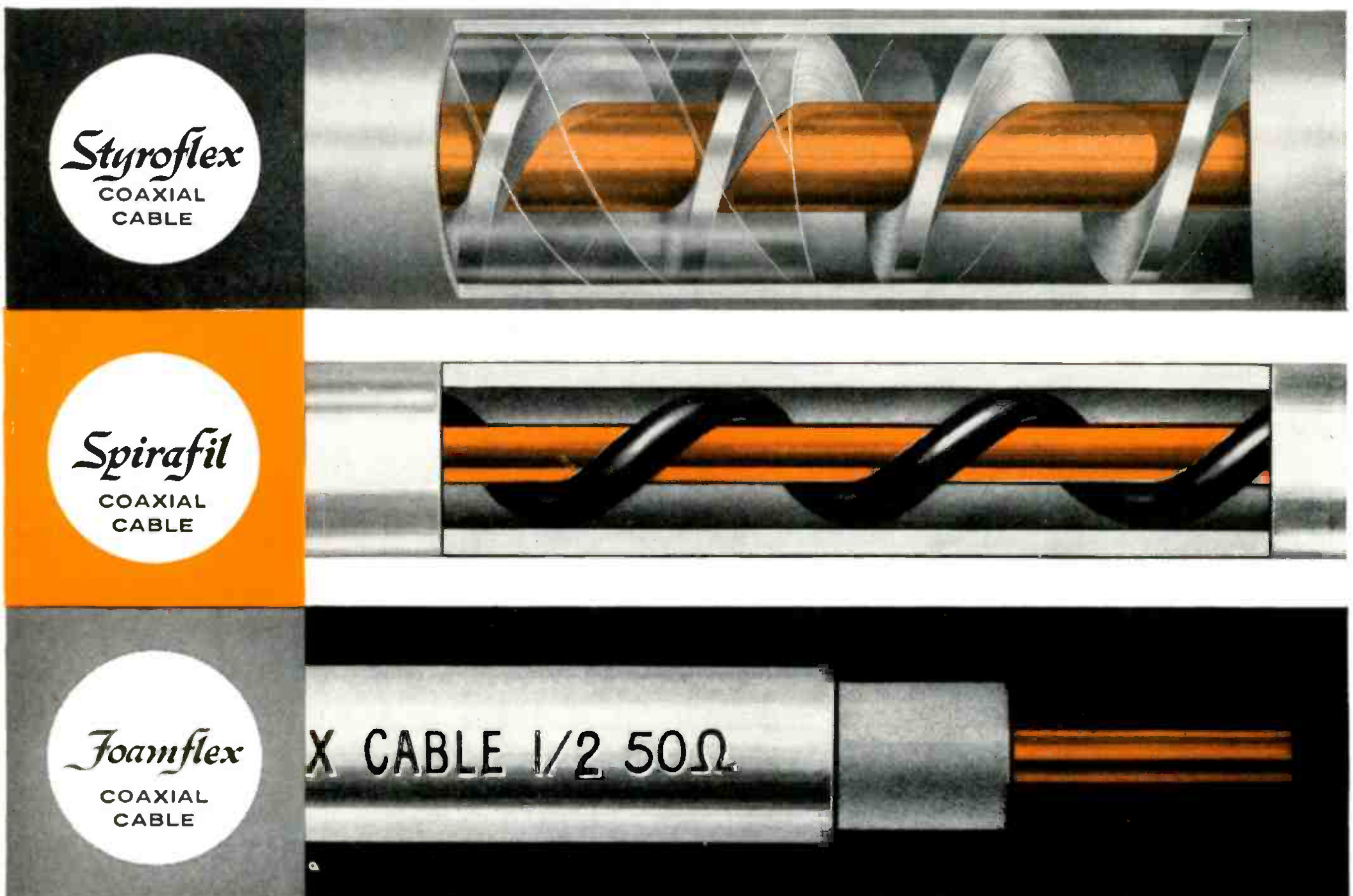

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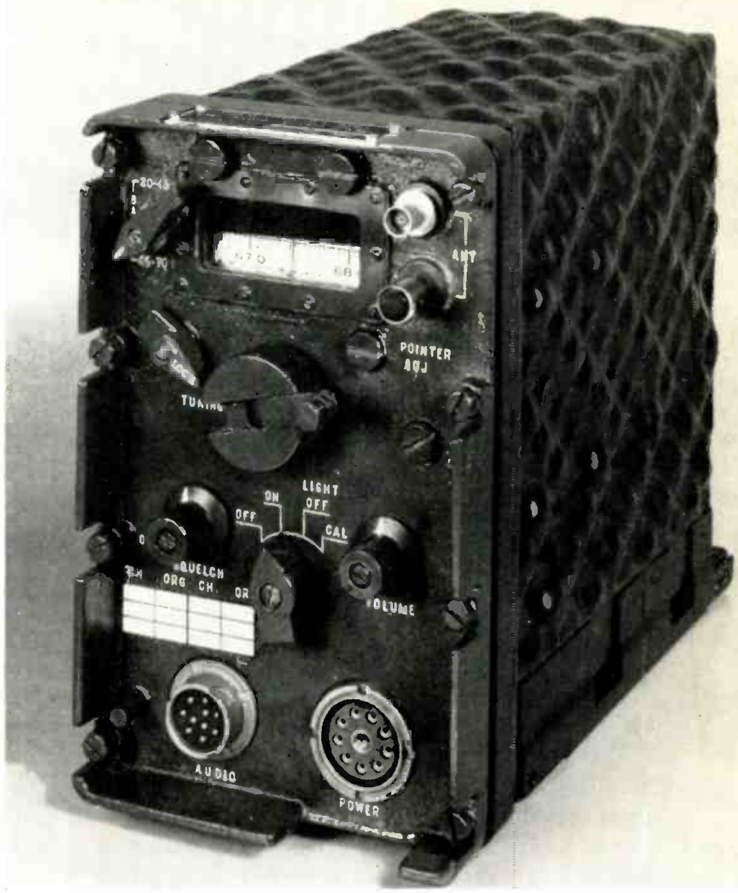
Fig. 1: The R-745 Radio Receiver replaces 3 larger units.



Standardization, Miniaturization, Compatibility . . .

Military Mobiles Become Transistorized

A decade ago, separate units were required to communicate between combat branches of a field army. Now, a new auxiliary receiver accomplishes this; reduces size, weight, power consumption; and, is more rugged.

By R. H. DECKER and D. E. KAMMER

Project Engineers, Communications Equipment Gp. Avco Manufacturing Corp., Crosley Div. Cincinnati, Ohio

R. H. Decker

D. E. Kammer

AT the conclusion of World War II, the U. S. Army had in operation a large number of radio sets for use in tactical units. Most of these varied in technical characteristics and could not be used for intercommunications between units.

This situation demonstrated the need for a radio set incorporating all the desirable features of the sets then in use as well as many new features. To provide a standardized integrated communication system, an entirely new series of FM radio sets was developed for field, vehicular, or man-pack use.

Standardization

By 1951, this new standardized series reached armored, artillery, and infantry units for installation. Thus, a phase of the overall standardization program of the Signal Corps had been completed. Basically, the vehicular sets designated the AN/GRC-3 through 8 series consists of an "A" set and a "B" set, both receiver-transmitters, and a stand-by or "auxiliary receiver."

The auxiliary receivers, three in all, each employ 14 miniature electron tubes and have self-contained vibrator power supplies operating from the 6, 12 or 24 v. vehicular storage batteries. They are identical in size and shape except for frequency range or band over which they operate, the number of channels available and the arm or unit they serve, which are shown in Table 1. A limited number of overlapping channels is provided.

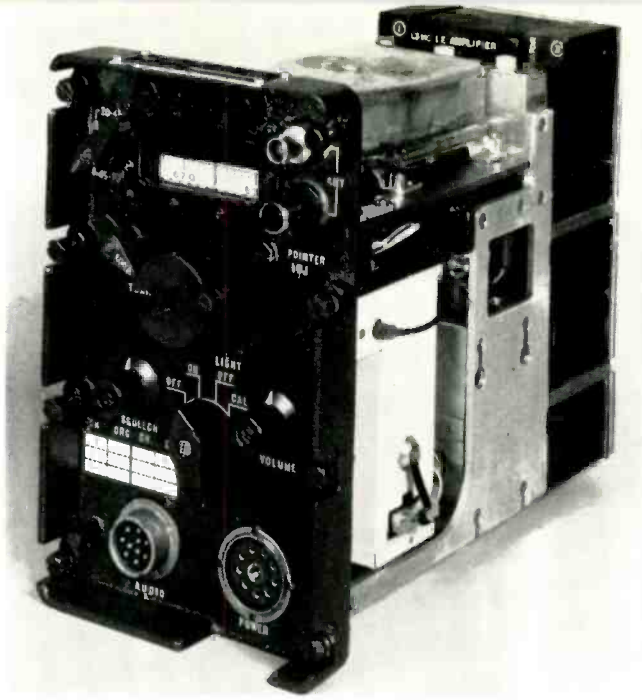


Fig. 2: Auxiliary radio receiver with its case removed.

Transistorization Program

With the introduction of the transistor in 1948 and its rapid advancement, a program was undertaken to develop an auxiliary receiver employing transistors and to be compatible with the present standardized auxiliary receivers. Under contract with the Combat Area Branch of the Signal Corps Engineering Laboratories, Ft. Monmouth, N. J., Crosley Div., AVCO Mfg. Corp., developed a new auxiliary receiver designated the R-745( )/VRC Radio Receiver, Figs. 1 and 2.

When the development was initiated, no transistors, except experimental units, could be considered for a receiver front end operating in the frequency range of the standardized series (20 to 55 MC). As an initial attempt to establish the reliability and practicability of transistors in military vehicular communications equipment, a hybrid auxiliary receiver was developed using both electron tubes and transistors. In addition to providing a reduction in receiver size, weight and power consumption, it was felt that the transistor would lead to a substantial reduction in vehicular communication equipment failures due to shock and vibration.

R-745 Characteristics

The R-745 Radio Receiver is a miniature double-conversion superhetrodyne receiver which provides for the reception of frequency modulated signals. It is continuously tunable over a 20 to 70 MC frequency range and is designed for 100 KC adjacent channel operation. It employs four subminiature electron tubes, 18 transistors, and obtains its power from a 24-v. vehicular storage battery.

Capable of being mass produced, the R-745 was also designed to meet specifications not previously found in equipment of this type. For example, in addition to employing transistors, a high degree of dial calibration accuracy and resetability, plus the overall frequency stability were incorporated. It exhibits a high order of sensitivity, selectivity, image rejection and spurious response rejection. The receiver was designed to operate satisfactorily under various conditions such as an ambient temperature range of −55°C to +65°C, high humidity conditions, heavy rain or short periods of immersion in water, shock and vibration, and input voltage variations of 22 to 30 v.

As in the current standardized series, the R-745 main frame is supported by a cast front panel, which is held tight against a rubber gasket contained in the main case. Glands or "O" ring seals on the shafts of all controls and sealed connectors make a watertight embodiment.

A replaceable desiccant, or moisture absorbing material, is included in the receiver to protect its components from moisture ladened air that may be trapped inside the gasket sealed assembly. The main case is designed to fit into the present standardized series mounting bases so that the R-745 may be substituted for the auxiliary receiver in an existing installation. For a comparison of the R-745 with the R-108, R-109 and R-110 see Table 2 and Fig. 3. It will be noted that one R-745 covers a 47% greater frequency range than all three radio receivers, R-108, R-109, and R-110 combined. It is also smaller, lighter and requires less power input.

Fig. 3: The R-745( )/VRC replaces the R-108/GRC, R-109/GRC, and R-110/GRC receivers.

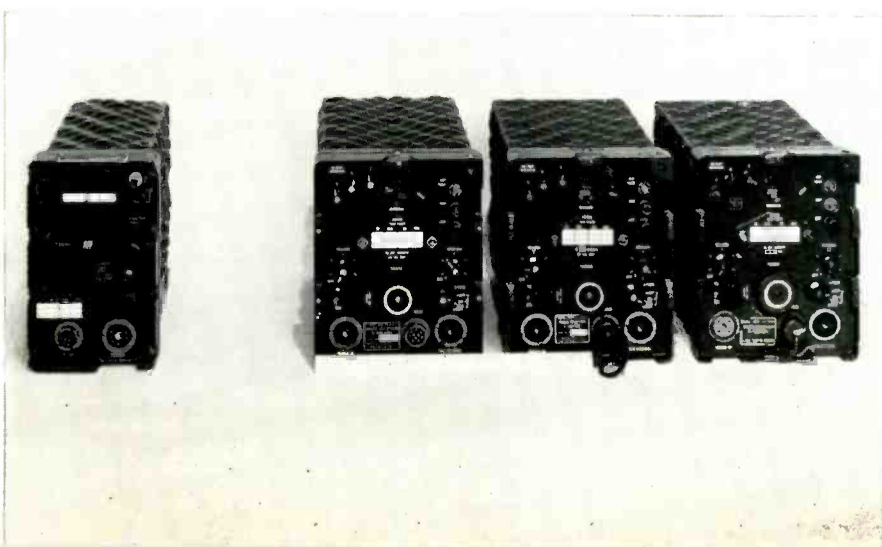


Fig. 4: The front end with cover in place.

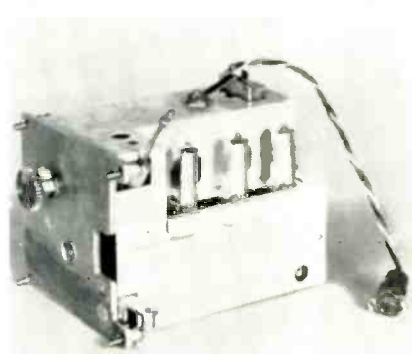


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Table 1

Standardized Auxiliary Receivers

Receiver Type	Frequency Range	Number of Channels	Basic Unit
R-108/GRC	20–27.9 MC	80	Armored
R-109/GRC	27–38.9 MC	120	Artillery
R-110/GRC	38–54.9 MC	170	Infantry

Table 2

Receiver Characteristics Compared

	R-108, 109 & 110	R-745
Sensitivity:	20 db S+N/N for 0.5 μv input. Deviation ± 15 KC, 1,000 cps	10 db S+N/N for 0.3 μv input. Deviation ± 15 KC, 1,000 cps
Frequency Range:	20 to 54.9 MC (3 receivers)	20 to 70 MC
No. of 100 KC Channels:	349 (3 receivers)	500 (in 2 bands)
First I-F:	4.45 to 5.45 MC	12.5 MC
Second I-F:	1.4 MC	1.3 MC
First Oscillator:	15.55 to 49.45 MC (crystal harmonics)	32.5 to 57.5 MC (VFO)
Second Oscillator:	3.05 to 4.05 MC (VFO)	11.2 MC (crystal)
Bandwidth:	6 db– 80 KC 30 db–140 KC 60 db–200 KC	6 db– 90 KC 20 db–130 KC 60 db–185 KC
Audio Power Output:		
Loudspeaker	1 w.	0.5 w.
Headphones:	50 mw.	25 mw.
Audio Output Impedance:	600 Ω	600 Ω
Squelch:	Carrier operated	Noise operated
Power Requirements:	6, 12 or 24 v. at 4 a.	26.4 v. at 500 ma.
Height:	9 in.	9 in.
Width:	7¼ in.	5½ in.
Depth:	12 13/16 in.	11⅛ in.
Weight:	25 lbs. (each receiver)	18¼ lbs.

The Front End

The front-end of the R-745 is divided into two subassemblies, the r-f section, Fig. 4, and the local oscillator, Fig. 5, both employing variable inductance tuning. The tuning range of 20 to 70 MC is divided into two bands selected by a front panel bandswitch: Band 1, 20 to 45 MC; Band 2, 45 to 70 MC. All tuned circuits are temperature compensated.

The r-f section consists of two r-f amplifiers and a mixed stage. Three 6205 sharp cut-off subminiature pentodes are used as the first and second r-f amplifier and the mixer. Printed circuitry is used throughout. Four individual printed circuit boards are plug-in items mounted parallel to each other with interstage shields placed in between, Fig. 6. The variable inductance silver-clad copper spiral tuning element and the bandswitch are an integral part of the boards.

Both the variable inductance tuning arm and the bandswitch rotor are held captive to the boards so that the tuning shaft and the bandswitch shaft may be withdrawn. The plug-in construction eliminates the need of interconnecting wiring and facilitates initial assembly and subsequent disassembly for trouble-shooting and maintenance purposes.

The local oscillator is continuously tunable over a frequency range of 32.5 to 57.5 MC, hetrodyning with the incoming signal to produce the first i-f of 12.5 MC. A 5636 subminiature pentode is employed in a Colpitts electron-coupled oscillator circuit. The frequency stability of the local oscillator is of paramount importance.

Excellent results were achieved by using a highly stable printed circuit board and electrical components, Fig. 7. The board is precision molded of a glass-bonded synthetic mica material. Molded in the board is the variable inductance solid silver spiral tuning element. The oscillator frequency drift is less than 0.1% at 32.5 MC and less than 0.05% at 57.5 MC over the temperature range of −55°C to +65°C.

Power for the plates and screen grids of the four tubes is obtained from a transistorized printed circuit power supply or dc to dc converter. The converter is a self-excited transistor power oscillator

Fig. 5: Local oscillator unit and cover.

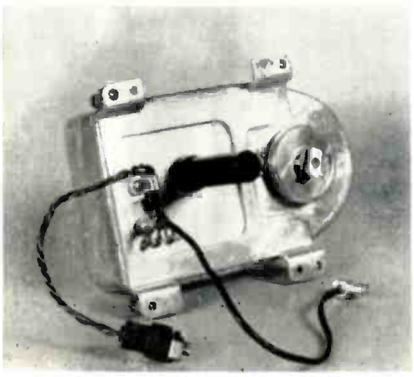
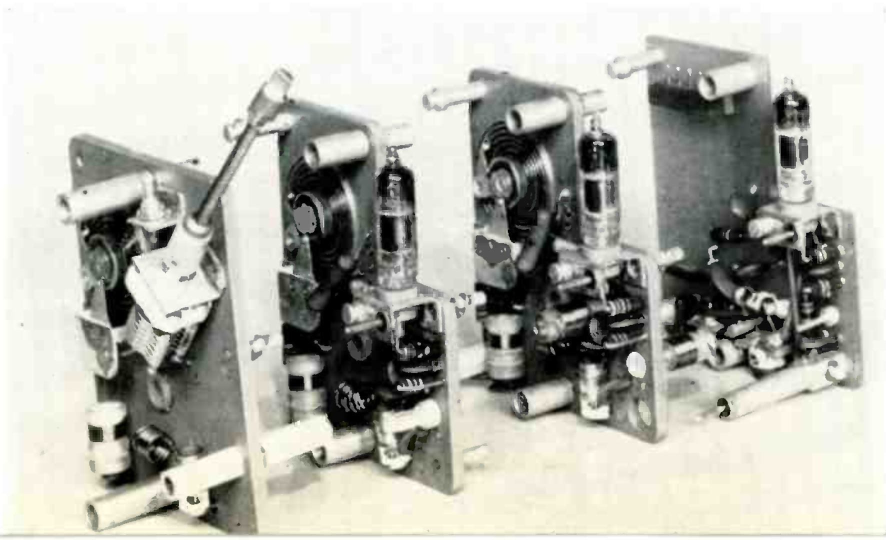


Fig. 6: Exploded view of the r-f section reveals unit construction of the three stages.



Military Mobiles

(Continued)

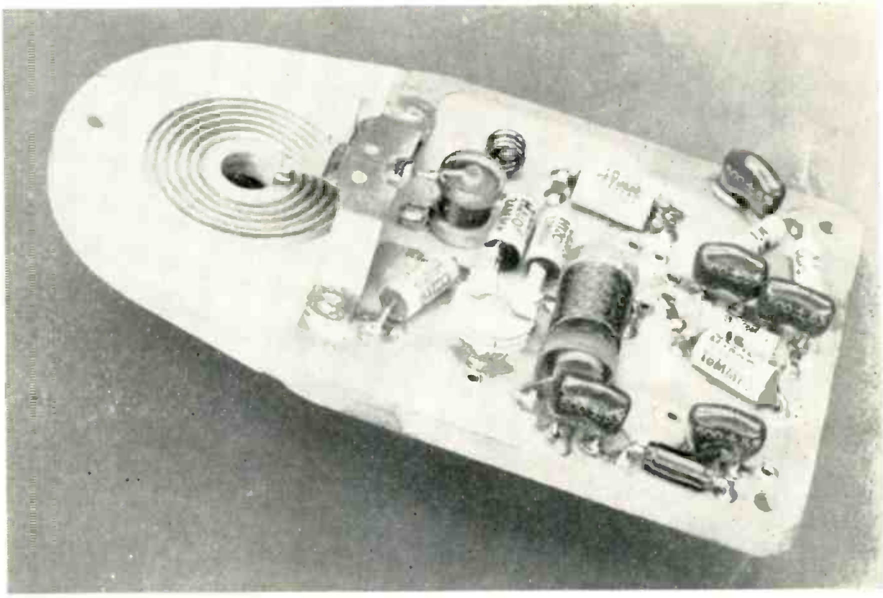


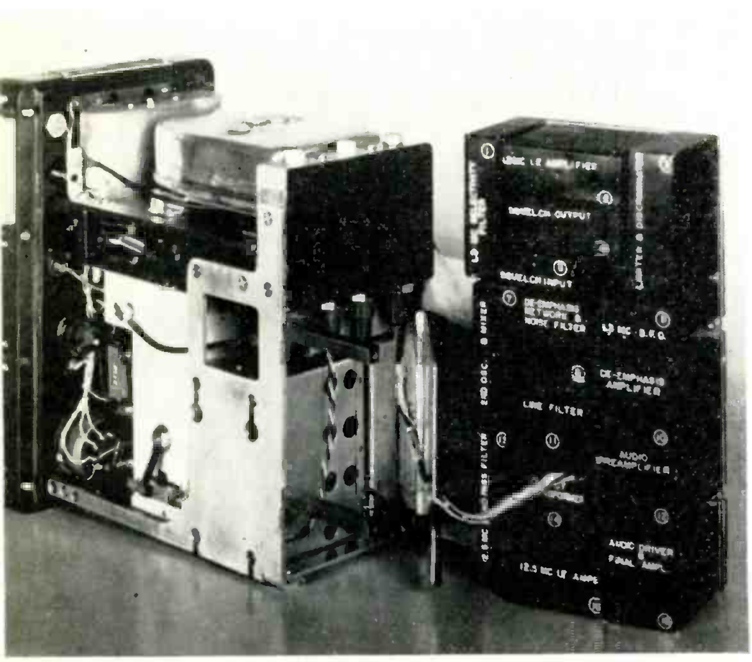
Fig. 7: The components which form the local oscillator are mounted on a printed circuit.

producing a 1000 cps square wave output. This is rectified in a conventional bridge circuit delivering an output of 105 v. at 20 ma. Input power for the converter, as well as heater power for the tubes, is obtained directly from the 24 v. vehicular storage battery.

Since the converter employs no mechanically moving parts, a long maintenance-free life is assured representing a substantial improvement in reliability over the conventional vibrator-type power supply. A magnetic circuit breaker mounted behind the front panel and resettable by the front panel power switch protects the power source from short circuits and overloads.

A unique dial mechanism, employing a 35 mm. stainless steel tape provides 41 in. of dial for each band. The megacycle frequency calibration marks and each 100 KC channel marking can easily be set and read from a distance of 3 ft. A built-in crystal calibrator is provided which may be energized by means of a front panel switch. The operator may check the dial calibration of each megacycle point and correct it if necessary by means of front panel hairline adjustment.

Fig. 8: Transistorized unit of receiver is shown here swung open.



Fixed Tuned Receiver

The i-f, audio, and squelch portion of the R-745 Radio Receiver is essentially a 12.5 MC fixed-tuned receiver (FTR) employing transistors throughout. This transistorized receiver is a complete assembly which is hinged to the R-745 main frame, Fig. 8. The interconnecting power and control cable as well as the 50 Ω coaxial input cable are sufficiently long to permit the FTR to open 90° with respect to the main frame and still be in operating condition.

The input to the FTR is obtained from the tuner. The output is 500 mw. of audio. At room temperature the transistorized unit is capable of limiting on signal levels below 10 μv. into the 50 Ω input.

Ease of maintenance was one of the primary design goals in the FTR. To accomplish this, individual plug-in amplifier packages and L-C type packaged filters were used, Fig. 9. These units were interconnected by means of a main printed circuit board which was hinged to the R-745's main frame. Rigidity was accomplished in the main printed circuit board by riveting a ⅛ in. aluminum plate to the board.

Banana pins riveted to the main chassis printed board were used to make the connections to the individual printed circuit boards in the plug-in packages through the female glass seal in the header. This type of construction made possible a plug-in package that could withstand rough handling as no pins protruded.

The FTR consists of 16 individual packages, 12 of which are complete plug-in packages. The other 4, which are the 12.5 MC bandpass filters, the 1.3 MC second i-f selectivity filter, the line filter, and the audio output transformer, were soldered into the main printed board. These units were soldered permanently into place because they are considered to be the most reliable.

Plug-In Packages

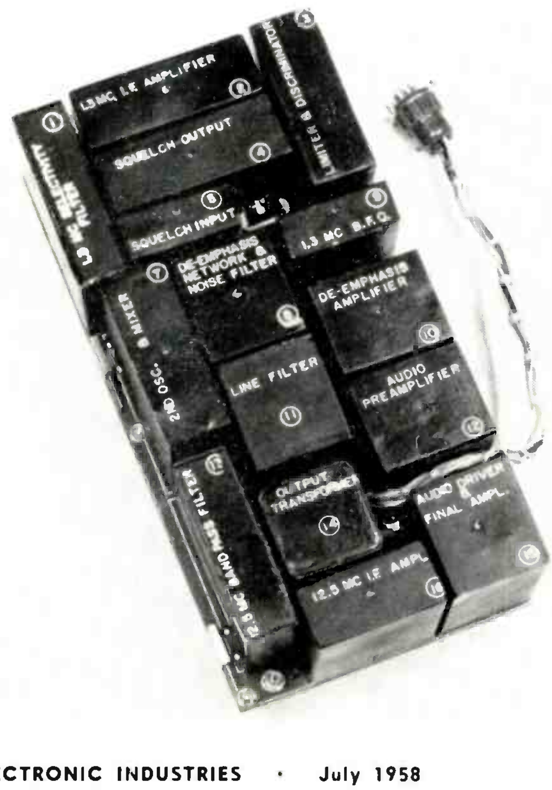
The plug-in packages have been designed for simplicity of manufacture and to obtain minimum insertion alignment. Fig. 10 illustrates a typical plug-in package. All plug-in packages are aligned independently and sealed. The bandwidths of all the i-f plug-in units are broad since the block type filters determine the i-f selectivity. No final alignment is required on the units after they are placed on the main interconnecting printed circuit boards.

The plug-in packages can be assembled very quickly since no hand wiring is required due to the universal use of printed circuitry. In addition, since components are placed only on one side of the printed circuit board, dip soldering techniques can be utilized. All components including transistors and diodes are soldered into place.

In the fixed-tuned receiver the 12.5 MC signal from the tuner is amplified and then passed through a 12.5 MC L-C bandpass filter which serves as the selectivity to attenuate ½ i-f response as well as other spurious frequencies. The 12.5 MC signal is then heterodyned in a transistor mixer with a 11.2 MC signal from a crystal oscillator with the resultant i-f of 1.3 MC. This signal is then passed through a bandpass filter having a 6 db bandwidth of 90 KC and a 60 db bandwidth of 185 KC before it is amplified and demodulated. The recovered audio is then passed through a de-emphasis network and amplified. There is also a 1.30 MC crystal beat frequency oscillator which is used in conjunction with the crystal calibrator when calibrating the R-745 tuning dial.

The audio amplifier used in this receiver is the direct coupled feedback type. By using the direct coupled system, it was possible to completely eliminate all the transformers with the exception of the output transformer thereby considerably reducing the size

Fig. 9: I-f squelch, and audio assembly is formed from plug-ins.



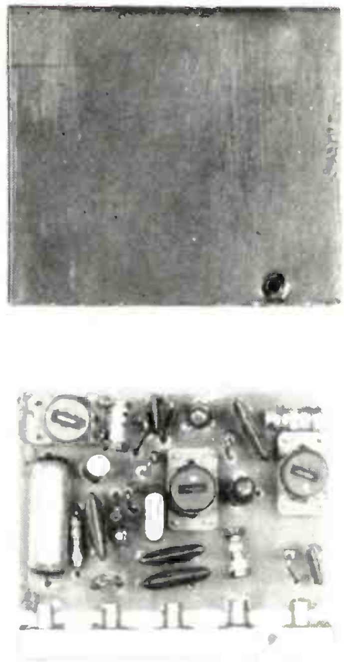


Fig. 10: A plug-in, typical of those in Fig. 9, with cover removed.

of the overall audio amplifier. In the output stage of the amplifier, an NPN and PNP power transistor were used in the complementary symmetry configuration thus eliminating the input transformer normally used in push-pull operation.

The audio output stage is operated essentially Class B. As such, the distortion usually rises slightly at low output levels. To minimize this distortion, the volume control was placed in the feedback loop. As such, the negative feedback is greatest at the minimum volume control setting thereby reducing the distortion.

In the audio amplifier both ac and dc feedback are used. The dc feedback is used primarily to stabilize the operating points of the transistors and prevent runaway at high temperature. The overall gain of the amplifier is 60 db. Due to the large amount of feedback, the gain decreases only 3 db over the temperature range of —55° to +75°C.

A noise operated squelch circuit is used to squelch the receiver. The noise input to the squelch circuit is derived from the output of the discriminator and then is amplified and rectified. The rectified output is then amplified by 2 dc amplifiers to drive a relay which squelches the audio output.

Fifty service test models of the R-745( )/VRC Radio Receiver have been completed for the Signal Corps. With the delivery of this model, the first phase of a conversion to transistorized vehicular radio communications equipment has been completed. Additional phases are under development and will appear this year.

Acknowledgments

The authors wish to acknowledge the valuable assistance of fellow engineers of the Communications Equipment Group of Avco Mfg. Corp., Crosley Div. We also wish to acknowledge the competent assistance and guidance of the Signal Corps Engineers of Combat Area Branch of the Signal Corps Engineering Laboratories, Ft. Monmouth, N. J.

A Patchable Time Sequence System

The time sequence system described here permits patching a number of control functions, both turn-on and turn-off to a precision of 0.1 seconds throughout a sequence period of 15 seconds. A signal generator eliminates roller-type switches and motor-driven cams.

By SAMUEL E. DORSEY
Electronic Engineer
China Lake, Calif.

THIS article concerns the development of an improved sequencing system which permits the patching of a number of control functions, both turn-on and turn-off, to a precision of 0.1 second throughout the sequence period of 15 seconds. This patching is in addition to certain fixed controls such as count-down lamps and gun-firing. Although provision is made for eight patchable functions, the system is flexible and more may be added if necessary.

The nucleus of the old sequencing system was a row of roller-type microswitches. The switches were actuated by properly situated pegs on a cam cylinder driven through speed-reduction gearing by a synchronous motor. The new system replaces directly the motor-driven cam cylinder.

A signal generator unit forms a 10 CPS signal which is passed through manually controlled switches to the main unit. This unit consists of a stepping switch panel, a patch panel, and a latching relay panel. These three panels, listed separately for descriptive purposes, comprise the main unit. Actually, they are in close proximity to each other, the patching binding posts and the latching relays being on opposite sides of one panel which is about four inches distant from the stepping switch panel.

Signal Generator

Fig. 1 shows the circuit of the signal generator which forms rectangular waves at a frequency of 10 CPS to provide the 0.1 second precision of the sequencing system. A sensitive relay is connected into an R-C charge-discharge circuit whose principal parts are, in addition to the relay, coil, two potentiometers and a capacitor. When the circuit is connected to the dc supply, current flowing through the normally closed contacts (1) of the relay tends to charge the capacitor and increase the magnetic field in the relay. When this field becomes large enough, the relay pulls in, opening the circuit to the dc supply. The capacitor then discharges through the relay and the shunt potentiometer until the current is no longer strong enough to hold the relay in. The

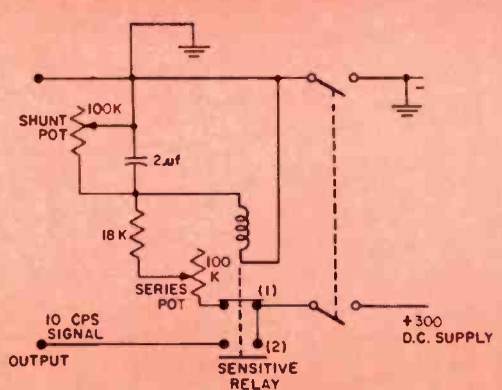


Fig. 1: A unique signal generator.

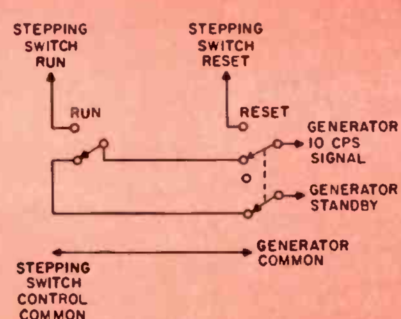


Fig. 2: Diagram of control switches.

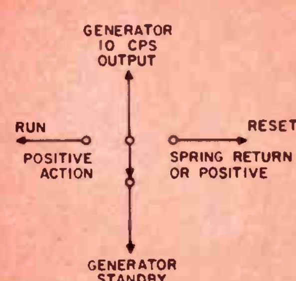


Fig. 3: Alternate control switch circuit.

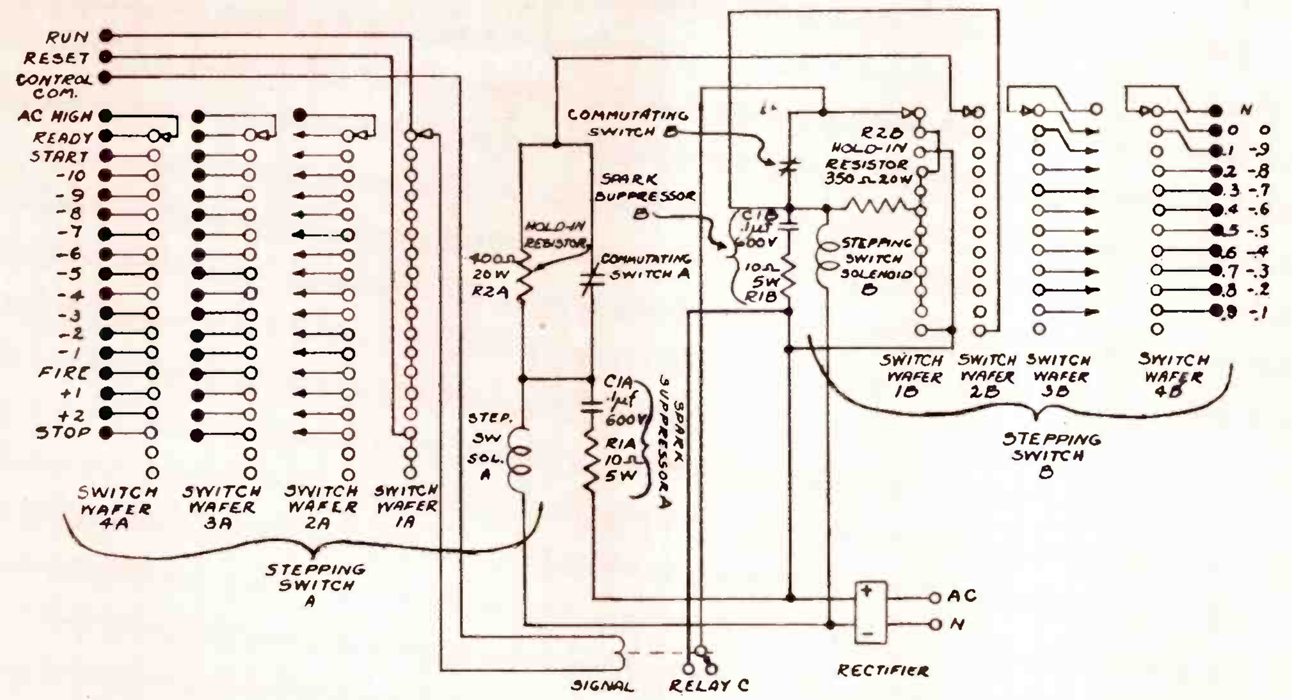


Fig. 4: Circuit diagram of stepping switch panel. Switches A and B are rotary switch wafers actuated by a rotary solenoid.

relay then releases and action starts again. The two potentiometers are so adjusted that the cycle of relay action repeats itself at a frequency of 10 CPS with a duty factor of about 0.5. The signal output to the sequencer is formed by the opening and closing of another set of contacts (2) in the relay.

In the operation of the sequencing system, the 10 CPS signal is switched by means of control switches to appropriate circuits in the stepping switch panel. The switching diagram in Fig. 2 represents a possible arrangement of relay contacts which may be used if it is decided to manually operate through push-buttons and relays already in existence in the Console. This diagram can also represent two toggle switches for direct manual control. A preferred connection is the alternate circuit given in Fig. 3, should direct control be decided upon.

Direct manual control of switches is preferred to push-button control in order that the sequencing action may be stopped at any desired moment simply by returning the switch to its downward or "off" position. However, a separate push-button can be readily installed for that purpose.

Switch Panel

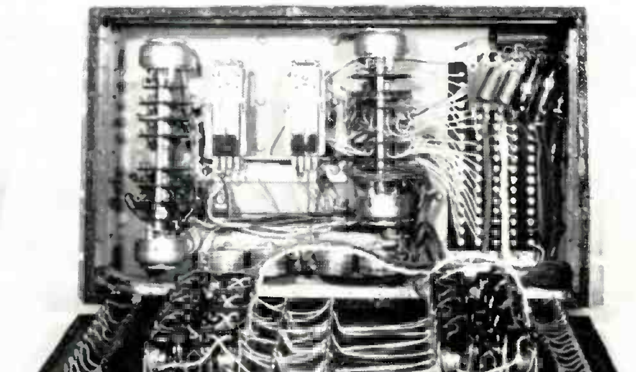
Fig. 4 is a circuit diagram of the stepping switch panel for the sequencing system. The principle objects on this panel are the two stepping switches A and B, with their power rectifier, and signal relay C (also the signal generator relay).

The coil of signal relay C receives its 10 CPS rectangular wave excitation from the signal generator circuit through the control switches and switch wafer 1A of stepping switch A. This signal causes repetitive pull-in and release of signal relay C at the 10 CPS rate. A set of contacts of signal relay C furnishes the pulsating opening and closing circuit required to operate the stepping switches.

The two stepping switches A and B are manufactured by the C. H. Leland Co. and are called "Ledex" switches. Each switch is made up of a number of rotary switch wafers which are actuated by a rotary solenoid placed at one end of the switch. (The switches used in this particular application were taken from stock and have solenoids on either end, making it possible to have reverse as well as forward action, if desired. However, the reverse action is not being used in this instance.)

Stepping switch B has 12 contact positions while only ten are required. Switch wafer 1B is wired in such manner that the switch rotor will by-pass two of its 12 positions, making it in effect a 10-position switch. By-pass action is accomplished by the commutating switch B which is part of the stepping switch. The hold-in resistor R2B shunts current around the commutating switch B in all positions except the 3rd and 12th (See switch wafer 1B). Signal

Fig. 5: Inside of view of patch panel shows parts location.



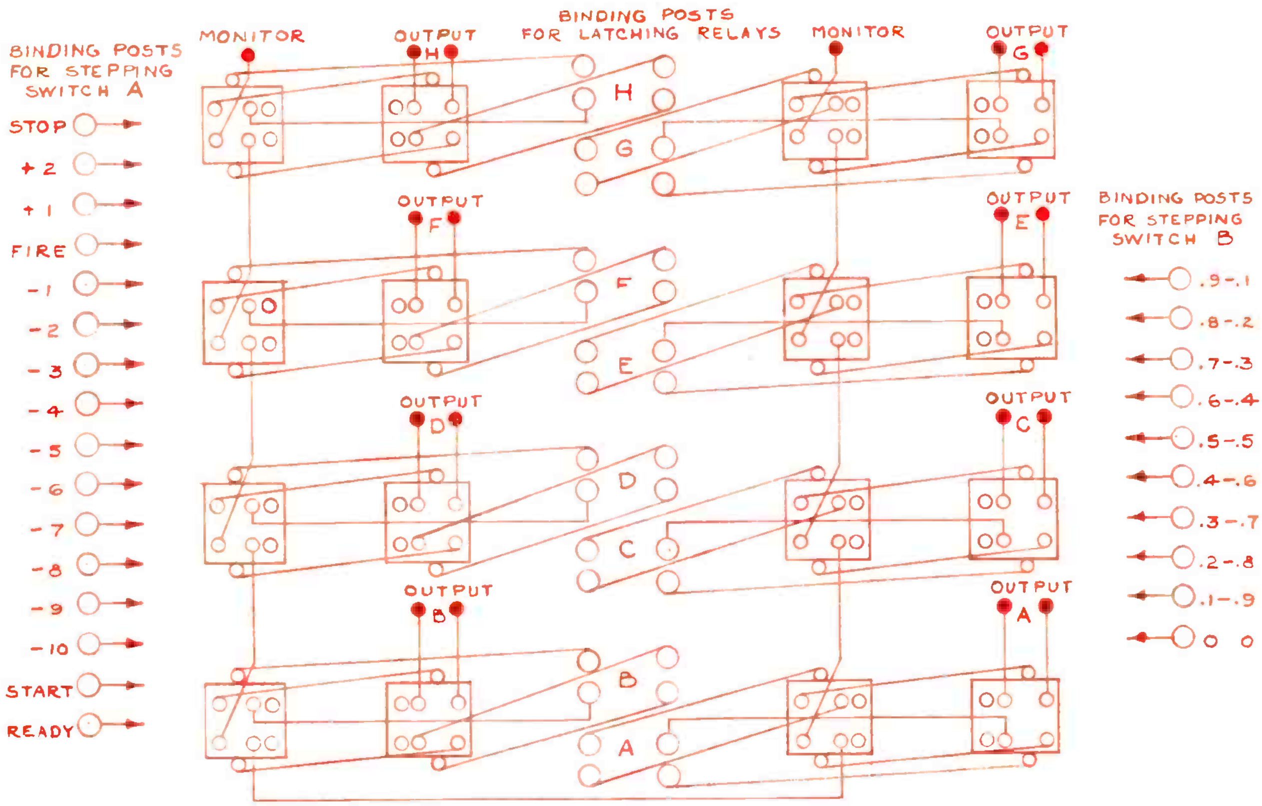


Fig. 6: Wiring diagram of the patch panel. Two rectangles side-by-side represent one latching relay.

Patch System *(Continued)*

relay C, acting ten times per second, produces a complete revolution of stepping switch B once every second.

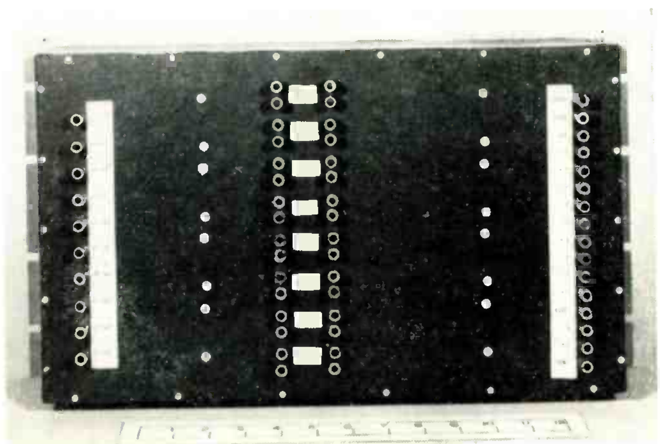
Commutating Switch

The action of the commutating switch is as follows: Normally, it is closed. As the solenoid pulls the switch rotor through its excursion, the commutating switch remains closed until 2° or 3° before the excursion ends, far enough so that the inertia of the solenoid will carry the switch rotor through its complete turn. Then the commutating switch opens and allows the solenoid to quickly return to its original position. If the hold-in resistor parallels the commutating switch, current will flow through this resistor and will prevent the switch from returning to its original position.

Stepping switch A is driven through a contact on switch wafer 2B by the power which operates the solenoid of stepping switch B. The switch wafer 1A circuits cause the sequencing to be turned on and off. To separate "run" and "reset," these lines from the control switches are connected through switch wafer 1A. The "run" line is connected to the first 15 points, and the "reset" line to the last three points, of the 18-position stepping switch A. The wiper of switch wafer 1A is connected to the coil of signal relay C. Therefore, if stepping switch A is in any one of its first 15 positions, and the signal output is applied between the "run" and "common" input terminals, sequencing will occur, advancing stepping switch A one position each second until the switch has moved into the 16th position, where it stops. Application of the signal between "reset" and "common" terminals will again activate the switches, whereupon the sequencing will resume until stepping switch A moves to the first or "ready" position.

Switch wafers 2A, 3A and 4A are all provided with leads from their wipers and the first 16 of their 18 points. Their wipers are routed to the main terminal plate for connection to ac high. The leads from the points of switch wafer 2A (Fig. 4) are routed to the patch panel. Those from switch wafer 3A and 4A are routed to the main terminal plate for external connection to the count-down lamps, gun-firing circuit, or to serve as spares. *(Continued on page 012)*

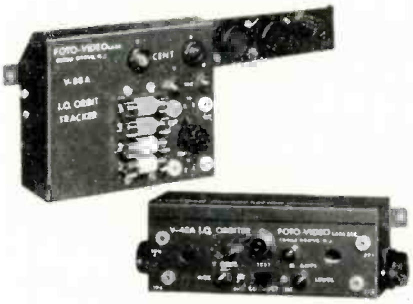
Fig. 7: Front view of the latching relay panel.



New Products

Orthicon Orbiter

The V-148A Image Orthicon Orbiter System consists of 3 units: the V-48A image orthicon orbiter, the V-88A image orth. tracker and the image orth. image section orbit yoke.

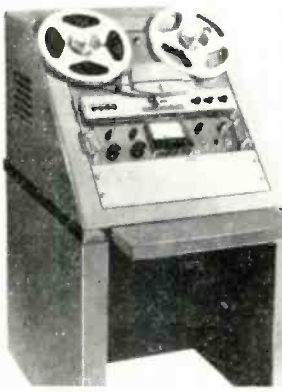


There are no moving parts or vacuum tubes, the unit being completely transistorized. Some features are: it adds hundreds of hours to tube life; high conversion efficiency; low heat dissipation; small size, light weight; nonmicrophonic operation; precise tracking of tube beam; and miniaturized to fit inside any TV camera. Foto-Video Labs., Inc., 36 Commerce Rd., Cedar Grove, N. J.

Circle 209 on Inquiry Card, page 83

RECORDER-REPRODUCER

The M-90 stereophonic recorder-reproducer is housed in a new attractive cabinet designed to the most exacting professional requirements. It



has push-button controls, 15 and 7½ ips with switch selection. Automatic tape lifter protects heads. Instantaneous start and stop. High speed cueing control; full remote control. Recorder interlock prevents accidental erasure. Dual record and playback amplifiers permit monitoring from each channel. Equalization selector switches. Magnecord Div. of Midwestern Instruments, Tulsa, Okla.

Circle 210 on Inquiry Card, page 83

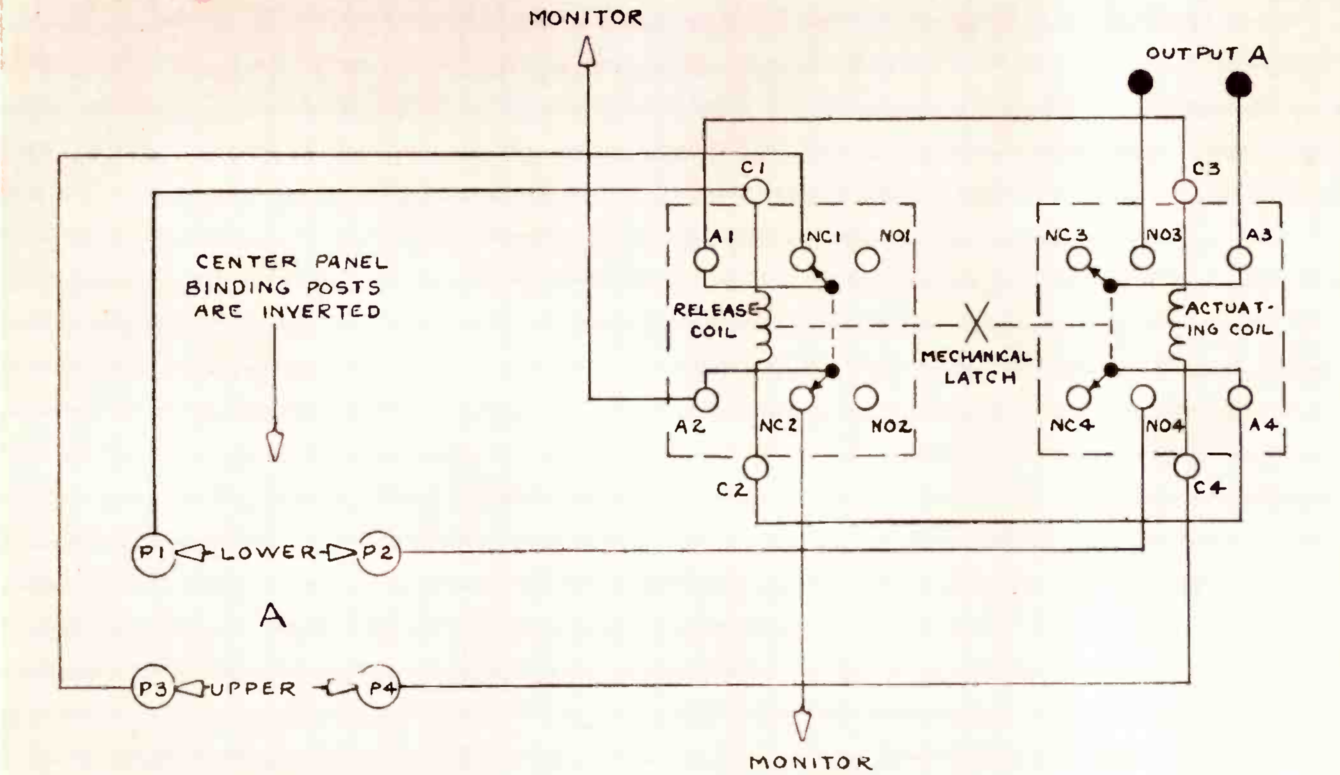


Fig. 8: Detailed diagram of latching relay "A." Like all of the latching relays, relay "A" is symmetrical.

Patch System *(Continued)*

The numbers 1A, 2A, 3A, 4A, or 1B, 2B, 3B, 4B, do not necessarily refer to physical location of the wafers with respect to each other.

Switch wafers 3B and 4B are provided with leads from their wipers and 10 of their 12 points. Their wipers are routed to the main terminal plate for connection with neutral or ac low. The leads from the points of switch wafer 3B are routed to the patch panel. Those from 4B are routed to the main terminal plate for spares.

The Patch Panel

The patch panel is made up of four vertical rows of G-R binding posts mounted on a micarta board (see Circuit Diagram, Fig. 6). In the left row, a binding post is provided for each of the labeled positions of stepping switch A. The right row has a binding post for each of the labeled positions of stepping switch B. The two center rows of binding posts provide connections to the coils of the latching relays. The posts in these rows are in groups of 4 for each of the 8 latching relays provided. Considering any one group of 4 binding posts, the two top (bottom in Fig. 6 which is inverted) are connected to the "close" coil of the relay to which they are attached. The two bottom posts of the group are connected to the "open" coil of their relay.

Eight latching relays are mounted on the inside of the patch panel. Each is indicated by a pair of rectangles (Fig. 6) with associated small, white circles. The circles in the rectangles represent the arrangement of the contact terminals of these relays. The small white circles tangent to the rectangles represent the coil terminals.

Latching Relay Operation

For a better description of the operation of the latching relays, a detailed diagram of relay A is given in Fig. 8. Like all the latching relays, relay A is symmetrical.

The relay is actually two separate dpdt relay sections mounted facing each other with a bar extending out from the armature of each other toward the other. The bars are so situated that they form a mechanical latch. The latch operates so that when the first section is actuated, its bar gets out of the way of the second section, allowing the spring of the second section to pull its armature into the drop-out position. Then, when the current in the first coil is interrupted, the bar of the second section holds the first section in actuated position until the second coil is energized.

The designation of one coil as the actuating coil and the other as the release coil is arbitrary. In Fig. 8 the terminals of the actuating coil are designated

(*Continued on page* O16)

New Products

TURNTABLE

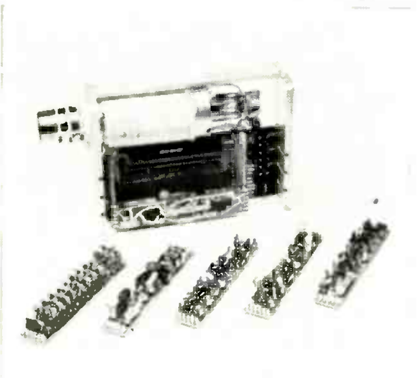
A twelve inch 3 speed turntable is designed for constant duty requirements of broadcast stations and other professional users. Features: Simplicity of design; fast accelleration;

unique record surface design eliminates loose 45 RPM record adaptors or unreliable "pop up" hubs. Lathe turned and balanced table. Entire mechanism mounted on heavy cast aluminum chassis. Available with 4 pole specially designed induction motor, or syncronous hysteresis motor. Meets all NARTB performance standards. QRK Electronic Products, 445 N. Circle Dr., Fresno 4, Calif.

Circle 211 on Inquiry Card, page 83

SMALL TV CAMERA

Complete transistorization of a TV camera has created a rugged, compact and automatic television system practical in many situations where television has not been previously feasible. Housed in a single unit measuring 2⅜ x 5⅝ x 7¾ in. and weighing approximately 4 lb. (without optics), it also features greater density and a significant decrease in power requirements. Basically of



modular construction, 6 plug-in, printed-wiring strips perform the various functions. Dage Television Div. Thompson Products, Inc., Michigan City, Ind.

Circle 212 on Inquiry Card, page 83

Circle 51 on Inquiry Card, page 83

CUES for Broadcasters

Correction, please

Editor, ELECTRONIC INDUSTRIES

I was very pleased to find my article titled "Inexpensive Audio Switching" featured on page 06. Electronic Operations section. Electronic Industries, May 1958.

I would like to submit the following correction. Switches and pilot lights #1 through #5 are numbered incorrectly. #5 should be in the position occupied by #1. All numbers in between would change in a corresponding manner. thus switch #5 should be at the top of the schematic shown in Fig. 4. The switches should then be numbered in decreasing order so that switch #1 occupies that shown as being occupied by #5.

The schematic, as such, is correct as shown. The fault in the switch numbering is entirely my fault and in no way reflects upon your excellent staff.

Sincerely,
HAROLD D. SCHAAF, Ch. Engr.
WRFD, Worthington, Ohio

Pin Locators

ED HOWELL, Tech. Supv.
WMIX, Mt. Vernon, Ill.

Cannon "P" type mike cord connectors have an engraved arrow on the top of their shells to help in locating pin positions and facilitate easier insertion of the plugs into their sockets. Even when new, these arrows are difficult to see. After the plug has been in use some length of time, it is sometimes impossible to locate the arrow in poorly lighted locations.

We have solved this problem by painting a line "down the arrow" on each of our plugs as it is put into service. Periodically, we renew the stripe so that it can be easily seen. Here we use bright red finger nail polish. Paint would be just as good. With this very conspicuous red stripe down the plug, it is no problem finding the top and inserting it correctly on the first try.

Console Modification

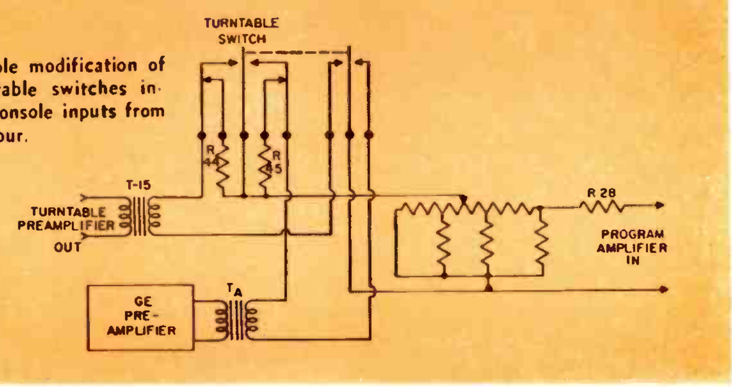
EDWARD BOYER, Ch. Engr.
WBOB, Galax, Virginia

With the increased emphasis on music, jingles, and sound effects, the two turntable inputs on our Raytheon RC-11 Console were inadequate. A few simple and inexpensive changes gave 4 turntable inputs without additional switches or controls on the console.

The additional inputs were gained by using the monitor position on the turntable switches as additional inputs. It was necessary to change the wiring so that the switch came between the pre-amplifier output transformer and the volume control, as shown in the diagram. Thus with the switch in the original program position, turntable #1 can be faded as needed; in the original monitor position, turntable #2 is fed into the fader control and program amplifier.

Since we were using GE cartridges, we bought a regular GE pre-amplifier and high quality matching transformer, high impedance to 500 Ω. The pre-amplifier ac supply was wired into an equipment rack, thus there was no extra equipment to be turned off or on.

No trouble was encountered in the installation and the response is ± 2 db from 70 to 8,000 cps.



This simple modification of the turntable switches increased console inputs from two to four.

Better Conelrad Receiver

W. B. TURNER, Ch. Engr.
WDKD, Kingstree, S. C.

Where the Conelrad receiver must be operated in a high noise level or close to a transmitter of high power I find an auto receiver will out perform any Conelrad Receiver on the low price market.

Select a new auto receiver (6 v.) model with push buttons. These can be set to the desired station to be monitored, the sky wave station, and the Conelrad frequency used in your area.

Discard the power supply and audio part of receiver. Connect the unit audio to existing amplifier and ac power supply; AVC of the tuner to an amplifier stage; and the grids together. A relay is connected to the plates of the tube (6SC7). When the AVC drops, the tube draws current closing the relay, connecting the amplifier to the speaker and warning bell. By using a latching relay with time delay circuit (E.I., Dec. 1957, p. 012), a better system would be had.

A range filter may be placed between the tuner and amplifier which will operate on the 1 KC tone.

The auto receiver is well shielded and contains an r-f stage which is not found in other receivers of equal cost. The outside antenna should be removed as far as possible from strong r-f fields and noise. RG-58/U cable, feeds the signal to the receiver.

CUES for Broadcasters

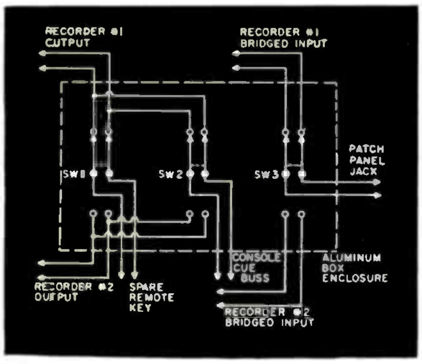
Recorder Switch Box

ROYCE BAERG, Ch. Engr.
KJCK, Junction City, Kansas

This station produces its own announcements by tape recording, a good deal of remote broadcasting, and some mobile broadcasting. Our console has only one control for remote work with several utility keys tied into it. All of this entails a lot of cueing.

We employ two tape recorders for playback with line outputs that can be used directly into the remote channel of our console. Problems arose when it became necessary to cue one tape while the other recorder was playing back or a remote broadcast was underway. Since no speakers are used in the recorders, cueing was done through the remote channel which had a cue position. Cueing with headphones was possible, but with a fast moving program schedule it was quite inconvenient. The solution was to devise a switching system that entailed no patching or plugging to slow down the operator.

A small aluminum box was secured and three DPDT lever switches installed. As the diagram shows, Switch 1 has outputs from



This switching system entails no patching.

the two recorders into it, with the output wired to a spare remote key on the console. In the aluminum box, Switch 2 contacts, with a center off position, are wired parallel to Switch 1 with the output connected to the cueing buss of the console. This takes care of cueing tapes on one machine while the other is playing or a remote is being run.

While we were at it, we installed Switch 3, identical to Switch 2, to act as input to each recorder. The bridged input of each recorder is brought out to the switch with the input alone terminated in a spare jack on the patch panel. This way, air checks can be recorded on either recorder, as well as any other material.

The small switch box can be mounted near or between the recorders for convenient use of the operator. As the box is fairly tight, no dust problems or switch failures have resulted in two years use.

$$$ for Your Ideas

Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double-spaced text is requested. Our usual rate will be paid for material used.

Patch System *(Concluded)*

as C3 and C4. C4 is connected to P4, the upper right binding post of the A group in the center of the patch panel. Coil terminal C3 is connected through contact arm terminal A1 in the release section of the relay where it is routed to the normally closed terminal NC1. From there, connection is made to P3, the upper left binding post in the A group.

The relay is shown in the position of release. It was released when voltage was applied to the lower binding posts P1 and P2. When the release section was operated, the latch allowed the actuating section to drop out. This permitted contacts A4 and NO4 to open the circuit of the release coil so that the current in the release coil was cut off. The cut-off action prevents the coil from heating up if some function miscarries, and does not interrupt the circuit elsewhere in the system.

Circuit is now made between binding posts P3 and P4 via terminal C4 through the actuating coil, through terminals C3 and A1, and through normally closed contact NC1. Immediately after the actuating coil is energized, its circuit will be broken as described for the release coil. When the relay is actuated connection will be made between the terminals of output A via NO3 and A3. Finally, the monitoring circuit through NC2 and A2 will be broken.

A normally open circuit is brought from each latching relay (NO3 and A3 to output A in Fig. 8) to terminals on the main terminal plate. There, the pairs of terminals are given letter designations, A through H, and may be connected directly or indirectly to any circuits in the Laboratory for which "on"—"off" control during the 15-second sequencing period is desired.

The monitoring contacts in all 8 relays are connected in series so that continuous circuit is made only when all of the relays are in their "open" position. The purpose of monitoring is to give indication during the set-up of a test that all of the latching relays are in their proper position for starting the test.

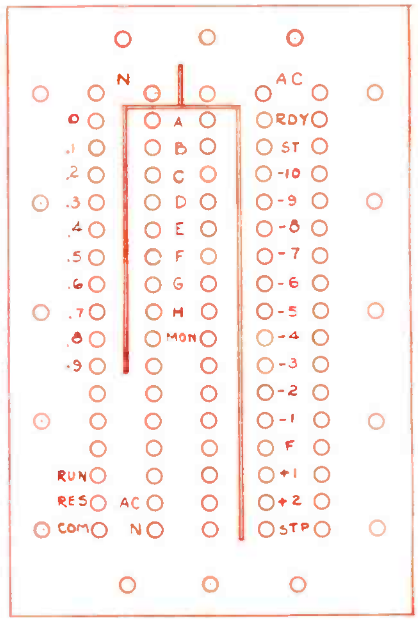
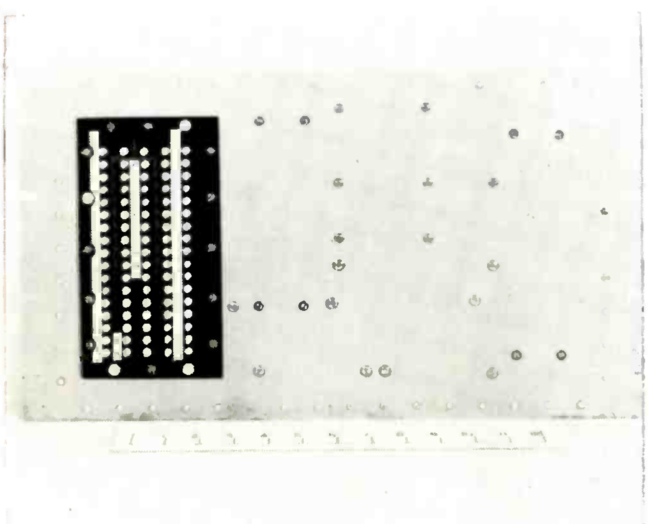


Fig. 9: All interconnections to the main unit are made to the terminal plate.

Fig. 10: Photograph of main terminal plate mounted on panel.



Terminal Plate

All interconnections to the main unit of the sequencing system are made to the terminal plate (Fig. 9) supplied for that purpose. The top terminals in the first and second columns, counting from left to right, are to be connected to neutral or ground. Those in the other three columns are to be connected through fuses to ac high.

The second through the eleventh terminals in the first column are connections from wafer 4B in the "tenth-seconds" stepping switch B, and are brought out for test purposes. The wiper of this wafer is brought out via the top terminal in this column. The top terminals in the second and third columns furnish connection from the wipers of the stepping switch (wafers 2A and 3B, Fig. 4) that serve the patch panel. The second through ninth terminals in the second and third columns are paired and labeled A through H. Each of these pairs is an output connection from one of the latching relays. The tenth pair are the monitoring terminals.

The top terminals of the fourth and fifth columns are connections from the wipers of stepping switch wafers 3A and 4A. Connections from the switch points of these wafers occupy all the other terminals in the fourth and fifth columns. Column four is provided for the count-down lamps and column five for firing the gun.

The three bottom terminals of column one are control terminals for run, reset and control common, as indicated in Fig. 4. The two bottom terminals in the second column serve as power input for both stepping switches.

Figure 10 is a photograph of the main terminal plate.

The fundamental principles of this system are the joint contribution of S. Furman, A. Milam and the writer who discussed this project during a conference in which the needs of the Thompson Aeroballistics Laboratory were considered.

International

ELECTRONIC SOURCES

ELECTRONIC INDUSTRIES' exclusive monthly digest of the world's top electronic engineering articles

ANTENNAS, PROPAGATION

Tropospheric Scatter Propagation—A Summary of Recent Progress, Harold Staras. "RCA." March 1958. 16 pp. This paper gives a short history of this new mode of propagation and then presents an explanation of many of its characteristics in terms of simple physical pictures rather than detailed mathematics. It is hoped that this presentation will provide a theoretical foundation for those who may become active workers in this new and exciting field as well as satisfying the scientific curiosity of many other readers. (U.S.A.)

Ferrite Radiators Shrink Missile Antenna Systems, H. C. Hanks, Jr. "El." April 25, 1958. 3 pp. Procedure for predicting approximate radiation pattern for ferrite elements in a microwave antenna system uses random balance technique. Results indicate that directivity property of ferrite elements permits ferrite arrays to provide half-power beam widths and side-lobe characteristics equal to those obtained with large conventional antenna systems. (U.S.A.)

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For more information on domestic articles, contact the respective publishers directly. Names and addresses of publishers may be obtained upon request from the above address.

AUDIO

Advances in the Design of Loudspeakers, F. K. Schroder. "Nach. Z." April 1958. 4 pp. With the aid of test examples it is shown how moving coil loudspeakers can be improved by beam impregnation, dip treatment or coating of the diaphragm as well as by an installation of short-circuit rings of copper in the magnet gap. The relationship between electro-acoustic properties and mechanical loading shows the importance of defining suitable load test methods. (Germany)

The Operation of Corona Loudspeakers, G. Bolle. "Nach. Z." April 1958. 7 pp. The paper relates to corona loudspeakers. On the basis of an explanation for the physics of generating sound pressure waves and a proof by formulae, the point discharge used in corona loudspeakers and possible interferences are discussed. The noise interference can be kept low when the radius of curvature on the point is small enough and when the fields strength at the point is large enough. (Germany)

Investigation of Extreme Values of Sound Pressure, D. E. L. Shorter and W. I. Manson. "BBC Mono." No. 16, March 1958. 10 pp. This monograph describes a survey undertaken by the Research Department of the BBC's Engineering Division in 1954 to obtain, for design purposes, up-to-date information on the microphone levels and dynamic range encountered in current broadcasting practice. (England.)

A Discussion of Some Factors Affecting Reproduced Radio Sound in an Automobile, Bertram A. Schwarz and Donald E. Brinkerhoff. "G. M. J." May-June 1958. 4 pp. The effects of the radio on the driver and passengers must be considered in its design. The automobile radio of today has been developed into a highly acceptable product which often aids the driver by increasing alertness and lessening fatigue. (U.S.A.)

Transistor Q-Multiplier for Audio Frequencies, G. B. Miller. "El." May 9, 1958. 3 pp. High selectivity and stability may be provided in audio-frequency equipment that must be portable, or in which power is at a premium, by use of transistorized Q-multiplier circuit. Series-resonant circuit is applied to variable-selectivity a-f amplifier and multichannel selective-calling unit. (U.S.A.)

REGULARLY REVIEWED

AUSTRALIA

AWA Tech. Rev. AWA Technical Review
Proc. AIRE. Proceedings of the Institution of Radio Engineers

CANADA

Can. Elec. Eng. Canadian Electronics Engineering
El. & Comm. Electronics and Communications

ENGLAND

ATE J. ATE Journal
BBC Mono. BBC Engineering Monographs
Brit. C.&E. British Communications & Electronics
E. & R. Eng. Electronic & Radio Engineer
El. Energy. Electrical Energy
GEC J. General Electric Co. Journal
J. BIRE. Journal of the British Institution of Radio Engineers
Proc. BIEE. Proceedings of Institution of Electrical Engineers
Tech. Comm. Technical Communications

FRANCE

Ann. de Radio. Annales de Radioelectricite
Bull. Fr. El. Bulletin de la Societe Francaise des Electriciens
Cab. & Trans. Cables & Transmission
Comp. Rend. Comptes Rendus Hebdomadaires des Seances
Onde. L'Onde Electrique
Rev. Tech. Revue Technique
Telonde. Telonde
Toute R. Toute la Radio
Vide. Le Vide

GERMANY

AEG Prog. AEG Progress
Arc. El. Uber. Archiv der Elektrischen Ubertragung
El Rund. Electronische Rundschau
Freq. Frequenz
Hochfreq. Hochfrequenz-technik und Electroakustik
NTF. Nachrichtentechnische Fachberichte
Nach. Z. Nachrichtentechnische Zeitschrift
Rundfunk. Rundfunktechnische Mitteilungen
Vak. Tech. Vakuum-Technik

POLAND

Arch. Auto. i Tel. Archiwum Automatyki i Telemechaniki
Prace ITR. Prace Instytutu Tele-i Radiotechnicznego
Roz. Elek. Rozprawy Elektrotechniczne

USA

Auto. Con. Automatic Control
Av. Age. Aviation Age
Av. Week. Aviation Week
Bell J. Bell Laboratories Journal
Comp. Computers and Automation
Con. Eng. Control Engineering
El. Electronics
El. Des. Electronic Design
El. Eq. Electronic Equipment
El. Ind. ELECTRONIC INDUSTRIES
El. Mfg. Electronic Manufacturing
IRE Trans. Transactions of IRE Prof. Groups
I. & A. Instruments & Automation
Insul. Insulation
M/R. Missiles and Rockets
NBS J. Journal of Research of the NBS
NRL. Report of NRL Progress
Proc. IRE. Proceedings of the Institute of Radio Engineers
Rev. Sci. Review of Scientific Instruments

USSR

Avto. i Tel. Avtomatika i Telemakhanika
Radio. Radio
Radiotek. Radiotekhnika
Rad. i Elek. Radiotekhnika i Elektronika
Iz. Acad. Bulletin of Academy of Sciences, USSR.

OTHER

Radio Rev. La Radio Revue (Belgium)
Kovo. Kovo Export (Czech)
J. ITE. Journal of the Institution of Telecommunication Engineers (India)
J. IECE. Journal of the Institute of Electrical Communication Engineers (Japan)
Phil. Tech. Philips Technical Review (Netherlands)
Eric. Rev. Ericsson Review (Sweden)
J. UIT. Journal of the International Telecommunication Union (Switzerland)

Automatic Speech Amplitude Control, Lyle R. Battersby. "El." May 23, 1958. 3 pp. Two miniature vacuum tubes and four crystal diodes provide automatic amplitude control for speech frequencies to increase amount of intelligence transmitted over radio communication system under adverse conditions. (U.S.A.)

CIRCUITS

***For Designers . . . Using Self-Resonant Frequency, J. P. Beverly.** "El. Ind." July 1958. 2 pp. Increasing demands for circuit simplicity, reliability, and economy suggest re-evaluation of the r-f coil. Self-resonant frequency characteristic offers unique design features. (U.S.A.)

Inverter with Thyratrons II, H. Becker. "El. Rund." May 1958. 3 pp. A three-phase inverter of 3.5 kVA output (frequency 500 c/s) can be constructed with three separately excited inverters with two inert gas-filled thyratrons PL 5544 each. The master oscillator is an inverter with two thyratrons PL 21. The detailed circuit as well as diagrams and oscillograms are dealt with. (U.S.S.R.)

Production of DC Voltage of 1 kV by a Tube Oscillator, R. Cantz. "El. Rund." April 1958. 2 pp. For the post-acceleration of cathode rays and similar applications an EHT power supply for only small current output is needed frequently. A device with a tube oscillator with a rectifier diode and a smoothing filter which can be loaded with 100 A at a dc voltage of 8 kV (no load voltage of approximately 8.8 kV) is described. Precise details of the circuit and the EHT transformer are given. (Germany.)

Electrical Methods of Integration, O. Anna. "El. Rund." April 1958. 2 pp. Electrical integration renders possible or facilitates the evaluation of measurements in many cases and excludes subjective errors. A short basic survey of the most important electrical methods of integration is given. The different methods are analysed in consideration of their fields of application as to time constant and integration period as well as accuracy. (Germany.)

Narrow Band Elimination Filter Employing Piezoelectric Resonators, E. Kudrewicz. "Prace ITR." Vol. 2. No. 1, 1958. 9 pp. The application and technical requirements of narow band elimination filters are discussed and a typical design of such filter is given. Owing to the introduction of a special frequency transformation the index function has been obtained in a form suitable for analysis. (Poland.)

Transients in Some Low-Power and Middle-Power Rectifier Circuits, T. Konopinski. "Prace ITR." Vol. 2, No. 1, 1958. 12 pp. Transients occuring in rectifier circuits at the moment of switching on the anode voltage have been the subject of a number of papers. In this paper currents flowing through rectifying elements are considered in both half-wave and full-wave rectifier circuits with a smoothing filter having inductance at the input and with a load in the form either of a pure resistance or of batteries. (Poland.)

Equivalent Circuits of Noisy Networks, Leo Young. "El. Eng." April 1958. 3 pp. This article derives and presents new equivalent circuits for predicting the noise figure of a combination of amplifiers, attenuators, and terminations, which may all be different temperatures. (England.)

1kc/s Transistor High-Gain Tuned Amplifier, R. A. Hall. "El. Eng." April 1958. 4 pp. By the use of junction transistors instead of thermionic valves an amplifier has been constructed which has the advantages of reduced power consumption, bulk and microphony. Particular attention has been paid to stability of gain and bandwidth against transistor variations; over a period of 12 months the maximum gain of about 125db has changed by only 1.5dB with no measurable change in bandwidth. (England.)

Impulse Voltage Wave Chopping Circuit For Use With A Recurrent Surge Oscilloscope, J. W. Armitage. "El. Eng." April 1958. 3 pp. A circuit is described which was designed to work in conjunction with an existing recurrent surge oscilloscope and was intended to provide better performance by the use of a hydrogen filled thyratron than had been possible with the mercury filled thyratron previously used. The chopping circuit is built up separately from the oscilloscope and is capable of chopping recurrent impulse waves up to 2.5 kV at a selected instant over a wide range of times. The collapse of the impulse wave is very rapid and a biasing arrangement has been introduced to eliminate the residual voltage drop in the thyratron from the chopped wave. (England.)

A Tunable Filter for Use in the Measurement of Excess Noise from Local Oscillators, W. P. N. Court. "El. Eng." April 1958. 2 pp. A method of forming a filter from available microwave components is described. This filter is tunable over a wide-band and need not be removed physically from the circuit when filter action is not required. (England.)

COMMUNICATIONS

***Military Mobiles Become Transistorized, R. H. Decker and D. E. Kammer.** "El. Ind. Ops. Sect." July 1958. 5 pp. A decade ago, separate units were required to communicate between combat branches of a field army. Now, a new auxiliary receiver accomplishes this; reduces size, weight, power consumption; and, is more rugged. (U.S.A.)

Optimum Frequency Deviation in the One-Channel Telemetering Systems, Yu. I. Chugin. "Avto i Tel." April 1958. 9 pp. The method of determination of optimum frequency deviation in the one-channel telemetering system with fluctuating noise is given. The method is based on the analysis of power noise spectrum. (U.S.S.R.)

The Radio-Frequency Protection Ratios Required by Modern VHF/FM Receivers, B. Gramatke, et. al. "Rundfunk." February 1958. 13 pp. This paper describes extensive investigations, of importance in the planning of a transmitter network, relating to the r.f. protection ratios required by eighteen VHF/FM receivers manufactured between 1956 and 1958, when receiving a wanted transmission in the presence of one or two interfering transmissions. (Germany.)

A New Method for the Automatic Monitoring of Broadcasting Systems, F. Enkel. "Nach. Z." March 1958. 6 pp. An automatic device for the supervision of the electro-acoustic properties of transmission systems, including the high-frequency radiation, is described in this paper. This supervision covers the frequency response of the transfer constants, the continuous measurement of noise and the testing of non-linear distortion. (Germany.)

A Telephone Set With Improved Intelligibility for Use in Private Exchange Installations, O. Brosze, et. al. "Nach. Z." April 1958. 5 pp. A brief summary of the trends in the development of microphones for telephone sets during the last few decades is followed by a report on a novel telephone set which has the feature of better intelligibility in the presence of noise. (Germany.)

Time Announcement with Re-Recorded Magnetic Tapes, F. Merkel and K. Schmidtner. "Nach. Z." April 1958. 7 pp. After a brief historical review and a discussion on the basic design principles for time announcing equipment a summary of the design, the equipment and the operation of such equipment with pre-recorded magnetic tapes is given. The measures taken for time keeping and synchronization of several installations are explained. (Germany.)

Frequency Modulation by Inductance Variation: A Magnetically-Stable Ferrite Modulator, F. Slater. "J. BIRE." March 1958. 16 pp. The factors affecting the production of frequency modulation are considered when the modulator is either a reactance valve or a variable inductance employing magnetic variation of the core permeability. It is shown that whilst the effectiveness of the reactance valve is reduced at high oscillator frequencies or with large fractional frequency deviations, the inductance modulator is not affected to the same extent. (England.)

H. F. Band Communication Receiver, J. A. Knight. "ATE J." April 1958. 6 pp. This article describes a hermetically sealed receiver covering the range from 2 to 16 Mc/s. An accurately stabilized oscillator combined with a 52-inch film scale makes it possible to select any 10 kc/s channel without previous 'netting.' It is powered by an internal 24 V vibrator supply unit, or alternatively from an external a.c. unit. (England.)

Comprehensive Comparisons In the Planning of Telecommunication Systems, R. Krzyczkowski. "ATE J." April 1958. 9 pp. This article describes a method of evaluating the problem faced by administrations commissioning new communication links: the problem of choice between radio, coaxial cable, and balanced-pair carrier cable. The method, known as the 'comprehensive comparison method,' is demonstrated by application to a hypothetical case to illustrate the weighting system evolved. (England.)

Atmospheric Radio Noise At Frequencies Between 10 KC/S and 30 KC/S, J. Harwood. "Proc. BIEE." May 1958. 8 pp. Measurements of the characteristics of very-low-frequency atmospheric noise in Southern England have been made with automatic equipment during the last few years. The results are described in terms of statistical parameters of the envelope at the output of a narrow-bandwidth receiver (300 c/s between 3 db points). (England.)

COMPONENTS

***New Developments Are Improving Performance of Silver-Zinc Batteries, Dr. Paul L. Howard.** "El. Ind." July 1958. 3 pp. Developments, materials, and techniques that offer the most promising prospects for this powerful cell are presented. Some of the more prominent applications are recalled. (U.S.A.)

***A Voltage Variable Capacitor, Gene F. Straube.** "El. Ind." July 1958. 4 pp. The design engineer now has a unique new component for electronic equipment. Here are the design characteristics of the new electronically variable, solid state capacitor. (U.S.A.)

The Theory of Structure of Combinational Mechanisms, S. M. Yakovlev. "Avto i Tel." March 1958. 12 pp. The paper includes the description of an induction potentiometer with linear correlation between output voltage and the angle of rotor turn in the range of about ±90°. The way of calculation ad experimental analysis of the potentiometer in question is considered. The experimental results are given. (U.S.S.R.)

Concerning Some Properties of Ferromagnetic Clutches, P. N. Kopay-Gora. "Avto i Tel." April 1958. 10 pp. Ferromagnetic clutches are compared with electromotors, friction and hydraulic clutches with regard to their starting time, electromagnetic time constant, control power and the ratio of output moment and inertia moment. The said parameters of ferromagnetic clutches appear to be better than those of electromotors and friction clutches. (U.S.S.R.)

Simplified Method of Designing Saturated Reactors, A. Mellinger. "Prace ITR." Vol. 2, No. 1, 1958. 14 pp. The paper presents a simple design method of the series saturated reactors (transductors) based on the B-H curves for the core material. The derived equations enable us to determine parameters necessary for the design of core dimensions, number of turns as well as wire gauge. (Poland.)

Automatic Methods in Radio Component Manufacture, D. Stevenson and R. B. Shepherd. "J. BIRE." April 1958. 5 pp. Part 1 describes a method of controlling a high-speed coil winder by an electronic counter. A specialized machine which winds single-layer coils is described. Part 2 deals with the development of a tool protection device for use with automatically loaded presses. The device detects the piece-part magnetically as it is ejected and so clears the interlocks to allow the press to continue operating. (England.)

The Performance of Thermally Inert Metal Blocks as Cold Junction Enclosures for Thermocouples, K. L. Morphew. "El. Energy." May 1958. 3 pp. The requirements of a high stability thermocouple cold junction for use in the accurate measurement of small temperature changes are examined. The suitability of different materials is then discussed, and there follows a description of two sets of experiments in which the thermal behaviour of two large thermally insulated cylinders was observed. (England.)

Wafer-Type Rectifiers for Millimeter Waves, W. M. Sharpless. "Bell. Rec." January 1958. 4 pp. (U.S.A.)

COMPUTERS

Electronic Computing for the Small or Medium Sized Business, L. E. Sandford. "El. & Comm." March 1958. 3 pp. Though management of small and medium sized business concerns have followed with interest the development of computers and their business application potential, little has been written to inform small business management of the preliminary investigation steps that will determine for them whether computers can be used to advantage in their business operations. (Canada.)

The Electronic Synthesis of Flexible Beam Behaviour, M. Squires and W. G. Hughes. "J. BIRE." March 1958. 23 pp. The paper relates to the use of electronic analogue computers to evaluate and display the vibrations of flexible beams and related structures. The method is characterized by the speed and continuity with which the desired information is presented and by the fact that it provides a continuous mental picture or model of the physical system being studied. The techniques described are applicable to "thin" beams in general and are capable of yielding static as well as dynamic information. (England.)

An Analogue Computer for Fourier Transforms, D. G. Tucker. "J. BIRE." April 1958. 3 pp. The paper gives the basic principles of a computer for obtaining a graphical display of the Fourier Transform of a function which can be represented by a finite number of ordinates over a finite range of the input variable. (England.)

The Application of Square Hystresis Loop Materials in Digital Computer Circuits, A. D. Holt. "El. Eng." April 1958. 4 pp. The properties and uses of magnetic materials, in particular those of ferrites, used in digital computers are described. Theories and the practical design of shifting registers are explained. Core matrix storage systems are reviewed. (England.)

A Basic Transistor Circuit for the Construction of Digital-Computing Systems, P. L. Cloot. "Proc. BIEE." May 1958. 8 pp. A basic circuit is described which uses one transistor, one capacitor and three resistors, from which a complete digital-computing system may be constructed economically. (England.)

Analogue Computation, E. Lloyd Thomas. "Brit. C. & E." May 1958. 11 pp. This article surveys the principles, practice and current applications of analogue computation. (England.)

Evaluation of Integrals Involving Combinations of Bessel Functions and Circular Functions. Leendert De Witte. "J. Assoc. for Comp. Mach." April 1958. 8 pp. A method is discussed for the evaluation of integrals containing combinations of Bessel functions and circular functions in which the non-circular part of the integral is fitted by sums of simple polynomials and exponentials. (U.S.A.)

SADSAC: A Sampled-Data Simulator and Computer Using Stepping Relays, Gilbert S. Stubbs. "Auto. Con." April 1958. 3 pp. (U.S.A.)

Pulse Time Displacement in High-Density Magnetic Tape, R. A. Skov. "IBM J." April 1958. 12 pp. In computer magnetic tape systems, a primary factor in character rate is recording density. Pulse time displacement places a direct limit on the maximum bit density which may be used in parallel NRZI recording systems in which recovery of the information on readback depends on correct synchronism of all tracks (U.S.A.)

On Some Error Bounds of Givens, Robert L. Causey. "J. Assoc. for Comp. Mach." April 1958. 5 pp. The author points out a slight error in one of Givens' proofs, and then obtains correct error bounds to replace those directly affected by the error. Our new proofs provide sharper bounds and also illustrate different techniques of obtaining bounds. (U.S.A.)

A High-Speed Computer Technique for the Transportation Problem, Jack B. Dennis. "J. Assoc. for Comp. Mach." April 1958. 22 pp. This paper describes a new digital computer technique for solving the classical transportation problem by the stepping stone method. This technique offers considerable advantage in speed over methods currently in use. (U.S.A.)

CONTROLS

•A Patchable Time Sequence System, Samuel E. Dorsey. "El. Ind. Ops. Sect." 4 pp. July 1958. The time sequence system described here permits patching a number of control functions, both turn-on and turn-off to a precision of 0.1 seconds throughout a sequence period of 15 seconds. A signal generator eliminates roller-type switches and motor-driven cams. (U.S.A.)

Concerning a Possibility of Determining an Axial Hydrodynamic Force in a Valve, I. M. Krassov and B. G. Turbin. "Avto. i Tel." March 1958. 4 pp. The paper deals with an axial hydrodynamic force that appears in valve hydraulic amplifier when the working liquid flows through it. The amplifier described may be a meter of the force. The experimental results are presented. (U.S.S.R.)

Nonlinear and Computing Devices are Used to Increase High Speed of Some Control Systems, G. M. Ostrowsky. "Avto. i Tel." March 1958. 9 pp. To improve the control quality, nonlinear devices are introduced in some automatic control systems. (U.S.S.R.)

The Analysis of the Control and the Synthesis of Automatic Control Systems with Lags, Fan-Chun Wui. 11 pp. "Avto. i Tel." March 1958. The synthesis of corrective devices of servosystems (1) is applied to automatic control systems with lags. Curves to synthesize the systems with lags and to analize their quality are given. (U.S.S.R.)

Determination of Parameters of Automatic Control Systems by Using Experimental Frequency Responses, A. A. Kardashov and L. V. Karnushin. "Avto i Tel." April 1958. 12 pp. Parameters of linear elements and control systems are determined on the basis of approximation of their experimental phase-amplitude characteristics. By means of interpolation approximative coefficients of the analytical expressions of the phase-ampliture characteristics are found. Then those coefficients are corrected with the help of the method of the least squares. The calculation is illustrated by a number of examples. (U.S.S.R.)

Improving the Transients in Corrective Elements with Variable Parameters, E. K. Shigin. "Avto. i Tel." April 1958. 6 pp. Some means of improving the transients in the fourth order automatic control systems having two integrators are described. To improve the transient process, introduction of the variable time constant of the integrator is shown to be expedient when there is a differentiator with the variable time constant introduced in the system. (U.S.S.R.)

Selective Low-Frequency RC-Amplifier as an Element of a Control System, Yu. G. Kochinev. "Avto. i Tel." April 1958. 5 pp. Dynamic properties of a selective low-frequency RC-amplifier with a double T-circuit are analyzed. (U.S.S.R.)

Principles of Control Engineering I, J. Schopper. "El. Rund." May 1958. 4 pp. The present introduction is intended to give the physicist and the engineer not well versed in control engineering a survey of the operation of the equipments for this field of application. After the different systems having been explained the basic equations are given and various examples are considered. (U.S.S.R.)

GENERAL

•Electronic Reader Sorts Mail, A. I. Tersoff. "El. Ind." July 1958. 5 pp. Automatic character sensing equipment is being developed and tested for the Post Office Department. It will automatically read and sort mail at a high speed. This equipment can also be used as an automatic input for data processing systems. (U.S.A.)

International ELECTRONIC SOURCES

Automatic Detection of Signs, K. Steinbuch. "Nach. Z." April 1958. 10 pp. The paper relates to the possibilities of detecting with the aid of automatic devices printed, type-written or hand-written signs. The main process of detection is a comparison (comparison in the most general sense) between the available sign and a choice of given signs. The detection should not be affected by deficiencies of shape. The paper is an attempt to describe known methods and two new methods as well as a systematic categorization. (Germany.)

A Variable Wave Length Wide Band Director with Continuously Adjustable Matching in the Range of $\lambda = 30 \ldots 70$ cm, A. Sander. "El. Rund." May 1958. 5 pp. The new adjustable wide band director is intended for microwave therapeutics. Different kinds of application with wavelengths between approximately 30 and 70 cm are possible by interchangeable diaphragms and Trolitul inserts. The mounted resonance transformer serves for optimum matching to the feeder mains. The theoretical principles of the design are dealt with. (Germany.)

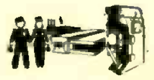
A Tape Recorder for Ultra Sonic Frequencies, H. Lennartz. "El. Rund." May 1958. 3 pp. With the help of the supplementary unit described in this article recarding and reproduction of the frequency range 0.5...120 kc/s (preferably 1...100 kc/s) can be realized with a studio tape recorder. The effect of the magnitude of the a. c. bias current at the upper frequency boundary is investigated and the investigation results are discussed with regard to various types of tape. The important points for the design of the recording amplifier, the feed of signal and a. c. bias currents and the correction of the distortion in the reproducing amplifier are dealt with. (Germany.)

The Role of the Engineer in Management, S. O. Jones. "Proc. AIRE." March 1958. 5 pp. Most engineers are forced to specialize early in their careers, but he who would enter management must, at the right time, give due attention to the non-technical aspects of industry such as the organization of men and matters of finance. (Australia.)

X-Ray Image Intensifier. "El. & Comm." March 1958. 4 pp. A medical telecast performed at the Hotel Dieu and Jean-Talon hospitals in Montreal recently demonstated a greatly improved method of fluoroscopic diagnosis. A new device, amplified the dim fluoroscopic image so that, for the first time, it could be picked up and successfully transmitted by the TV camera. (Canada.)

Industrial Applications of A. C. Polarography, R. L. Faircloth and D. J. Ferrett. "J. BIRE." March 1958. 7 pp. The a. c. polarographs that have recently been developed, such as the Mervyn-Harwell squarewave polarograph, have very greatly extended the range and usefulness of techniques for analysis of metals and non-metals. Concentrations of 1 in 10,000,000 can be measured and these instruments overcome many of the disadvantages of conventional polarographs. The principles of the square-wave palarograph are discussed and recent work on the pulse polarograph and the r.f. polarograph is described. The range and versatility of these instruments offer many opportunities for plant-control and instrumentation. (England.)

The Electronic Synthesis of Flexible Beam Behaviour, M. Squires and W. G. Hughes. "J. BIRE." March 1958. 23 pp. The paper relates to the use of electronic analogue computers to evaluate and display the vibrations of flexible beams and related structures. The method is characterized by the speed and continuity with which the desired information is presented and by the fact that it provides a continuous mental picture or model of the physical system being studied. The techniques described are applicable to "thin" beams in general and are capable of yielding static as well as dynamic information. (England.)



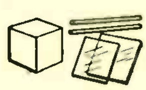
INDUSTRIAL ELECTRONICS

Numerically Controlled Machine Tools, O. S. Puckle. "Proc. AIRE." March 1958. 10 pp. The paper opens with a very brief description of the way in which numerically controlled machine tools works. It then proceeds to discuss some of the general requirements of production engineers in various industries and considers what they might expect from these controlled machine tools. The most suitable basis for the design of analogue numerical control systems and some of the different components and techniques which may be embodied in the equipment are examined. (Australia.)

Some Aspects of the Application of Closed Loop Servo Systems to Machine Tool Control, R. J. F. Howard. "J. BIRE." April 1958. 11 pp. The paper discusses the combined design of machine tool and control equipment with particular reference to a two-axis profile follower system. The power requirements of the feeds are reviewed and in particular the effects of calling for excessive power on motor size and on motor torque/inertia radio and hence overall servo system performance. (England.)

A Crystal Controlled R.F. Induction Heater, E. Cohen. "El. Eng." April 1958. 6 pp. The construction, operation and performance of a 2kw crystal controlled radio frequency induction heater is described. The several advantages associated with fixed frequency operation are discussed and it is shown that the greater complexity of the circuit is more than compensated by absence of radio frequency interference with essential services, greater efficiency conversion of d.c. input to r.f. output and ability to match an external load to the output impedance of the final power amplifying stage, by a novel construction of the output transformer. Experiments indicate that a graphite susceptor, if suitably thermally insulated, can be raised to a temperature in excess of 2,000° C in eight minutes. (England.)

Scope Analyzes Reciprocating Engines, Edward Sammis. "El." May 9, 1958. 4 pp. Specially designed cathode-ray oscilloscope permits selected laboratory techniques to be applied in field maintenance of reciprocating engines used in industrial and marine service. (U.S.A.)



MATERIALS

Ferrites for Magneto-Strictive Filters, S. Schweizerhof. "Nach. Z." April 1958. 7 pp. The paper is a report on the development and the practical application of ferrite oscillators for filter circuits in carrier-frequency engineering. The requirements for the characteristic values of the core material are outlined. Commercial ferrites do not meet these specifications and for this reason new ferrites with an improved temperature stability and higher Q-values have been developed. (Germany.)

Technology of Manufacturing Barium Ferrite, R. Lappa. "Prace ITR." Vol. 2, No. 1, 1958. 27 pp. Magnetic properties of barium ferrite are briefly surveyed and then the Institute's research work on technology of obtaining barium ferrite is reported. Successive stages of technological process are discussed: 1) initial raw materials used, method of mixing them and grinding, and composition of mixtures; 2) preliminary sintering of the mixture with special emphasis on presumptive kinetics of the process; 3) subsequent grinding of the presintered product; 4) pressing and final sintering of shaped pieces of barium ferrite. (Poland.)

Magnetically Soft Ferrites, M. O. Williams. "ATE J." April 1958. 16 pp. This article is concerned with elements of the modern theory of ferro- and ferri-magnetism, and discusses the principles that have guided the development of the modern ferrites. It then examines their special properties at frequencies above those at which the conventional magnetic materials are applicable, and relates them to modern theory. Typical applications are mentioned. (England.)

Metal-Flake Artificial Dielectric, Properties at S-Band Frequencies, Shanker Swarup. "E. & R. Eng." May 1958. 4 pp. The validity of the various expressions suggested for the dielectric constant of the obstacle-type artificial dielectric has been checked at a wavelength of 14.712 cm. A new expression, which is a modification of the Clausius-Mossotti relations, has been suggested for the dielectric constant of metal-flake artificial dielectric. This expression predicts a value of dielectric constant which compares very well with the experimental results even for high-volume fractions of the metal flakes. (England.)

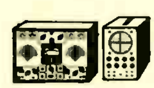
Properties, Appraisal and Selection of Ferroelectric Materials, B. Lewis. "Brit. C. & E." May 1958. 6 pp. High dielectric constant, non-linearity and piezoelectric activity are among the properties which characterize ferroelectric materials. This article describes how these and other properties are related, how they are measured, and how materials are selected for particular applications. (England.)

A Hystereis Effect in Cadmium Selenide and Its Use in a Solid-State Image Storage Device, F. H. Nicoll. "RCA." March 1958. 9 pp. A brief description is given of a new hysteresis effect in cadmium selenide photoconductive powder. (U.S.A.)

Application of Non-Linear Magnetics, Part III, Herbert F. Storm. "El. Des." April 16, 1958. 4 pp. Combinations of a saturable reactor with other circuit components produce extraordinary effects which usually cannot be duplicated by linear circuitry. (U.S.A.)

A Method for Soldering Aluminum, G. M. Bourton and P. R. White. "Bell Rec." May 1958. 4 pp. Ordinary methods for affixing two pieces of aluminum have presented a number of difficulties. Recently, however, a soldering technique using zinc-base solders has been evaluated. This technique has proved feasible and, furthermore, it is expected to expand greatly the possibilities for aluminum construction. (U.S.A.)

Electronic Uses of High Temperature Liquid Dielectrics, C. G. Currin. "El. Des." May 14, 1958. 2 pp. By providing a barrier between components and the atmospheric environment, liquid dielectrics reduce the probability of insulation failure, one of the prime causes of equipment malfunction and failure. (U.S.A.)



MEASURE & TESTING

***A Practical Approach to Solving Thermistor Problems,** Robert S. Goodyear. "El. Ind." July 1958. 5 pp. Much has been written concerning the general characteristics and applications of thermistors, but little on how-to-solve actual problems. Three application problems, each high-lighting a different major characteristic, are solved here. (U.S.A.)

The Analysis of Sampled-Data Systems, Fan Chun-Wui. "Avto. i Tel." April 1958. 10 pp. A well-known method of analyzing continuous linear systems is generalized and applied to the qualitative evaluation of the forced motion of sampled-data systems. (U.S.S.R.)

Semigraphical Method of Determination of Relay System Characteristics, L. P. Kuzmin. "Avto. i Tel." April 1958. 13 pp. The paper deals with semigraphical method of determination of relay system characteristics. The said characteristics are required for analysis of periodic regimes in relay systems by means of the frequency method. (U.S.S.R.)

Radio Doppler Measurements on the Russian Satellites at the National Standards Laboratory, G. J. A. Cassidy. "Proc. AIRE." March 1958. 5 pp. A description is given of the methods used at the National Standards Laboratory to obtain information on the position of the Russian satellites by use of the Doppler effect on the 40 Mc/s transmissions from the satellites, as observed at one receiving station. Values for the period and other orbit parameters deduced for the first two satellites are given. (Australia.)

Modern Telephone Enquiry Services in the Germany Federal Post Office, G. Bollmus. "Nach. Z." April 1958. 6 pp. The progressive introduction of long distance dialing services has forced the German Federal Post Office to provide the telephone subscribers with an enquiry service for all telephone numbers within the Federal Republic. The new organization of the telephone enquiry service is described and the operation of the technical equipment is explained. (Germany.)

Electronics in Measurements, G. Fritze and F. Peters. "El. Rund." April 1958. 5 pp. Three applications are chosen from the field of electronic measurements: An ac measuring amplifier for currents and voltages with precise ratio for the measuring range extension and the reduction of the self-consumption of precision instruments, a dc millimicroammeter for the measurement of smallest direct currents and an electronic limiting value indicator to signal when given measuring values are reached by indicating instruments. The demands for such units are discussed and industrial units are described. (Germany.)

The Measuring of Extremely Short Luminescent Periods of Electronically Excited Luminophors, K. Heine. "El. Rund." May 1958. 4 pp. A method and a unit which can be utilized for measuring luminescent periods of luminophors are described. The measuring range reaches from 10^{-3} to approximately 3.10^{-8}s. The scale is produced by a cathode ray oscillograph and indicates a diagram of time functions. At electronic excitation the measurement itself is carried out in an evacuated valve. (Germany.)

An Electronic Counter with Cold Cathode Tubes, H. Nottebohm. "El. Rund." May 1958. 2 pp. An electronic counter constructed with cold cathode tubes and transistors is described. Forward, as well as backward counting, is possible. The necessary high pulse voltage is delivered by a transistor amplifier connected in series. (Germany.)

A Description of an Optical Instrument for Monitoring Sound Signals, E. R. Wigan. "BBC Mono." #16, March 1958. 17 pp. This monograph describes a new type of program meter instrument, having a moving bar of light in place of a pointer, which has been designed to take the place of the conventional pointer-type instrument with which the signal voltages on BBC sound circuits are usually measured. (England.)

Magnetic Amplifier Digital Techniques, W. L. Marks. "El. Energy." April 1958. 5 pp. The discrete delay of the half-cycle response magnetic amplifier is exploited to provide a digital system of the same frequency as the a.c. supply. (England.)

Some Methods of Phase Measurement Used in Transfer Function Analysis, D. J. Collins and J. E. Smith. 'El. Eng." April 1958. 5 pp. There are available, at the present time, a variety of instruments and techniques for the purpose of transfer function determination. The methods of phase measurement are diverse, and the article attempts to summarize the more conventional systems in use and to indicate their limitations. (England.)

RADAR, NAVIGATION

***Man-Machine Systems Call for Displaying Integrated Instrumentation,** Douglas G. Aid and Dr. Charles Süsskind. "El. Ind." July 1958. 4 pp. Adequate human response in modern closed-loop man-machine systems requires simplified integrated display of command data. A method of generating such a display is developed, and the specific techniques for simplifying the instrumentation of jet aircraft are described. (U.S.A.)

A Radar Sonde System for Upper Air Measurements, N. E. Goddard and H. A. Dell. "Phil. Tech." 27 February 1958. 6 pp. Short description of a radar sonde system developed by the Mullard Research Laboratories in conjunction with the Royal Radar Establishment, for measurements of wind speed, wind direction, temperature, pressure and humidity up to high altitudes. (Netherlands in English.)

The Effect of Fluctuation on Time Range-Finder Operation, I. N. Amiantov and V. I. Tikhonov. "Avto. i Tel." April 1958. 9 pp. The paper deals with problems of measuring range errors caused by fluctuation and with problems of stability of an automatic tracking system. (U.S.S.R.)

Radome Sandwich Using Artificial Dielectric Foam, William R. Cuming. "El. Des." April 16, 1958. 4 pp. (U.S.A.)

SEMICONDUCTORS

***The Germanium Photo-Tetrode,** Frieda A. Stahl and George Dermit. "El. Ind." July 1958. 3 pp. Light can give control characteristics analogous to those resulting from the emitter in the grounded-base transistor. Likewise, a light-controlled tetrode equivalent is possible, and has been developed. (U.S.A.)

***Bilateral Conductivity in Power Transistors,** Dr. Ioury G. Maloff. "El. Ind." July 1958. 3 pp. This similarity of positive and negative portions of collector current curves, base voltage constant, is treated for the first time. The property, most useful in horizontal deflection output stages, appears in most junction triode p-n-p power transistors. (U.S.A.)

Physical and Electrical Properties of Silicon-Rectifiers for Telecommunication, H. L. Rath. "El. Rund." April 1958. 4 pp. The characteristic properties of smaller silicon-rectifiers are discussed by way of dc current characteristic. The heating occuring on load is produced by transit losses. In comparison with selenium-rectifiers the superiority of silicon-rectifiers concerning load curves for half-wave and bridge circuit is dealt with. A protective resistance is necessary because of sensitivity to shock loads. (Germany.)

Controlled Saturation in Transistors and Its Application in Trigger Circuit Design, Part 2, N. F. Moody. "El. Eng." April 1958. 5 pp. (England.)

Transistor Amplifiers: Common Base Versus Common Emitter, R. F. Purton. "ATE J." April 1958. 7 pp. The author compares the gain stability and frequency response of common-base and common-emitter amplifiers. He shows that the performance of the two amplifiers can be described by similar equations, and that in both cases gain stability and bandwidth are determined by the values of the external resistances in series with the transistor electrodes. (England.)

An Investigation of the Current Gain of Transistors at Frequencies up to 105 Mc/s, F. J. Hyde and R. W. Smith. "Proc. BIEE." May 1958. 8 pp. Apparatus is described by means of which the short-circuit current gain is measured directly. Results of such measurements are presented for commercial alloy-junction and surface-barrier transistors; corrections are applied to yield the internal diffusion-current gain. (England.)

Transistor Noise, Its Origin, Measurements and Behaviour, L. H. Wilson. "J. BIRE." April 1958. 19 pp. The sources of noise in semiconductors and the mathematical techniques needed in their discussion are indicated in order to survey the theory of noise in transistor amplifiers and to consider methods of measurement. The variation of transistor noise with operating point and frequency is discussed and a comparison is made of noise levels in audio amplifiers using transistors and valves respectively. (England.)

A Proposed High-Frequency Negative-Resistance Diode, W. T. Read, Jr. "Bell J." March 1958. 46 pp. This paper describes and analyzes a proposed semiconductor diode designed to operate as an oscillator when mounted in a suitable microwave cavity. The frequency would be in the range extending from 1 to 50 kmc. The negative Q may be as low as 10 and the efficiency as high as 30 per cent. (U.S.A.)

Large-Area Germanium Power Transistors, B. N. Slade and Jane Printon. "RCA." March 1958. 11 pp. (U.S.A.)

DC Feedback Equations for Transistor Amplifiers, Howard Lefkowitz. "El. Des." April 16, 1958. 4 pp. (U.S.A.)

IRE Standards on Solid-State Devices: Methods of Testing Point-Contact Transistors for Large-Signal Applications, 1958. May 1958. 11 pp. This Standard stipulates the methods of measuring the important characteristics of point-contact transistors in power amplifiers, pulse amplifiers, oscillators, multivibrator-type switches, regenerative pulse generators and other large-signal applications. (U.S.A.)

On the Statistical Mechanics of Impurity Conduction in Semiconductors, P. J. Price. "IBM J." April 1958. 7 pp. The statistical mechanics of the impurity electron state is for a semiconductor with a low density of donors, and a small amount of ac deptor compensation, is analyzed. Expressions are obtained for the number of dissociated donor ion states according to the Mott model, and for the effects of multiple trapping, and of dispersion of the trapping energies, on this number. (U.S.A.)

TELEVISION

Method of Interlace Scanning Measurement in Television Receivers, J. Kamler. "Prace ITR." Vol. 2, No. 1, 1958. 10 pp. In the paper a method of determining the quality of interlace scanning is described. The method is based on the objective measurement with the use of oscilloscope. The method described does not require any controlling instruments to be connected to the points lying inside the receiver and therefore the measurement can be performed during normal work of the receiver. (Poland.)

Dosimetry of the Very Weak X-Radiation Generated in Television Receivers and X-Ray Diffraction Apparatus, W. J. Oosterkamp et. al. "Phil. Tech." 27 February 1958. 4 pp. Television picture tubes emit very soft, extremely weak X-radiation, which can be detected at the outside surface of a home television receiver. To preclude all danger for the user, the dose rate according to international recommendations should not exceed 2 milliront-gens per hour (in the future the permissible limit may well be set still lower). The dose rate can be checked with thin-windowed Geiger-Muller counters, whose windows are sufficiently transparent to the soft radiation. (Netherlands in English.)

Color Television Experiments, Norbert Mayer. "Rundfunk." February 1958. 11 pp. After a brief introduction describing the American NTSC system, the paper gives details of the apparatus with which some experiments concerning that system were carried out. (Germany.)

The Televising of Non-Transparent Still Pictures by Means of the Flying-Spot Scanning System, (Television Episcope), R. Theile and F. Pilz. "Rundfunk." February 1958. 10 pp. Instead of transmission with the standard television camera or by means of a specially made transparency, it would seem advantageous, both on technical and economic grounds, to make available a special pick-up device in the form of a "television episcope." The paper discusses the methods of signal production that would be suitable for such a device. (Germany.)

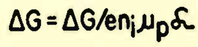
The Importance of the Vision Receiver in the Black-Level Transmission in Television, Herbert Grosskopf. "Rundfunk." February 1958. 11 pp. After giving a brief survey of the most important measures and of those that are nowadays nearly always taken into account, for controlling the black level in transmission, the paper stresses the fundamental importance of the picture monitor. After discussing circuit details, the paper passes by way of considerations of the brightness response characteristic of the monitor, to recommendations for standardizing the adjustment of the picture controls in the studios, with a view to obtaining a uniform gradation in the television picture. (Germany.)

A Survey of Picture Storage Tubes with Reproduction of Gradations, H. G. Lubszynski. "Nach. Z." March 1958. 10 pp. Storage tubes with reproduction of gradations may be classified according to their method of operation. Some of the problems encountered during the design and operation of these tubes as well as the limits for their capacity of storage are described. Recording velocities of 30 to 100 picture elements per microsecond and total reproduction periods from fractions of a second to several hours have been obtained. (Germany.)

A Combined Pulse Length Filter For TV Sets, W. Schroder. "El. Rund." April 1958. 4 pp. The integration filter having been used up till now to synchronize the vertical deflection circuits in TV sets and the differentiation filter having been utilized more seldom form together a combination filter superior to the hitherto existing circuits. (Germany.)

16 mm Telerecording Equipment, M. E. Pemberton. "El. Rund." April 1958. 3 pp. The cine camera of Marconi's telerecording equipment has a pull down mechanism with a claw obtaining the necessary acceleration by three stages. There is a pull down time of 1.33 ms, so that it is possible to pull the film through during the interval between television pictures. The design of the equipment and particulars of the pull down mechanism are considered. The results of the experiments for the life of the film perforation were quite amazing. (Germany.)

Impressions of Television in England, P. Neidhardt. "El. Rund." April 1958. 4 pp. The author gives a report on a journey which he carried out on invitation of the BBC London at the end of 1957 which afforded him an opportunity to become acquainted with the development of monochrome and color television in England. (Germany.)



THEORY

Statistical Analysis of Nonstationary Processes In Linear Systems by Using Inverse Simulating Devices, A. V. Solodov. "Avto. i Tel." April 1958. 13 pp. The theory of constructing structure circuits called inverse circuits is described. The inverse circuits are used while analyzing nonstationary random processes by means of the simulation method. Conjugation of the inverse circuits with real regulators is shown to be possible. An example is given to illustrate the suggested way of analyzing automatic control systems. (U.S.S.R.)

From Logic to Logical Algebra, F. Weitzsch. "El. Rund." May 1958. 5 pp. Logical operations which are true or false are frequently inconvenient. Therefore one tries to replace the often very complicated logical considerations by mathematical methods. This is also applied to electronic gates. Binary scale with numbers 0 and 1 is utilized for instance in this case. This application is not confined to conventional arithmetic operations but it is also suitable for the combinatorial analysis. (Germany.)

Language and Laws of Boolean Algebra, Boris Beizer and Stephen W. Leibholz. "El. Mgr." May 1958. 10 pp. Basic concepts of boolean algebra as a system engineer's tool for understanding and designing electrical, mechanical and hydraulic switching systems. (U.S.A.)

TRANSMISSION

Parallel-Plate Transmission Lines and Equivalent Radiators, A. B. Hillan. "E. & R. Eng." May 1958. 4 pp. The connection between parallel-plate transmission lines and equivalent radiators which have at least one infinite dimension is discussed. Calculation establishes that there is an exact correlation and demonstrates that in the case of an infinite plane irrotational current sheet there are no induction field terms, the radiated field being a faithful reproduction of the current density in the sheet. (England.)

A Waveguide Load Made from Commercial Film Resistors, U. v. Kienlin and A. Kurzl. "Nach. Z." March 1958. 4 pp. A discussion on various constructions of waveguide loads for microwaves is continued with a description of a design in which commercial cylindrical film resistors are used. Loads of this type have been manufactured for the waveguides 58 mm x 29 mm and 34 mm x 15 mm. The reflection coefficient is less than 1% over a relative frequency band of 15 or 30%. (Germany.)

TUBES

The Effect of a Suitable Choice of the Surface Resistance for Attenuators in Traveling Wave Tubes on Gain and Stability of These Tubes, W. Eichin and G. Landauer. "Nach. Z." March 1958. 7 pp. The attenuation as a function of surface resistance on an attenuator in a traveling wave tube with predetermined helix dimensions passes through a maximum. For obtaining a certain attenuation the surface resistance of the attenuator for the helix can be chosen so that the resistance is either higher or lower than the value corresponding to this maximum. (Germany.)

The Life Test Contribution to the Improvement of Valve Reliability, R. Brewer. "Brit. C. & E." April 1958. 6 pp. Vibration-fatigue and electrical life tests carried out on four types of CV4000 series "reliable" valves have shown a high order of reliability in both types of test. The development of these valves has benefited from the study of the causes of failures occurring in the life tests of commercial valves. This study has shown how valve assembly, processing and design faults can affect life, and it has thus provided an important feedback path by which improvements in valve reliability have been made. (England.)

The Design and Manufacture of a Low-Cost Cold-Cathode Trigger Tube, A. Turner. "El. Eng." April 1958. 4 pp. The long life, reliability and low power consumption of cold-cathode trigger tubes make them suitable for use in medium-speed computing and data processing applications. In the past the relatively high price of trigger tubes has limited their range of application, and the GTR120W tube has been designed to overcome this economic difficulty by the careful choice of materials and the development of processes which can easily be mechanized. (England.)

Thermionic and Cold-Cathode Valves, a Review of Progress, W. H. Aldous. "Proc. BIEE." May 1958. 9 pp. (England.)

An Electrostatically Focused Traveling-Wave-Tube Amplifier, K. K. N. Chang. "RCA." March 1958. 12 pp. By applying the principle biperiodic beam focusing a new traveling-wave tube, entirely electrostatically focused, has been achieved through the use of a pair of concentric bifilar helices and an annular gun. (U.S.A.)

Broadband Oscilloscope Tube, D. J. Brangaccio et. al. "Bell J." March 1958. 14 pp. By applying traveling wave tube principles to the design of a helix type vertical deflection system it has become possible to build up an oscilloscope tube whose bandwidth characteristic is flat over 600 megacycles. The trace on the fluorescent screen is readable without other optical means. The tube construction is similar to commercial cathode ray tubes, the only exception being that the alignment of the various tube elements has a closer tolerance. In actual use this tube allows one to view directly repetitive pulses a few milli-microseconds in width. (U.S.A.)

Cathode-Ray Tube Adds Third Dimension, Edward L. Withey. "El." May 23, 1958. 3 pp. Cathode-ray screen is mounted within vacuum tube behind transparent viewing globe. Screen is driven in oscillation toward and away from the observer along the Z-axis. Electron gun illuminates screen from the rear. Electromagnetic pickup on moving assembly gives output signal proportional to instantaneous position of screen along Z-axis. (U.S.A.)

U. S. GOVERNMENT

Research reports designated (LC) after the PB number are available from the Library of Congress. They are photostat (ph) or microfilm (mi), as indicated by the notation preceding the price. Prepayment is required. Use complete title and PB number of each report ordered. Make check or money order payable to "Chief, Photoduplication Service, Library of Congress," and address to Library of Congress, Photoduplication Service, Publications Board Service, Washington 25, D. C.

Orders for reports designated (OTS) should be addressed to Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Make check or money order payable to "OTS, Department of Commerce." OTS reports may also be ordered through Department of Commerce field offices.

The Application of Ultrasonic Energy to Cold Welding of Metals, J. B. Jones and C. F. DePrisco, Aeroprojects Inc. Nov. 1953. 61 pages. $1.75. (PB 131083, OTS) Ultrasonic spot and seam welding was successful in nonferrous sheet materials in .005-inch and .010-inch gages without the use of elevated temperatures. Ultrasonically spotwelded 2S aluminum developed adequate strength and pressure-sealing characteristics in reasonable ultrasonic exposure time and at reasonable power levels. Internal deformations of the faying surfaces were present, but no comparable external indentation occurred. No corrosion effects were evident after 2000 hours of exposure to salt water or to aerated distilled water at 95 C. Preliminary experiments indicated that other metals, particularly brass, copper, and gilding metal, can be ultrasonically welded.

Effects of Impurities on the Resonator and Lattice Properties of Quartz, D. L. Hammond, et al, S. C. E. L. Nov. 1955. 24 pages. 75 cents. (PB 131087, OTS) The current high level of precision in the fabrication of crystal units combined with improved techniques of controlled introduction of large amounts of impurities into the lattice of the synthetic materials makes possible the identification of the effect of each impurity. This opens up the possibility of a custom-made material with specific characteristics superior to those of natural quartz. With this ultimate objective, a study was undertaken to determine the effects of impurities on the properties of quartz. The study involved synthesis of quartz with added impurities, investigation of the resonator properties of the doped material, and examination of lattice spacing and the form and width of diffraction patterns in the synthetic materials.

A Differential Thermal Analysis Apparatus for Temperatures Up to 1575°C, K. G. Skinner, N. R. L. May 1957. 15 pages. 50 cents. (PB 121999, OTS) The determination of mineralogical and/or physical-chemical parameters up to 1575°C is vital in the evaluation of ceramic materials such as barium titanate. The differential thermal analysis (d.t.a.) apparatus aids in determining such parameters by comparison of the temperature of the sample with a neutral sample while both are simultaneously heated at a uniform rate. Resulting data may show the temperatures at which a phase change, disassociation, reaction, melting or solidification, or recombination of constituents takes place. The presence of one or more materials in the sample also may be detected. In NRL's barium titanate research program, however, the combination of high temperatures and chemical reactivity of the $BaTiO_3$ test materials excluded the use of the conventional d.t.a. apparatus. A specially-designed device is described which combines the advantages of high-temperature operation (1575 C) and holders which do not react with the sample. Excellent reproducibility is reported, with a probable error for the heating rate in 45 tests averaging only 0.005°C/min.

Industrial Preparedness Study: Silicon Power Rectifiers, D. Bakalar and others, Transitron Electronic Corp. Apr. 1956. 128 pages. $3.25. (PB 121547, OTS) This project was undertaken to perfect development, engineering, and production of a new type of silicon power rectifier. Specifically, a rectifier was needed with the capabilities of selenium but not using the strategically scarce material. Silicon offered the additional advantage of effectiveness at higher temperatures at which selenium cannot be used reliably. Silicon power rectifiers were developed with efficiencies of 96 percent and effective operation up to 135°C. Forward and reverse characteristics were excellent. A feasible production process and manufacturing techniques also were developed. The process can produce a high yield of rectifiers of superior quality. Rapid manufacture of large quantities of rectifiers is possible, and tests at high and low temperature can be performed efficiently. The report anticipates that the silicon rectifiers will replace a considerable number of selenium units of similar power ratings for many high temperature applications, particularly in compact, lightweight military equipment.

Design Guide for the Retarding-Field Oscillator, E. M. Boone, Ohio State Research Foundation. May 1957. 185 pages. $4.75. (PB 131201, OTS) This manual was prepared to expedite design for production of retarding-field oscillators operating over ranges of frequencies. Dimensions, construction details, and drawings of parts for the basic oscillator are included, along with discussions of operating principles and theory of the oscillator. Also treated are the Heil gun prototype, power-coupling systems, resonator structure, repeller, and other parts of the standard oscillator design. Frequency limitation is discussed, and design data for specific frequency ranges with performance characteristics at high and low frequencies are provided. Construction techniques involving hobbing methods, brazing, and preparation of cathodes by compressing properly proportioned mixtures of nickel powder and the carbonates of barium and stronium are described. It is shown that tubes with nickel matrix cathodes produce more power output at the same beam current than the same structures using oxide-coated cathodes.

Final Report on Theoretical and Experimental Investigation of Microwave Printed Circuits, H. S. Keen, Airborne Instruments Laboratory, Inc. Nov. 1956. 22 pages. 75 cents. (PB 131019, OTS) Significant economies in production costs and development time are reported resulting from this study of the uses and applications of symmetrical strip transmission line in predictable microwave circuits. Savings in weight and size over more conventional transmission-line structures also were accomplished. Based on the findings, the strip transmission line is called a major advance in the art of microwave circuitry. The investigation established limitations and general operating characteristics of the strip line. A wide variety of circuit elements using the medium were designed and developed. Of particular value to the production engineer are the advantages shown to be possible through use of photochemical etching methods in strip-transmission-line circuits. Trough waveguides were shown to be simple waveguide structures which can be easily fabricated and have many of the advantages of strip transmission line for development work.

Exploding Wire Light Source for High Speed Interferometry, M. R. Lewis and D. B. Sleator, Aberdeen Proving Ground. Feb. 1956. 33 pages. $1. (PB 121423, OTS) A high-intensity, short-duration exploding-wire light source was developed for use with a ten-inch Mach-Zehnder interferometer. The exploding wire was devised from a piece of yarn spun from several aluminum or aluminum alloy filaments of ordinary flash bulb filler. Yarn made of extremely fine wire appeared to give a shorter duration than a single strand wire of the same diameter as the yarn and under the same conditions. The light was of such intensity that a bandwidth of 16A° in the 4358A° region yielded interferograms of greater density and contrast than those obtained with a BH-6 tube source previously used with the interferometer. The report presents experimental procedures leading to the development, along with tables and oscilloscope traces of intensity versus time as a function of various wire parameters.

Project Vanguard Report No. 18, Minitrack Report No. 1—Phase Measurement, C. A. Schroeder, et. al. NRL. 31 pages. $1.00. (PB 131220, OTS) A report briefly describing Minitrack, the earth satellite tracking system which has been tracking the Russian Sputnik, has been released. This report, first of a series which will be forthcoming on Minitrack, gives detailed information on the phase measurement portion of the system. The most basic problem created by a satellite after it is placed in its orbit, according to NRL, is proving that the satellite is in fact orbiting and measuring its orbit. Minitrack was developed to provide acquisition and tracking by radio techniques. Minitrack is a phase comparison system which receives through eight antennas the signals from the low-power, lightweight transmitter in the satellite. By phase-comparison techniques, it measures the angular position of the satellite as it passes through the antenna beam, recording its "signature" automatically without the need for additional tracking information. Analysis of this signature provides the complete angular history of the satellite passage.

Ferroelectric Materials Survey With Particular Interest in Their Possible Use At High Temperatures, C. F. Pulvari, Catholic Univ. of America. Feb. 1957. 74 pages. $2. (PB 121949, OTS) The increasing demand for ferroelectric materials for use above Curie temperature 120 C, the maximum for $BaTiO_3$, prompted this compilation of data on materials of the oxygen octahedra type. Considered were ferroelectrics without H_2O molecules, or those which are chemically and physically stable. Data for different materials are arranged individually, and brief descriptions of their known crystal and ferroelectric properties are included. All available literature references are presented for each material. Materials covered include titanates, niobates, tantalates, stannates, zirconates, vanadates, rhenium trioxide, gallates, and fenates.

Nonmetallic Ferromagnetic Materials: Part VII—Microwave Ferrites, H. C. Rothenberg and E. B. Mullen, General Electric Co. Dec. 1955. 49 pages. $1.25 (PB 131053, OTS) This report reviews a phase of the Air Force's program for development of improved electronic components in general and nonmetallic ferromagnetic materials in particular. The work described had two objectives: measurement of microwave ferrites produced earlier; and conception and initial development of applications for the materials. The theory of ferrites was treated qualitatively and semiquantitatively. Considerable attention was given to the measurement of the permeability tensor components, and a technique was developed for precise comparison of ferrite characteristics at X-band frequencies. A number of ideas were advanced for ultimate production of finished devices. These included use of a microwave duplexer with a ferrite gyrator and two 3 db hybrid couplers, and an electrically tunable cavity useful for wider range tuning of klystrons.

Predictions of Arrival Sequences of Simulated Radar Targets as a Function of Display Size, Target Size, and Target Sharpness, L. M. Schipper and J. Versace, Ohio State Univ. Nov. 1956. 19 pages. 50 cents. (PB 131179, OTS) Sequence judgments of the type "Which aircraft will arrive first" must be made very frequently by air traffic controllers. The ability of observers to judge which of two aircraft would arrive at fixed reference line first was investigated as a function of simulated display size, target size, and target sharpness. The major finding was a lack of systematic change in prediction accuracy with changes in any of the three variables.

International ELECTRONIC SOURCES

PATENTS

Complete copies of the selected patents described below may be obtained for $.25 each from the Commissioner of Patents, Washington 25, D. C.

Vacuum Tube and Electrical Signalling Apparatus, #2,817,785. Inv. K. L. Bell. Assigned one half to B. J. Chromy and 15% to H. J. A. Runsdorf and H. N. Runsdorf. Issued Dec. 24, 1957. An image is projected onto a flat photosensitive cathode. A flat grid is arranged coextensive with and parallel to the cathode. A wave of electrons is projected from all elemental areas of the cathode towards corresponding areas of a target electrode which is angularly disposed with respect to the cathode so that the electron wave reaches different elemental areas of the target at different times; each wave reaches substantially the whole target area.

Image Storage Device, #2,817,781. Inv. E. Emanuel. Issued Dec. 24, 1957. The composite screen of a vacuum tube consists of a luminescent part, a photoelectric part, and a light-transparent part therebetween. The light-transparent part contains a polyester.

Semiconductors, #2,817,798. Inv. D. A. Jenny. Assigned Radio Corporation of America. Issued Dec. 24, 1957. A single crystal body of an alloy of germanium and at least 1% silicon and having semiconductive properties has at least one rectifying electrode connected thereto.

Electric Translation Apparatus, #2,817,819. Inv. H. H. Chamberlain. Assigned General Electric Company. Issued Dec. 24, 1957. Two series-connected photocells control the frequency of a relaxation oscillator providing an a.c. output. The output is rectified and controls the deflection of a galvanometer which carries a mirror reflecting light onto the photocells by an amount depending on the galvanometer deflection. The d.c. input to be converted into an a.c. output is applied to the galvanometer winding.

Microwave Horn and Paraboloidal Reflector Antenna System, #2,817,837. Inv. G. V. Dale and H. T. Friis. Assigned Bell Telephone System. Issued Dec. 24, 1957. A paraboloidal reflector is placed near the mouth of a sectoral biconical horn. The horn has two plane sides and two conical sections having a common apex and both being outwardly concave. The common apex is also the focal point of the paraboloidal reflector which is positioned to reflect the energy emitted by the horn by approximately 90° with respect to the longitudinal axis of the horn.

Microwave Duplexer, #2,818,501. Inv. G. Stavis. Assigned General Precision Laboratory, Inc. Issued Dec. 31, 1957. The receive-transmit antenna is coupled to a pair of unidirectional couplers, such as ferrite rotators. A transmitter is coupled to one path of each of the ferrite rotators and a receiver to the other path of each of the ferrite rotators. The coupling paths for the transmitter being different from the coupling paths for the receiver by an odd integral multiple of a quarter wavelength.

Target Structure for Three-Color Cathode Ray Tubes or the Like, #2,818,525. Inv. B. M. Felburg. Assigned Hoffman Electronics Corp. Issued Dec. 31, 1957. The face plate of the target structure comprises a plurality of three-phosphor triangular areas. A unitary member is disposed normal to and close to the face plate, this member consists of a plurality of major wall elements delineating the triangular areas.

Electron Discharge Device, #2,818,528. Inv. J. Feinstein. Assigned Bell Telephone Laboratories, Inc. Issued Dec. 31, 1957. A thermionic cathode is surrounded by a secondarily emissive cathode which is in turn surrounded by an anode, both cathodes and the anode having a common axis. The controlling magnetic field extends parallel to this axis and can be shunted from the inter-cathode region.

Electroluminescent Image Device, #2,818,531. Inv. S. Ch. Peek, Jr. Assigned Sylvania Electric Products, Inc. Issued Dec. 31, 1957. A series of conductive lines is provided on each side of an electroluminescent phosphor layer, the two series being insulated and the projection of one series of lines upon the other being at an angle thereto. A rectifier is connected to each of the lines in at least one of the series.

Germanium Diodes, #2,818,537. Inv. H. Wolfson. Assigned International Standard Electric Corp. Issued Dec. 31, 1957. Contacts are applied to opposite surfaces of a semiconductor body. A thin contact film of an alloy of the semiconductor material with either lead or tin covers a part of one of the two surfaces and a cat whisker electrode is in contact with the film.

Oscillographic Impedance Indicators, #2,818,546. Inv. A. E. Laemmel. Assigned Polytechnic Institute of Brooklyn. Issued Dec. 31, 1957. An elliptical wave is established in a circular waveguide sidearm suitably coupled to the unknown impedance. A voltage proportional to the difference between the magnitudes of the polarized field at two points angularly spaced by 90° is applied to one pair of deflection control of a C.R. tube. Another similar voltage derived at points spaced 45° from the previously mentioned points is derived and applied to the other deflection control.

Phase Modulating Device, #2,818,548. Inv. B. Kazan. Assigned Radio Corporation of America. Issued Dec. 31, 1957. A delay line is placed adjacent one surface of a photoconductive layer, contacting it at spaced points along an imaginary line, the points being spaced by an appreciable fraction of the wavelength at the operating frequency. A transparent conducting coating is applied to the other side of the photoconductive layer, a light beam traveling along this transparent layer in the direction of the imaginary line.

Vehicle Guiding System, #2,818,553. Inv. D. L. Jaffe. Assigned Polarad Electronics Corp. Issued Dec. 31, 1957. Two transmitting loops are located in a plane perpendicular to the intended path of the vehicle and equally distant and on opposite sides of the path. The loops produce induction fields which are 180° out-of-phase which are received and compared on the vehicle. When the vehicle is located on the desired path, the two received fields cancel.

Magnetic Control Systems, #2,818,555 and 2,818,556. Inv. A. W. Lo. Assigned Radio Corporation of America. Issued Dec. 31, 1957. A body of substantially rectangular hysteresis loop magnetic material is provided with at least three apertures so located that their magnetic flux paths are linked. Separate windings, at least one of which involves more than one aperture, are provided for the input, output, control and setting currents.

Center-Fed Waveguide Antenna, #2,818,566. Inv. J. B. Rankin. Assigned Radio Corporation of America. Issued Dec. 31, 1957. An outer waveguide concentrically surrounds and has one wall in common with an inner waveguide. The inner waveguide is short-circuited and probes interconnect the two waveguides at spaced points. Energy in the inner waveguide is thus coupled to the outer waveguide by the probes and from there into free space.

Monaural-Binaural Transmission of Sound, #2,819,342. Inv. F. K. Becker. Assigned Bell Telephone Laboratories, Inc. Issued Jan. 7, 1958. A plurality of microphones are placed at sped points and each directly connected to one transmission channel. A cross-coupling path extends from each microphone to the channel of each other microphone; each of these paths contains a delay device.

Data Transmission and Control System, #2,819,438. Inv. M. A. S. Angelo. Assigned Sperry Rand Corp. Issued Jan. 7, 1958. In this servo-system, the position of an object is indicated by the phase of an a.c. current, the position of the object being controlled by an electromotor. Two reversible polarity error signals vary cyclically in magnitude at respectively different rates in dependence of the phase difference as indicative of the object position indicating and positioning currents. A selected one of the error signals will then be applied to the electromotor.

Electrical Circuit, #2,819,442. Inv. H. C. Goodrich. Assigned Radio Corporation of America. Issued Jan. 7, 1958. A rectifier, having a voltage-current characteristic comprising two similarly inclined low-resistances branches interconnected by a high-resistance branch is supplied with an a.c. signal. A filter network is connected into the rectifier current path to maintain the average d.c. through the rectifier substantially equal to zero.

Molecular Resonance Modulators and Demodulators, #2,819,450. Inv. Chas. H. Townes. Assigned Bell Telephone Laboratories, Inc. Issued Jan. 7, 1958. Microwave energy is guided through a gas at low pressure. The gas is characterized by sharp resonance lines of selective absorption of microwave energy in an amount depending on the numbers of the molecules in the various possible energy levels. This number is changed by subjecting the gas to higher frequency electromagnetic waves. Thus absorption will vary as this higher frequency electromagnetic waves, the intensity of which is modulated by a control signal.

Electromagnetic-Wave Generating System, #2,819,451. Inv. G. D. Sims. Assigned The General Electric Co., Ltd. Issued Jan. 7, 1958. A TM_{11} wave mode is launched in a circular guide which is coupled to an arcuate waveguide also of circular cross-section and having a longitudinal axis in a predetermined plane to generate a TE_{01} wave substantially free from other modes from a TM_{11} wave.

Microwave Filters, #2,819,452. Inv. M. Arditi, G. A. Deschamp, and J. Elefant. Assigned International Telephone and Telegraph Co. Issued Jan. 7, 1958. A waveguide is formed by two slightly spaced ribbon-like conductors. The first conductor being a fraction of a quarter wavelength wide, and having lateral projections, the second conductor being wider to present a planaro conducting surface for the TEM mode. The lateral projections present spaced reflecting lump impedances to form resonant sections, the susceptance value of certain projections being adjustable.

Color Television, Frequency Control System, #2,820,091. Inv. N. W. Parker and B. S. Parment. Assigned Motorola, Inc. Issued Jan. 14, 1958. Color and audio signals are transmitted over separate carriers. A color control wave is generated, its frequency multiplied by a predetermined factor and mixed with the video signal carrier to produce the audio carrier wave. The video signal contains portions of the color control wave.

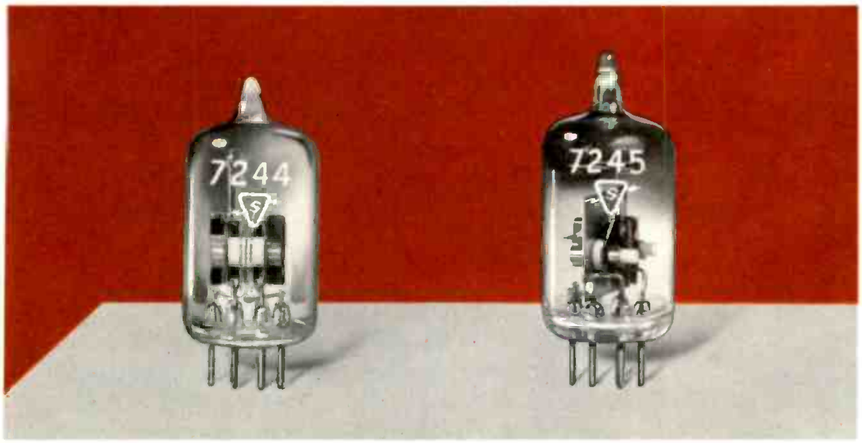
Circuit-Arrangement for Controlling the Gradation of Picture Signals, #2,829,110. Inv. J. J. P. Valeton and F. H. J. Van Der Poel. Assigned North American Philips Co., Inc. Issued Jan. 14, 1958. The amplifier contains two tubes and the video signal is simultaneously applied to both tubes and their outputs are added. One tube has an operating range accommodating all of the signal, the other has a narrower range. Both tubes are biased according to the black-representative amplitude of the signal.

Electronic Counter Systems, #2,820,153. Inv. H. J. Woll. Assigned Radio Corporation of America. Issued Jan. 14, 1958. A plurality of cascade-coupled bistable pulse transfer circuits are connected over a control circuit to an advance pulse circuit. The control circuit triggers alternate bistable circuits into a non-indicating state in response to pulses of one polarity and the remaining bistable circuits into a non-indicating state in response to pulses of opposite polarity.

Electron Tube News
—from SYLVANIA

Pioneering new concepts—Everywhere in electronics

IN BASIC TUBE DESIGN . . .

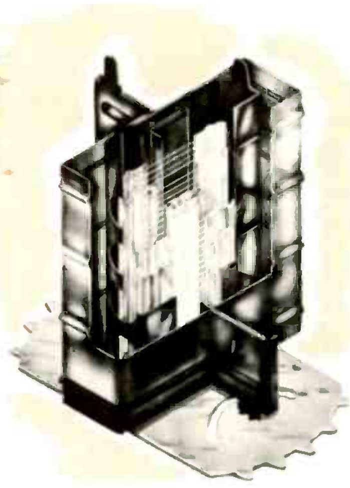


Double triode, type 7244, and single triode, type 7245

Stacked mount in glass bulb offers practical answers to industry's current needs

Sylvania's stacked mount structure is now available to design engineers because of a new glass envelope design that facilitates mass production of the tubes. Complete electrical, mechanical and environmental tests show that the new tube is capable of meeting the highest requirements of today's operational equipment. Its unique stacked construction offers an inherent ruggedness and reliability for superior vacuum tube performance. Actual test data comparing the stacked structure with conventional structures indicates as much as a 2 to 1 improvement in vibrational output at 6 times the G level.

The new stacked tube has already excited tremendous military interest. Eventually an entire line will be available for military and industrial applications.



▲ Cutaway view of the Framelok design

Widespread interest in Sylvania's exclusive Framelok design fosters new type development

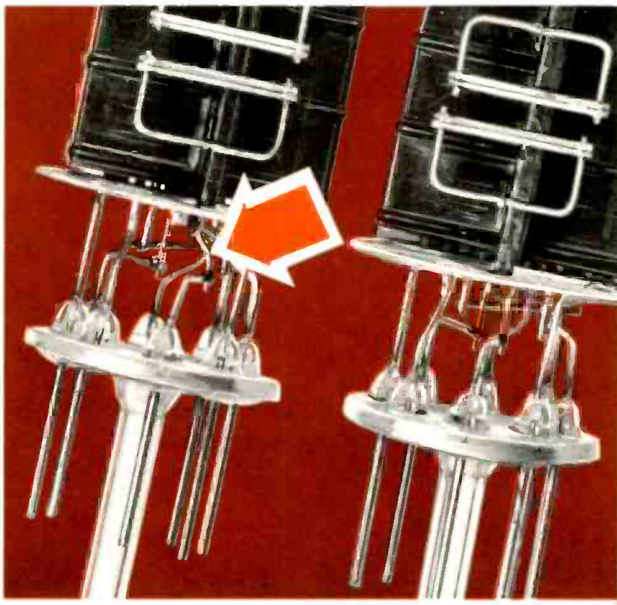
Accelerated development of new Framelok tube types is underway at Sylvania as a result of fast-growing acceptance of the revolutionary design shown for the first time at the 1958 IRE Convention.

Design engineers are already analyzing new circuit requirements in terms of the Framelok design. New application possibilities ranging from television to audio are developing rapidly.

Behind this widespread acceptance are these basic reasons why designers prefer the Framelok design over conventional types:

• Greater uniformity of electrical characteristics in tube after tube • Greater stability of electrical characteristics during tube life • Less change in electrical characteristics due to element temperatures at high dissipation levels • Better control of cutoff • Lower knee voltage—more uniform control of knee • Less chance for shorts, microphonism and noise • Better plate-to-screen current ratio • Higher screen grid dissipation • Less arcing.

Send for your free copy of Sylvania's new Framelok Grid Booklet, including a grid sample, for full information on the electrical and mechanical characteristics of the Framelok design

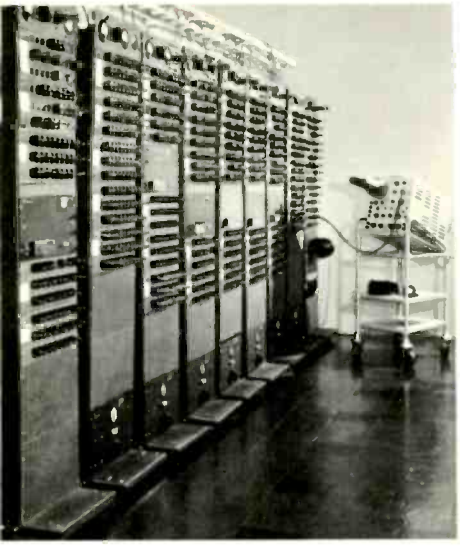


Entertainment receiving tubes are subjected to military-type inspection procedures

These two mounts may look alike to the untrained eye . . . but trained inspection personnel can spot defects in one (left) that could cause future trouble. All Sylvania entertainment tube types must pass this visual mount inspection procedure based on that used for military types. As a result equipment manufacturers enjoy fewer line rejects, lower manufacturing costs.

SYLVANIA SETS THE

Gold Brand Standard



Gold Brand Subminiatures undergo 1,000-hour life tests

Life tests on subminiatures are increased to insure maximum reliability

Sylvania increases the life assurance on its premium subminiature tube line by increasing its life test program from 500 to 1,000 hours. The increase establishes additional positive proof of the high reliability and excellent performance of the subminiature tube line.

Gold Brand types meet missile requirements

Gold Brand Premium Guided Missile types withstand severe durability tests

Every tube type in Sylvania's Gold Brand Guided Missile line meets environmental testing more severe than that required in many advanced military specs. Each type is subjected to severe vibrational fatigue tests at sweep frequencies from 30 cps to 3000 cps at 10 G's for 6 hours in several standard positions.

All Gold Brand Sylvania subminiature tubes undergo the White Noise Test. The tubes are subjected to a white noise vibrational spectrum covering the frequency band of 100 to 5000 cps., the rms G-level is 2-3 G's per octave with peak G-level of 15 G's. The tubes are tested for both rms and peak vibrational output and limits are established on each.

Type	Description
6946	Medium-Mu Triode
6947	Medium-Mu Double Triode
6948	High-Mu Double Triode
6788	Sharp cutoff audio-frequency pentode
6943	Sharp cutoff RF Pentode
6944	Semi-Remote cutoff RF Pentode
6945	Audio-Frequency Beam Pentode

Gold Brand types meet rigid new specifications

Sylvania writes new Gold Brand Specs for commercial and industrial applications

To meet your needs for reliable tubes in commercial and industrial equipment, Sylvania has written new specifications which tailor military standards to commercial, and industrial requirements. Some of the typical controls specified for Gold Brand tubes include Multiple Life Tests ranging from 500 to 1,000 hours, Impact Shock Tests of up to 500 G, Fatigue Tests, Vibration Tests, Glass Strain Tests and Variable Control Tests.

The following are the 12 Gold Brand types on which full specifications are available:

Type	Description
407A	Medium-mu double triode (9-pin miniature)
408A	Sharp-cutoff pentode (7-pin miniature)
6AU6WA	Sharp-cutoff pentode (7-pin miniature)
6X4WA	Double diode (7-pin miniature)
5654	Sharp-cutoff pentode (7-pin miniature)
5670	Medium-mu double triode (9-pin miniature)
5725	Dual-control pentode (7-pin miniature)
5726	Double diode (7-pin miniature)
5749	Semi-remote cutoff pentode (7-pin miniature)
5751	High-mu double triode (9-pin miniature)
5814A	Medium-mu double triode (9-pin miniature)
6005	Beam Pentode (7-pin miniature)

Gold Brand subminiature Type 6814 meets rugged requirements of airborne computers

Type 6814 for missile computers

Prime example of a Gold Brand subminiature ideally suited for airborne computer use is type 6814. Fully proven in current operational equipments the tube features controlled sharp cutoff and zero bias plate current for good switching action. It exhibits exceptional freedom from development of cathode interface throughout life.

The 100% Production DC shorts test as well as a standard AC shorts test on type 6814 minimizes the possibility of flicker shorts—assuring greater reliability in this tube's many applications, particularly in switching and triggering circuits. In addition, it withstands a minimum 1000-hour life test.

You can get the complete engineering story on Sylvania's Gold Brand Lines in the new 33-page Gold Brand booklet.

IN NEW TUBE TYPES . . .

Five new types are added to the receiving tube line

Type 12DV8—Designed for 12-volt auto radios, this 9-pin miniature double-diode, space charge grid tetrode can be used as a combined detector, AVC rectifier and transistor driver. The tetrode section has the advantage of low R_p for better transistor matching.

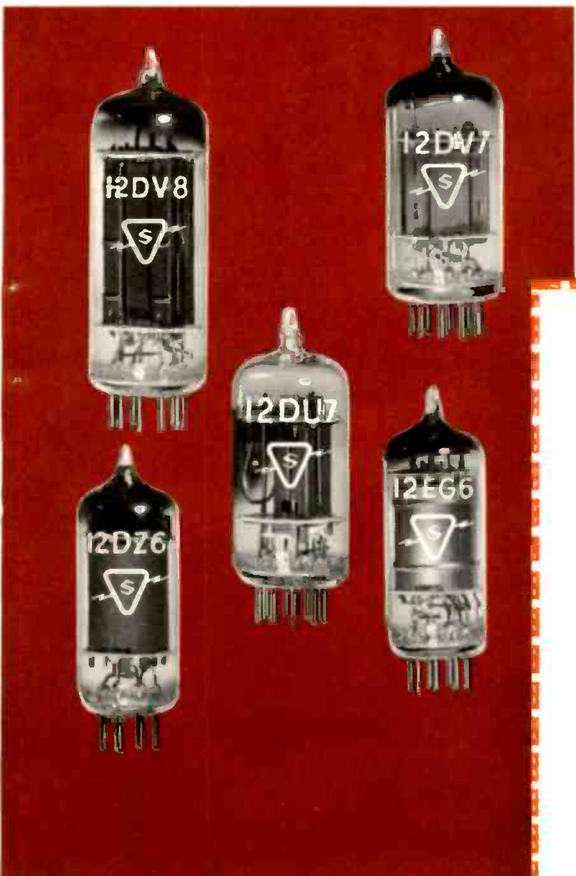
Type 12EG6—This tube is designed primarily for use in 12-volt auto radios as an RF amplifier. It is a 7-pin miniature dual control Heptode with a unipotential cathode. AVC voltage can be applied to two control grids reducing back biasing of the AVC line with large RF signals.

Type 12DZ6—This miniature pentode has a remote cutoff to give a Gm of 50 umhos at a bias of 10 to 12 volts for improved AGC characteristics in hybrid radio receivers. The plate resistance of 15,000 ohms, coupled with a Gm of 3600 umhos, insures high performance in weak signal areas.

Type 12DU7—This 9-pin miniature double diode-tetrode can be used as a transistor driver in addition to functioning as a detector and AVC rectifier in hybrid auto receivers. In this multipurpose, low-cost tube, power output distortion is controlled to a maximum of 5%.

Type 12DV7—A double diode-triode for use in 12-volt hybrid auto radios. With a 12-volt plate supply the triode features a plate current of 750 ua, a mu of 15 and a Gm of 1000 umhos. The diodes feature a separate cathode connection for maximum flexibility in detector and AVC circuits.

New receiving tube types



New five-inch experimental evaporated phosphor CRT

IN NEW TRANSPARENT PHOSPHOR TUBES . . .

Experimental five-inch evaporated phosphor CRTs offered for applications research and development

Steady progress is being made in the development of evaporated (transparent) phosphor cathode-ray tubes at Sylvania. Now 5-inch and other small tubes are being produced and are available for experimental purposes.

High industry interest in evaporated (transparent) phosphor tubes is centered around the major benefits the tubes offer over conventional CRT s. Among the more important characteristics are:

- **Higher resolution**—Transparent screens are capable of higher resolution than conventional settled screens because the phosphor crystals are smaller by many orders of magnitude. Video displays with sharper definition are possible.
- **Improved contrast** in high ambient light conditions—Transparent phosphors permit outside light to pass through the "screen" cutting reflection to a minimum. This characteristic is highly important where scopes must operate in high ambient light.
- **Minimum Screen Noise**—Because evaporated phosphor crystals are much smaller than those in conventional coatings, screen noise, the interplay of light reflections on the crystal faces, is reduced. The result is sharpest possible definition.
- **More Uniform Light Output**—The phosphor coating on evaporated screen CRTs is some 10 times as thin as standard coatings. This smooth screen coating contributes to far greater uniformity in light output.
- **Less Screen Burn**—Transparent phosphor tubes offer better resistance to screen burning because the crystals are closer to the glass faceplate. This allows better heat dissipation and cooler operation.

Since all of these advantages are not available in a single evaporated phosphor tube design, it is necessary to specify which characteristics are most important for the intended application. Send full information on your particular application when you request experimental samples. Write to Sylvania direct or call your Sylvania representative.

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SYLVANIA ELECTRIC PRODUCTS INC.
1100 Main St.
Buffalo 9, N.Y.

In Industrial Television . . .

Special CRT is specifically designed for industrial TV monitor use

Now, higher fidelity in industrial television is possible with new cathode-ray tube, type 8FP4. It gives added definition and resolution to industrial television performance.

Type 8FP4 is an 8" rectangular all-glass, magnetic focusing tube with an ion trap and 90° magnetic deflection.

New test picture tube speeds receiver production line testing

A new 8" 110° test picture tube, type 8YP4, is specifically designed for television receiver and picture tube testing. Its small size, light weight and convenient shape make it the ideal production line test tube.

The 8YP4 is equipped with a conventional base and a convenient adaptor for conversion to a rigid pin base. It has built-in automatic electrostatic self-focusing making external focus connections or adjustments unnecessary. It employs a 6.3 volt, 600 ma heater that will also operate in 450 ma series heater strings.

New ITV monitor

In Industrial and Military C-R Tubes

New CRT type 5ADP2

New high-precision scope tubes, types 5ADP, 5ABP, and 5AQP, were developed for photography, radar and specialized uses

Sylvania again expands its line of special-purpose industrial and military cathode-ray tubes with a series of high-precision types designed for specialized uses. These tubes incorporate a high-precision electron gun made to ultra-fine tolerances. Sharp clean scope presentations result for high-precision photography.

The new tubes, types 5ADP, 5ABP, and 5AQP, are available in screen phosphors ranging from P1 to P11.

In Television Picture Tubes . . .

Sylvania combines the advantages of 110° deflection and 450 ma heater in three new picture tubes

Sylvania, trend setter in electron-tube design, has developed new 110° picture tubes incorporating the 450 ma 6.3 volt heater. The new tubes, types 17CTP4, 21DHP4 and 24AQP4, combine the space savings of 110° tubes with the power and cost advantages of 450 ma heaters. The low power heater not only reduces heat with total set power savings of approximately 18 watts but permits use of a lower wattage, less expensive series resistor. The end result is a line of picture tubes that meet the needs of new portable and console TV receiver designs.

Type 24AQP4 with 450 ma heater

SYLVANIA

Sylvania Electric Products Inc.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., Montreal

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

Please send the following information on the items checked below:

ENGINEERING DATA SHEETS

Receiving Tubes
- ☐ 7244
- ☐ 7245
- ☐ 12DV8
- ☐ 12EG6
- ☐ 12DZ6
- ☐ 12DU7
- ☐ 12DV7

Cathode-Ray Tubes
- ☐ 5ABP
- ☐ 5AQP
- ☐ 5ADP
- ☐ 8FP4
- ☐ 8YP4
- ☐ 17CTP4
- ☐ 21DHP4
- ☐ 24AQP4

- ☐ Sylvania Framelok Grid Booklet
- ☐ Sylvania Gold Brand Booklet
- ☐ Additional explanation, and application requirement form for Sylvania transparent phosphor CRT s

Name ______________________

Address ______________________

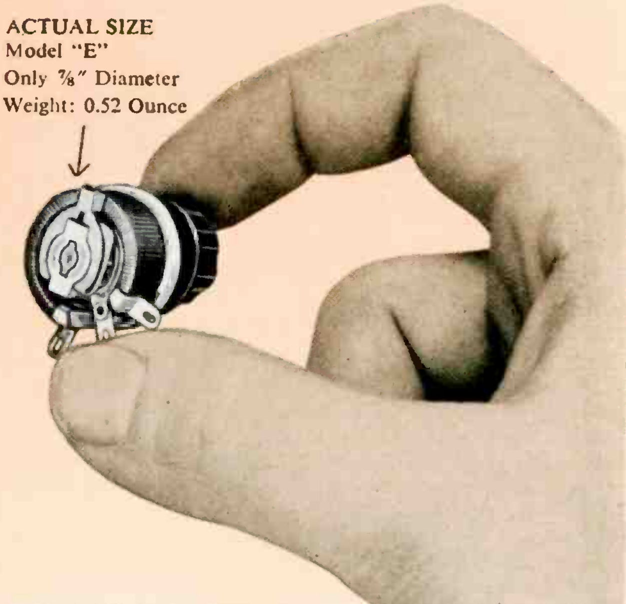
Company ______________________

Use this handy business reply card to request additional information on these important new Sylvania developments

NEW OHMITE

12½ WATT MINIATURE RHEOSTAT

ACTUAL SIZE
Model "E"
Only ⅞" Diameter
Weight: 0.52 Ounce

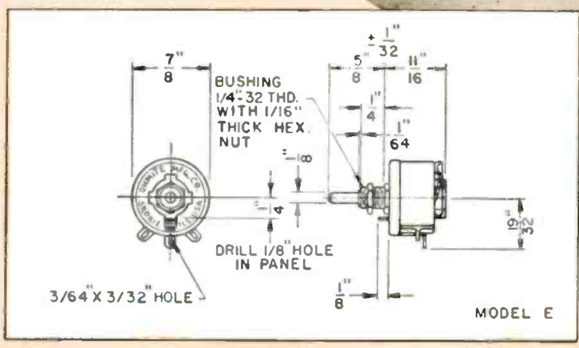


High power handling capability for small size

Newest addition to the Ohmite line of vitreous-enameled rheostats is the new Model "E" miniature 12½-watt rheostat. This new unit is smaller than many one- or two-watt potentiometers. It provides time-tested Ohmite all-ceramic and metal design features for uses where as much as 12½-watt dissipation is required and space is extremely limited. Built to operate at a maximum hot spot temperature rise of 300° C at an ambient of 40° C, Model "E" is also useful for operation at high military ambients, derated linearly to zero at 340° C, attained. Rugged, lasting, power rheostat performance is thus available in such small size that new possibilities in miniaturization and dependability are afforded the apparatus designer.

Like the larger Ohmite rheostats, Model "E" has a ceramic base, and ring-shaped ceramic core. Vitreous enamel holds the turns of wire against shifting, and fastens the base and core together. Also, the Model "E" has a ceramic hub insulating the shaft; a metal-graphite contact; folded spring arm; independent compression spring; slip-ring; a stop directly connected to the shaft. The entire assembly is a miniaturized, dependable version of the time-proven Ohmite power rheostat design. Mounting is by a ¼"—32 threaded bushing. The shaft is ⅛" in diameter. Resistance range: up to 5,000 ohms with 23 stock values; higher values available with OHMICONE inorganic coating. Resistance tolerance: ±10%. Torque: 0.1 to 0.2 pound-inch. A small finger-grip knob, in keeping with the rheostat dimensions, is available.

Special length shafts and bushings, screwdriver shafts, locking type bushing, tandem mountings, enclosures, etc., similar to the variations available on the larger rheostat, can be provided upon specific request.



INDUSTRY'S MOST COMPLETE LINE OF RHEOSTATS

Now 11 Sizes! — 12½ to 1000 Watts

All sizes available from stock in a wide range of resistance values, including the NEW Model "E." Ten sizes are available to meet MIL-R-22A requirements in *each* of the 26 type designations.

RHEOSTATS   RESISTORS   RELAYS
TAP SWITCHES   TANTALUM CAPACITORS
R. F. CHOKES   VARIABLE TRANSFORMERS

OHMITE® QUALITY Components

WRITE FOR BULLETIN 157

OHMITE MANUFACTURING COMPANY 3662 Howard Street, Skokie, Ill.

New Products . . . for the Design Engineer

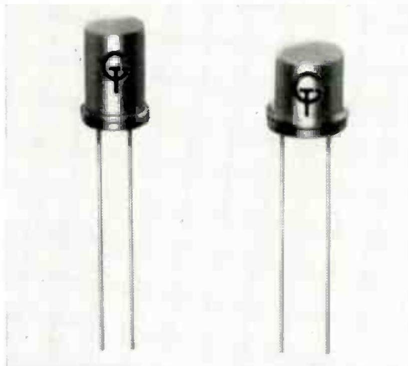
TERMINALS FOR MISSILES

A new line of high temperature, heat resistant terminals and connectors, trade marked "Strato-Therm" has been developed. They give sound electrical and mechanical performance at continuous temperatures as high at 2000°F. Both terminals and connectors provide fully circumferential support to the wire insulation for vibration resistance. They accommodate nickel, manganese-nickel, iron or nichrome wires, either solid or stranded or in combination. Wire size range covers 22 through 10 AWG. AMP Incorporated, Harrisburg 31, Pa.

Circle 203 on Inquiry Card, page 83

WIRE WOUND RESISTORS

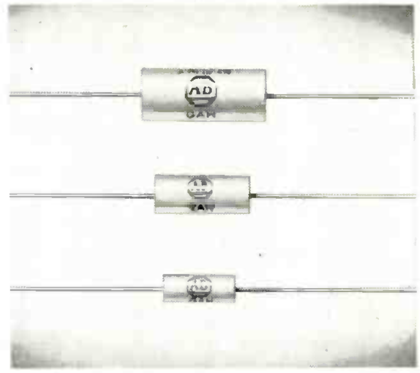
A new line of bobbinless precision wire wound resistors are available. Packaged in two case styles, R-2 and R-5, these units are ideally suited for printed circuit boards, and subminiature assemblies for airborn and missile applications. Some features are: Welded case construction insures a hermetic seal; welded terminations practically eliminate noise in the resistor; bobbinless construction eliminates strain and stress on wire under extreme environmental conditions; tolerances can be controlled to ±0.05%. General Transistor Corp., 91-27 138th Place, Jamaica 35, N. Y.



Circle 205 on Inquiry Card, page 83

PRECISION RESISTORS

A new line of hermetically sealed, precision resistors, which use a specially designed metal alloy grid resistance element is available. Available in three types: the CAH, 0.25 w. the EAH, 0.50 w. and the GAH, 1.0 w., with full ratings at 100°C ambient temperatures. Standard resistance tolerances are 0.1%, 0.25%, 0.5%, and 1.0%. In all tests, these resistors exceed MIL Specifications for wire wound and metal film type precision resistors. They employ a noninductive resistance element. Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 4, Wisc.



Circle 207 on Inquiry Card, page 83

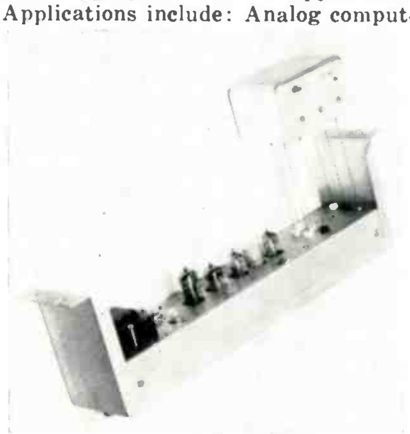
WIRING HARNESS

Multiconductor film insulated flat wiring is now available. Called "Plyo-Duct," this new application is available in both standard parallel line arrangements and special custom patterns as designed by the user. It is available on spools in 8 and 15 conductor sizes. The flat copper conductors are 0.0027 in. in thickness and 0.075 wide. Overall thickness is 0.008 in. The 0.156 in. center to center spacing allows the harness to employ standard pin terminal printed circuit connectors. Methode Manufacturing Corp., 7447 W. Wilson Ave., Chicago 31, Ill.

Circle 204 on Inquiry Card, page 83

PACKAGED AMPLIFIER

Packaged amplifier, Model UPA-2, combines a new level of flexibility and convenience with the reliability of printed circuit operational amplifier. It can drive a 12,000 ohm load to 100 v. in either direction, and permits large values of cable capacitance. The user can select the desired operation and, within limits, the performance level appropriate to the application. Applications include: Analog computing, measurement and control, continuous data reduction, and feedback operations of many kinds. George A. Philbrick Researches, Inc., 230 Congress St., Boston, Mass.



Circle 206 on Inquiry Card, page 83

TIME DELAY RELAYS

A series of heavy duty models have been added to a standard line of transistorized time delay relays. These units are all-electronic, utilizing transistors and RC time-constant circuit elements. All moving parts except the relay contacts have been eliminated. Time delay periods available from 0.01 to 60 sec. Choice of 1-pole dt., 10 a. resistive or 3-pole, dt., 10 a resistive. Operates from —55° to 125°C. Shock resistance is 50 g's for 11 msec. Input voltage is a nominal 28 vdc. (18 to 31 vdc). Tempo Instrument, Inc., 240 Old Country Rd., Hicksville, N. Y.

Circle 208 on Inquiry Card, page 83

Ultrasonic Delay Lines

(*Continued from page* 76)

less relative amplitude with decrease in temperature.

Where application requirements are such that the variations in performance characteristics due to temperature changes cannot be tolerated, it becomes necessary to provide a temperature controlled housing around the delay line.

Where it is necessary to closely match time delay between two or more delay lines, and retain the delay match over a temperature range, temperature control becomes more essential. The degree of precision of temperature control required is dictated by (1) the delay time of the delay line, and (2) the allowable mismatch required by the application. The problem of design to meet any particular delay match requirement is limited only by the availability of suitable temperature control equipment, physical size requirements, and economics.

Economical Factors

In specifying a set of desired performance characteristics for a delay line, it is useful for the customer to have some idea of cost. The following summarizes, in a very general way, the major factors influencing the cost of the delay line.

Cost increases at an increasing rate since the diameter of the fused silica blank varies directly with delay time.

If close tolerances are required on nominal delay time, special handling and additional manufacturing operations may be required which can affect cost significantly.

Delay Time Match

The cost of matching time delay among two or more lines varies greatly depending on the tolerances involved. The tolerances determine the extent of special testing required and the number of additional manufacturing operations involved.

Carrier Frequency

Process problems become more involved at higher frequencies, thus cost increases with frequency. This factor becomes most significant with delay times over 1000 μsec. and frequencies over 20 MC.

Spurious Response Level

Spurious response level is a major cost factor. Costs increase directly with spurious response level since requirements (1) are related to fused silica blank size (determines reflection pattern compression possible) and (2) significantly influence production assembly costs.

Terminal capacitance is usually not a major cost consideration unless close tolerances are required. Under 75 μμf nominal terminal capacitance, ±5μμf usually does not impose special production problems.

Cost of packaging is directly related to (1) the mechanical complexity of the case design, and (2) production assembly costs which are in turn influenced by the case design, internal shielding, etc. Usually case design is not a major cost factor.

(*Continued on page* 118)

(*Continued from page 117*)

Design Latitude

To provide optimum performance at lowest cost to the customer, it is generally desirable to have as much design flexibility during the prototype development stage as can be provided.

Specifically, several suggestions can be made:

Indicate which performance characteristics are most critical to the application, and if practical indicate each performance specification as "essential," "desirable," or "not important."

Leave specifications of voltage attenuation and terminal capacitance flexible until initial prototype development is complete.

Leave the package design (and the allotted space in the equipment) open until the prototype order is placed and a proposed package design can be submitted for approval. In this connection it would be helpful to indicate the maximum space available and the approximate desired location of terminals.

Thermistor Problems

(*Continued from page 55*)

of 34 to 2100 is 0.016. Looking this up on an R-T chart Table 1, column C shows the operating temperature of the thermistor bead to be about 180°C. Because of this high operating temperature, small ambient variations will have little effect on our control. However, large ambient changes will affect the control so it would be a good idea to put the thermistor in a small crystal oven. The thermistor could be supplied in a crystal can for the purpose!

Problems of surge suppression and time delay are the most difficult to solve because there is very little published information available. Usually it boils down to trying a few thermistors until one is found that does the job. However, suppose we have data such as that shown in Figs. 3 and 4. Assume we have a relay that has 3000 Ω resistance and pulls in at 5 ma. We want to use it in a 60 v. circuit and want about 1 sec. delay. Can we do it with the thermistor described in Figs. 3 and 4?

Looking at Fig. 3, we see that a 60 v. source with 4500 Ω in circuit will reach 5 ma in 0.75 sec. so we must increase the time about 33% to get to 1 sec.

Obviously, we need more series resistance to increase the time delay.

We can assume that a 33% increase in time delay with 60 v. on the circuit will also give a 33% increase in time delay with 45 v. on the circuit. Therefore we look at Fig. 4 to determine what resistance change will give this much time change. With 45 v. on the circuit and 4500 Ω in series, we see that 5 ma will be reached in about 1.5 sec. A 33% time increase would bring this to 2.0 sec. Also in Fig. 4, we see that to reach 5 ma in 2.0 sec., we need a resistance about halfway between 4500 Ω and 6500 Ω or 5500 Ω.

Therefore 5500 Ω in series with the thermistor and 60 v. will take 1 sec. to reach 5 ma. Since the relay is 3000 Ω, we need 2500 Ω in series with the relay and the thermistor to give the desired time delay.

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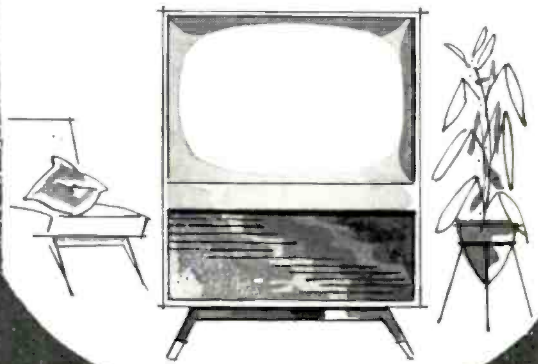

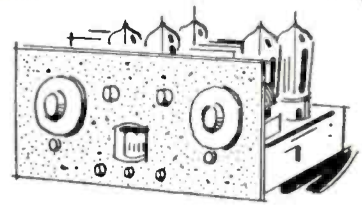

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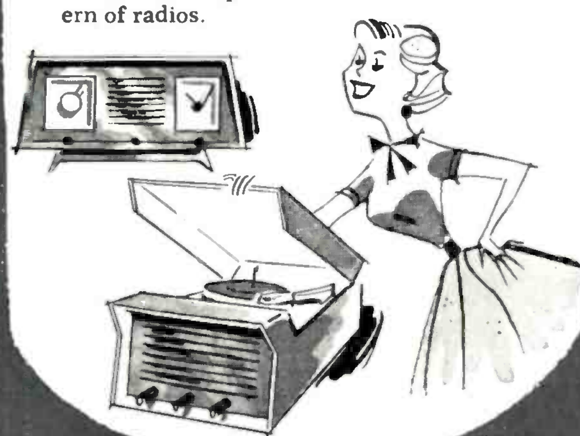

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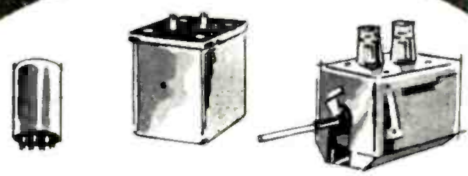

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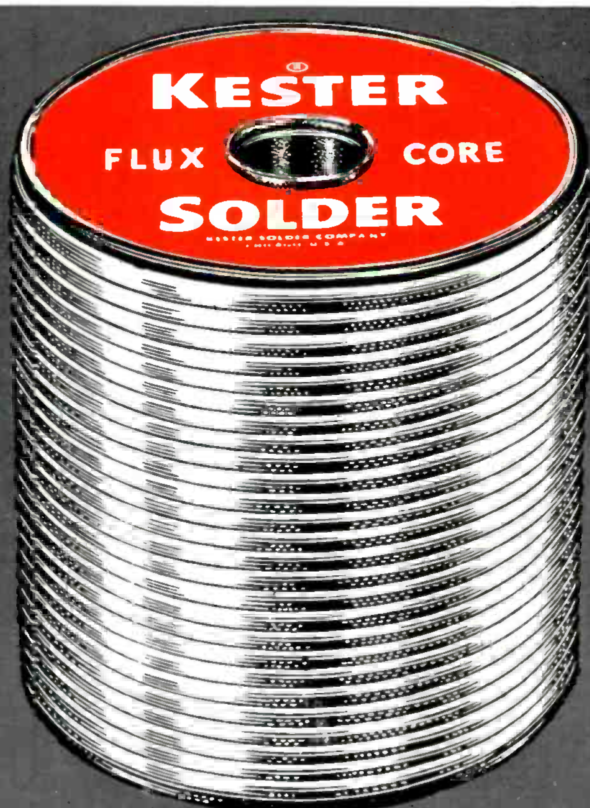


Circle 59 on Inquiry Card, page 83

The Tecnetron Principle*

OUR first article on the tecnetron (Electronic Industries, March, 1958, page 78) has aroused a great deal of interest, mainly because of the exceptional characteristics of the new device: simplicity, ease of manufacture, high input and output impedances, mutual conductance actually increasing with frequency, utilization up to several hundred Mc/s, simple associated circuitry, etc.

Circuitwise, the tecnetron is very similar to a triode tube, although its characteristic curves are rather reminiscent of a pentode (Fig. 1). There are several prevalent misconceptions about the Tecnetron — here are more complete details on the principle and applications of the device.

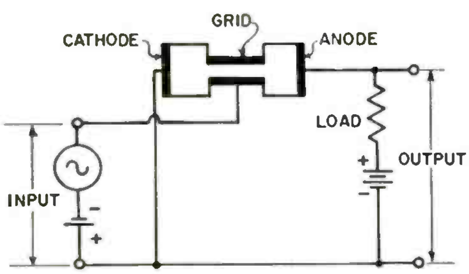


Fig. 1: Tecnetron is similar to triode.

"Grid" Contact

The middle or grid contact is normally a few volts negative with respect to the cathode, exactly like the grid bias of a conventional tube. An interesting point is that this electrode can withstand inverse voltages of the order of 250 volts, that is roughly five times the corresponding value for transistors. This is due to the fact that grid contact is not a junction, as will be explained later.

Under 250 volts, the average inverse current is approximately 3 microamperes, which corresponds to an inverse resistance of 83 megohms. This compares with a direct current of 10 milliamperes for 0.5 volts, giving a direct resistance of 50 ohms. The ratio of inverse to direct resistance is thus of the order of 1.6 x 10^6.

*Based on a technical analysis by Dr A. V. J. Martin, Carnegie Institute of Technology, Pittsburgh, Pa.

Dissipation

The temperature characteristic is better than that of most germanium transistors. The tecnetron functions without difficulty in an ambient temperature of 70°C. Notice that the thermal dissipation in the grid contact is very small.

Another important point is the noise characteristic. No complete and accurate measurements are available yet; it seems, however, that the noise is comparable to transistor noise.

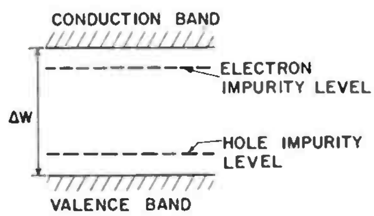


Fig 2: Surface layer is fed electrons.

Striction Effect

The main misunderstanding concerns the grid contact. To repeat what was said in the previous article, the grid contact is not a junction.

It may be as well to state it again another way: the tecnetron is not a junction device and uses no junction.

The basic phenomenon is field effect modulation, investigated in 1928 by Lilienfeld who observed that when an electric field is applied to a semi-conductor its equivalent cross-section, hence its resistance, varies with the intensity of the applied field. It follows that if a flow of carriers goes through the semi-conductor, it will undergo a striction effect when an electric field is applied.

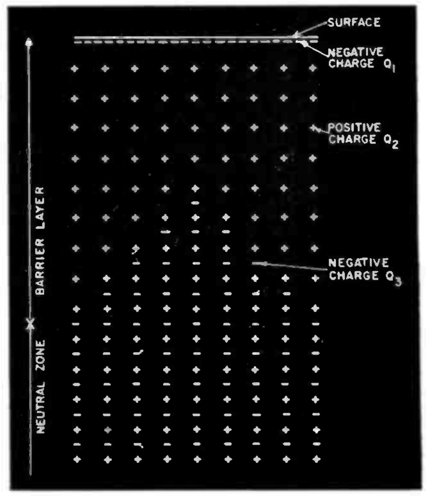


Fig. 3: Physical model of the theory.

Shockley described, in 1952, what he called the unipolar transistor, based on the effect discovered by Lilienfeld and which may be said to be a plane striction.

In the tecnetron, however, the striction appears in a cylindrical structure and is a volume effect, giving rise to a quadratic variation instead of a resistance variation of the semi-conductor in a transverse plane. An important effect, as far as frequency response is concerned, is that a simultaneous variation of resistance and capacity is obtained. Moreover, the variation is much more important, for equal control voltage variation, than in the case of plane striction.

Barrier Layer Effect

The indium-germanium grid contact is not a junction, but a rectifying contact obtained by juxtaposition of a metal and a semiconductor. It has rectifying characteristics which compare favorably with those of the best junctions as has been indicated previously. As a matter of fact, any metal may be used whose diffusion does not hinder the formation of the surface layer of electrons. Such is the case of tin, which has been used successfully. Indium and tin are indicated because of their great ductility.

The rectifying effect is attributed to a natural barrier layer existing at the surface of the semiconductor. Several theories have been proposed. A simplified version of Teszner's explanation follows.

The physical mechanism giving

rise to the barrier is based on the displacement of electrons near the surface. Thermal energy sets free an electron, which can attach itself to a surface atom. This binding of the electron is facilitated by impurities and by crystal imperfections, necessarily by existing at the surface. This electron leaves behind itself an ionized atom, which can in its turn borrow an electron from the next atom and so on.

In this way, the surface layer is fed electrons until saturation occurs. Saturation occurs when the energy band is filled (Fig. 2). Then there will be a potential barrier.

However, the surface layer creates a negative electric field such that it will be compensated by the positive charges only at a certain depth inside the semi-conductor.

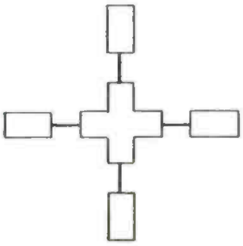


Fig. 4: Simple quadruplet cross.

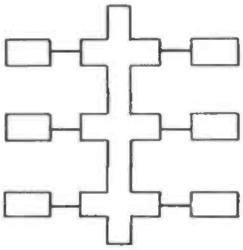


Fig. 5: Double grid device.

Fig. 6: Ring contact between grids.

Between this depth and the surface, the resulting field is negative and repels the electrons coming from deeper inside. It is then doubtful whether the surface layer can be saturated without the effect of some external field. In fact, most rectifying contacts undergo a forming process whose aim is precisely to saturate the surface layer.

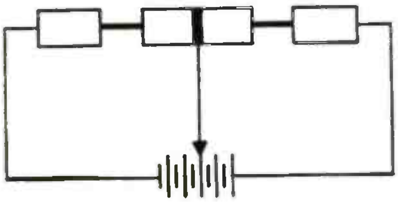


Fig. 7: Ring can be left floating or connected to a voltage as shown in this illustration.

To sum up, an n-type semi-conductor presents, at its surface or at the interface with a chemically or physically insulating layer, a concentration of electrons. This creates a barrier for electrons penetrating into the semi-conductor, but does not hinder the displacement of electrons in the other direction, e.g. out of the semi-conductor.

Figure 3 represents a physical model of the theory. For simplicity, the semi-conductor is assumed to be pure n-type; this does not in any way restrict the validity of the model. The qualitative distribution of charge carriers indicated is characterized by:

—A concentration of electrons at the surface, creating a negative charge Q_1.

—A uniform distribution of positive charges in the semi-conductor Q_2.

—A negative charge Q_3 at some not well defined distance from the surface, cancelling partially the positive charge Q_2.

The total resulting charge distribution, as seen on Fig. 3, is then

a—Strongly negative at the surface;

b—Positive just inside the semi-conductor;

c—Zero, or neutral, inside the semi-conductor.

a and *b* constitute the barrier layer as shown.

It is this type of mechanism which is put to good use in the "grid" structure of the tecnetron.

Related Devices

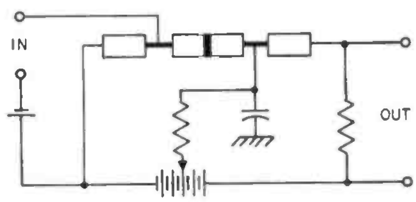
The three fundamental triode circuit arrangements can be used with the tecnetron.

Its pulse performances are being actively investigated.

Its ease of manufacture and simplicity of circuitry induce one to

(*Continued on page* 122)

Fig. 8: Ring can serve as anode of the first element and cathode of the second element.



(*Continued from page* 121)

look into the possibilities of some related devices, a few of which will be presently described.

A multiple unit can be made on the basis of some geometrical figure like the cross of the star. A simple quadruplet cross arrangement is illustrated Fig. 4.

A variant of this idea is the ladder device of Fig. 5.

A double grid device (Fig. 5) offers the advantage of having two distinct inputs modulating the same flow of carriers. This principle can obviously be extended to more complex arrangements.

However, an interesting possibility suggests itself in relation with Fig. 6, namely the addition of a ring ohmic contact between the two grids. Among other arrangements, this ring can be left floating, in which case one obtains simply Fig. 6.

The ring can be connected to a voltage equal to the voltage in the semi-conductor at its position. (Fig. 7).

It can also (Fig. 8) be used as the anode of the first element, and simultaneously as the cathode of the second element. One then obtains a simple physical structure equivalent to a dc coupled cascode; that is, a grounded-cathode stage followed by a grounded-grid stage.

The second grid can be correctly biased, with respect to the common anode-cathode, by a number of ways. The circuit indicated is simply one of many possible arrangements.

Finally, the possibility of using particular geometrical shapes to obtain special control or transfer characteristics should not be overlooked. The ease of manufacture of the tecnetron makes it particularly well adapted to this type of arrangement.

Power Transistors

(*Continued from page* 89)

tor current generates a large induced voltage across the load inductance driving the operating point from "C" to "D." The energy formerly stored in the load inductance is now transferred to the shunt capacitor, and the circuit, if not interrupted, would go into a damped oscillation of frequency determined by its LC value. However, the discharge is allowed to move the operating point from "D" only to "E." At this point nearly all energy from the shunt capacitor has been returned to the load inductance and the positive base pulse is removed. This allows the negative d-c bias (supplied by the transformer) to take control.

Now the collector is a fraction of a volt positive with respect to the emitter and the transistor will act as its own diode with current rising from "E" to "F" on the diagram. The trace period begins at "F" with the operating point proceeding from "E" to "O." The current during this part of the trace is supplied by the energy stored in the load inductance, this energy being returned to the power supply, thereby reducing the drain on the supply.

During the whole scan period the output transistor operates along the straight line of the bilateral characteristic such as shown by the upper curve in Fig. 3.

Bilateralism, the absence of discontinuities, and the linearity of the transition of the transistor collector current from a high positive value through zero and to a high negative value, make power transistors extremely useful for a horizontal deflection output stage. In addition to being a generator of sawtooth current, it serves as its own damper and saves circulating energy by returning it to the power supply.

Acknowledgments

An acknowledgment is due Werner Hasenberg of the RCA Victor TV Engineering for taking transistor characteristic curves and to Leonard Krugman of the RCA Victor Radio and "Victrola" Engineering for reading and correcting the manuscript.

References

1. Goodrich, H. C., "A Transistorized Horizontal Deflection System," *RCA Review*, vol. 19, #3, p. 293, Sept. 1957.

2. Sziklai, G. C., "Symmetrical Properties of Transistors and their Applications," *Proc. IRE*, vol. 41, #6, p. 717, June 1953.

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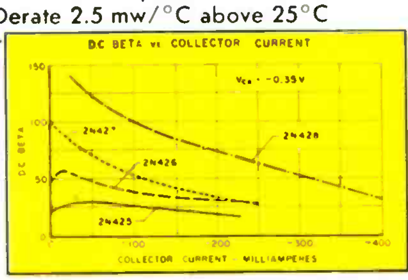
2N426	– 30	– 20	– 18	3.0	40
2N427	– 30	– 20	– 15	5.0	55
2N428	– 30	– 20	– 12	10.0	80

Collector dissipation in free air, 150 mw
Derate 2.5 mw/°C above 25°C



FOR COMPLETE TECHNICAL INFORMATION concerning 2N425-428 switching transistors, contact the nearest Motorola regional office; or wire, write, or phone:

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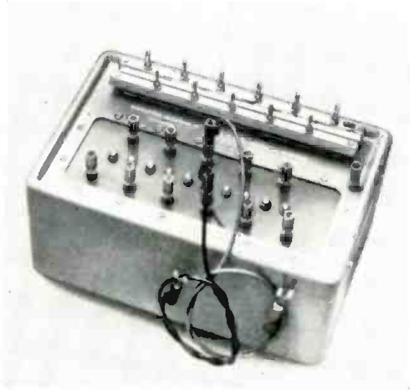
Circle 62 on Inquiry Card, page 83

New Products

RESISTANCE CALIBRATOR

The Resistance Calibrator permits calibrations up to 100 Megohms with an accuracy of ±0.01%. There are many measurements, such as the accurate measurement of small currents, voltages, and time constants, where the calibrator may be used as a precision voltage divider. It consists of 10 calibrated steps using encapsulated precision wire wound resistors. Each step is adjusted to ±0.01% of nominal. It is available on special order with oil-filled, hermetically sealed, wire wound resistors. International Resistance Co., Hycor Div., 12970 Bradley Ave., Sylmar, Calif.



Circle 213 on Inquiry Card, page 83

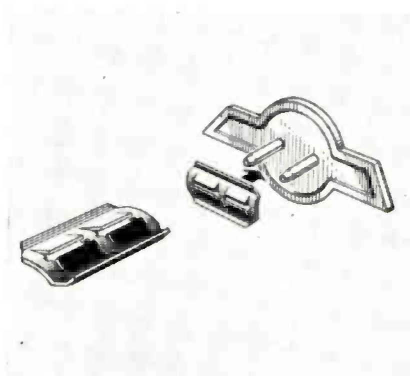
ANALOG COMPUTER

New desktop size, high accuracy analog computer for engineering analysis and research is available. Model 3400 computer offers 0.1% performance with chopper stabilized printed circuit amplifiers. A typical computer contains 10 amplifiers, five initial condition power supplies, and supporting control and metering circuitry. Some features are: Positive and negative reference voltage available at problem board; removable problem board with expanded jack field; repetitive or continuous operation for scaled and real time solutions. Donner Scientific Co., Concord, Calif.

Circle 215 on Inquiry Card, page 83

FASTENERS

A new Push-On type Speed Nut, designed to provide rapid, secure fastening for name plates, emblems, medallions and other forms of product identification is available. Owing to the widths of the new fastener's twin push-on impressions it can accommodate two 3/32 in. studs with center-to-center dimensions ranging from ¼ to ⅝ in. Ideal for reducing parts handling and assembly time, the fastener can be used to secure individual name-plate letters. Assembly is simple. Tinnerman Products, Inc., P. O. Box 6688, Cleveland 1, Ohio.



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VERNIER POTENTIOMETER

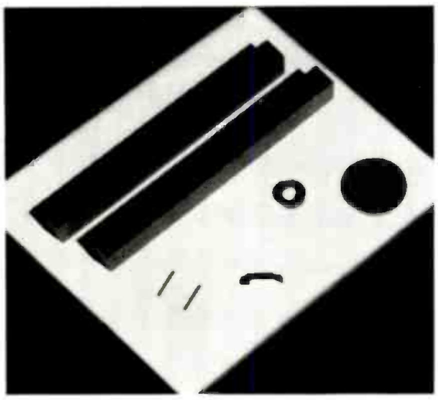
The Type 301-A vernier potentiometer provides the desirable combination of high resolution and small size in less than two turns of the adjustment shaft. It consists of an outer case containing the main slide wire and a concentric smaller potentiometer providing vernier action with the vernier resistance paralleling a portion of the main slide wire. The vernier slider is directly attached to the shaft and is connected to the slider terminal through a suitable slip ring. Rinco, Inc., 7962 S. E. Powell Blvd., Portland 6, Ore.

Circle 216 on Inquiry Card, page 83

New Products

FERRITES

These ferrites, sintered oxides of such metals as nickel, magnesium, and manganese, are blended and sintered according to a special process. Homogeneity of these materials is assured, and finished pieces of almost any size and shape specified may be produced within a tolerance of 0.0005 in. Type N-50 ferrites are designed for use in electromechanical filters, feature an extremely low temperature coefficient. Type N-51 ferrites, useful in transducers, are especially suited for hydrophones and similar devices requiring low power. Kearfott Company, Inc., 1378 Main Ave., Clifton, N. J.



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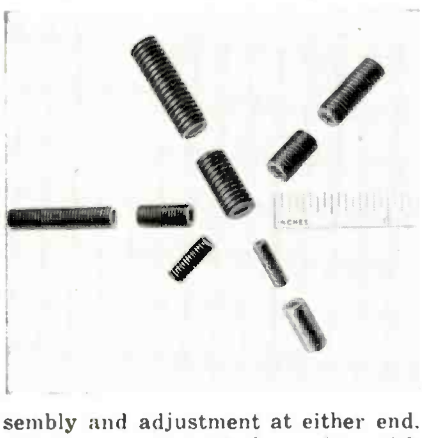
FERRITE SLUGS

A full line of threaded ferrite slugs for permeability tuning of inductors, filters and transformers used over the frequency range of 1 KC to several megacycles is available. These cores are designed for use where a high Q, high permeability core is desired and space is at a premium. The screw driver slot runs completely through the core, permitting easy assembly and adjustment at either end. All slugs are furnished complete with self-threading Resinite TruTork coil forms. Ferroxcube Corp. of America, 50 E. Bridge St., Saugerties, N. Y.



Circle 218 on Inquiry Card, page 83

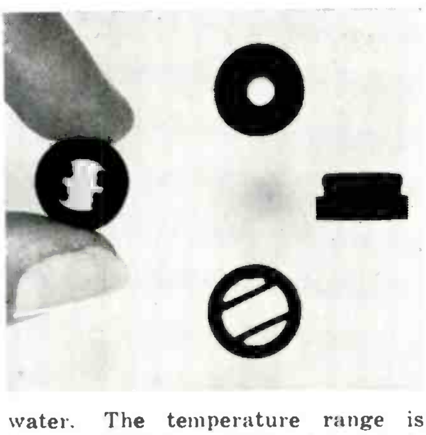
COAXIAL COUPLERS

A broad band series of coaxial couplers covering a 2½ to 1 frequency range with flat coupling and high directivity from 4,000 to 10,000 MC has been introduced. Each coupler has a name plate which includes a chart providing calibration to 0.2 db accuracy at 5 frequencies. To insure the high directivity characteristics of these couplers, the secondary arm termination is completely build-in. Models are available for 10, 20, and 30 db coupling, all with Series N, female connectors and a 1.2 primary line and 1.3 secondary line VSWR. Narda Microwave Corp., 160 Herricks Rd., Mineola, N. Y.

Circle 219 on Inquiry Card, page 83

TRANSISTOR MOUNTING

The transistor mounting provides a standardized mounting of all transistors regardless of size or shape. It offers shock resistance and prevents movement of the transistor when subjected to severe vibration. Good heat sinking is afforded due to long transistor leads. The quality of low moisture absorption is virtually unaffected by changes in either fresh or salt water. The temperature range is from −60°C to +99°C with a continuous operating temperature of 85°C. Delbert Blinn Co., P. O. Box 757, Pomona, Calif.



Circle 220 on Inquiry Card, page 83

New Products

LONG LIFE DRY CELL

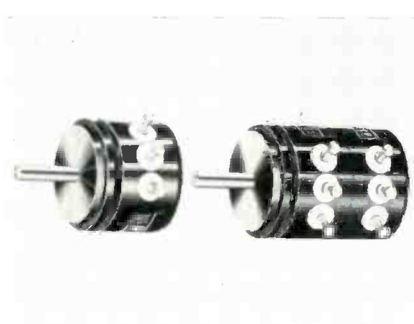
A new type of chargeable dry cell, using an alkaline lead oxide-silver system, offers long shelf and service life and relatively constant voltage throughout a wide temperature range.

It was developed by the U. S. Naval Ordnance Laboratory, Silver Spring, Md. Cell delivers rated capacity over a wide range of discharge rates. It withstands sudden drains of several ma. without excessive voltage drop. Nominal output of the cell is 0.9 v.; average capacity is 1500 ma. hours. It is 1.190 in. in diameter, 0.591 in. high. P. R. Mallory & Co., Inc., Indianapolis, Ind.

Circle 221 on Inquiry Card, page 83

POTENTIOMETERS

A series of precision potentiometers with all aluminum cases and covers is being produced. They are manufactured in AIA sizes to close standard resistance and linearity tolerances. Number and location of taps available varies with specific models. All servo mount types are equipped with ball bearings; bushing mount types have sleeve bearings. Any reasonable number of sections may be ganged together at the factory to desired resis-

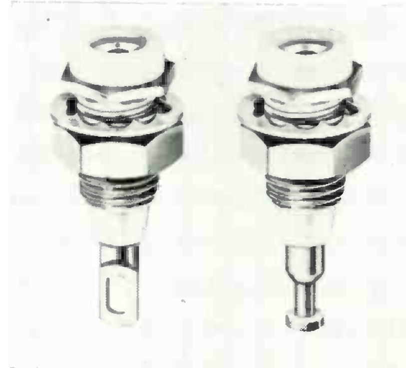


tance and phasing. Available in power ratings of 1.5, 2.5, 3.5 and 5 watts. Osborne Electronics Corp., 712 E. Hawthorne Blvd., Portland, Ore.

Circle 222 on Inquiry Card, page 83

HIGH-TEMP JACK

A high-temperature test jack utilizing Teflon insulation is available. The latest addition to a broad line of standard and miniature jacks, it is designed for use at temperatures



from −100°F to 500°F. Available with spade or turret type solder terminals. It features beryllium copper spring-pin contact which is inverted to provide extra smooth insertion and firm seating of a standard 0.080 test prod. Solder terminal is silver-plated with gold wash for fast, strong solder connections. Conforms to MIL STD-242A (Ships). Raytheon Manufacturing Co., Waltham 54, Mass.

Circle 223 on Inquiry Card, page 83

TUBING

Now being used in all general purpose zippertubing, the new "stretch" material (vinyl compound) increased pull strength at the closure point by 100%. Zippertubing is a flat vinyl tape which is wrapped around wires, cables, ducts, pipelines, etc., then zipped shut. The increased flexibility allows the vinyl to absorb the strain formerly placed on the bead which closes the jacket. Other features are flame resistance and fungus retard-

ment. Temperature ranges from −65° to +221°F. Conforms to Military Spec. Mil-I-631C. The Zippertubing Co., 752 S. San Pedro St., Los Angeles 14, Calif.

Circle 224 on Inquiry Card, page 83

Where Is It?

(*Continued from page 90*)

ficult to see. And in molecule-thick films, the color can vanish completely. The answer lies in creating an increased visual contrast between the cement coating and the clean background. This can be accomplished by fluorescence under ultra-violet light.

The production and inspection method is simplicity itself. All that is necessary is that fluorescence be incorporated in the cement or bonding material being used, then operations are carried out with the work illuminated by an ultra-violet lamp. The correct lamp is important. For critical inspection work it is desirable that surrounding light be subdued, but complete darkness is rarely necessary. Most work can be done with ambient white light of sufficient brightness to see clearly the non-fluorescent parts of an assembly. A highly successful technique for making cements, glues, bonding compounds, and plastics fluorescent to the proper degree has been developed by Shannon Luminous Materials, Hollywood, Calif.

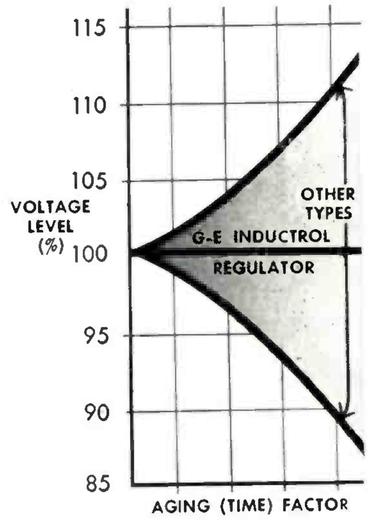
A plastic or cement can easily be made to fluoresce brightly in the bulk form, but when the material is spread out in extremely thin insulating films, the fluorescence may be found to be quite ineffective. Unusual methods are necessary to make the fluorescence useful under such conditions.

Several manufacturers of precision potentiometers have found the need for two distinctive fluorescent colors in their production and inspection process. One color in the mandrel bonding cement, and another in the "bridge" of epoxy resin applied at the ends of the coil so that the wiper blade may slide smoothly off the end of the coil. A bright green fluorescence is generally used for the mandrel cement, while a brilliant bluish white fluorescence is used in the epoxy resin.

The first manufacturer to utilize this technique found that rejects and returned defectives were cut to practically zero. In addition there was a clear-cut solution to the problem of operator guidance in the plant, since defective workmanship could easily be traced back to the individual at fault. The gains in product quality, customer satisfaction, and overall labor costs were found to outweigh the cost of the fluorescent technique many times over.

The fluorescent materials developed for use in the technique described here were specifically designed so that they will not interfere with dielectric or insulating properties of the plastics or resins employed. Although it is not often the case, some applications are rather critical in this respect.

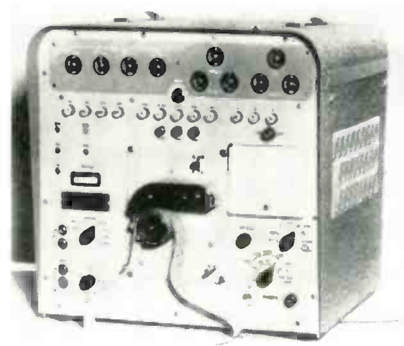
As the electronic industry moves more and more toward sub-miniature and even microscopic components and assemblies, the problem of applying and inspecting for bonding cement, insulating bridges and the like will gain increasing importance. The new techniques can help solve these problems.



New Products

MEASURING INSTRUMENT

Robotester LA-302 is an automatic, tape programmed measuring instrument. Random selection utilized throughout any two of 250 circuit points can be selected for measurement of resistance, polarized dc or ac voltage or insulation resistance. New circuit techniques improve operating reliability for low cost maintenance. Voltage measurements are from 0.5 to 500 v. and Hi-Pot is accomplished at 500 vdc with a theoretical 10,000 megohms upper limit. The resistance range is from one ohm to 9.99 megohms. Lavoie Labs., Inc., Matawan-Freehold Rd., Morganville, N. J.



Circle 225 on Inquiry Card, page 83

ITV CAMERA HEADS

A practical, economical means for tilting and rotating small industrial type TV cameras by remote control is available. Mounted on a light-duty tripod or other support, the head will handle cameras up to 20 lbs. Powered by two Bodine motors, the RCH-3 will tilt the camera 45° up or down and rotate 370°. It can also operate a camera in a vertical position. The control unit can be located at a considerable distance from the head. The Houston Fearless Corp., 11853 W. Olympic Blvd., Los Angeles 64, Calif.

Circle 226 on Inquiry Card, page 83

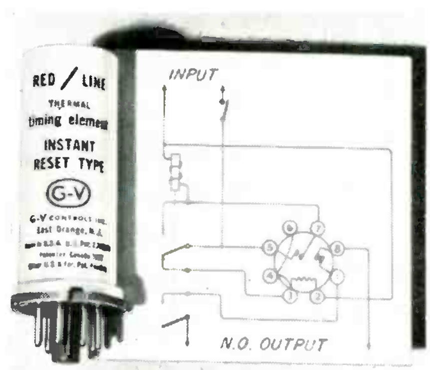
POWER RECTIFIER

A new type of diffused junction silicon power rectifier has been developed. This small unit is rated for continuous service at 20 a. dc at maximum peak reverse potentials up to 40 v. Four of these rectifiers in a full wave bridge circuit will provide for a 10 horsepower 230 vdc motor. It is specifically designed for dc power supply and magnetic amplifier applications requiring reliable performance in ambient temperatures up to 150°C. It provides good power handling ability in miniature form. Fansteel Metallurgical Corp., 2200 Sheridan Rd., North Chicago, Ill.

Circle 227 on Inquiry Card, page 83

TIME DELAY

A time delay which is instantly reset, either at the end of its cycle or part way through, is provided by the Type DM Thermal Timing Element when combined with a small magnetic relay in the circuit illustrated. Thermal timing elements are available for any delay period from 5 seconds to 6 min. and for operating voltages from 6.3 v to 230 v. The elements may be used interchangeably on ac or dc. G-V Controls, Inc., 28 Hollywood Plaza, East Orange, N. J.

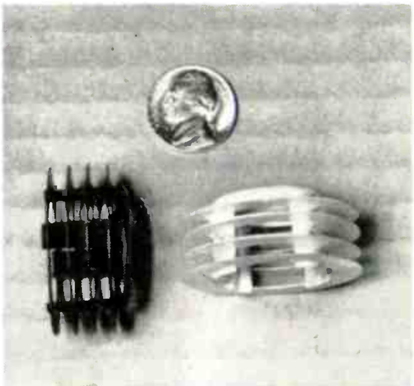


Circle 228 on Inquiry Card, page 83

New Products

DIODE RADIATOR

A new heat-dissipation device designed to prevent "Thermal Runaway" in power tronsistors has been developed. It consists of a series of black ebanol finished metallic rings



or fins mounted on a plate which is interposed between the diode and the mica insulating washer atop the chassis. The radiator in no way interferes with servicing or operation of the diode. Reduces operating temperature of diodes as much as 30°C under typical conditions. Part #3B640 meets MIL-E-6272A (Vibration) and MIL-STD-202A (Environment). The Birtcher Corp., 4371 Valley Blvd., Los Angeles 32, Calif.

Circle 229 on Inquiry Card, page 83

TELEMETERING OSCILLATORS

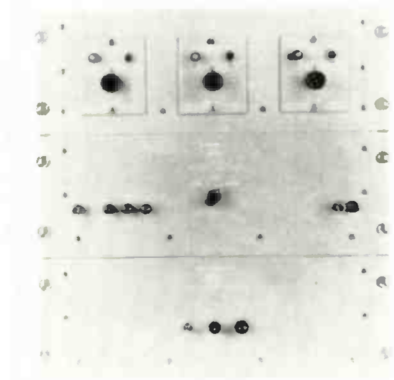
Six new voltage-controlled subcarrier telemetering oscillators are available. Model 0-22, little over a one-inch cube, draws a total of only 25 milliwatts; one volt gives 7½% frequency change; input is ½ megohm and output up to several volts in RDB channels. Transistor mixers, power supplies and rack cases for various

oscillator combinations are available. Resistance to vibration and shock up to 20g and 2000 cycles is specified for most units. Dorsett Laboratories, Inc., Norman, Okla.

Circle 230 on Inquiry Card, page 83

TEMPERATURE CONTROL

The Temperature Limit Control System Model TLC-3297 is a 3 channel warning and control system designed to monitor process-tube temperatures in nuclear reactors. The

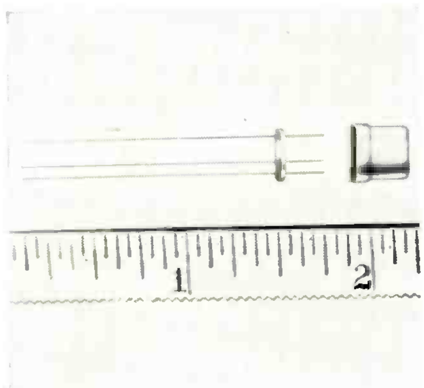


unit is readily adaptable to any critical temperature application where channel monitoring from a remote location is desirable. Basically, the system operates from signals produced by resistance-probe sensing elements; when preset temperature limits are exceeded, the TLC actuates the warning system. Temperature readout is accurate. Arnoux Corp., 11924 W. Washington Blvd., Los Angeles 55, Calif.

Circle 231 on Inquiry Card, page 83

TRANSISTOR BASES

The E-I standard line of transistor closures includes strain-free solderable types, compression weldable types and compression solderable types. Two, three and four lead types are available. Diode closures are supplied in a wide range of shapes and sizes. Custom types of miniaturized transistors and diode bases and other



miniature sealed components, for special requirements can be supplied to exact specifications. Electrical Industries, 691 Central Ave., Murray Hill, N. J.

Circle 232 on Inquiry Card, page 83

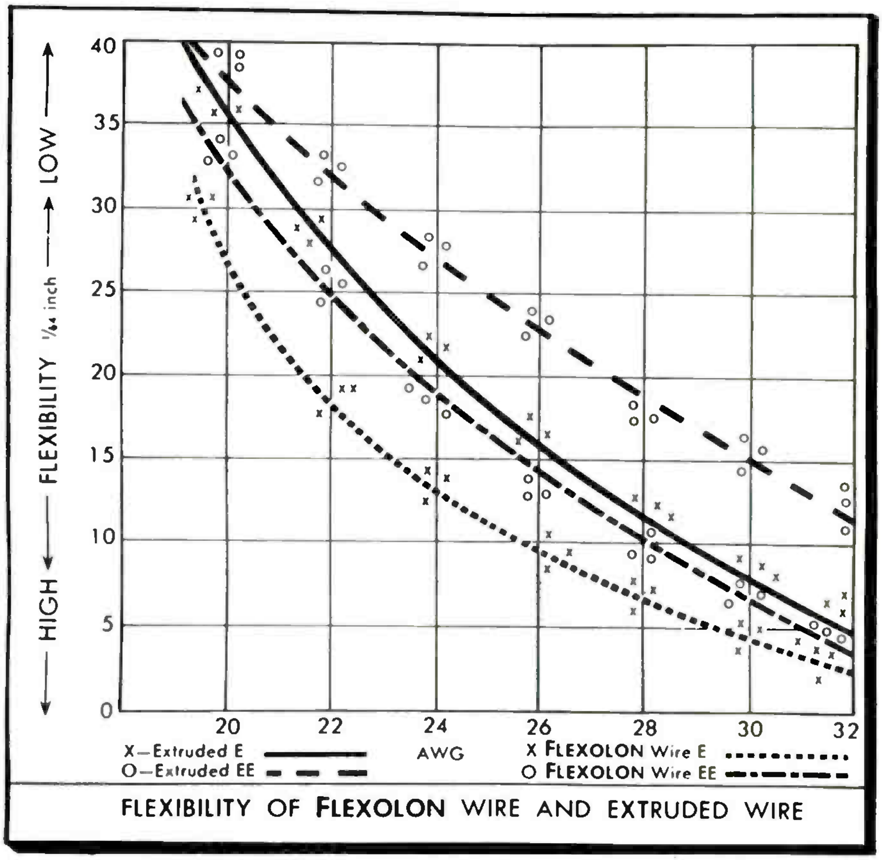


Fig. 3: Lower numerical values of flexibility coefficient indicate the more flexible wire.

High Temp. Wire

(*Continued from page* 92)

Lengths

While not necessarily an electrical or mechanical characteristic, it is due to the superior performance of these characteristics that the new manufacturing process produces much longer lengths than competitive processes.

Lengths of all wire types are limited solely by the occurrence of flaws in the dielectric material. Securing long lengths in excess of 150 ft. in either extruded or spiral wrapped materials has been, and undoubtedly will continue to be, a major problem of the wire industry. Because the occurrence of flaws is minimized, and lengths of this new wire are obtained that are far in excess of those obtained with any other manufacturing technique.

Fig. 2 shows the distribution of wire lengths. Although a minimum 250 ft. length is specified for "Flexolon" wire, its average of the distribution of shipped lengths is approx. 750 ft.

Color Guard Striping

The use of corrosive fuel elements and the exposure of high temperature wire to other corrosive actions led to the development of a stripe for this wire which would be impervious to the effects of these atmospheres. The stripe was ap-

(*Continued on page* 140)

Table 1

Effects of Fuming Acid on FLEXOLON Wire Stripe (F) and Teflon Extruded Wire Stripe (T)

	Light brown		Dark brown		Black		Red		Orange		Yellow	
Time-hrs. (Time of observation after start)	T	F	T	F	T	F	T	F	T	F	T	F
0.5	Began Fading	No Change	No Change	No Change	No Change	No Change	No Change	No Change	Slight Fading	No Change	No Change	No Change
0.10	Further Fading	-	-	-	-	-	Slight Fading	-	Half Faded	-	-	-
0.15	Hardly Visible	-	Slight Fading	-	Slight Fading	-	-	-	Barely Visible	-	-	-
0.20	Not Visible	-	-	-	-	-	-	-	No Longer Visible	-	Slight Fading	-
0.30	Insulation is pure white	-	Fading Slowly	-	-	-	-	-	Insulation is pure white	-	-	-
0.45	-	-	-	-	-	-	-	-	-	-	Insulation is pure white	-
1.00	-	-	-	-	Fading Slowly	-	Not Visible	-	-	-	-	-
2.00	-	-	-	-	-	-	Insulation is pure white	-	-	-	-	-
5.00	-	-	-	-	Has Ragged Edges	-	-	-	-	-	-	-
12.00	-	-	Looks Tan	-	Half stripe looks grey	-	-	-	-	-	-	-

SENSITIVITY:

100 μVOLTS

PER SCALE DIVISION

(without pre-amplification)

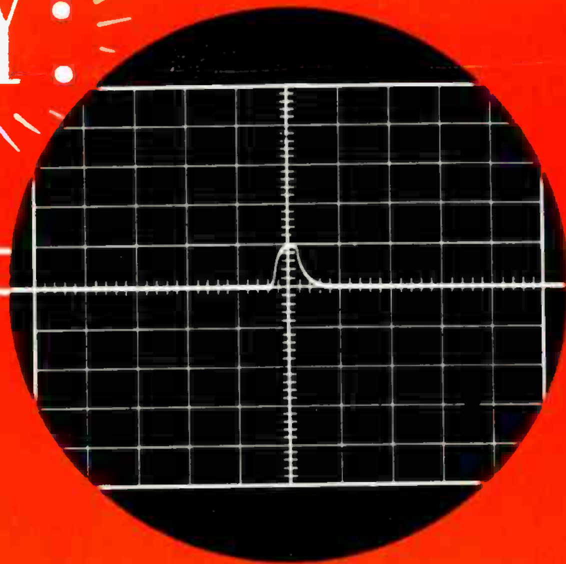


PHOTO REDUCED 33%

DU MONT 403

The Du Mont 403 is the most sensitive oscilloscope commercially available. This outstanding sensitivity permits direct measurements from low output transducers such as strain gages, pressure pickups, accelerometers, heart monitoring equipment, and others that normally require pre-amplification.

The 403, when used as a direct-reading voltmeter, offers full scale amplitude measurements from 1 millivolt to 500 volts, continuously variable in 17 steps. At maximum sensitivity, the 403 allows resolution of signals in the region of 20 microvolts.

Stability, commensurate with this outstanding sensitivity, is another feature of the 403.

The 403 is another in the Du Mont 400 Series Instruments. It is designed for fast, easy, and accurate measurements, along with complete accessibility and reliability.

One of the 400 Series

FEATURING

AMPLIFIERS: Direct coupled amplifiers. Single-ended or balanced Y-input.

EXTREME SENSITIVITY: 1 millivolt to 500 volts full scale, continuously variable.

FREQUENCY RANGE: DC to 300 KC.

Y AMPLIFIER CALIBRATION: 5%.

SWEEPS: 19 calibrated linear sweeps, 0.5 sec/cm to 0.5 μsec/cm. Calibrating accuracy, 5%.

EXPANDED SWEEP: Any 10 cm portion of 50 cm sweep may be expanded 4 times and positioned on screen.

$580

F.O.B. Clifton, N. J.

complete details on request...

DU MONT®

INSTRUMENT DIVISION

Allen B. Du Mont Laboratories, Inc., Clifton, N. J., U.S.A.

Circle 72 on Inquiry Card, page 83

News of Manufacturers' Reps

REPS WANTED

A well-known manufacturer of **motors, tachometers, generators,** and **special purpose motors** desires reps for Texas, Indiana, Ohio, Northwest U. S., Southwest U. S., Southeast U. S., Philadelphia, Washington, and Baltimore areas. (R7-1, Editor, ELECTRONIC INDUSTRIES.)

A manufacturer of high quality **transformers, magnetic amplifiers, etc.** desires representation in New England and North Central States. (R7-2, Editor, Electronic Industries).

Well recognized **custom precision sheet metal fabricator** for the electronic field is seeking reps throughout the U. S. and Canada. Brochure available on their patented development in the field of large enclosures and housings. (R7-3, Editor, ELECTRONIC INDUSTRIES.)

Plastic Capacitors, Inc., has appointed **Comonenes, Inc.**, 5451 Broadview Rd., Cleveland 29, Ohio, as reps in Ohio, West Pennsylvania, and West Virginia and **The Ken Randall Co.**, 121 N. Broad St., Washington, D. C., as their reps in Southern New Jersey, Delaware, Maryland, Washington, D. C., Virginia and Eastern Pennsylvania.

Rinco, Inc., Portland, Ore., has announced the appointments of the following reps and territories: **Beechey Enterprises**, Toronto, Ont., for Eastern Canada and Erik Ferner, Brooma, Sweden, in the country of Sweden.

Specialized Electronics Corp., Atlanta, Ga., are now reps for Power Sources, Inc. in Mississippi, Alabama, Georgia, Tennessee, and the two Carolinas.

Brooks, Feeger & Morrow, 114 San Pedro, S.E., Albuquerque, New Mexico, has been appointed rep for Clevite Electronic Components Div.

Marty Bettan, of Flushing, N. Y., has been appointed sales rep of the Magnecord Div. of Midwestern Instruments in the Northern New Jersey and Metropolitan New York area.

The C. L. Pugh Co., Columbus, Ohio, are now reps in Ohio, Western Pennsylvania and West Virginia for Irish tape, a product of ORRadio Industries Inc.

William H. Myers, Jr., Syracuse, Ind., has been appointed rep for The Staver Co.

Bordewieck Engineering Sales Co., are now reps for Computer Control Co., of Wellesley, Mass.

Win W. Tompkins & Co., Palo Alto, Calif., has been named sales rep for Dage Coaxial Cable Connectors in Northern California.

Clair A. Campbell and **Thomas Harrower** are now sales reps for Chatham Electronics, a div. of Tung-Sol Electric Inc. They will handle the line of airborne power supplies.

The Cochrane-Barron Co. has been appointed sales agents in Southern California, Arizona, New Mexico and Nevada territories for The William Brand & Co.

Knoblock & Malone, Inc. are now reps for Pulse Engineering, Inc. with headquarters in Chicago. They will cover Illinois, Indiana and Wisconsin.

A-F Associates, electronic equipment manufacturers' reps, has established offices at 385 E. Green St., Pasadena, Calif.

E. V. Roberts and Associates are now reps for Daystrom Pacific, a division of Daystrom, Inc., in Southern California and Arizona. They will handle the company's line of potentiometers.

Withers and Ropek, Chicago, Ill., are now reps for Filtors' line of hermetically sealed sub-miniature and micro-miniature relays in the northern part of Illinois and the southern part of Wisconsin.

Maitland K. Smith Co. with offices in Atlanta, Ga., Birmingham, Ala., Matthews, N. C., and Clearwater, Fla., are now Southeastern sales reps for Hughey & Phillips, Inc.

Dayton-Anderson Electronics Co., Grosse Pointe Farms 36, Mich., are representing the Navigation Computer Corp. in Michigan, Ohio and Western Pennsylvania. They are handling the full line of digital data handling equipment.

Barnes Development Co., Lansdowne, Pa., has appointed the following reps to handle their line of automatic component test equipment: **W. K. Geist Co.** of Los Angeles, Calif., in Southern California, Arizona and New Mexico; **Ellenje Company** of Palo Alto, Calif., in Northern California and Nevada and **Peninsula Associates** of Seattle, Wash., in Washington and Oregon.

PROFESSIONAL OPPORTUNITIES

Reporting late developments affecting the employment picture in the Electronic Industries

Design Engineers • Development Engineers • Administrative Engineers • Engineering Writers
Physicists • Mathematicians • Electronic Instructors • Field Engineers • Production Engineers

Plan Would Increase Engineering Teachers

The American Society for Engineering Education has presented a plan to increase the number of young teachers for engineering schools of the United States to Dr. James R. Killian, Jr., Special Assistant to the President for Science and Technology.

To encourage more good students to enter graduate work, the period when most engineering students discover their interest in a teaching career, the ASEE feels that basic research in engineering must be expanded and that Federal agencies supporting basic research in engineering should greatly enlarge both the number and the amount of their grants. The increased amounts should cover the true costs, including the portion of faculty salaries required to direct the project, says ASEE, be for longer periods (five years), and contracts should provide means for construction or enlargement of the buildings required. Specific recommendations:

1. A substantial increase in the number of National Science Foundation fellowships for first-year graduate study in engineering.
2. A program of secondary grants to those who fail to qualify for full fellowships under the NSF program.
3. Supplementary Federal grants to holders of NSF fellowships who take part-time teaching assignments.
4. A new program of awards under the NSF to increase the financial aid to graduate students who combine teaching with their education and research experience.

ASEE calls particular attention to the important role of basic research in preparing engineering teachers: Federal support of basic research "will determine the supply of individuals with the requisite background to educate engineers in an age when basic understanding of scientific principles must replace dependence on intuition and experience."

ASEE's Committee on the Development of Engineering Facilities expects to release a comprehensive report on anticipated engineering enrollments and requirements for teachers up to 1967 late this month. The report will indicate that a shortage of nearly 1000 engineering teachers already exists, and that about 9500 new teachers will be required in the coming decade.

OLD PHONE WEEK

A total of 133 years of telephone work is counted by these three retiring employees of Stromberg-Carlson; Frank Wilson, Raymond O. Hoffmann, Chief Telecommunication Sales Engineer and Ralph Gardiner.

GE Plans Georgia TV Tube Plant

General Electric Co. will begin manufacturing television picture tubes in Augusta, Ga., for replacement purposes in the South, according to Henry F. DeLong, general manager of GE's cathode ray tube department.

GE will lease the 60,000 sq.-ft. Thomas and Howard Building in Augusta and produce all popular sizes of picture tubes.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 85.

Science-Writing Gets $100,000 Rockefeller Grant

Columbia University has received a $100,000 grant by the Rockefeller Foundation for an advanced science-writing program to begin this Fall at the Graduate School of Journalism. The award supplements a $70,000 grant by the Alfred P. Sloan Foundation and will assure the program of three years of operation.

Six fellowships will be given in the first year and seven to 10 in the two succeeding years. The fellowships will go to science writers for a year's study at the school. The program, which is aimed at providing a greater volume of accurate, interestingly written news of science and technological developments, is designed:

1. To increase appreciably the number of dependable science and technology writers for newspapers, press services, magazines, radio and television, and industry.
2. To increase substantially the number of reporters who, though not necessarily devoting full time to science, will be able to handle such material accurately and interestingly.
3. To provide means of helping science writers broaden their knowledge of both subject matter and techniques.
4. To help develop writer-educators capable of giving science writing instruction.
5. To serve as a pilot project whose experience can be drawn upon by other educational institutions.

Although there are no set requirements for the first year, most participants will be college graduates with a minimum of three years' active reporting, technical writing or teaching. The program will be under the supervision of the Dean of the School of Journalism, Edward Barrett, and the immediate direction of Professor John Foster.

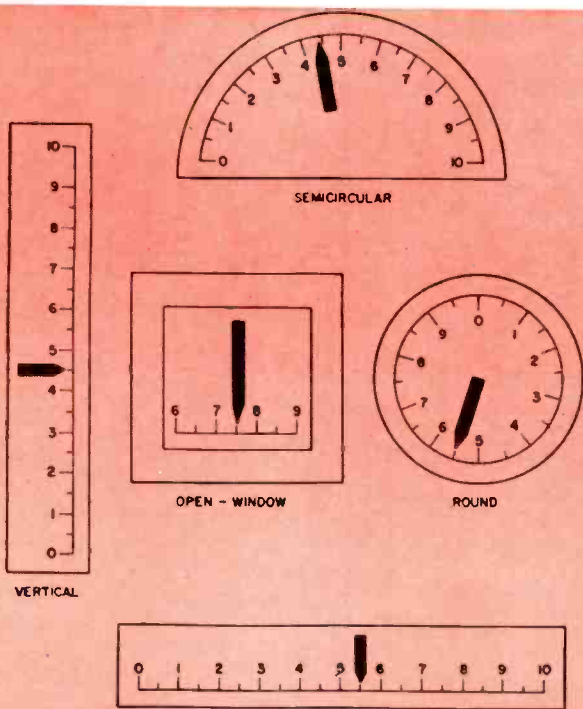


Fig. 1: Of these five dials the open-window type was far superior in point of legibility.

For optimum design of the man-machine combination it is necessary to fully appreciate the superior qualities of each. For given applications either one may have significant advantages over the other.

Human Factors in Electronic System Design

By **MAX A. PAPE,**
40 E. 40th Ave.,
San Mateo, Calif.

"HUMAN factors concepts" (or human engineering) is a phrase that is heard with increasing frequency these days. Its greatest impetus came from the military. Today human enginering is largely used in missile and aircraft design and production. Industry has been slow to use human engineering, possibly because the phrase itself has been misunderstood. Actually, any system that uses the man-machine combination should integrate the design function with the psychological and physiological sciences for safety and performance.

Through the entire course of system developments, products which affect man or which are affected by the performance of man should be evaluated by human engineers. Knowing the abilities and limitations of man in various tasks, the human engineer allocates functions to man and machine. He decides where man can best be used in the system—for accuracy, economy and safety.

Machines are protected individually against accidents. Humans are protected individually against accidents, but no attempt has been made to correlate the two protective operations. As machines have increased in complexity, accidents to human operators have increased. Why? Because the human has not been given his rightful place.

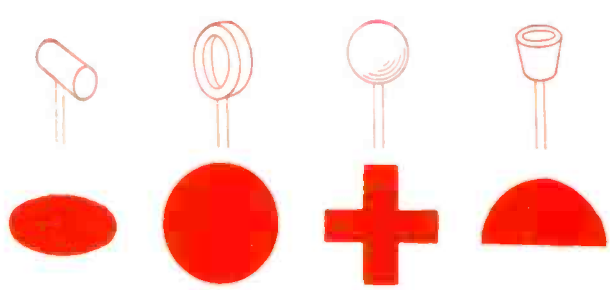
Man Must Be recognized, Systemwise, For What He Is—A Component Characterized By Non-Linear Outputs.

To the design engineer, man is the limiting factor in system design. To the human engineer, machine components are of interest only insofar as their performance affects man. If limitations of human capacities are not considered, the operator may be forced beyond his abilities and resources, including such factors as fatigue or physiological stress.

The complete understanding and knowledge of man's abilities and limitations, including psychological and physiological data, represent the bulk of the human engineer's working material. He has been trained to apply the newer principles from the behavioral and medical sciences.

If it were possible at the present time to make a human factors analysis of industrial accidents, half of them would probably point to poor design for and integration of the human component. Yet, extensive research has been done in the use and effects of light, color, sound, touch, environmental variables, auditory communications, atmospheric conditions, speed, strength, force, space, design and arrangement of controls and levers, and arrangement of equipment.

Fig. 2: Shape coding. Top row is distinguished by touch, bottom row by visual senses.



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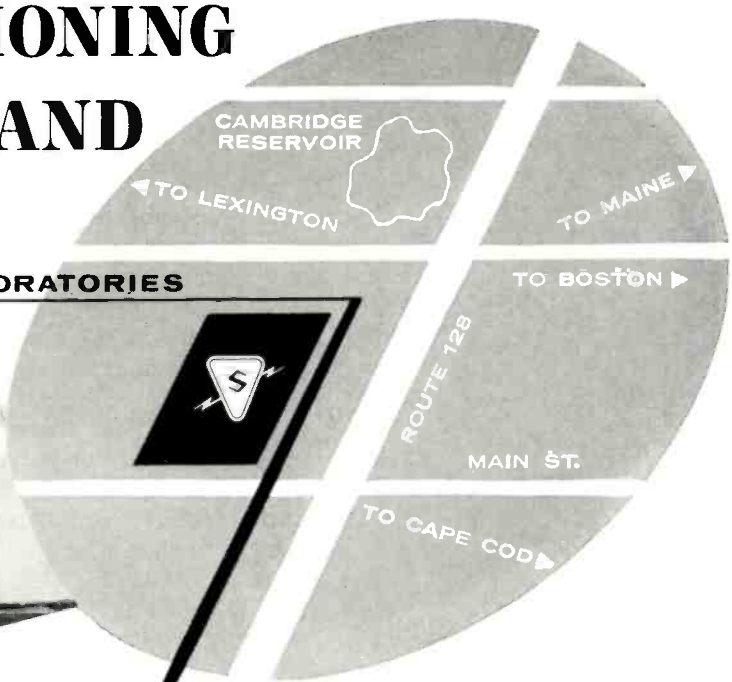

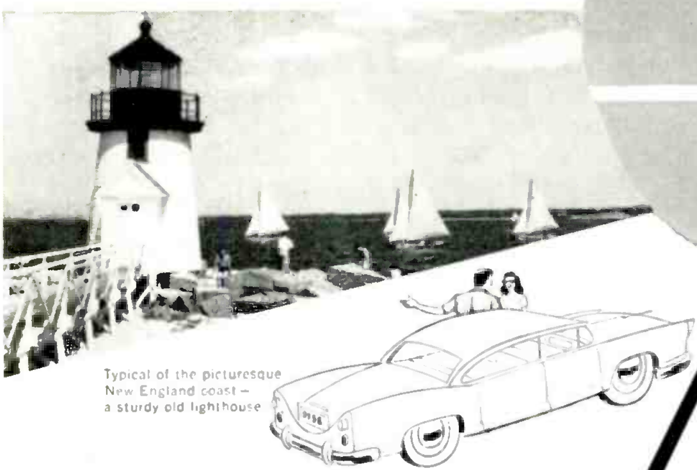

Typical of the picturesque New England coast — a sturdy old lighthouse

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Cruising north along Route 128 through historic Middlesex County, you'll see Sylvania's Waltham Labs high above the highway. Stop off on your way to nearby Lexington for what could be an important interview about a future in advanced electronics with Sylvania.

Big things are happening in your profession at Waltham Laboratories. This is where Sylvania engineers and scientists are developing the Data-Processing nerve-center of BMEWS (giant new program for a Ballistic Missile Early Warning System).

Work on PLATO (AMM system for which Sylvania is Weapons System Manager) is also centered here... plus development programs for other major electronic defense projects.

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(Previous digital data processing experience is important for most assignments.)

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- Microwave components design including multi-channel filters incorporating fast-acting microwave switches
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SYLVANIA

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100 First Avenue • Waltham 54, Massachusetts

Circle 504 on "Opportunities" Inquiry Card, page 85

Human Engineering *(Continued)*

Studies have been made on the optimum placement, size and type of knobs, handles, controls, dials and switches.

Fig. 1 is only one example of a system design which makes use of human engineering principles.

When the system is still in its design stage, plans should be made for the position and activity of man by employing human factors concepts. This includes removing or changing anything that might prove a personal hazard. Error can be designed-out of a machine; the quirks of human nature cannot be altered, neither can they be designed-out. When the system goes from function to operation, operating efficiency becomes the prime target. The amount of training for personnel should be decided by the human engineer. It is he who should evaluate man's work load and organization of work procedures. (Adequate training has been found to be closely related to safety on the job. Accidents are noted more frequently in situations marked by brief training programs for new workers).

It is the human engineer, too, who should write the step-by-step job description of human operators because, by education and training, he can best interpret the discrimination, recall and decision-making characteristics of the operator. The responsibility for interpreting malfunction, overloading, underloading, errors, mistakes and accidents should be in the lap of the human engineer.

Man is the one weak link in a possibly fool-proof complex system. Because man is complex, too, his capabilities and limitations should be evaluated by using human factors concepts. Glance briefly at man's senses. The classical five senses are: sight, hearing, taste, touch and smell. Of these, taste and smell are of comparatively small importance to the system engineer. Each of the other three, however, is very important.

Sight

Vision is more than just being able to see. From the safety standpoint, man must be able to see under varying conditions. Color, as part of vision, has many implications. Choice of color must be made not only for visibility under various conditions, but for psychological reasons. (Some colors induce sleep; some induce irritations, etc.) Being able to see is, again, only part of the story. The object being seen or analyzed must be illuminated, and this takes into consideration different kinds of light. Objects often appear different in color when viewed by daylight or incandescent light; when viewed by transmitted or reflected light, and when viewed by lights of different intensity. There are also psychological factors such as the motivation of the observer, whether he knows where or when to look, whether he knows what he is likely to see, etc.

Hearing

The nature of sound can be described by three quantities: loudness (corresponding roughly to wave amplitude), pitch (corresponding approximately to frequency in the case of a pure tone), and quality (corresponding to the admixture of different wavelengths of sound).

The ear tends to integrate the sensation it receives at any instant. The ability of the individual to hear one sound in the presence of another is important to the human engineer. It is, in fact, one of the places where man is far superior to the machine.

The ear contains more than hearing apparatus. The inner ear is responsible for equilibrium and dizziness.

Data of this type is useful for determining whether an operator can detect an auditory signal—such as a warning sound; whether an operator can understand tone-coded or time-coded sounds in the presence of other sounds.

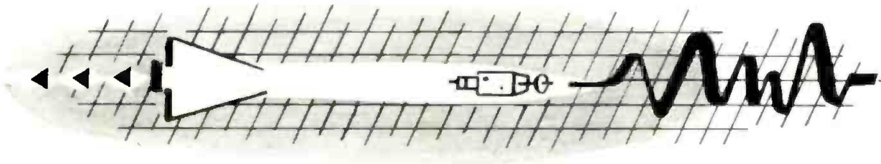
Touch

The sense of touch is composed of many different senses, including sensations of heat and cold, tactile discrimination, etc. Human engineers are interested particularly in

(*Continued on page* 138)

ENGINEERS

YOU CAN ACCOMPLISH MORE IN AIRCRAFT & MISSILE ELECTRONICS



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Design and testing of aircraft antenna and radome installations and systems. Advanced degree in EE or physics preferred with 10-15 years experience.

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MS in engineering, physics or mathematics; 7-10 years experience in aircraft or missile technology in one of these fields: electronics, aircraft or missile performance, armament, structures, applied math.

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MA or PhD in physics, applied math or engineering with minimum 2 years analog computer experience.

DYNAMICS ANALYSIS
Electrical or electronic engineer to supervise group of EE's and applied mathematicians engaged in analysis of radar and guidance systems, servos, analog computers and related areas. 3-5 years experience required.

COMPUTER PROGRAMMERS
Minimum 2 years programming experience in engineering problems on IBM 704.

SYSTEMS ANALYSIS
Openings in Dynamics Analysis Section at Sr., Principal & Group Engineer levels. EE's with 2-3 years exp in design & analysis of radar & guidance systems, servos, analog computers & related fields. ME's with 3-5 years exp in analysis of electromechanical, electro-hydraulic & mechanical systems. Background in aerodynamic control & airplane dynamics desirable.

INSTRUMENTATION ENGINEERS (Flight Test)
Laboratory — BSEE with electronic laboratory exp to maintain computing equipment, calibrate all instrumentation and evaluate test equipment.

Electronics — BSEE with specific airborne electronic systems exp.

PROJECTS ENGINEERS (Flight Test)
BSEE with airborne electronics or electronic systems experience.

Please send your resume in complete confidence to: **Mr. George R. Hickman, Engineering Employment Manager**

REPUBLIC AVIATION
FARMINGDALE, LONG ISLAND, NEW YORK

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(*Continued from page* 136)

the tactile senses (what we feel with our fingertips) and kinesthetic sense (which allows us to know the position of our extremities even when we cannot see them).

Operators often use controls which they do not see. There are many ways to code such controls—the easiest being a difference in size or shape of knobs. Many experiments have been conducted to determine pairs that are not confused with each other. In one such experiment (227 attempts at identification) there were eight shapes out of twenty-two which were never confused. See Fig. 2.

We cannot do away entirely with the human component. In many cases, it is less expensive to use a human rather than a machine to make decisions. When space is limited, man is better for recall than a machine because the human brain is so much smaller than the machine brain with comparable recall ability. Man can read signals accurately (and less expensively) than machine. Although in some cases the human brain is less accurate, in emergency situations that have not been designed into the machine, man is far from reliable.

Man has many advantages. He can: perceive, make decisions, manipulate controls, handle maintenance and support activities, monitor machines action, use memory, recognize patterns of light and sound even if partly obliterated, reason; use judgment, perform a variety of functions in very little space, develop concepts and create methods, is flexible in coping with situations that cannot be anticipated.

But man also has many more limitations than a machine. For instance, man: requires space and air, is subject to stress, adds weight to the system, gets fatigued, loses speed of response, is affected by temperatures and humidity, is affected by shock (acoustical or other), is subject to glare, drugs, toxic substance, loss of sleep, danger, accidents; and must be trained.

You can see for yourself the need for psychological and physiological sciences in system design. Man is here to stay. Make use of him to the utmost—and let human factors concepts help you build into *all* your components reliability, safety and performance.

"Designing Multiple Feedback Loops"

I. Correction

In Appendix I of this article (ELECTRONIC INDUSTRIES, May, 1958) it is stated that a necessary and sufficient condition for the characteristic function, F, to have a zero in the closed right half of the complex frequency plane, for an operating point in the rectangular parallelepiped, P, is that F have a zero on the real frequency axis. The above statement is a necessary and sufficient condition when determining absolute stability, but is only a sufficient condition when determining conditional stability. It is possible for the rectangle P shown in Figure 4A to lie completely inside the boundary of the set of unstable operating points (B) and for all points in P to correspond to unstable operation.

In order to prove that all points in P correspond to stable operation, it is necessary to show:

1. That the characteristic function F does not have a zero on the real frequency axis for all operating points in P. This insures that the boundary B does not intersect P.

2. That at least one point in P corresponds to stable operation. This precludes the possibility of P lying entirely inside B.

Condition 2 is automatically satisfied when considering absolute stability since in this case, the origin of the space of operating points is contained in P (refer to Figure 2A) and this point corresponds to stable operation (passive circuit). When considering conditional stability, however, the origin of the space of operating points is not contained in P (refer to Figure 4A) and it is necessary to prove that at least one point in P corresponds to stable operation.

Based on this discussion, the T-plane plot of Figure 4C corresponds to unstable operation since it is impossible to prove that any one point in P corresponds to stable operation. In this case, P lies entirely within B and all points in P correspond to unstable operation.

(*Continued on page* 140)

Electronics Engineers . . .

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(*Continued from page* 138)

II. Clarification

In Theorem II, the exact meaning of the word enclose is not clearly pointed out. A clearer statement of Theorem II is:

A sufficient condition for absolute stability is that no straight line segment drawn between contours in the T-plane at corresponding value of frequency, pass through the critical point $(-1+j0)$.

III. Addition

The principal results given in this paper were presented by the author at the National Electronics Conference, Chicago, Illinois, on October 7, 1957, under the title "Transistor Multiple Loop Feedback Amplifiers."

The stability criterion discussed in this paper was originally proposed by H. W. Bode.

* * *

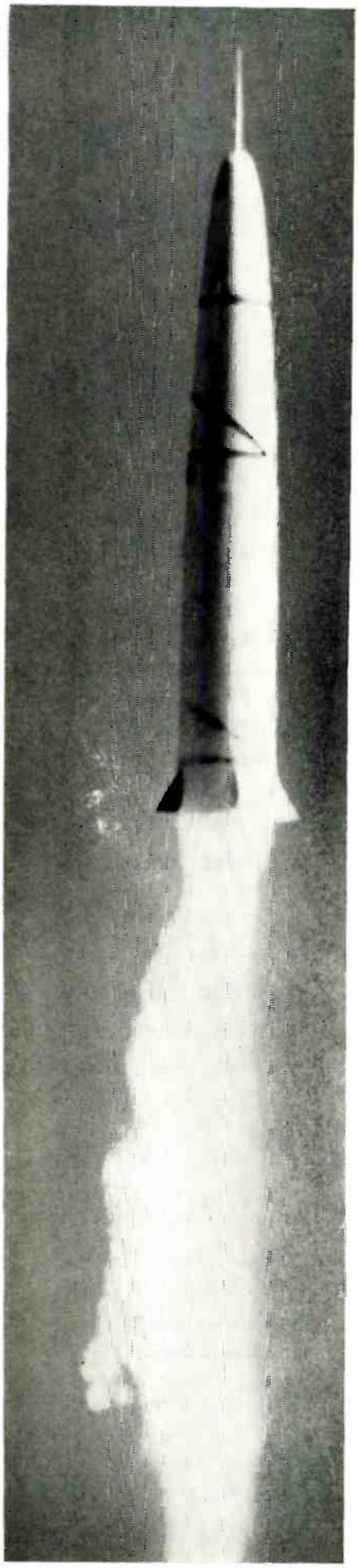
High Temp. Wire

(*Continued from page* 130)

plied below the exterior surface of the protective "Teflon" insulation. As a result, the stripe is not subject to the detrimental effects of corrosion and abrasion. To test the effectiveness of this method of color striping, striped samples were submerged in a bath of concentrated red fuming nitric acid. Observations were taken over a period of 12 hrs. on the submerged 12 in. samples used to determine the effect of this highly corrosive bath on the striping.

Table 1 illustrates the effectiveness of the technique in protecting the stripe from all adverse effects during the 12 hr. test period. In some cases, the stripe code on extruded "Teflon" completely disappeared following a 30-minute immersion. In other cases, color faded or changed in basic character so that final reading of the color code of the "Teflon" extruded wire was impossible.

While it is unlikely that hook-up wire in service will be subjected to the severe conditions of this test, the characteristics of "Flexolon" wire assure that color coding will be readily identifiable following extensive subjection to corrosive atmosphere—an important requirement for many applications.



Industry News

Raymond J. Condon and **Russell H. Whempner** beco ne Eastern and Western Sales Managers, respectively, for the Military Products Group of Minneapolis-Honeywell Regulator Co.

John A. McCormick has been named Manager of System Sales for two-way radios, and **Marvin C. Cisler**, Manager of Components Engineering at GE's Communication Products Dept. Other GE appointments include **Thomas I. Paganelli** to Manager of the Missile Detection Systems Section of the Heavy Electronic Equipment Dept., and **Alvin R. Deas** to the Managership of the Semiconductor Rectifier Mfg. plant at Clyde, N. Y.

Albert Haselman moves to the post of General Sales Manager of Prodelin, Inc.

Perry R. Roehm is now serving as Director of Marketing for International Telephone & Telegraph Corp. Mr. Roehm was formerly President of Norden-Ketay Corp.

P. R. Roehm

R. R. Eppert

Ray R. Eppert has been named President of Burroughs Corp.

Dr. William Duerig has joined Midwestern Instruments, Inc. as Vice President in Charge of Research and Engineering. Dr. Duerig comes from Electro-Mechanical Research, Inc.

Dr. Louis Malter has assumed the position of Director of Central Research for Varian Assoc. Dr. Malter had served as Chief Engineer of the Semiconductor and Materials Div., RCA.

William C. Maes has joined Magnetics, Inc. as a West Coast Field Sales Representative. **Walter H. Bollinger** is now a Sales Representative for Control, a division of Magnetics, Inc. Mr. Bollinger's area will be Western Pennsylvania and West Virginia.

John D. MacNamara moved to the position of Manager for the New York District for the Weston Instruments, Div. of Daystrom Inc.

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Circle 507 on "Opportunities" Inquiry Card, page 85

Industry News

Norman Saunders will now serve as East Coast Field Engineer for General Transistor Corp.

H. P. McTeigue has been appointed to the newly created post of Manager, Marketing, Government Service Dept., RCA Service Co.

Richard A. Arnett is now serving as Marketing Manager of the Industrial Instrumentation Div. of Texas Instruments Inc

R. A. Arnett

F. W. Steen

Paul W. Steen has been appointed Manager of Distributor Sales for the Narda Ultrasonics Corp.

Gerald L. Landsman has been appointed Assistant Director of Research and Development of Motorola's Military Electronics Division. Other promotions at Motorola include **Burt Mendelsohn** to the position of Assistant Director of Marketing for the Communications and Industrial Electronics Div.; **Herbert I. Ackerman** to District Sales Manager for New England, New York State, and Eastern Canada, for Motorola Semiconductor Products; **Allen B. Anderson** to Manager of Advertising and Public Relations of Military Electronics Div. at Phoenix; **Robert B. Corby** to Manager of Marketing activities in missile range instrumentation.

R. F. Duncumb becomes Sales Engineer for California and Arizona for Clevite Electronic Components Div. Mr. Duncumb most recently was a Sales Engineer for Helipot Corp.

James R. Kallaher is the newly-appointed General Sales Manager for National Vulcanized Fibre Co. Donald W. Stewart succeeds Mr. Kallaher as Chicago Manager. Ralph E. Bryant succeeds Mr. Stewart as Boston District Sales Manager.

E. F. Coy has accepted the position of Vice-President—Marketing upon joining Electronic Communications Inc. Mr. Coy was formerly Director of Sales of the Mechanical Div. of General Mills.

(*Continued on page 144*)

Industry News

(*Continued from page* 143)

Curtis W. Symonds has rejoined Sylvania Electric Products Inc. as Controller of the Semiconductor Div. A few of the other Sylvania appointments include: **Michael Balag** to the newly created post of Manager of Manufacturing and Engineering for the Semiconductor Div.; **John B. Donner** as Project Manager for Sylvania's electronic defense substem contract for the Strategic Air Command's B-52 long-range bomber; and **Eugene J. Vigneron** as Manager of the Needham (Mass.) operations of Sylvania Electronic Systems.

Hugh A. Young has joined Packard-Bell Electronics Corp. as Sales Manager of the Technical Products Div. Mr. Young was formerly Western Regional Manager for A. B. DuMont Labs., Inc.

H. A. Young

C. D. Butler

George D. Butler has joined International Resistance Co. as Director of Sales. Mr. Butler was formerly Director of Sales for Norden-Ketay Corp.

Joseph D. Ceader and **Hugo Sundberg** have been reelected Chairman of the Board and President respectively of Oxford Electric Corp. Most of the other officers and Directors were also reelected.

Frank P. De Luca, Jr. is now a Vice-President of Acoustica Associates, Inc. Mr. De Luca will be responsible for the operation of the firm's newly-opened facilities on the West Coast.

Robert Tate is the new Director of Customer Liaison and Service at the Waldorf Instrument Co., Electronics Div. of F. C. Huyck & Sons.

Dr. Simon Prussin and **Frank Steinebrey** have joined the research and development staff of Pacific Semiconductors, Ind. Dr. Prussin will engage in the study of silicon crystal structure while Mr. Steinebrey will be assigned to the company's high power silicon transistor development group.

ELECTRONIC

RCA Receives Top Navy Award

The Navy's Certificate of Merit was presented to the Radio Corporation of America in recognition of Their "outstanding service" in the field of guided missile development and technology.

The newly created award, highest civilian honor the Navy can bestow, was presented by Rear Admiral John Quinn, Deputy Chief, Navy Bureau of Ordnance, to Dr. E. W. Engstrom, Senior Executive Vice President of RCA. The presentation ceremony was held at RCA's Moorestown Plant.

INDUSTRIES Advertisers — July 1958

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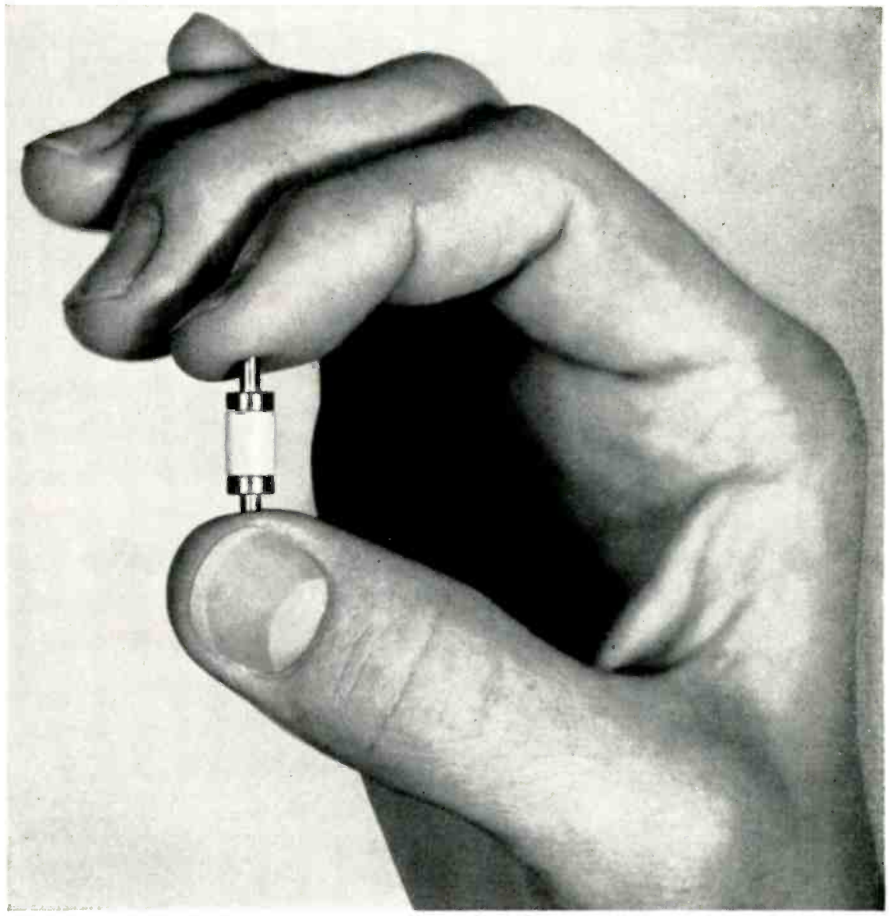

NEW DIODE SPEEDS VOICES— AT 6,000,000,000 C.P.S.

How the radio art can be improved through solid state science is illustrated by a recent development at Bell Telephone Laboratories. To make voice signals travel by microwaves they must first be "converted"—caused to vibrate at billions of cycles per second. To date, it has been possible to accomplish this conversion only at the cost of appreciable loss of signal energy. Could a more efficient converter be provided?

In the field of solid state science it was known—as a laboratory curiosity—that semiconductor diodes can be made not only to convert the frequency of signals, but also to amplify them. At Bell Laboratories Dr. Arthur Uhlir, Jr., and his associates calculated that this amplifying action could be put to practical use. They proved the point by developing a junction diode converter which can deliver up to 40 times as much signal energy as previous converters.

This efficient new converter will be applied in a new Bell System microwave highway able to transmit thousands of telephone conversations and a dozen television programs simultaneously at six billion cycles per second. In other forms it is being developed, under Signal Corps contract, for radar and military communications where more efficient frequency conversion can also be used to advantage.

This development is an example of the many different ways in which Bell Laboratories works to improve your telephone service and communications at large.

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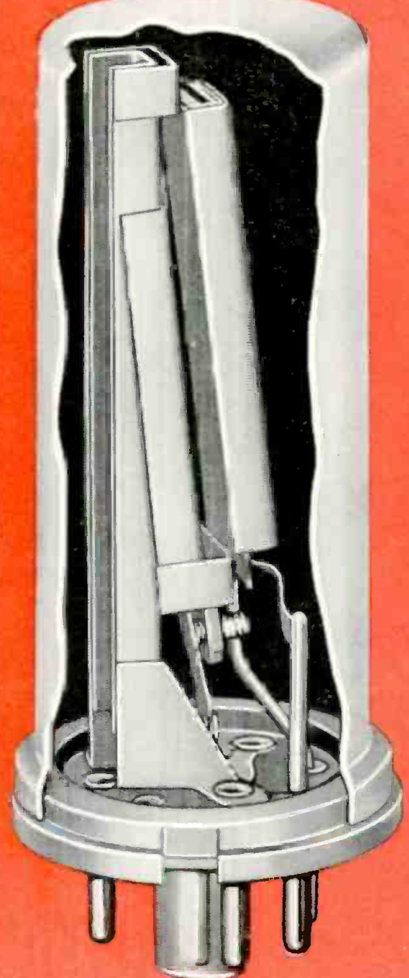

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  Relay mechanism is of stainless steel, differential expansion type, used in all G-V Thermal Relays. All parts are welded into a single integral structure.
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  No glass is used in mechanism, encasing shell, or base. This avoids the danger of cracking or breakage in handling and use.
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  Heating elements are conservatively designed, wound with Nichrome wire on mica and encased in stainless steel, insuring long heater life even when energized continuously.
- **DUST TIGHT ENCLOSURE**
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- **TAMPER PROOF**
  Time delay intervals are preset at the factory. Thus changes of delay interval in the field which might damage associated equipment are avoided.
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5 sec.	5 sec	5 sec.	—
10 sec.	10 sec	10 sec.	10 sec.
20 sec.	20 sec	20 sec.	20 sec.
30 sec.	30 sec	30 sec.	30 sec.
45 sec.	45 sec	45 sec.	45 sec.
60 sec.	60 sec.	60 sec.	60 sec.
90 sec.	90 sec.	90 sec.	90 sec.
120 sec.	120 sec.	120 sec.	120 sec.
180 sec.	180 sec.	180 sec.	180 sec.

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