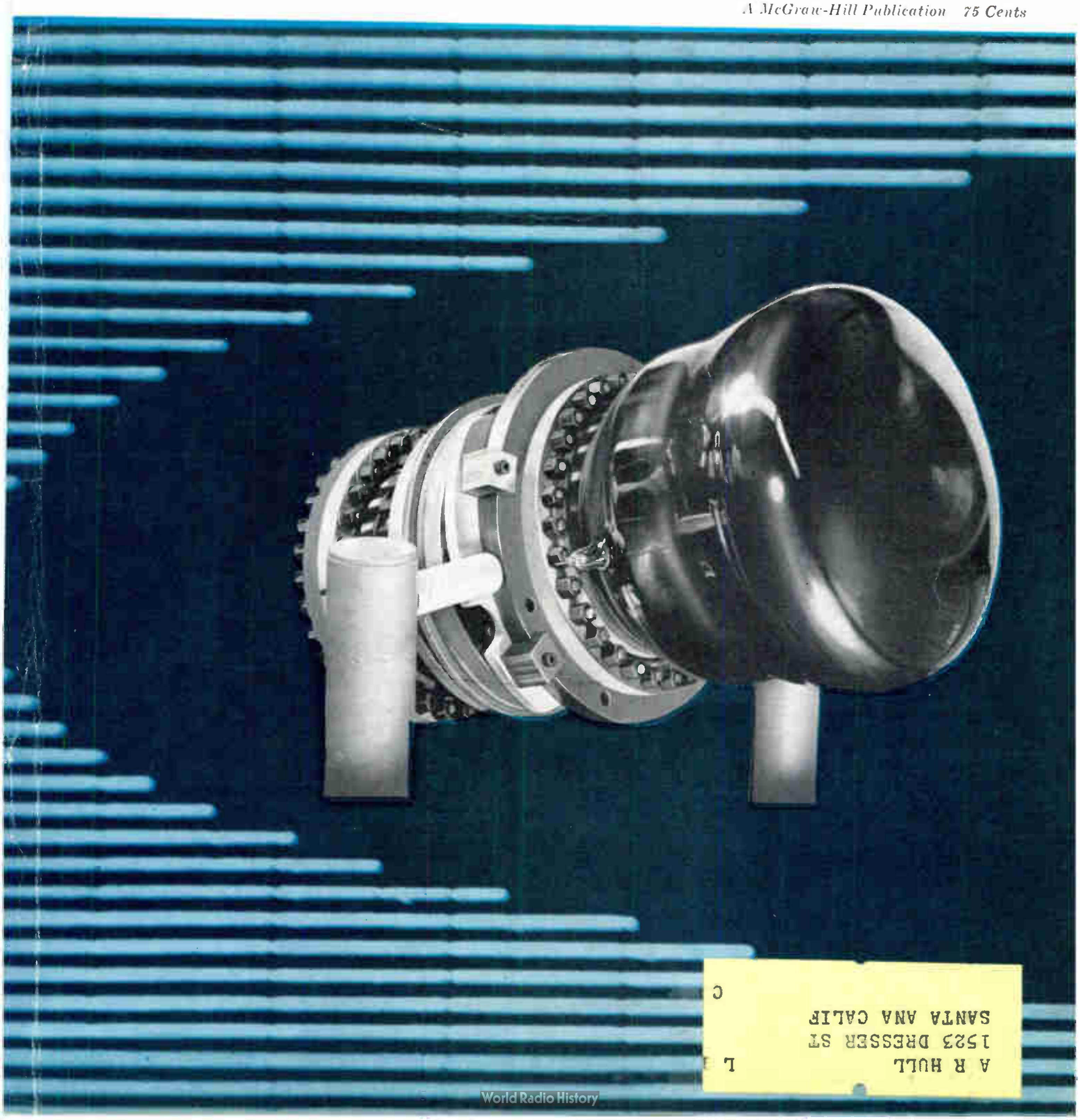
August 26, 1960

electronics

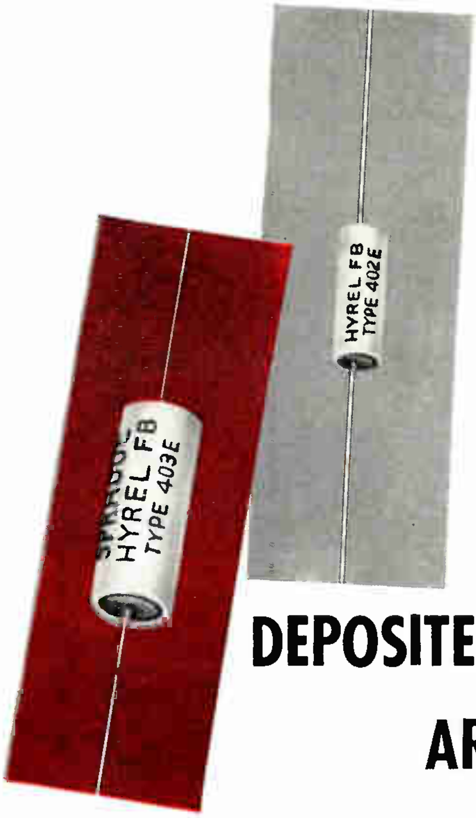
Miniature grid-controlled electron injectors make possible a 39-trace cathode ray tube of reasonable size described on p 51

New circuit extends transistor frequency performance. See p 56

A McGraw-Hill Publication 75 Cents



ALL UNITS ACTUAL SIZE



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WRITE FOR ENGINEERING BULLETIN 7010B

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CIRCLE 5 ON READER SERVICE CARD

COMMENT

Accuracy and Precision

I frequently encounter the problem of defining the terms *accuracy* and *precision* as related to electronic equipment. If you have a standard definition or one that is most commonly used, I would appreciate knowing it . . .

E. M. THOMASON
MONSANTO CHEMICAL CO.
TEXAS CITY, TEXAS

"Accuracy" is defined as "exact or careful conformity to truth or to some standard, free from . . . error." It signifies the result of careful attention to detail. "Precision," derived from the Latin verb meaning "to cut off," is defined as "having determinate limitations, exactly or sharply defined or stated, not vague or equivocal." It signifies the result of exacting attention to minute detail; its third definition is "minutely exact."

In standard industry usage, the word "accuracy" properly is used to mean freedom from error, especially as a result of care. Precision, on the other hand, relates to the degree of fineness with which an operation is performed or a reading taken. In instruments, accuracy depends on calibration against an accepted standard; precision depends on such instrument characteristics as the number of divisions on a scale or the number of places in a digital presentation.

A former professor of ours used to point out that a three-place log table containing no errors is accurate; a five-place log table is more precise but, if it contains errors, less accurate.

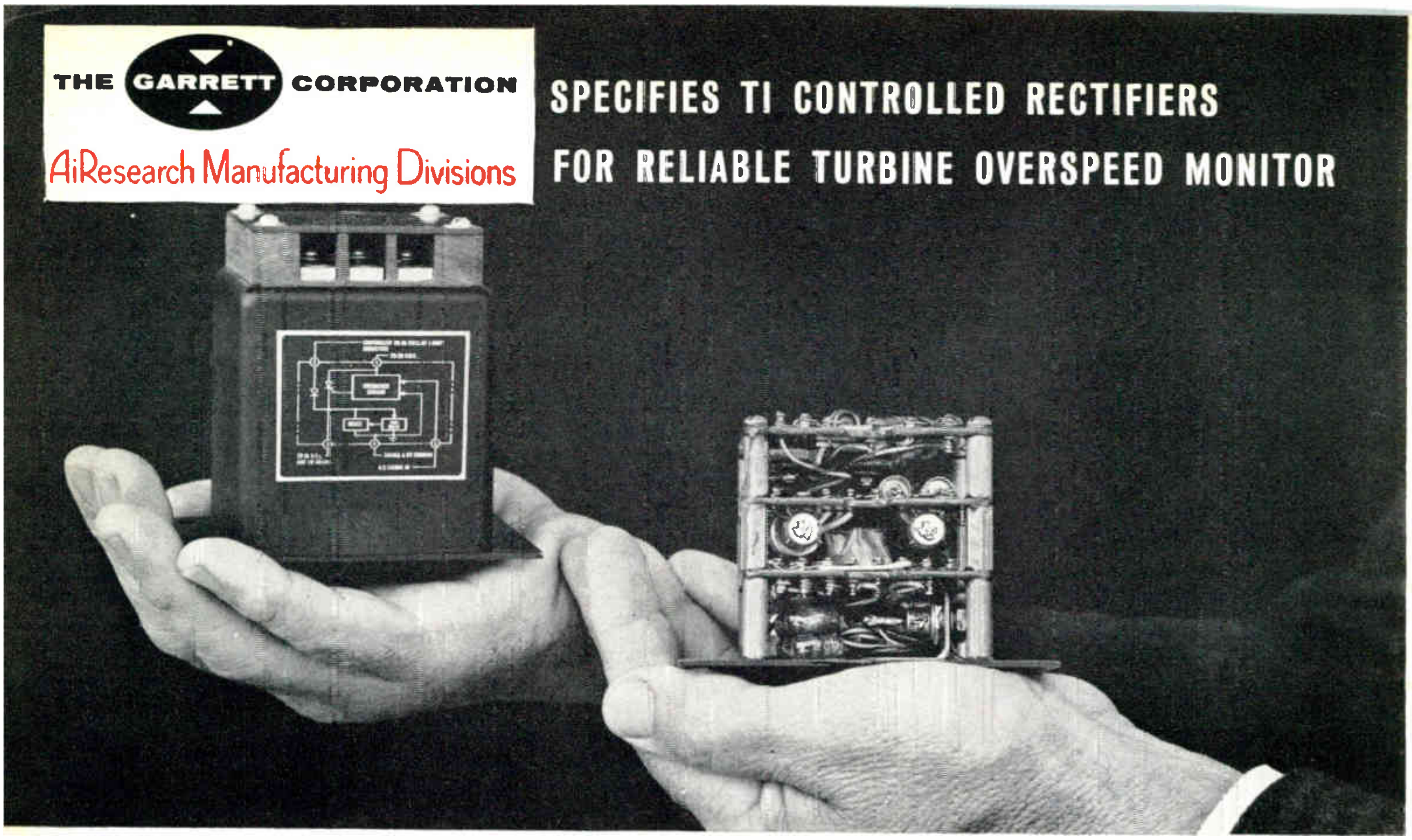
Nanosecond

The other day I read in your magazine the word *nanosecond*, probably standing for one thousandth of one millionth of a second, or one billionth of a second.

Can you tell me the definition of this word, and its derivation? I am interested in the word from which *nano* came.

EDMUND C. BERKELEY
NEWTONVILLE, MASS.

Eclectic colleague Berkeley apparently missed our March 4 issue,



All-diffused TI 2N1595 in TO-5 case provides superior static control

Engineers at the Los Angeles AiResearch Manufacturing Division of the Garrett Corporation designed the Turbine Overspeed Monitor for use in missiles and aircraft. This 12-ounce unit utilizes electromagnetic sensing at 5000 cps for firing TI silicon controlled rectifiers to provide 1 amp of corrective current at 24 volts dc.

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Type	At 80°C Case Temp: Av Rect Fwd Current Amps	At 80°C Case Temp: Recurrent Peak Current Amps	Non-Recurrent Surge Current 1 Cycle at 60 cps Amps	Min Fwd Off Voltage* v	PIV	Min Breakdown Voltage v	Max Case Temp °C	Max Fwd Gate Current ma	Gate to Cathode PIV v	max Fwd Voltage Drop @ Avg Rect Fwd Current @ 25°C Stud Temp v @ a	Gate Current Req to Fire ma Typ	Gate Current Req to Fire ma Max
2N1600	3	10	25	50	50	60	150	100	5	2 @ 3 amps	1	10
2N1601	3	10	25	100	100	120	150	100	5	2 @ 3 amps	1	10
2N1602	3	10	25	200	200	240	150	100	5	2 @ 3 amps	1	10
2N1603	3	10	25	300	300	360	150	100	5	2 @ 3 amps	1	10
2N1604	3	10	25	400	400	480	150	100	5	2 @ 3 amps	1	10
2N1595	1	3	15	50	50	60	150	100	5	2 @ 1 amp	1	10
2N1596	1	3	15	100	100	120	150	100	5	2 @ 1 amp	1	10
2N1597	1	3	15	200	200	240	150	100	5	2 @ 1 amp	1	10
2N1598	1	3	15	300	300	360	150	100	5	2 @ 1 amp	1	10
2N1599	1	3	15	400	400	480	150	100	5	2 @ 1 amp	1	10
TI-010	1	3	15	50	50	60	150	100	5	See data sheet for switching information		
TI-025	1	3	15	50	50	60	150	100	5			
TI-050	1	3	15	50	50	60	150	100	5			

*Measured with 1K ohm resistor gate to cathode

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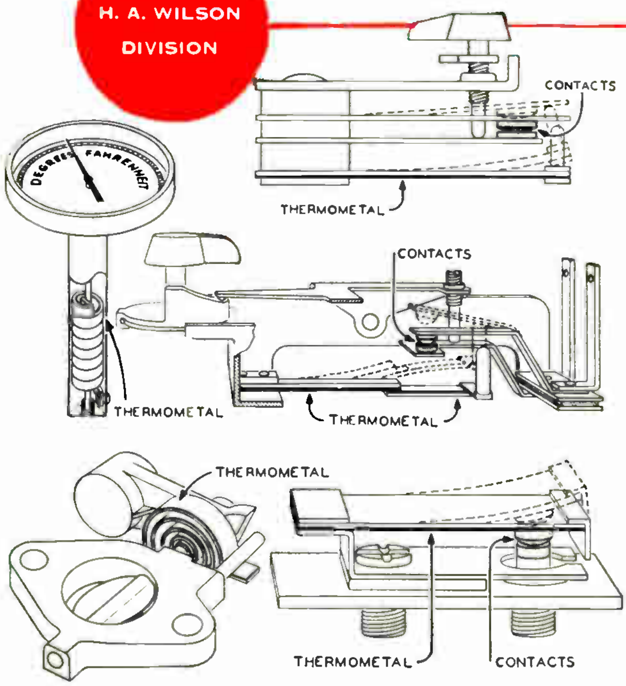

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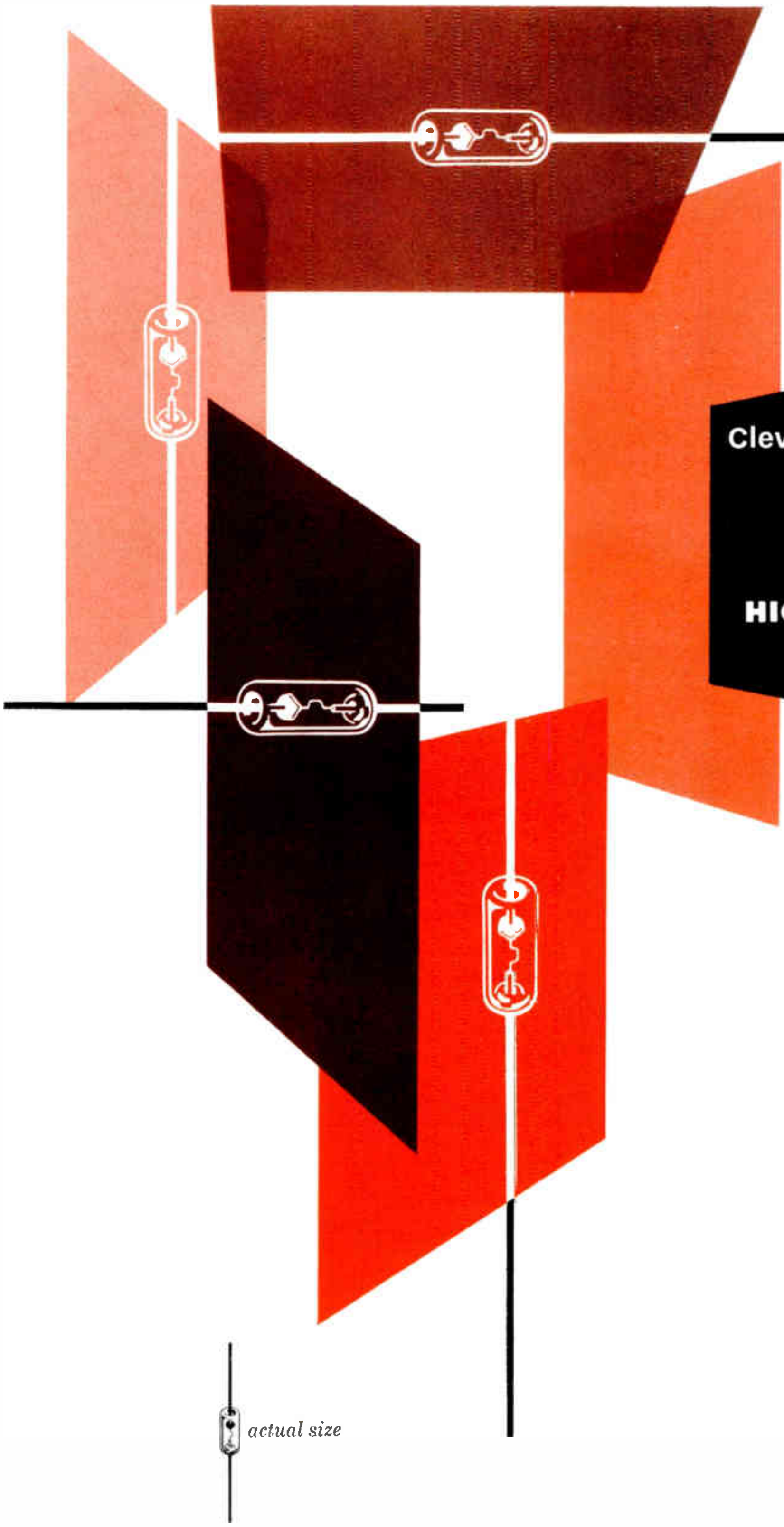

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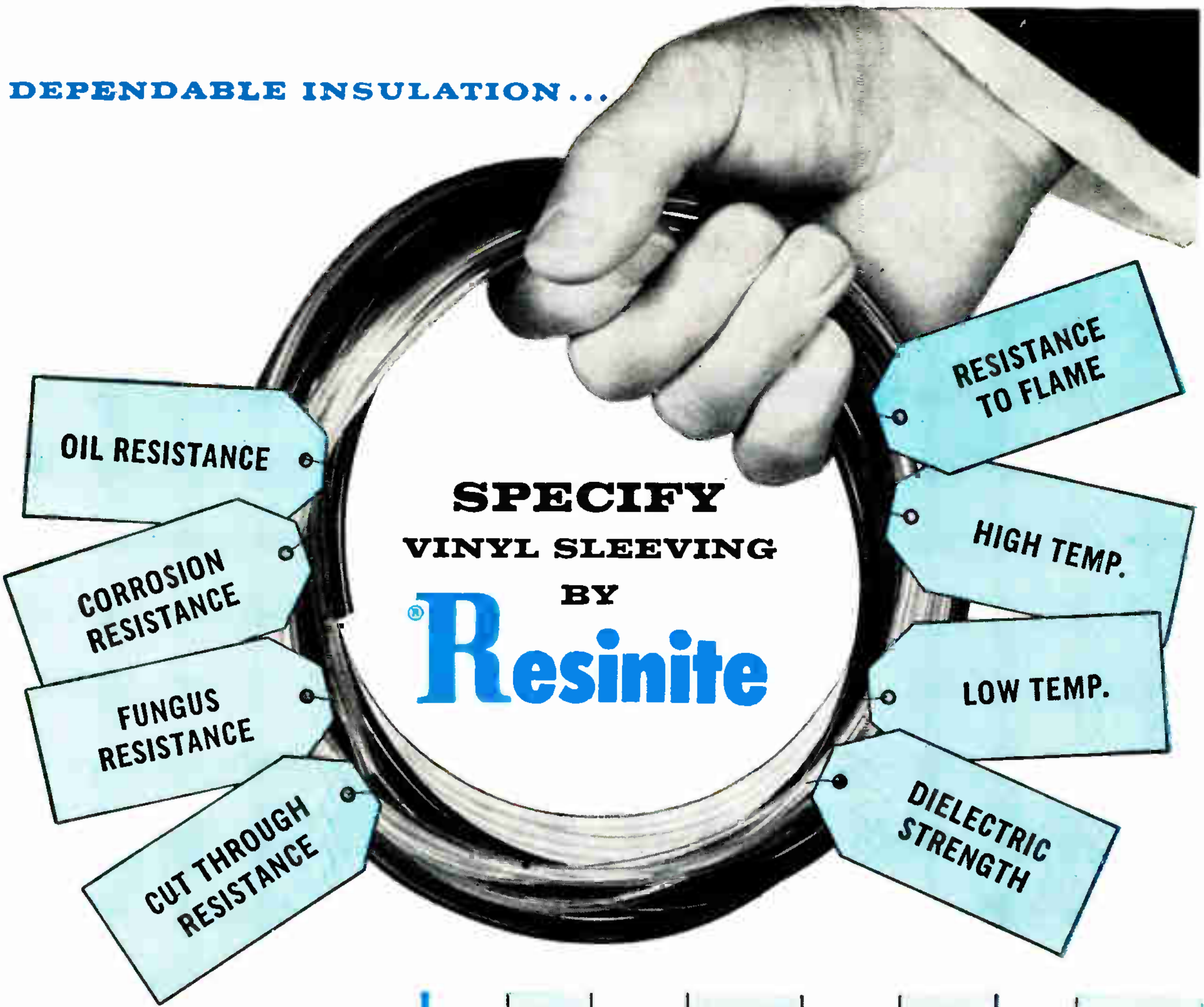

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DIELECTRIC STRENGTH	400 volts/ mil av.	390 volts/ mil av.	900 volts/ mil min.	1,000 volts/ mil	1,000 volts/ mil	900 volts/ mil av.	800 volts/ mil av.	8,000 4,000 2,500 volts
CUT-THROUGH RESISTANCE	Good	Good	Good	Excellent	Outstanding	Good	Good	Outstanding
OIL RESISTANCE	Slight Swelling	Slight Swelling	Slight Swelling	Excellent	Excellent	Slight Swelling	Slight Swelling	Excellent
RESISTANCE TO FLAME (SELF-EXTINGUISHING)	5 sec. max.	5 sec. max.	6 sec. max.	10 sec.	1 sec.	5 sec. max.	5 sec. max.	45 sec/ inch
FUNGUS RESISTANCE	Yes Clear Fungicide	Yes Amber Fungicide	Yes Clear Fungicide	Available (105C only) Clear Fungicide				
CORROSION RESISTANCE	Good	Good	Good	Good	Good	Good	Good	Good
SPECIFICATION CONFORMANCE	MIL-I-7444B Types I & III	MIL-I-7444B Type II	MIL-I-631C Type F Form U Grades a and b Cl. I & II Cat. 1	MIL-I-631C Type F Form U. Gr C Class I (105C only) Class II Cat. 1 Also U.L. 105°C	U.L. 105°C	MIL-I-631C Type F Form U Grade a Cl. II Cat. 1	AMS 3630	ASTM D372-53T NEMA-VSI-1950 MIL-I-3190(4)

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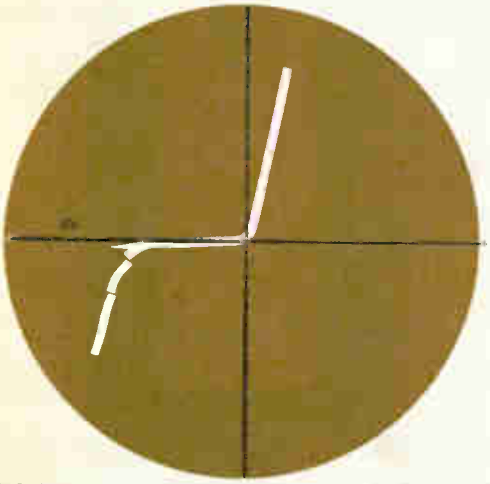
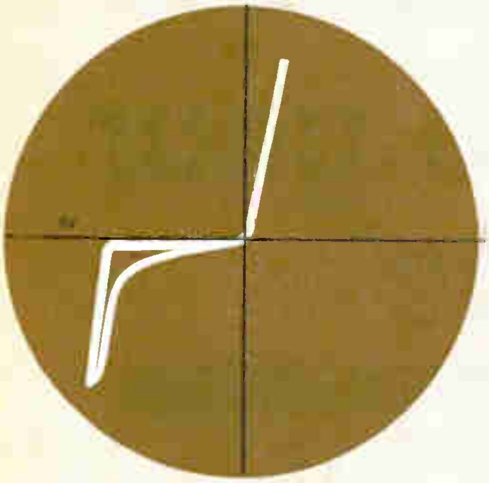
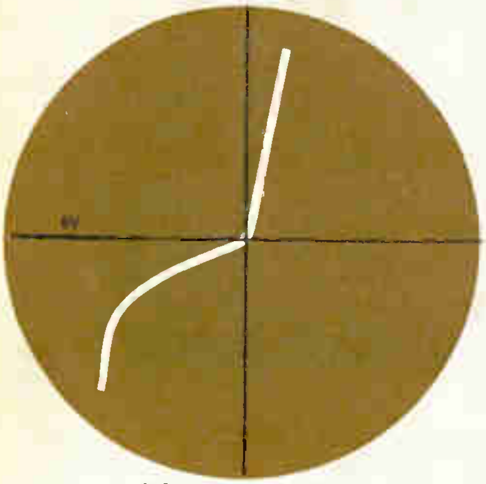


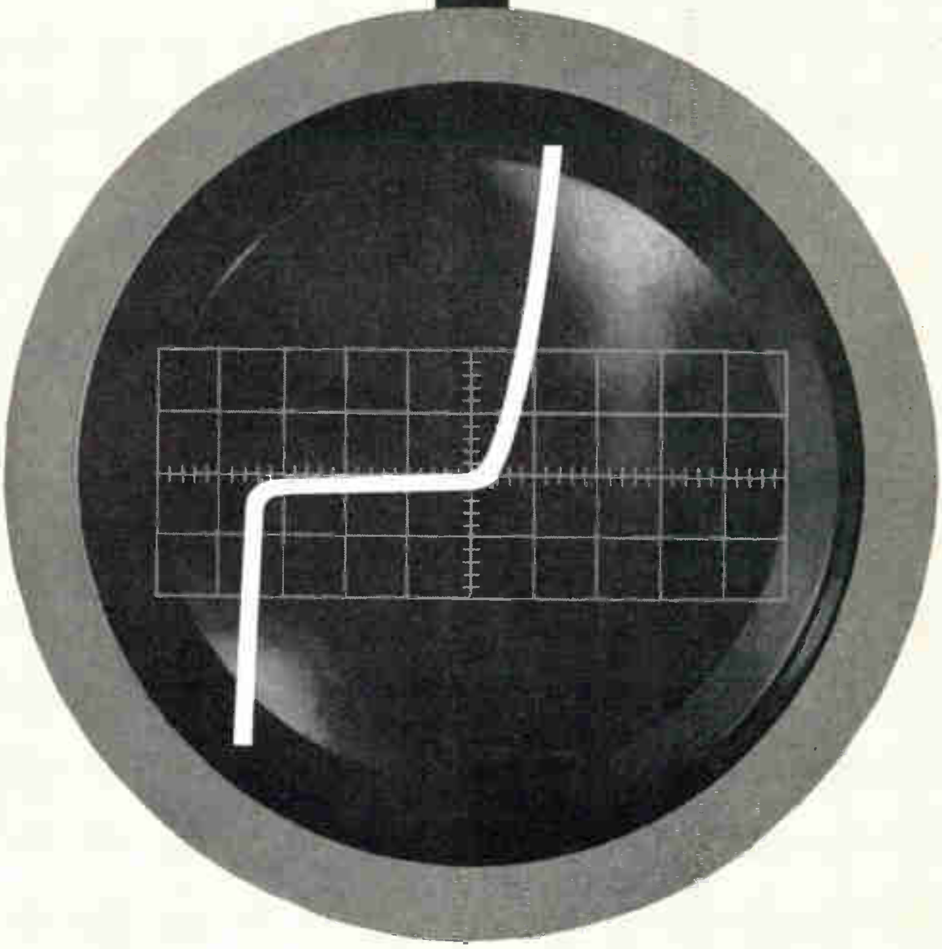
NO MULTIPLE BREAKS OR DISCONTINUITIES



NO HYSTERESIS



NO ROUND KNEES



SARKES TARZIAN

SILICON ZENER VOLTAGE REGULATORS

Tarzian silicon voltage regulators, commonly called zener diodes, are constant voltage devices used to control output voltage of power sources and as voltage reference elements capable of operating over a wide temperature range. Hermetic sealing and mechanical ruggedness provide long term reliability even under the most adverse conditions.

Three power classifications cover a wide range of applications.

¼ Watt Zener Regulators

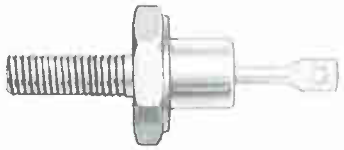
Specifications 25°C.

Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)	Jedec Type
.25T5.6	5.6	25	3.6	1N708
.25T6.2	6.2	25	4.1	1N709
.25T6.8	6.8	25	4.7	1N710
.25T7.5	7.5	25	5.3	1N711
.25T8.2	8.2	25	6.0	1N712
.25T9.1	9.1	12	7.0	1N713
.25T10	10	12	8.0	1N714
.25T11	11	12	9.0	1N715
.25T12	12	12	10	1N716
.25T13	13	12	11	1N717
.25T15	15	12	13	1N718
.25T16	16	12	15	1N719
.25T18	18	12	17	1N720
.25T20	20	4	20	1N721
.25T22	22	4	24	1N722
.25T24	24	4	28	1N723
.25T27	27	4	35	1N724
.25T30	30	4	42	1N725
.25T33	33	4	50	1N726
.25T36	36	4	60	1N727
.25T39	39	4	70	1N728
.25T43	43	4	84	1N729
.25T47	47	4	98	1N730
.25T51	51	4	115	1N731
.25T56	56	4	140	1N732
.25T62	62	2	170	1N733
.25T68	68	2	200	1N734
.25T75	75	2	240	1N735
.25T82	82	2	280	1N736
.25T91	91	1	340	1N737
.25T100	100	1	400	1N738

1 Watt Zener Regulators

Specifications 25°C.

Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)
1T5.6	5.6	100	1.2
1T6.2	6.2	100	1.5
1T6.8	6.8	100	1.7
1T7.5	7.5	100	2.1
1T8.2	8.2	100	2.4
1T9.1	9.1	50	3.0
1T10	10	50	3.5
1T11	11	50	4.2
1T12	12	50	5.0
1T13	13	50	5.8
1T15	15	50	7.6
1T16	16	50	8.6
1T18	18	50	11
1T20	20	15	13
1T22	22	15	16
1T24	24	15	18
1T27	27	15	23
1T30	30	15	28
1T33	33	15	33
1T36	36	15	39
1T39	39	15	45
1T43	43	15	54
1T47	47	15	64
1T51	51	15	74
1T56	56	15	88
1T62	62	5	105
1T68	68	5	125
1T75	75	5	150
1T82	82	5	175
1T91	91	5	220
1T100	100	5	260



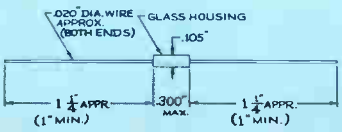
10 Watt Zener Regulators

Specifications 25°C.

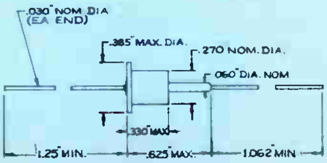
Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)	Jedec Type
10T5.6	5.6	1000	1	1N1803
10T6.2	6.2	1000	1	1N1804
10T6.8	6.8	1000	1	1N1805
10T7.5	7.5	1000	1	1N1806
10T8.2	8.2	1000	1	1N1807
10T9.1	9.1	500	1	1N1808
10T10	10	500	2	1N1351
10T11	11	500	2	1N1352
10T12	12	500	2	1N1353
10T13	13	500	2	1N1354
10T15	15	500	2	1N1355
10T16	16	500	3	1N1356
10T18	18	150	3	1N1357
10T20	20	150	3	1N1358
10T22	22	150	3	1N1359
10T24	24	150	3	1N1360
10T27	27	150	3	1N1361
10T30	30	150	4	1N1362
10T33	33	150	4	1N1363
10T36	36	150	5	1N1364
10T39	39	150	5	1N1365
10T43	43	150	6	1N1366
10T47	47	150	7	1N1367
10T51	51	150	8	1N1368
10T56	56	150	9	1N1369
10T62	62	50	12	1N1370
10T68	68	50	14	1N1371
10T75	75	50	20	1N1372
10T82	82	50	22	1N1373
10T91	91	50	35	1N1374
10T100	100	50	40	1N1375

NOTES: Standard tolerance is ± 10% however, closer or wider tolerances are available on request.
Also available on request:
(a) Special voltage ratings.
(b) Symmetrical double anode types (for clippers).

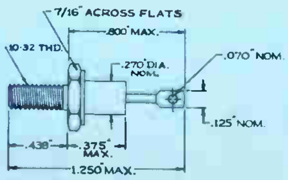
DIMENSIONS



DIMENSIONS



DIMENSIONS

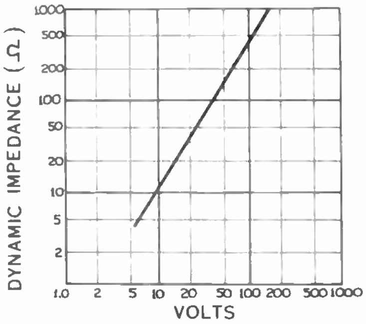


SARKES TARZIAN SILICON VOLTAGE REGULATOR ZENER DIODES
Characteristics and Application

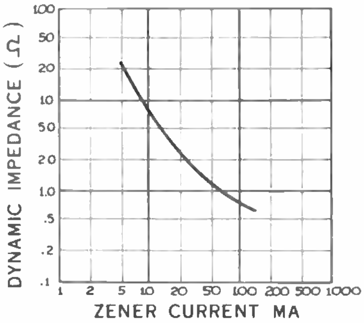
Dynamic Impedance

Dynamic impedance is a measure of voltage change effects on operating current and provides a practical measure of regulating performance. Dynamic impedance is measured by superimposing a small AC current upon the DC test current and measuring the resultant voltage across the diode.

The following curves show the effects of voltage and current on dynamic impedance.

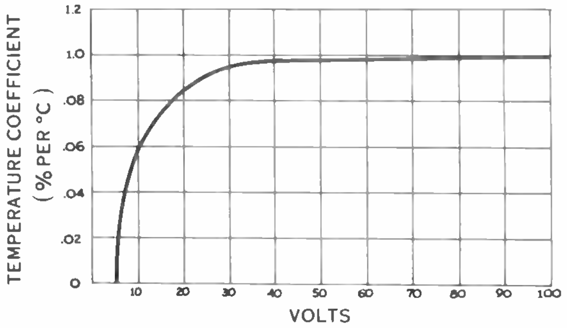


TYPICAL CURVE FOR 1T7.5



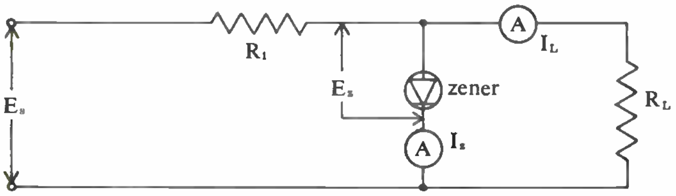
Temperature Coefficient

The operating voltage of a silicon regulator changes with operating temperature. This characteristic must be considered in design. The following curve shows temperature—voltage relationships typical in silicon zener diodes.



Typical Application

REGULATOR CIRCUIT



As the input voltage increases the inverse bias across the zener diode will increase and cause a large current to flow. This increase will cause more current to flow through R_1 and increase the drop thereby adjusting the load voltage. Load variations have a similar effect. The result is a substantially constant output voltage.

Determination of R_1 is as follows:

$$R_1 = \frac{E_s - E_z}{I_z + I_L}$$

$$I_z = \left(\frac{E_s - E_z}{R_1}\right) - I_L$$

$$P_z = \left(\frac{E_s - E_z}{R_1} - I_L\right) E_z$$

Where:

- R_1 is the series resistor
- E_s is the source voltage
- E_z is the zener diode voltage
- I_z is the zener diode current
- I_L is the load current
- P_z is the zener diode power dissipation

Where the load current and input voltage are variable:

$$R_1 = \frac{E_s\,(\text{min.}) - E_z}{I\,(\text{max.}) + .1I_L\,(\text{max.})}$$

$$P_z\,(\text{max.}) = \left(\frac{E_s\,(\text{max.}) - E_z}{R_1} - I_L\,(\text{min.})\right) E_z$$

For constant load current but variable input voltage:

$$R_1 = \frac{E_s\,(\text{min.}) - E_z}{I_L + .1I_L}$$

$$P_z\,(\text{max.}) = \left(\frac{E_s\,(\text{max.}) - E_z}{R_1} - I_L\right) E_z$$

For constant input voltage but variable load current:

$$R_1 = \frac{E_s - E_z}{I_L\,(\text{max.}) + .1\,I_L\,(\text{max.})}$$

$$P_z\,(\text{max.}) = \left(\frac{E_s - E_z}{R_1} - I_L\right) E_z$$

NOTES: The above equations allow a tolerance of 10% to compensate for load regulation.
If dynamic impedance is a significant percentage of the value of R_1, this must be taken into consideration.
A high impedance source presents additional problems and must be considered if it is significant compared to R_1.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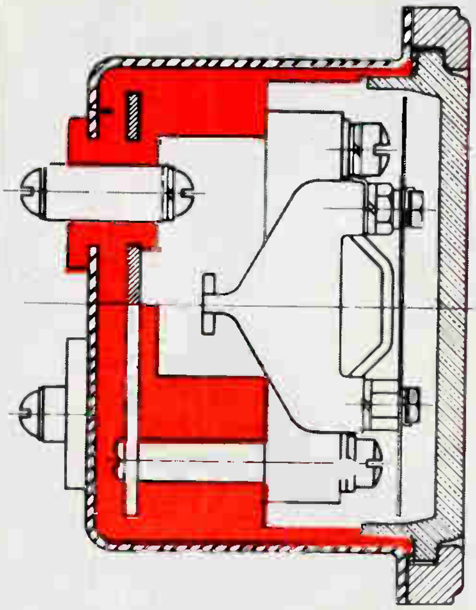

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Reliability is assured with Weston Model 1539 Ruggedized Panel Meters . . . even under extremes of vibration, shock and climatic conditions.

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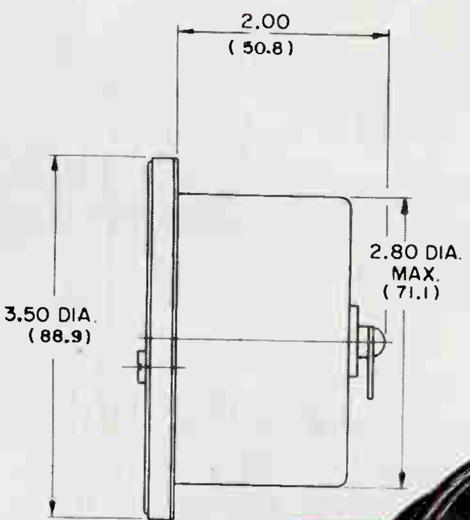
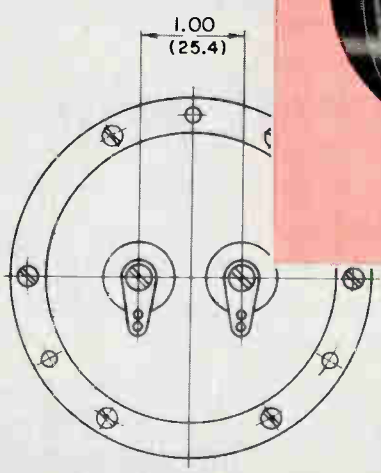
Call your Weston representative for details on these long-scale Ruggedized instruments, or write for Catalog 01-501 which contains full technical data. Weston Instruments Division, Daystrom, Inc., Newark 12, New Jersey. *International Division, 100 Empire Street, Newark 12, New Jersey. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ontario.*



Mechanism: Permanent magnet moving coil. **Available as:** Rectifier-type AC voltmeter, milliammeter, microammeter; AC or DC Tachometer Indicator. DC ranges: 200 μa through 20 ma, 100 mv through 500 volts, self-contained.



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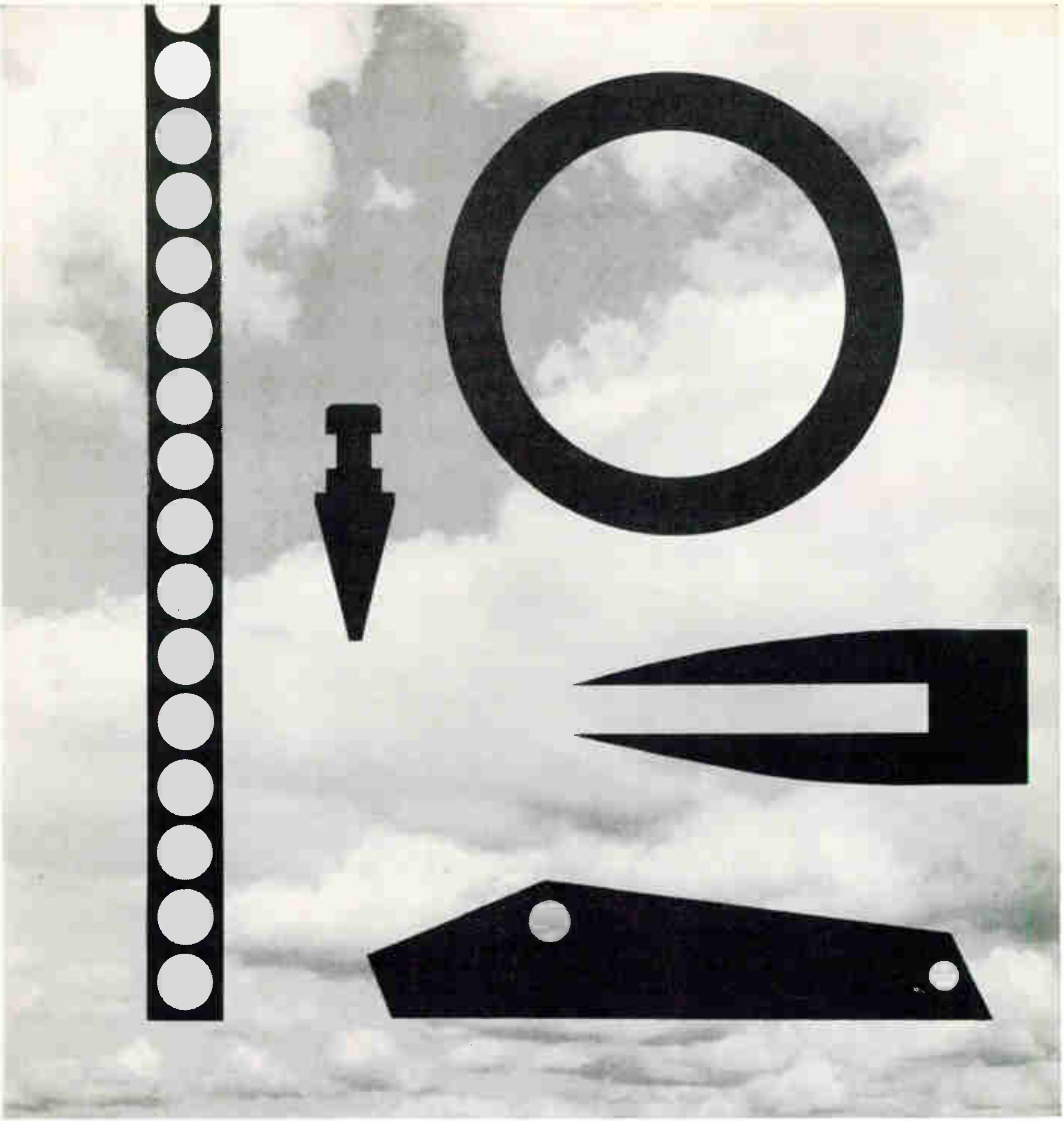

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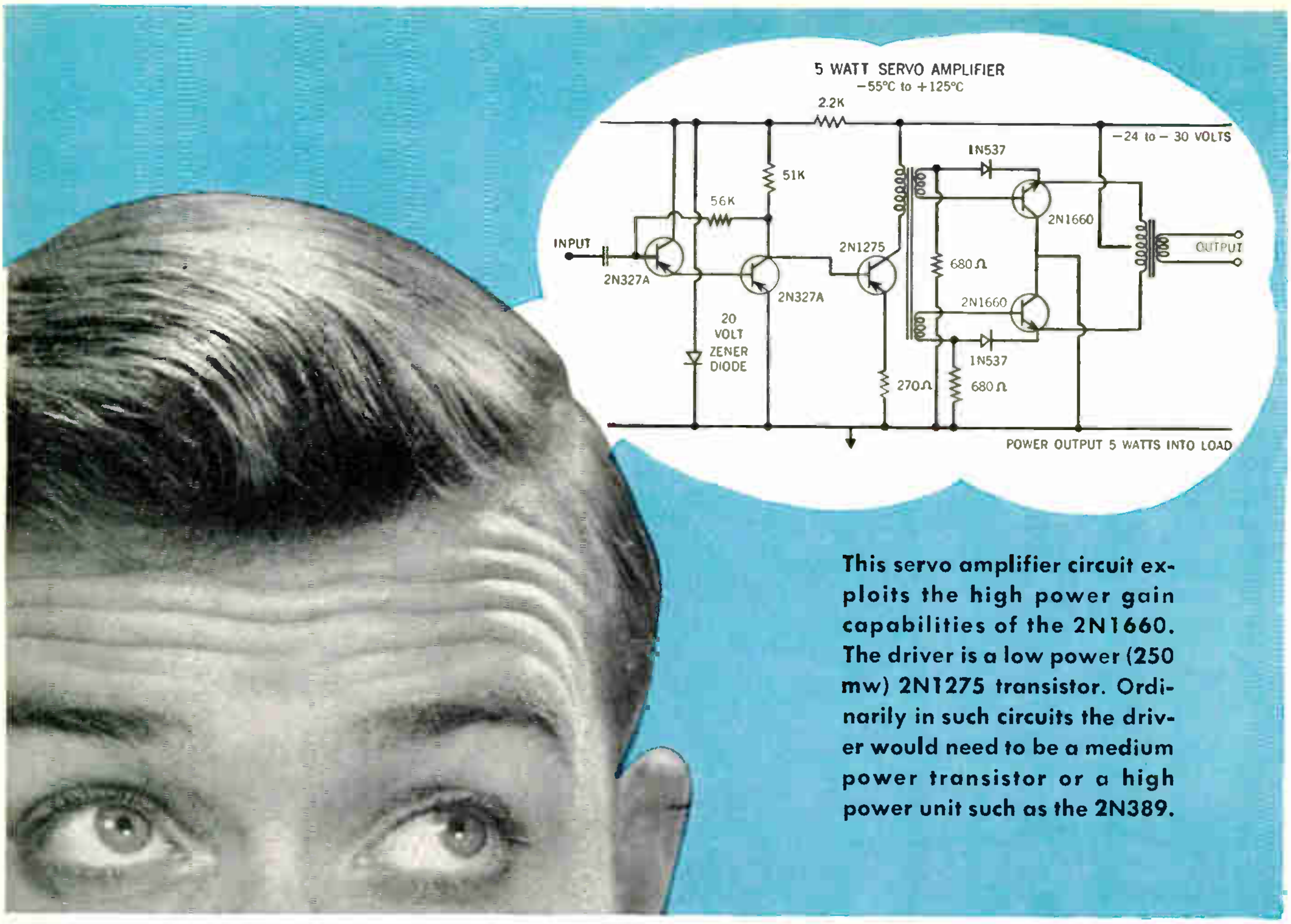

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Put these new silicon power transistors to use for regulated power supplies . . . power switching . . . power amplifiers . . . power oscillators . . . core drivers . . . servo amplifiers — wherever reliable h.f. power handling is a problem.

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Raytheon NPN Diffused Silicon Power Transistors
Temperature Range −65°C to +200°C.

Type	BVCER Min. Volts	BVEBO Min. Volts	Vsat Max. Volts	HFE Min.	VBE Max. Volts	Ft. Min. Mc
Conditions:	R1=33 ohms		1c=1A 1B=0.2A	Vc=15V 1c=1A	Vc=15V 1c=1A	Vc=30V 1c=100MA
2N1660	60	10	4.0	45	3.0	25
2N1661	80	10	4.0	45	3.0	25
2N1662	100	10	4.0	45	3.0	25
2N1657	60*	3	3.0	15‡		
2N1470	60*	3	3.0	15‡		
2N389	60	10	5.0	12	8.0	
2N424	80	10	10.0	12	8.0	

*BVCES ‡Vc=5.0 V; 1c=1.0 A

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Small Business Group to Meet

Problems, complaints to be studied Sept. 13 at Indiana conference. EIA playing key role

SMALL BUSINESS PROBLEMS are slated for more discussion and study by Electronic Industries Association members on Sept. 13 at French Lick, Ind.

The agenda for EIA's Small Business Committee meeting includes:

1) How small business can team up with large corporations and fill in gaps.

2) Review House of Representatives Bill No. HR 11207 defining small business.

3) Review protection of small business being considered by government regulation.

4) Review technical manpower being expended in military procurement for preparation of many elaborate but unsuccessful technical proposals.

5) Develop an up-to-date list of companies that can be classified as small business.

6) Consider establishing territories along the lines of Small Business Administration for regional decentralization of the activities under committee jurisdiction.

At a recently held regional conference, some small business firms took the opportunity to air some complaints. Speakers said:

"The small businessman suffers from the lack of progress payments during the development and prototype stage of a contract. He is also hampered by the need to make payments for tools and advanced production costs prior to the delivery of merchandise.

"He is handicapped by lack of knowledge of planned expansion by the Department of Defense."

The Small Business Committee is planning further organization on a regional basis so frequent meetings will be possible.

The aim of these meetings, according to Ray Zender of Lenz Electric, Chicago, will be educational.

"We need to call attention to government groups like the Small Business Administration," he told ELECTRONICS. "The small business executive has been missing out on the channels of operation where federal help is available. He should learn as much as he can about these for the good of his company."

Arrangements have also been made to have larger electronics firms demonstrate and explain what programs they administer in support of small business, Zender said.

Mercury Data Display

Console, by Stromberg-Carlson, displays Project Mercury capsule flight data and astronaut's reactions

Mideast Banks Use Tv, Computers

ELECTRONIC OFFICE EQUIPMENT, a few computers and some closed-circuit television are bringing "office automation" to the Near East.

Banks in Lebanon, Iraq and Jordan are already using multiple electronic bookkeeping systems provided by National Cash Register at $20,000 each.

Big computers are in use, too; Arabian American Oil uses an IBM705 and two electronic calculators; Bahrein Petroleum uses an IBM1401; Kuwait Oil and the Iranian Consortium use Hollerith 500-series systems.

Intra Bank of Lebanon, with 15 branches in various Arab countries, uses a closed-circuit tv from Siemens & Halske in it main Beirut office. The system is used to inspect and validate counter transactions.

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Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

MEETINGS AHEAD

Aug. 29-31: Metallurgy of Elemental and Compound Semiconductors, AIME, Statler Hotel, Boston.

Sept. 7-8: Value Engineering, EIA, Disneyland Hotel, Anaheim, Calif.

Sept. 7-8: Automatic Control, Joint Conf., ASME, IRE, AIEE, ISA, MIT, Cambridge, Mass.

Sept. 8-9: Conference on Technical Communications, Society of Technical Writers and Editors, Univ. of Dayton, Dayton, O.

Sept. 9-10: Communications: Tomorrow's Techniques—A Survey, IRE, Roosevelt Hotel, Cedar Rapids, Ia.

Sept. 11-16: American Chemical Society, Annual, Statler Hilton, New York City.

Sept. 13-14: Bionics Symposium, Applying Biological Principles to Engr. Design, ARDC, Wright Air Devel. Div., Dayton Biltmore Hotel, Dayton, O.

Sept. 14-15: Industrial Electronic Test Equipment Symposium, Armour Research Foundation, Chicago.

Sept. 15-16: Engineering Management Conf., IRE, Morrison Hotel, Chicago.

Sept. 15-17: Upper Midwest Electronic Conf., Twin Cities Elec. Wholesalers, Civic Auditorium, Minneapolis.

Sept. 19-21: Data Transmission, International Smp., PGCS of IRE and Sectie Voor Tele. of Koninklijk Ins. van Ingonieurs, Delft, Neth., Contact B. B. Barrow, Benelux Section, IRE, Postbus 174, Den Haag, Nederland.

Sept. 19-22: Space Electronics and Telemetry, Nat. Symposium, Shoreham Hotel, Washington, D. C.

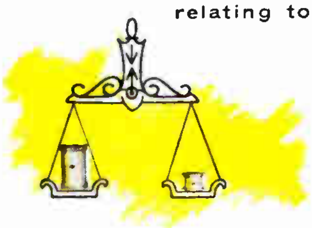
Sept. 21-22: Industrial Electronics, Annual, PGIE of IRE, AIEE, Sheraton-Cleveland Hotel, Cleveland.

Sept. 23-24: Broadcasting Symposium, PGB of IRE, Willard Hotel, Washington, D. C.

Oct. 10-12: National Electronics Conf., Hotel Sherman, Chicago.

a continuing series on technical topics relating to electronic applications

Folio 11 REFERENCE DATA FILE SANGAMO



Considerations In Selecting Mica Capacitors

Mica Capacitors may have identical capacitance and voltage rating on their name plates, yet one may be up to a hundred times larger than another—why? It is the purpose of this article to discuss how the dc voltage rating, rf voltage rating, rf current rating, corona starting voltage, and pulse application affects size and physical configuration of mica capacitors. Examples will be given showing typical Sangamo types that are used to account for these electrical environmental variations.

DC Voltage Rating — Many electronic applications require that a mica capacitor be used in a circuit of moderate to high-voltage dc with a slight ac voltage superimposed on it. Because mica exhibits a very low dissipation factor, very little heat is generated due to the small amount of ac. Of primary concern is the dc voltage stress. Mica has a very high dielectric-strength capability. Hence, required capacity can be contained in a package that is significantly small such as Sangamo's Types D, DR, KR, CR, H and A. (Figure 1)

Fig. 1

Type-DR Type-H Type-A

RF Voltage and Current Rating — Like the small mica capacitors described above, capacitors of a larger size are frequently required to operate with a comparable dc voltage across their terminals. However, in transmitting rf oscillator tank circuits, radio frequency is predominant and the primary requirement is the ability to handle a large magnitude of rf current. It is therefore necessary to use a capacitor that can dissipate the heat generated

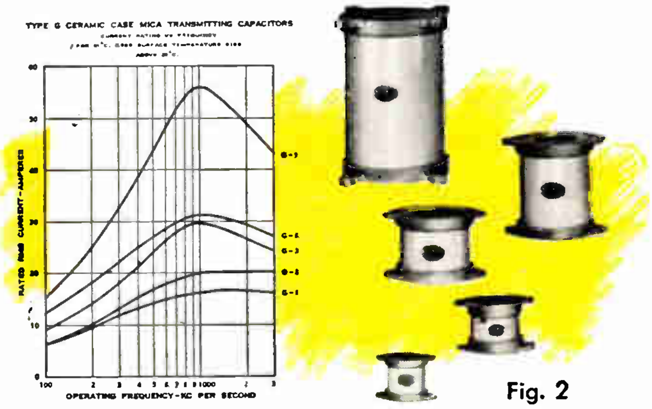


Fig. 2

by the rf field. Because these factors are so important, transmitting capacitors are rated in rms current and peak working volts. They are usually potted in a material that has a high thermal conductivity and packaged to have a large surface area. Sangamo's Types E, F, and G are examples of high rf current application capacitors Figure 2 shows, for example, the relative size and current-carrying ability of Types G1, G2, G3, G4 and G5.

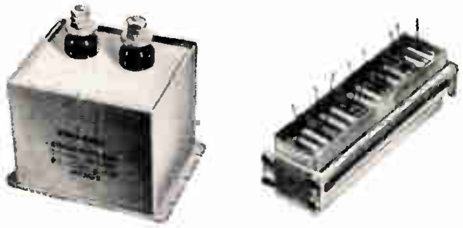
Corona Starting Voltage — Corona can occur in any capacitor where the conditions are right. Capacitor manufacturers are aware of this and design accordingly. Where amplitude and frequency of ac voltage across the capacitor are relatively low, a wax impregnant can be used. However, when voltage is low and frequency is high, a liquid impregnant is used. The difference is due to the physical nature of the impregnant. The wax, when cooling, leaves holes and promotes corona, while a liquid impregnant is homogeneous. A typical example of a liquid impregnated capacitor that is used for miniaturization, low distributed inductance, and high frequency applications is the Sangamo Button® Capacitor. (Figure 3)

Fig. 3

Type M-23 Type M-63 Type M-72

Pulse Application — Unfortunately there are no industry standards on capacitor ratings for pulse applications. Design and testing of these capacitors follow individual specifications at the present time. Applications involving high-frequency pulse operation should be reviewed carefully with regard to corona and peak stresses. These two factors are very closely related to life expectancy of the capacitor. With the growth of pulse circuitry, users and manufacturers must begin to develop meaningful specifications, standards, and test procedures for pulse capacitors. Figure 4 shows typical examples of Sangamo Capacitors designed for pulse applications. The Type N-87 is a multiple-section Sangamo mica capacitor designed for packaging with other components in a hermetically sealed, oil-filled enclosure.

Fig. 4



Type N-38 Type N-87

Your inquiry for more complete information on special applications of Sangamo mica capacitors is invited.

SC60-5

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ACTUAL SIZE

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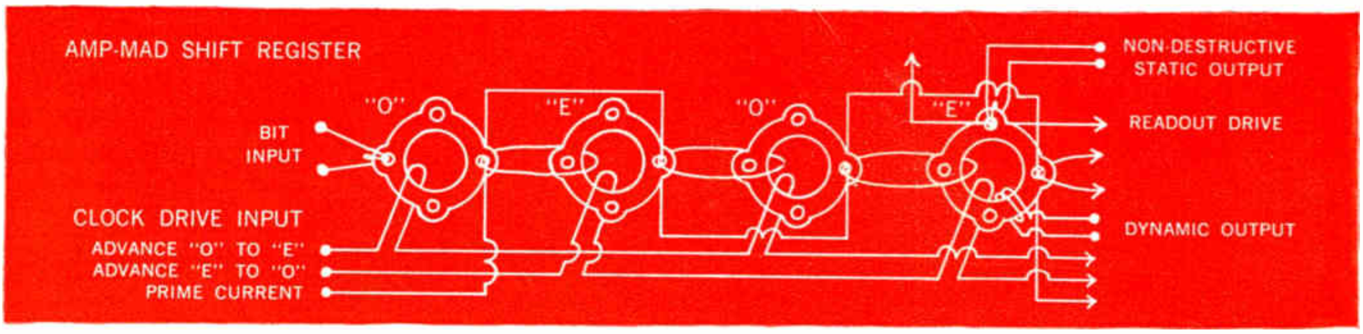
- small size—ideal for miniaturization requirements
- ultimate in reliability and simplification



For complete information, including operating data, send for our AMP-MAD Shift Register brochure.*

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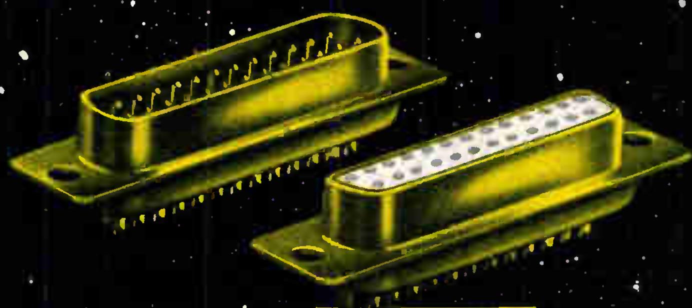

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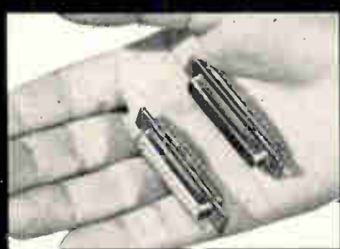

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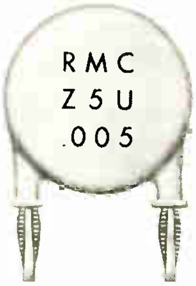

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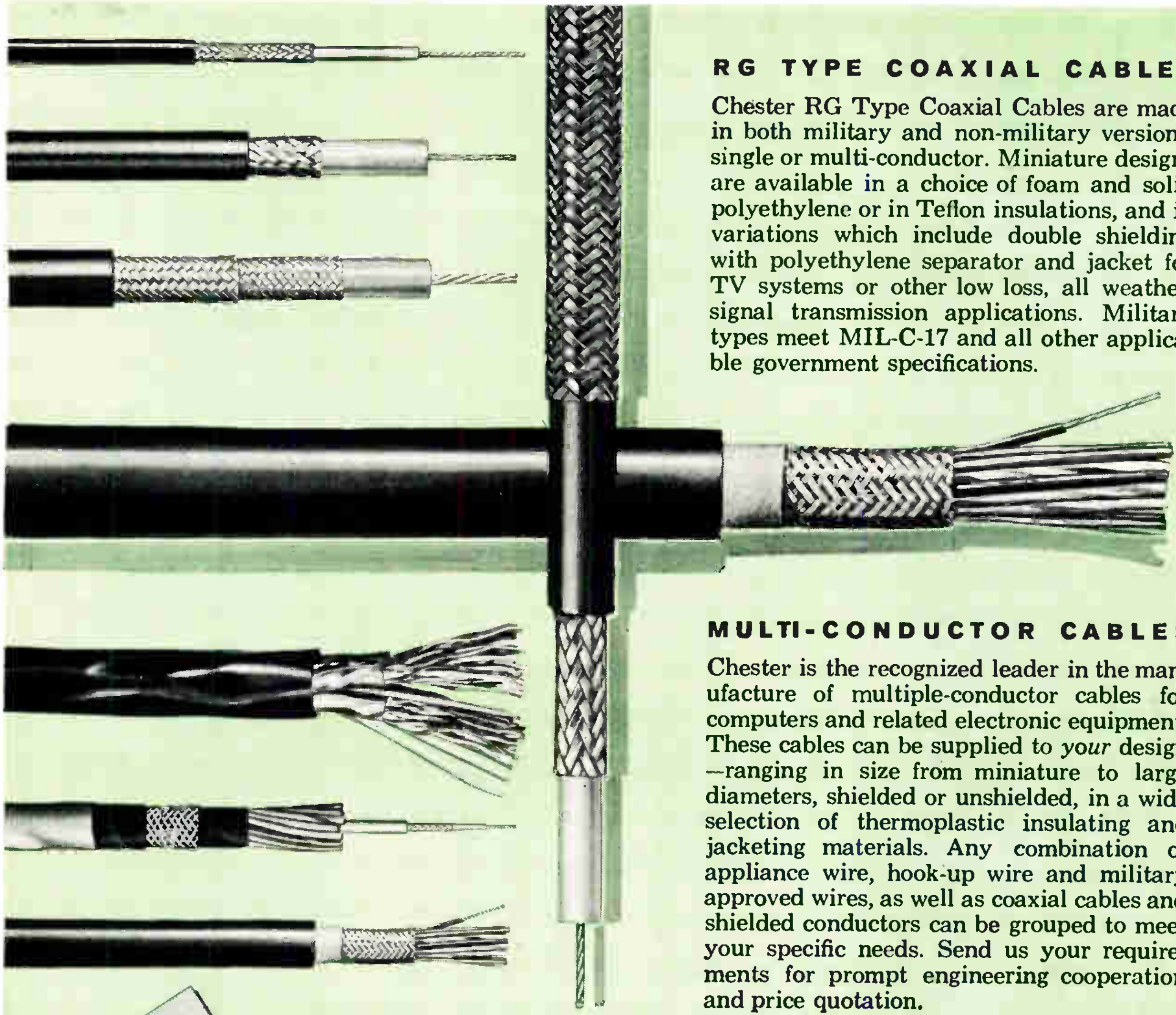

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Chester RG Type Coaxial Cables are made in both military and non-military versions, single or multi-conductor. Miniature designs are available in a choice of foam and solid polyethylene or in Teflon insulations, and in variations which include double shielding with polyethylene separator and jacket for TV systems or other low loss, all weather, signal transmission applications. Military types meet MIL-C-17 and all other applicable government specifications.

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CIRCLE 73 ON READER SERVICE CARD

Tung-Sol high power germanium transistors

2N174, 2N174A, 2N173, 2N278, 2N277, 2N443, 2N442, 2N441, TS748*

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Collector Voltage BV_{CB} ($V_{EB} = +1.5v$)	80	80	60	60	50	50	40	40	Volts
Collector Voltage BV_{CES} ($I_C = 0.3A$)	70	70	50	50	45	45	40	40	Volts
Emitter Voltage BV_{EBO}	60	60	40	40	30	30	20	20	Volts
Collector Current I_C	15	15	15	15	15	15	15	15	Amp
Junction Temperature T_j	−55 to +95	−55 to +95	−55 to +95	−55 to +95	−55 to +95	−55 to +95	−55 to +95	−55 to +95	°C

*The TS748 is specially designed to meet the requirements of MIL-T-19500/13A and is supplied with flexible leads.

...deliver up to 15 amperes

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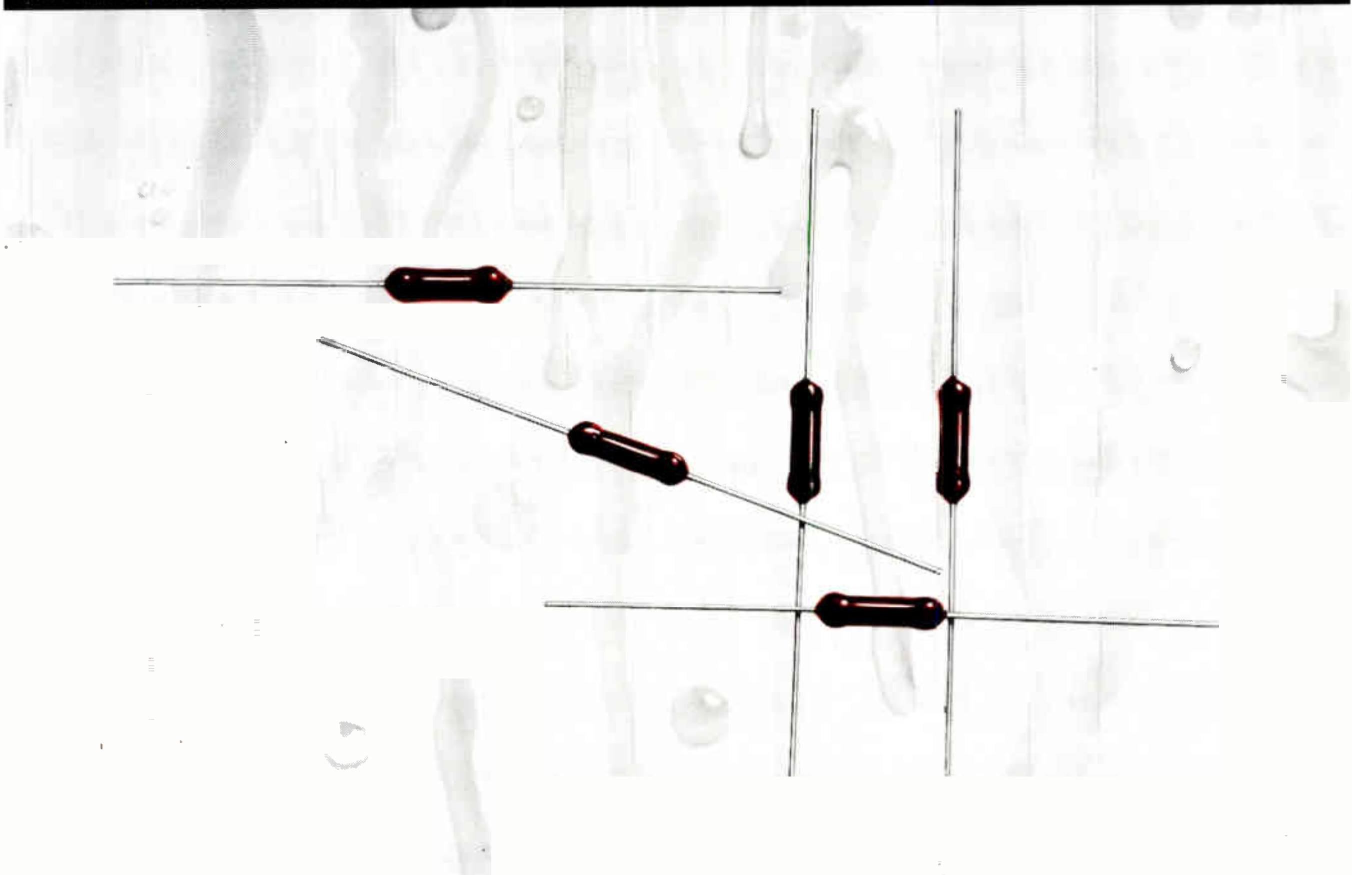
TUNG-SOL

In PRECISION FILM RESISTORS if it's news, expect it first from IRC



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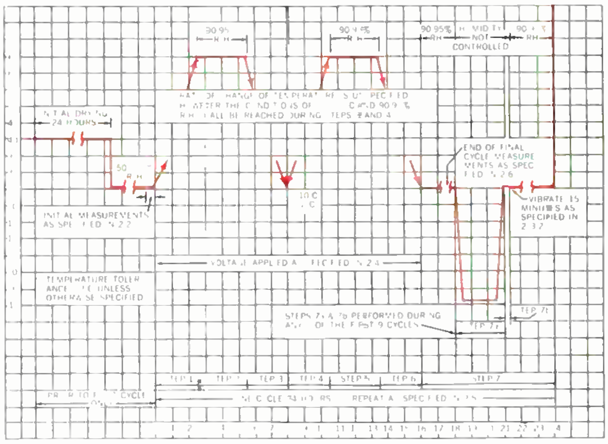
Superior Insulation—over 100 megohms *after* 30 cycles of moisture.

M Coat is currently available in the ½ watt size of IRC Precision Film Deposited Carbon Resistors, a type already noted for superior temperature characteristics, close tolerances, accuracy, and stability at high frequencies.

Rating: ½ watt at 70°C Ambient
Standard tolerance: ±1%
Range: 10 ohms to 2.49 megohms
Max. continuous working voltage: 350

Recommended Applications: Computer, amplifier, metering, and voltage divider circuits.



Graphical representation of moisture resistance test.

Write for Bulletin AE-15, International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

IRC

***Trademark Exclusive IRC Moisture-proof Coating*

Leading supplier to manufacturers of electronic equipment

RCA-50EH5–

a high power-sensitivity audio-output pentode for low-cost stereo amplifiers, radios, and 1-tube phonographs

If you're interested in a low-cost high-sensitivity stereo or monophonic amplifier design, here's the tube that makes it possible.

RCA-50EH5 is a 7-pin miniature power pentode with extremely high transconductance – 14,600 micromhos – and high power sensitivity at very low plate and screen voltages. This RCA workhorse delivers 1.4 watts power output with only 110 volts plate supply and a driving signal of only 3 volts peak.

Many design features contribute to the high performance of the 50EH5. New cathode base material minimizes inter-element leakage, cuts noise and hum, prolongs life and improves reliability. Improved heater material extends heater life. Special plate material minimizes gas-current runaway. And *EVERY RCA-50EH5 is thoroughly tested* for power output, hum, noise, shorts and continuity, emission and gas.

HIGH POWER-SENSITIVITY FOR LOW-COST STEREO!

Discover for yourself how this superlative performer points the way to better low-cost audio circuits. See your RCA Field Representative, or write directly to RCA Electron Tube Division, Commercial Engineering, Section H-19-DE-4, Harrison, N. J.

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The Most Trusted Name in Electronics
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CIRCLE 29 ON READER SERVICE CARD

New Developments in Computers

First six months of 1960 saw more than a dozen new systems enter the market, plus data-communications devices, peripheral equipment

By FRANK LEARY
Associate Editor

WITH THE YEAR half over, the computer industry is exhibiting a mixed appearance. There have been many new installations in the last six months, and more to go in every week; but the rate is slowing. Countering this are new capabilities and flexibilities, and many new systems, which are attracting new buyers.

Pace of new installations during the first half of the year is about half that of 1959. Middle-sized computers have fared better than either small or large ones in percentage of increase; of the more than 800 medium-sized systems currently installed, about 200 went in this year.

About 100 large systems have gone in, bringing total installations to more than 600. The population of small-scale general-purpose systems now approaches 3,000 installed, of which more than 400 went in this year.

This pace—good as it is—is slower than the installation rate last year when the computer population at least doubled. Informed industry opinion figures that delayed reaction from the 1958 recession is one cause. Another is undoubtedly caution inspired by fear of obsolescence.

With almost all computermakers praising their newest —and yet untried—systems to the implicit disparagement of older products, many businessmen are marking time, waiting for the transistorized systems to prove out in use.

Several factors are influencing the market for the better. Besides new and improved data-processing systems, data transmission over commercial lines or by microwave is attracting much attention. Several systems for carrying computer data rapidly from one place to another have recently been announced. Improvements in peripheral gear also are helping attract buyers.

New computer systems entering the market in the last six months include, in the large-scale category, IBM's 7074 and 7080, RCA's 601, the Univac III, Control Data Corp.'s CDC1604 and the Bendix G20.

New medium-sized systems include General Electric's GE225, the Honeywell 400 and Royal McBee's RPC9000. Among small systems, the CDC160 of Control Data, the Monrobot XI, RCA's 301, Royal McBee's RPC4000 and Packard Bell's PB250 are new.

Deliveries of these systems so far are limited to three CDC1604s, one RPC9000, one CDC160 and four Monrobot XIs, according to a recent census. The same count also reveals that, among previously announced systems, no IBM7080s or Honeywell 800s have as yet been installed.

Installations of National Cash Register's NCR304 system (with central computer and some other electronics made to order by GE) have started this year, as have installations of the Philco 2000 and IBM7070.

Of the new systems just entering the market, none marks a radical departure from previously announced technology. IBM's 7074 is an outgrowth of the 7070, made by replacing three modules of the older computer with two faster modules. The company says the 7074 is twice as fast as the 7070 for business processing, up to 20 times as fast for scientific work.

Remington Rand says its Univac III has a processing speed nine times faster than the Univac II. It is an all solid-state system, using both transistors and high-speed magnetic amplifier circuitry. Fast tape units permit a data-transfer rate on input and output of 133,000 alphanumeric or 200,000 numeric characters a second.

Systems for bank bookkeeping are catching on fast. Burroughs says some 60 of its visible-record computers are on order; an undisclosed number of IBM's bank systems has also been ordered. General Electric has installed two of its GE210 bank systems, one for California's giant Bank of America, the other for the First National Bank of Arizona.

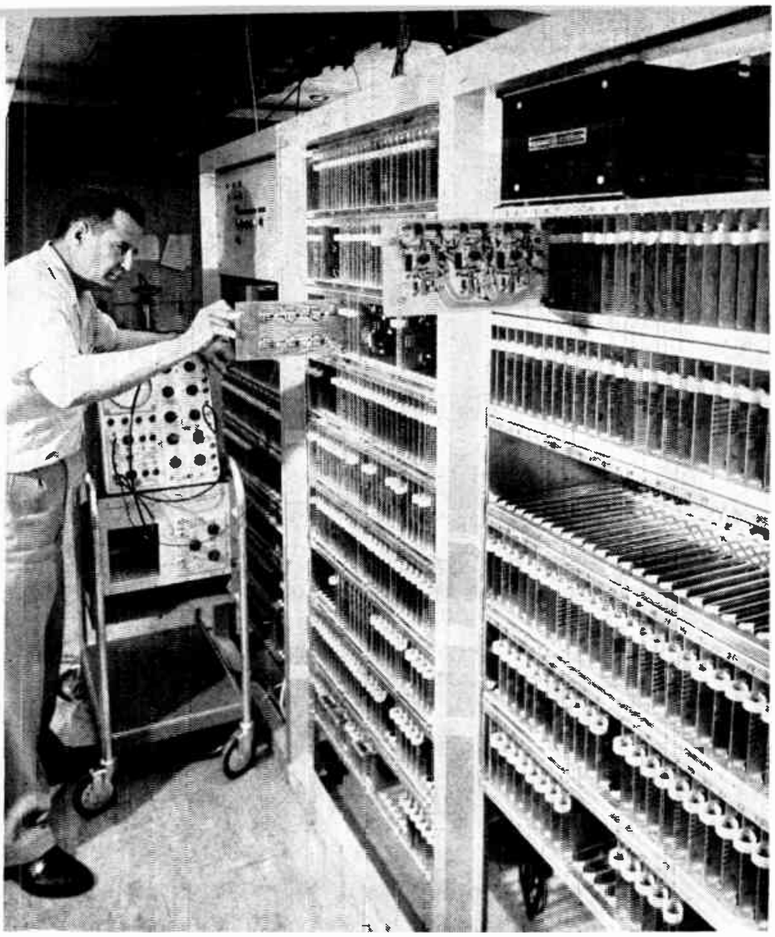
There are several developments in data-communications. IBM's 1009 data-transmission unit permits the company's small 1401 computers—of which some 3,000 are reported on order—to enter into direct memory-to-memory communication with each other over telephone lines. Data flows at 150 characters a second from the core storage of the 1401 through a 1009 unit into a modulating subset provided by the utility company.

After passing over telephone or telegraph lines, the information goes through a demodulating subset, through another 1009 and to the core storage of the receiving 1401. Operators using telephone facilities merely dial the number of the receiving office, switch on the subset, and hang up when the data transfer is concluded.

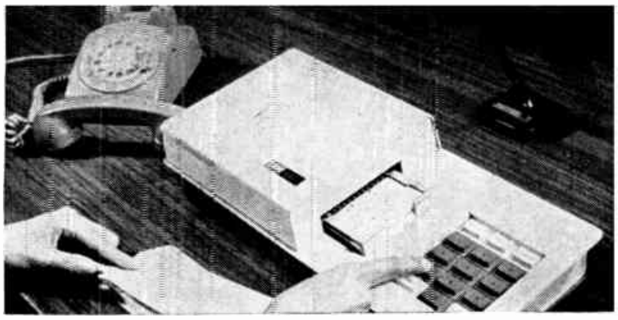
Collins Radio has built two data-transmission systems. One, a magnetic-tape system, connects Army's Signal Supply Agency in Philadelphia to a signal depot in Lexington, Ky., 650 miles away. The other links a Douglas Aircraft engineering department in Charlotte, N. C., to the Douglas computing center 2,200 miles distant in Santa Monica, Calif. Each can transmit data at 300 characters a second over commercial telephone lines. The Douglas link uses punch-card data; the Signal Corps hookup transmits directly between IBM magnetic-tape units.

Telautograph Corp. has installed an interrogation system using standard teletypewriter lines and Olivetti interrogating sets to permit 20 remote locations to get information from an IBM Ramac computer installed at Lockheed's big West Coast plant.

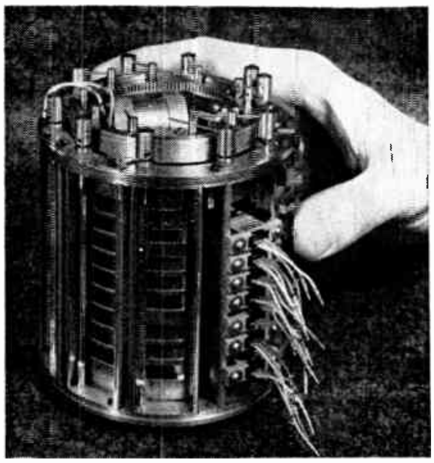
IBM's data-transmission system (see photo) permits transfer of card-punched data over telephone



Among new computers is this medium-scale data-processing system from General Electric, designated the GE225



IBM 1001 data-transmission system connects card reader and keypunch to remote card-punching unit by commercial telephone lines



Miniaturization of electromechanical components is demonstrated by this new drum, capable of holding 100,000 bits

lines, also can be used to enter new data from a keypunch through the same remote unit. Receiving station is a card punch modified with a data translator. Modulating and demodulating subsets are provided by the telephone company; the telephones can also be used for normal voice communications. Transmission speed for punched cards is about 12 columns a second.

Motorola has developed a data-transmission multiplex system capable of sending 62,000 characters a second by microwave relay. System works from magnetic-tape input, converts data recorded in parallel to serial form, inserts timing pulses to separate alphanumeric characters. A single wideband subcarrier is used for the data. A parallel-transfer system using several subcarriers has also been developed: systems in use can transmit data at 15,000 characters a second.

New types of auxiliary equipment have increased the flexibility and speed of data-processing. IBM is producing a device to convert data punched on paper tape directly onto magnetic tape for computer use. Machine reads standard 5-level or IBM 8-level code at 150 characters a second, writes 7-track magnetic tape of the type used in IBM data-processing equipment.

Univac III came onto the market able to work with magnetic tape or a 700-card-a-minute card reader, can also convert card-punched or paper-tape data onto magnetic tape. Printers working with currently marketed big systems are commonly in the 500-, 700-, or 1,000-line-a-minute class.

New device recently released by IBM, called the 870, permits a user to type a document in two copies, simultaneously record the same information on two punch cards and one paper tape.

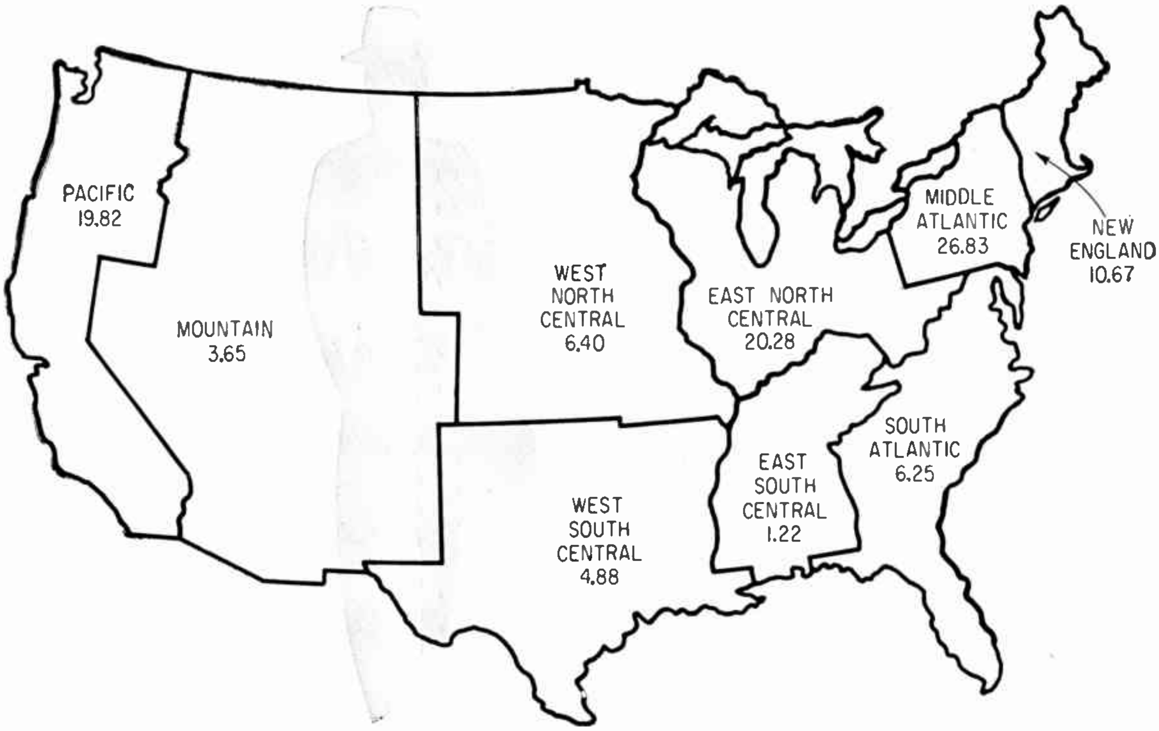
Other recent work is stressing the reduction in size of electromechanical components, to match the reductions afforded in electronic gear by transistorization.

IBM recently announced, for example, the development of a 6-oz drum 3 in. long and 3 in. in diameter (see photo) that can hold 100,000 bits of information. The drum spins at 6,000 rpm; heads are embedded in slider bearings that float on the airstream 0.0001 in. away from the drum surface.

Many computers produced heretofore are memory limited; the high-speed processing capabilities are held up by requirements of memory lookup, latency, readout and regeneration, and so forth. Increased high-speed core storage has helped minimize this problem. In its new 1401 system, IBM offers a basic 4,000-character storage; to increase the small system's flexibility, the company added a 1406 storage unit which can expand the memory to 16,000 characters. Univac III has 16,384 words of core storage which can be expanded to double that capacity.

Automatic program-interrupt features which permit the programmer to interlace several problems and program the priority of the procedure have been added to most large systems. The Philco 2000, CDC1604, Univac III and most of the other large systems entering the market contain this capability.

Programming in general is now being recognized as an essential part of computer manufacture. Compiling routines are designed as part of new systems prior to their being offered for sale. GE's 225, for instance, is sold with a general compiler as part of the system.



Distribution of electronics reps. Figures represent percentage of U.S. total in each region

Manufacturers' Reps to Sell $2½ Billion

By EDWARD DeJONGH
Market Research Editor

MANUFACTURERS' REPRESENTATIVES will sell about $2½-billion-worth of the products manufactured by the U.S. electronics industry this year. The figure represents 25 percent of total factory-sales volume of approximately $10 billion anticipated by the industry for 1960. Last year, rep sales totaled $2.2 billion.

Information comes from ELECTRONICS' 1960 Survey of Electronics Manufacturers' Representatives, and provides the first estimate of rep sales ever made from a broad sample of actual sales by rep firms.

ELECTRONICS surveyed 1,450 representatives, including 1,150 from the U.S., nearly 80 percent of the 1,500 reps who serve the industry in this country. Replies were received from 685 firms, of which 656 were from the U.S. and 29 from foreign sources, mostly from Canada and Mexico.

Typical rep among the 483 who supplied information on expected sales volume for 1960 looks for a 25-percent sales increase over 1959, indicating total rep sales of $2.8 billion for the year. But in evaluating the sampling, allowance was made for possibly decreased sales expectations among those who did not reply. Also, many estimates were made in the first quarter of the year, when Soaring-Sixties thinking was stronger than it is today.

Survey conclusions check with informed opinions in electronics representative circles. Bill Weber, executive secretary of Electronic Representatives Association, says "Total sales of the reps in this country had previously been roughly estimated at between $2½ and $3 billion."

Many firms are thinking of 1960 sales increases far in excess of the 25-percent average. A sixth of the respondents expect at least a 50-percent increase, and 3 percent of them look for sales to double.

Related sales information uncovered by the survey shows the 1,500 firms in industry employ 6,055 salesmen, an average complement of four salesmen per firm.

Sales of the average-sized firm in 1959 amounted to $1,464,000, with the average salesman turning in business worth $367,000 during the year.

Geographical distribution of rep organization headquarters has changed little in the past year. Returns from the current survey show that 67 percent of all rep activity is centered in three main regions. The Middle Atlantic region has 27 percent of all U.S. reps, the East North Central region 21 percent, and the Pacific region 20 percent (see map).

Comparison with last year's survey shows the three leaders, as a group, have dropped three percent. Each of four other regions—New England, South Atlantic, East South Central and Mountain—made gains of up to one percent of the U.S. total, while the West South Central region was off slightly.

Reps are continuing to maintain the technical level of their personnel. As in last year's survey, 90 percent of the respondents said they have engineering or technical talent with special knowledge of electronic equipment.

Previously growing interest in taking on additional services and functions is apparently leveling off. One out of four say they are equipped to service electronic equipment, about the same ratio as last year. Seventeen percent report they are willing to handle contracts to service industrial electronic equipment in their territories; in 1959, 21 percent expressed the same willingness.

There was a small decline in the number who expressed interest in soliciting business from jobbers. Percentage was down from 69 percent in 1959 to 67 percent in 1960. It has been previously thought that rep activity in soliciting jobber business would increase this year because of increased activity of jobbers or distributors in selling components to original equipment manufacturers.

However, there was some increase in the percentage of jobber reps, those reps who spend 50 percent or more of their sales efforts on jobbers. Respondents who say they distribute their effort this way numbered 21 percent, up a percentage point from 1959.

Number of reps with storage or warehouse facilities is slightly more than half, hardly changed from last year.

Five hundred representatives, or three out of four respondents, mention interest in acquiring new manufacturers' lines. Components (not specified by type) are most wanted items, with 371 mentions, followed by instruments with 79. Most popular specific components sought are relays, transistors and semiconductors, capacitors, connectors and microwave components. Test and measuring equipment (not specified) are top items in the instrument group, followed by meters and oscilloscopes.

Hi-fi is one product much sought after in the end-equipment field. Computers or data-processing equipment and microwave equipment trailed.

Among replies which did not fit a specific product group were 43 who said they want jobber lines and nine who would like to add systems.

ERA has just completed a related survey of rep operating expenses among its member firms, which shows that average representative's net profit before taxes in 1959 was 10.6 percent of total commission income. Largest single item of expense in the 89.4-percent overhead total was salaries, which account for 49.1 percent of total commission income.

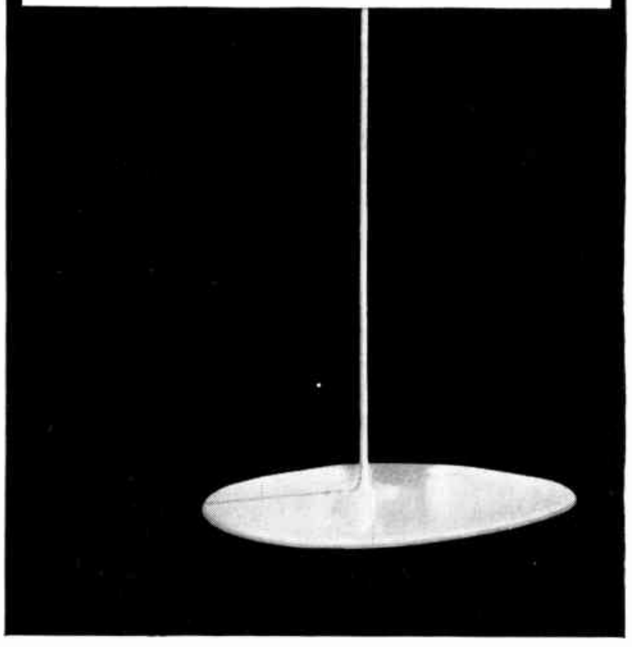
General Electric RTV* liquid silicone rubber

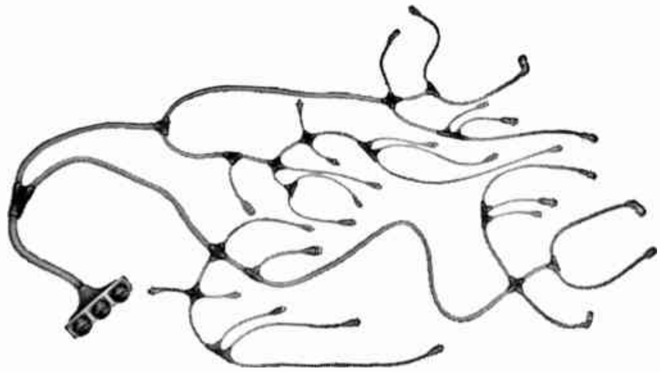
*Room Temperature Vulcanizing

New low viscosity for easier encapsulation and impregnation

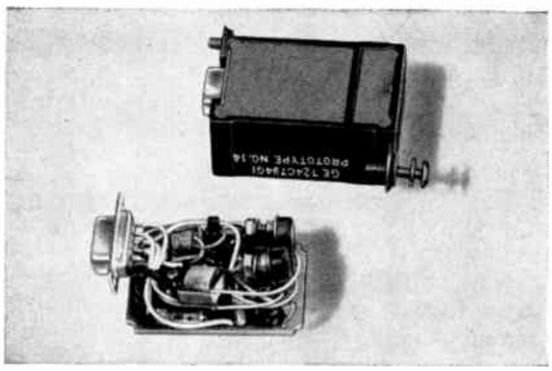
The latest addition to General Electric's RTV family offers lower viscosity than any other available silicone rubber compound — a typical viscosity of 120 poises. Easily pourable, it flows freely in and around intricate contours, making it ideal for protecting electrical and electronic components.

With RTV's new low viscosity, the range of G-E RTV compounds now extends from 120 to 12,000 poises. You can now meet your specific requirements by selecting from several G-E RTV compounds, all of which offer room temperature cure, heat and ozone resistance, and good electrical properties. Write for a free test sample, briefly describing your application.

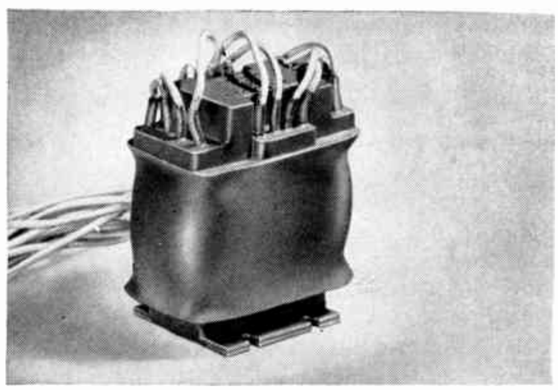




General Electric silicone rubber used extensively by Aerojet-General Corp. for the Titan ICBM's propulsion-system wiring harness. Breakouts and junctions molded from G-E RTV, wiring is silicone insulated, jacketing is high-strength G-E silicone rubber — all chosen for their stable insulating properties, resistance to temperature extremes and weathering, and stability in storage for many years.



Sight amplifier module potted with RTV by the Armament and Control Section of G.E.'s Light Military Electronics Department. Used on the Lockheed CF-104 and F-104G jet aircraft, RTV provides mechanical support and vibration damping, protects unit against moisture and ozone. (Bottom photo shows module before potting.)



High-voltage, high-altitude transformers from Laboratory For Electronics, Inc. are encapsulated with General Electric RTV to meet MIL-T-27A specs. This prevents flashover at maximum ratings of 2200 volts rms and 80,000 feet. General Electric RTV was selected for its good heat transfer, low viscosity and mechanical strength.

GENERAL ELECTRIC

Silicone Products Department, Waterford, New York

SARKES TARZIAN

SILICON ZENER VOLTAGE REGULATORS

Tarzian silicon voltage regulators, commonly called zener diodes, are constant voltage devices used to control output voltage of power sources and as voltage reference elements capable of operating over a wide temperature range. Hermetic sealing and mechanical ruggedness provide long term reliability even under the most adverse conditions.

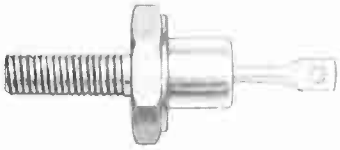
Three power classifications cover a wide range of applications.

¼ Watt Zener Regulators

Specifications 25°C.

1 Watt Zener Regulators

Specifications 25°C.



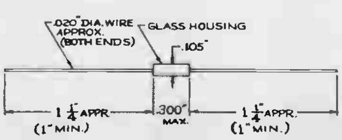
10 Watt Zener Regulators

Specifications 25°C.

Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)	Jedec Type	Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)	Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)	Jedec Type
.25T5.6	5.6	25	3.6	1N708	1T5.6	5.6	100	1.2	10T5.6	5.6	1000	1	1N1803
.25T6.2	6.2	25	4.1	1N709	1T6.2	6.2	100	1.5	10T6.2	6.2	1000	1	1N1804
.25T6.8	6.8	25	4.7	1N710	1T6.8	6.8	100	1.7	10T6.8	6.8	1000	1	1N1805
.25T7.5	7.5	25	5.3	1N711	1T7.5	7.5	100	2.1	10T7.5	7.5	1000	1	1N1806
.25T8.2	8.2	25	6.0	1N712	1T8.2	8.2	100	2.4	10T8.2	8.2	1000	1	1N1807
.25T9.1	9.1	12	7.0	1N713	1T9.1	9.1	50	3.0	10T9.1	9.1	500	1	1N1808
.25T10	10	12	8.0	1N714	1T10	10	50	3.5	10T10	10	500	2	1N1351
.25T11	11	12	9.0	1N715	1T11	11	50	4.2	10T11	11	500	2	1N1352
.25T12	12	12	10	1N716	1T12	12	50	5.0	10T12	12	500	2	1N1353
.25T13	13	12	11	1N717	1T13	13	50	5.8	10T13	13	500	2	1N1354
.25T15	15	12	13	1N718	1T15	15	50	7.6	10T15	15	500	2	1N1355
.25T16	16	12	15	1N719	1T16	16	50	8.6	10T16	16	500	3	1N1356
.25T18	18	12	17	1N720	1T18	18	50	11	10T18	18	150	3	1N1357
.25T20	20	4	20	1N721	1T20	20	15	13	10T20	20	150	3	1N1358
.25T22	22	4	24	1N722	1T22	22	15	16	10T22	22	150	3	1N1359
.25T24	24	4	28	1N723	1T24	24	15	18	10T24	24	150	3	1N1360
.25T27	27	4	35	1N724	1T27	27	15	23	10T27	27	150	3	1N1361
.25T30	30	4	42	1N725	1T30	30	15	28	10T30	30	150	4	1N1362
.25T33	33	4	50	1N726	1T33	33	15	33	10T33	33	150	4	1N1363
.25T36	36	4	60	1N727	1T36	36	15	39	10T36	36	150	5	1N1364
.25T39	39	4	70	1N728	1T39	39	15	45	10T39	39	150	5	1N1365
.25T43	43	4	84	1N729	1T43	43	15	54	10T43	43	150	6	1N1366
.25T47	47	4	98	1N730	1T47	47	15	64	10T47	47	150	7	1N1367
.25T51	51	4	115	1N731	1T51	51	15	74	10T51	51	150	8	1N1368
.25T56	56	4	140	1N732	1T56	56	15	88	10T56	56	150	9	1N1369
.25T62	62	2	170	1N733	1T62	62	5	105	10T62	62	50	12	1N1370
.25T68	68	2	200	1N734	1T68	68	5	125	10T68	68	50	14	1N1371
.25T75	75	2	240	1N735	1T75	75	5	150	10T75	75	50	20	1N1372
.25T82	82	2	280	1N736	1T82	82	5	175	10T82	82	50	22	1N1373
.25T91	91	1	340	1N737	1T91	91	5	220	10T91	91	50	35	1N1374
.25T100	100	1	400	1N738	1T100	100	5	260	10T100	100	50	40	1N1375

NOTES: Standard tolerance is ± 10% however, closer or wider tolerances are available on request.
Also available on request:
(a) Special voltage ratings.
(b) Symmetrical double anode types (for clippers).

DIMENSIONS



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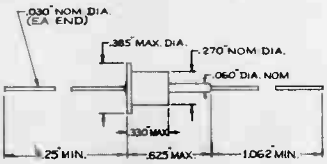

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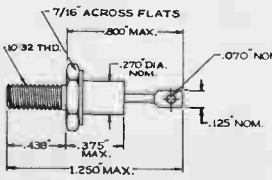
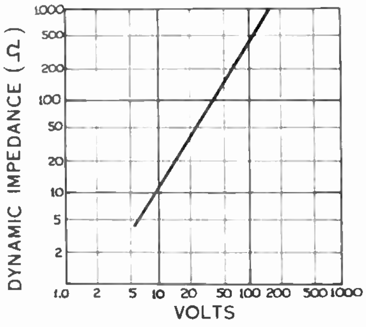


SARKES TARZIAN SILICON VOLTAGE REGULATOR ZENER DIODES
Characteristics and Application

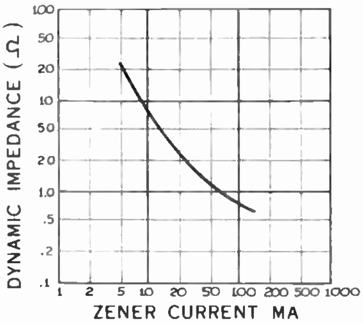
Dynamic Impedance

Dynamic impedance is a measure of voltage change effects on operating current and provides a practical measure of regulating performance. Dynamic impedance is measured by superimposing a small AC current upon the DC test current and measuring the resultant voltage across the diode.

The following curves show the effects of voltage and current on dynamic impedance.

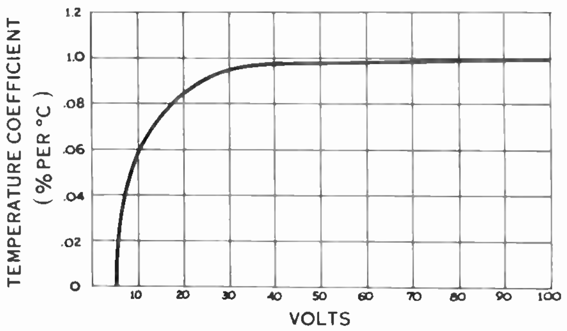


TYPICAL CURVE FOR 1T7.5



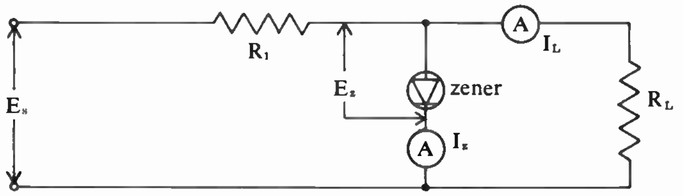
Temperature Coefficient

The operating voltage of a silicon regulator changes with operating temperature. This characteristic must be considered in design. The following curve shows temperature—voltage relationships typical in silicon zener diodes.



Typical Application

REGULATOR CIRCUIT



As the input voltage increases the inverse bias across the zener diode will increase and cause a large current to flow. This increase will cause more current to flow through R_1 and increase the drop thereby adjusting the load voltage. Load variations have a similar effect. The result is a substantially constant output voltage.

Determination of R_1 is as follows:

$$R_1 = \frac{E_s - E_z}{I_z + I_L}$$

$$I_z = \left(\frac{E_s - E_z}{R_1}\right) - I_L$$

$$P_z = \left(\frac{E_s - E_z}{R_1} - I_L\right) E_z$$

Where:

- R_1 is the series resistor
- E_s is the source voltage
- E_z is the zener diode voltage
- I_z is the zener diode current
- I_L is the load current
- P_z is the zener diode power dissipation

Where the load current and input voltage are variable:

$$R_1 = \frac{E_s\,(\text{min.}) - E_z}{I\,(\text{max.}) + .1 I_L\,(\text{max.})}$$

$$P_z\,(\text{max.}) = \left(\frac{E_s\,(\text{max.}) - E_z}{R_1} - I_L\,(\text{min.})\right) E_z$$

For constant load current but variable input voltage:

$$R_1 = \frac{E_s\,(\text{min.}) - E_z}{I_L + .1 I_L}$$

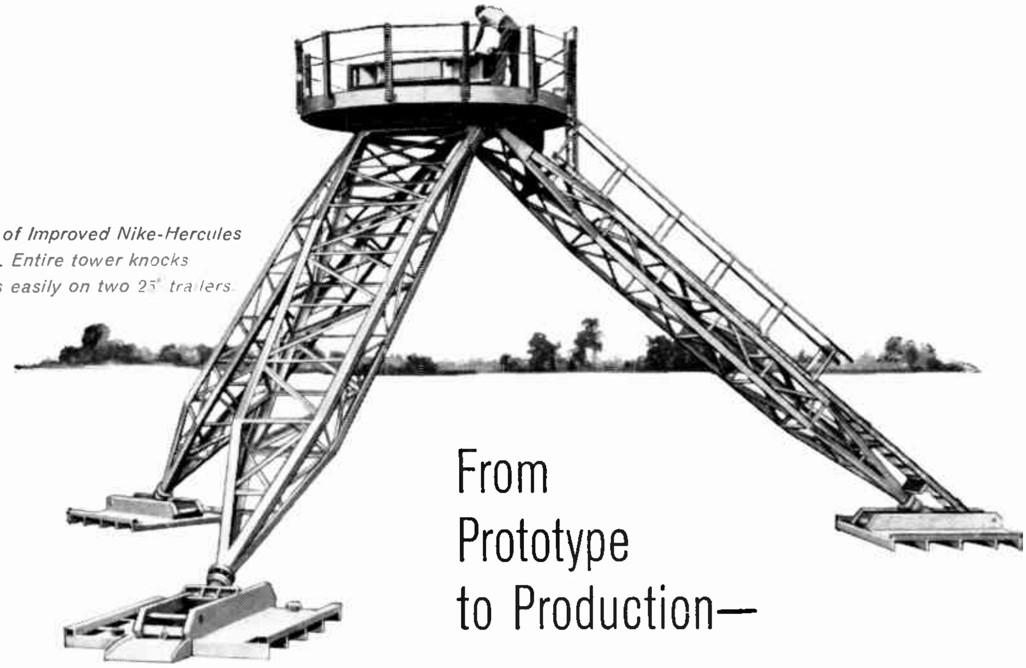
$$P_z\,(\text{max.}) = \left(\frac{E_s\,(\text{max.}) - E_z}{R_1} - I_L\right) E_z$$

For constant input voltage but variable load current:

$$R_1 = \frac{E_s - E_z}{I_L\,(\text{max.}) + .1\,I_L\,(\text{max.})}$$

$$P_z\,(\text{max.}) = \left(\frac{E_s - E_z}{R_1} - I_L\right) E_z$$

NOTES: The above equations allow a tolerance of 10% to compensate for load regulation.
If dynamic impedance is a significant percentage of the value of R_1, this must be taken into consideration.
A high impedance source presents additional problems and must be considered if it is significant compared to R_1.



Field Army Version of Improved Nike-Hercules Radar Tower. Entire tower knocks down and packs easily on two 25' trailers.

From Prototype to Production—

Dresser-Ideco offers a complete antenna tower service

Fixed-Site Version of Improved Nike-Hercules Radar Tower incorporates the field army tower mounted on a 25' height-extension and fitted with a radome.

These antenna support structures for the U.S. Army's Improved Nike-Hercules Missile System illustrate the kind of complete structural service rendered by Dresser-Ideco Company.

In designing and building both the field army and fixed site versions of this tower for Bell Telephone Laboratories, Inc. and Western Electric Company, Dresser-Ideco performed the following services:

- **Conducted design and feasibility studies**
- **Made structural design analyses**
- **Prepared manufacturing shop drawings**
- **Wrote erection and maintenance manuals**
- **Manufactured the two prototype towers**
- **Erected and tested prototype of the field army tower**
- **Test-erected complete fixed-site tower**
- **Shipped and erected complete structure at White Sands Missile Range**

Far more than "steel burners," Dresser-Ideco personnel are highly specialized structural engineers and technicians. The company is fully staffed to provide complete structural steel services ranging from research and development to field erection and testing of prototypes and large-scale manufacture and installation of production units.

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Communications centers like this Kansas City installation are proving the value of electronics to police. Dictaphone recording gear (far wall) keeps audio record of all verbal exchanges

Police Gear Sales Springing Back

SALES OF ELECTRONIC gear to police departments are climbing back to levels they held prior to the 1958 recession, according to manufacturers interviewed this week.

From 1953 to 1957 the police market hovered slightly under $8-million annually. Estimates vary regarding the sales decline experienced during 1958 and 1959, but a frequently mentioned figure is 30 percent.

It's estimated that this year sales of electronic equipment to police users will top the $7-million mark, and pass the $8-million level by the end of 1961.

In commenting on the upturn, the more optimistic industry spokesmen say sales might surpass the figures they presently anticipate. In support of this, they mention the many areas where, in addition to communications, electronics are proving their value in police work.

Traffic-control systems, visual data transmission systems, certain computer applications, as well as accounting and general recordkeeping, all form part of this expanding market.

Although these and other areas are growing in importance, communications gear continues to account for the major portion of all sales. One manufacturer estimates that 10 percent of all mobile radio gear sold goes to police users. One New Jersey company says about 30 percent of its total volume is in police radio systems.

It is significant to note that at the Associated Police Communication Officers Conference held earlier this month in Philadelphia, 26 electronics manufacturers participated. In addition to technical papers presented by company engineers and administrators, there were exhibits of new systems and devices aimed at police use.

A spokesman for Allen B. DuMont Laboratories says the police market is a very competitive one, and points out that equipment must be built to take a quasimilitary usage and still maintain reliability.

A General Electric man points out the extremely cost-conscious nature of the police market, in which voters can examine the proposed budgets of their communities and approve or protest new facilities.

"At the same time," he told ELECTRONICS, "the police are an important influence in design of radio equipment and often lead the way on standards."

One sales manager calls the police field "our toughest market, but one of our most valued." From a sales point of view, the manufacturer must meet competitive open bidding in almost all cases.

The days when a contract to furnish communications gear and other equipment depended on contacts in the municipality, rather than on equipment reliability, have long passed. The open-bid situation, according to salesmen, drives down the price but proves rewarding in terms of volume.

Manufacturers speak with respect for police customers because of the level of their technical knowledge. Most departments, according to a number of manufacturers, are very knowledgeable technically and consider communications their right hand. Many police communications officers are old-line radio men who, in many cases, began their careers in ham radio.

Although manufacturers provide service facilities on a regional basis, many police departments have members with enough engineering background to service their own equipment.

One benefit electronics has brought to police groups, in addition to rapid communications and data transmission, is the facility to record all conversations.

Among equipment available for this purpose is Dictaphone Corp.'s line of police recording equipment. Departments use the gear to keep an audio record of all incoming calls. Police are able to check indistinct alarm calls, record false reports and inaccurate descriptions, receive moment-by-moment details of speeder chases and maintain an automatic radio log.

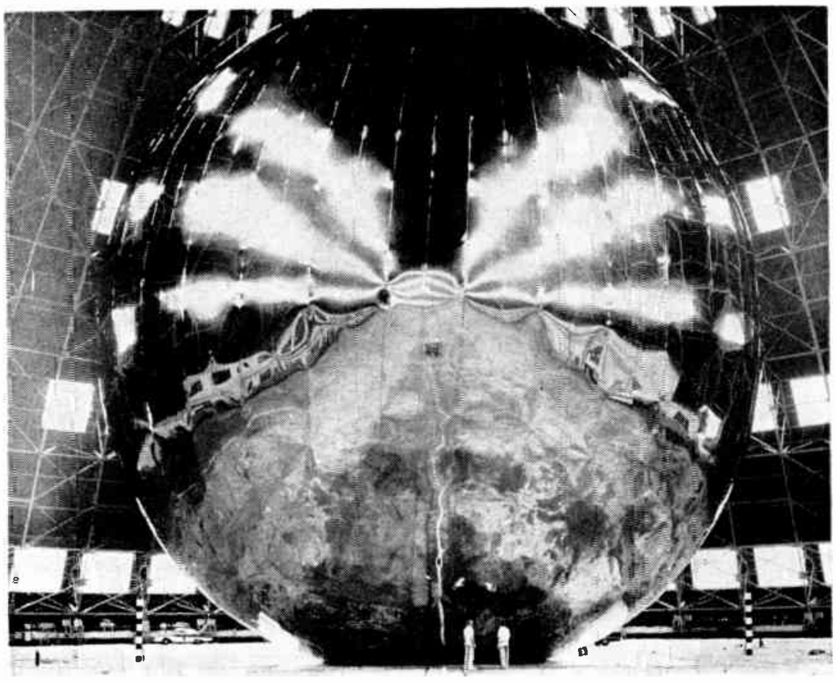
How Echo I Opens New Space Era

LARGEST SATELLITE ever orbited was lofted recently by National Aeronautics & Space Administration in an experiment designed to test the feasibility of global communications by passive satellite reflections.

Dubbed Echo I by NASA director Keith Glennan after is was successfully in orbit, the satellite went up after a launching-pad failure on May 13 and two postponements on Aug. 9 and 10.

Communications were established on the second orbit between Bell Telephone Laboratories' station at Holmdel, N. J., and the big dish at Goldstone, Calif., operated by CalTech's Jet Propulsion Laboratory for NASA.

First message, a statement by President Eisenhower, stressed that "peaceful purposes for the benefit of all mankind" inspired the experiment.



Two men (center) are dwarfed by 100-ft-dia communications satellite

Glennan described the launching as " well nigh perfect." The satellite—or satelloon, as some were calling it—was programmed to orbit 1,000 miles up at nearly 16,000 mph. Its two-hour circular orbit started at a southeasterly angle inclined 47 deg to the equator.

Echo is a 100-ft sphere of aluminized 0.0005-in. Mylar, weighs about 125 lb. It rode aloft deflated and packed in a 26½-in. cannister in the nose cone of a Thor-Delta rocket.

Upon ejection from the launcher, the two hemispheres of the cannister separated and the plastic sphere spilled free. Previously injected crystals of subliming solid inflated the sphere; the sublimation process will continue for a month or so to compensate for micrometeorite punctures.

A special horn-reflector antenna recently completed at Holmdel is the eastern terminus of the satellite link. Goldstone is using its 85-ft dish at the western terminus. Transmission frequency is 960 Mc westbound, about 2.39 Gc eastbound. F-m is used with a deviation of ± 150 Kc at the highest modulation frequency of 3 Kc.

Computermakers got into the act in a big way. The Echo satelloon's successful orbit was established by Bell Telephone Laboratories' command-guidance system, which uses the Athena computer to derive course-correction data. The computer was designed for the Titan ICBM by Remington Rand Univac, was used for the same purpose when NASA threw Tiros I into orbit on April Fools Day.

After launch, an IBM709 at NASA's Goddard Space Flight Center, Greenbelt, Md., was immediately put to work aiming the radio antennas on the East and West Coasts so they could find the sphere to bounce their signals off it.

Two other IBM709s were involved in the project. One, at Cape Canaveral, calculated velocity, trajectory and impact point of the rocket for the range safety officer. The other, at IBM's Space Computing Center in downtown Washington, is keeping precise tabs on Echo's orbit, also produces timetables for observers throughout the world.

Echo I is the first of 12 missions included in the Delta space-vehicle program. Other Delta launchings scheduled for 1960 include Tiros II, Echo II and a lunar probe.

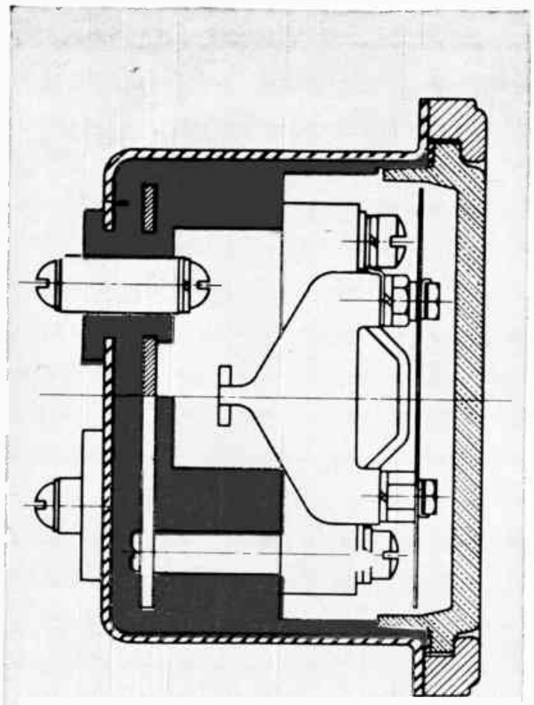
On the same day as the Echo I launch, a Navy helicopter finally was able to recover a capsule which had been ejected from a Discoverer satellite.

The 300-lb capsule was tossed out of Discoverer XIII over Alaska, retrieved in the planned recovery zone north of Hawaii. Air Force has been trying to recover a Discoverer capsule since February 1959; of twelve previous tries, seven went into orbit, six payloads were successfully ejected, four tries were made at recovery. One capsule is believed to have landed on Spitzbergen, may have been recovered by Soviet scientists.

The successes of Aug. 12 have followed a couple of disheartening failures. Besides the two Echo postponements, an attempt to rocket an unmanned Project Mercury capsule on July 29 was wrecked when the Atlas booster exploded shortly after takeoff and was lost in the Atlantic.

In other recent space developments:

McDonnell Aircraft has awarded a 5-month study contract to Collins Radio to investigate radio communications problem incident to soft-landing an unmanned spacecraft on the moon. Raytheon won a study contract to investigate active doppler velocity sensors for soft moon landings; aim is to find a system that will work 120 miles up over water, 360 over land.



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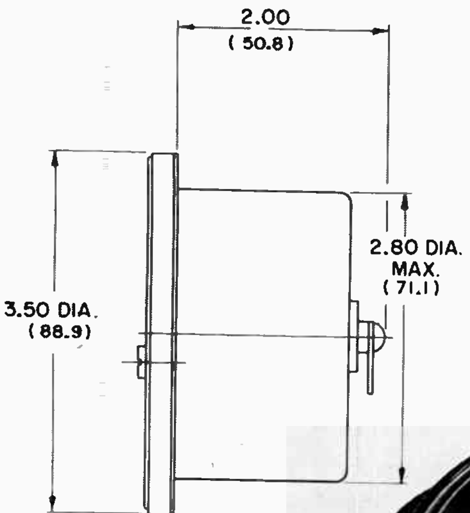

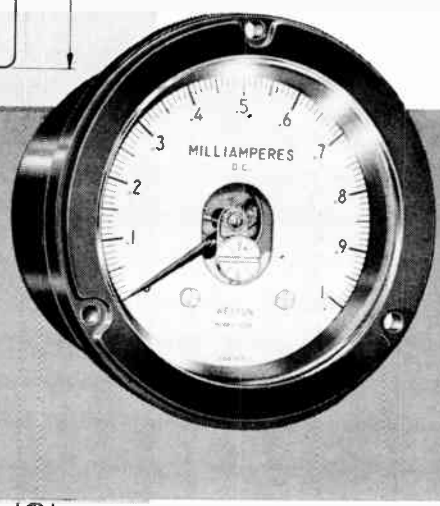

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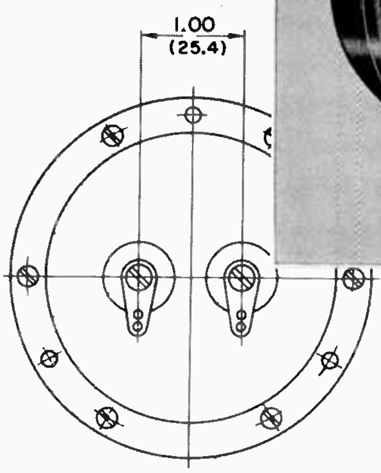

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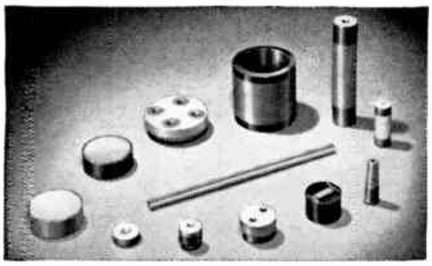

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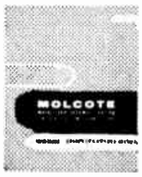

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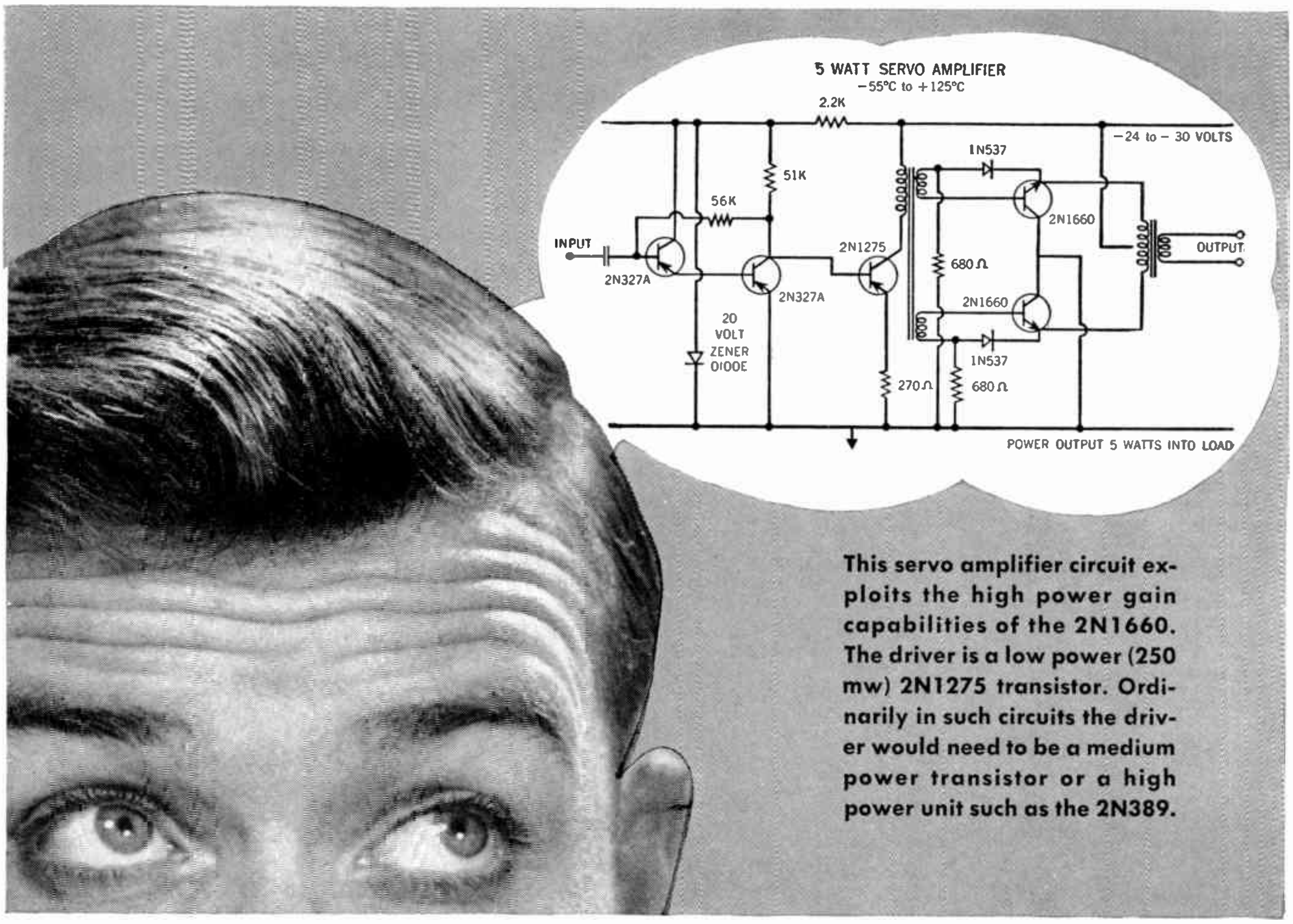

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2N1661	80	10	4.0	45	3.0	25
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2N1657	60*	3	3.0	15‡		
2N1470	60*	3	3.0	15‡		
2N389	60	10	5.0	12	8.0	
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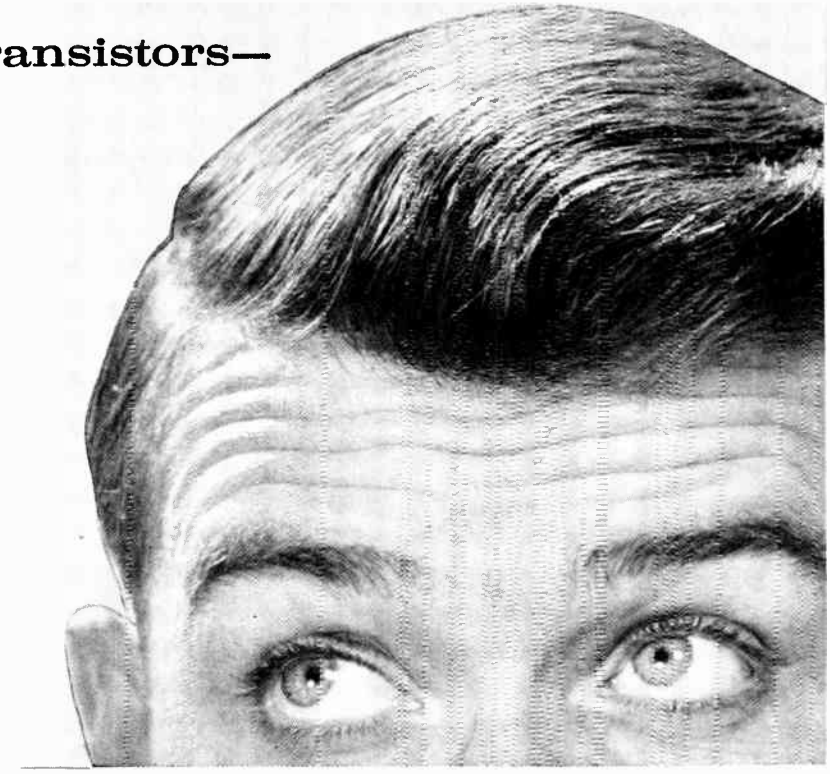

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Britain Steps Up Controls Research

Industrial instruments stressed as government gives funds to record total of 50 associations

LONDON—THE FIELD of industrial automatic controls is getting new attention in Britain, McGraw-Hill World News reports this week.

The British Scientific Instrument Research Association, after concentrating in its early years on laboratory-type instruments, is now embarking on a program of industrial instrument research.

Overall, Britain's pattern of cooperative industry research by government-aided associations is growing.

These are among highlights from a report just published by the Department of Scientific and Industrial Research (DSIR).

The report, "Research For Industry," reveals that in 1959 the number of government-aided research associations reached a new high of 50. Their income from both industry and government contributions totalled over $20 million, a hike of $1.1 million over 1958.

Of this total income, industry provided the bulk. DSIR contributed $4.7 million, a figure up by $840,000 over the 1958 contribution. This increased spending on research, says the report, is in line with the overall trend in Britain.

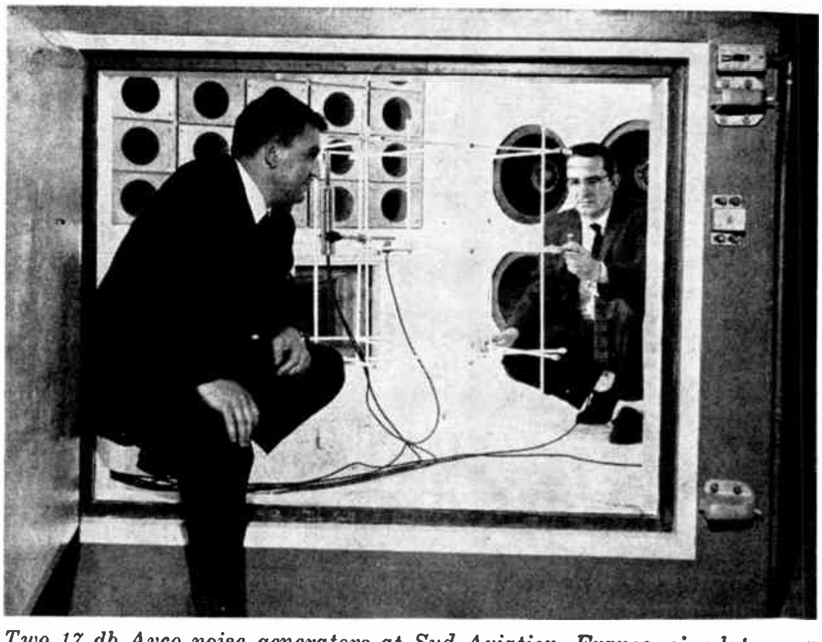
In 1958, manufacturers invested 4.2 percent of turnover in research and development, compared with 3.1 percent in 1955.

While each of the 50 research associations is an example of cooperative research within a section of industry, the report highlights three areas—creep, metal fatigue and shipbuilding—where combined research programs among several associations are in progress.

These are areas, reports the DSIR, where "we have aided the pooling of resources in all ways at our disposal."

On creep research the National Engineering Laboratory, cooperating with the National Physical Laboratory and the Electrical Research Association, has set up a creep information center to disseminate data on conventional British high temperature materials. A new laboratory slated to open in 1961 at a cost of around $450,000, will investigate creep phenomena in

Giant Noise for Testing Parts



Two 17 db Avco noise generators at Sud Aviation, France, simulate roar of rockets and jets to test parts under acoustic vibrations steam plant and turbine applications.

Fatigue research under a committee comprising the National Physical Laboratory and the British Welding Research Association is making its prime work investigations of fatigue failures of low-alloy high tensile steels in welded constructions. Aircraft and reinforced concrete structures are omitted from the committee's terms of reference. A report is due later this year.

The British Scientific Instrument Research Association is busy detecting elements and building up a card index on the 200 parameters that are measurable in industrial processes.

When complete, this bureau for detecting elements will provide industry with complete information of currently available techniques and their limitations. Other work includes development of position sensitive photo-conductive diodes capable of detecting a one angstrom unit movement in two directions at right angles. Also under development is a new gas flowmeter.

Japan to Export Tunnel Diodes

JAPAN's electronics industry continues to proliferate new consumer goods and components.

Hayakawa Electric of Osaka has come out with a transistor radio that operates off a silicon solar cell. Dubbed the sunshine radio, the set can operate from ordinary chemical batteries as well, is expected to retail at about $15 more than ordinary transistor radios. It will be produced on a trial basis until Hayakawa figures out if anyone wants to pay the premium for a radio that operates only when the sun is out.

In other news, Sony Corp. announces that its tunnel diodes will go on sale on the domestic market this month at prices ranging from $2.80 to $10. Monthly production levels are currently about 30,000, are expected to pass a million by November when Sony opens a plant at Atsugi, near Yokohama. After that, the fast switching components will be offered for export, and the manufacturing techniques will be offered for license.

Small Business Group to Meet

Problems, complaints to be studied Sept. 13 at Indiana conference. EIA playing key role

SMALL BUSINESS PROBLEMS are slated for more discussion and study by Electronic Industries Association members on Sept. 13 at French Lick, Ind.

The agenda for EIA's Small Business Committee meeting includes:

1) How small business can team up with large corporations and fill in gaps.

2) Review House of Representatives Bill No. HR 11207 defining small business.

3) Review protection of small business being considered by government regulation.

4) Review technical manpower being expended in military procurement for preparation of many elaborate but unsuccessful technical proposals.

5) Develop an up-to-date list of companies that can be classified as small business.

6) Consider establishing territories along the lines of Small Business Administration for regional decentralization of the activities under committee jurisdiction.

At a recently held regional conference, some small business firms took the opportunity to air some complaints. Speakers said:

"The small businessman suffers from the lack of progress payments during the development and prototype stage of a contract. He is also hampered by the need to make payments for tools and advanced production costs prior to the delivery of merchandise.

"He is handicapped by lack of knowledge of planned expansion by the Department of Defense."

The Small Business Committee is planning further organization on a regional basis so frequent meetings will be possible.

The aim of these meetings, according to Ray Zender of Lenz Electric, Chicago, will be educational.

"We need to call attention to government groups like the Small Business Administration," he told ELECTRONICS. "The small business executive has been missing out on the channels of operation where federal help is available. He should learn as much as he can about these for the good of his company."

Arrangements have also been made to have larger electronics firms demonstrate and explain what programs they administer in support of small business, Zender said.

Mercury Data Display

Console, by Stromberg-Carlson, displays Project Mercury capsule flight data and astronaut's reactions

Mideast Banks Use Tv, Computers

ELECTRONIC OFFICE EQUIPMENT, a few computers and some closed-circuit television are bringing "office automation" to the Near East.

Banks in Lebanon, Iraq and Jordan are already using multiple electronic bookkeeping systems provided by National Cash Register at $20,000 each.

Big computers are in use, too; Arabian American Oil uses an IBM705 and two electronic calculators; Bahrein Petroleum uses an IBM1401; Kuwait Oil and the Iranian Consortium use Hollerith 500-series systems.

Intra Bank of Lebanon, with 15 branches in various Arab countries, uses a closed-circuit tv from Siemens & Halske in it main Beirut office. The system is used to inspect and validate counter transactions.

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MEETINGS AHEAD

Aug. 29-31: Metallurgy of Elemental and Compound Semiconductors, AIME, Statler Hotel. Boston.

Sept. 7-8: Value Engineering, EIA, Disneyland Hotel, Anaheim, Calif.

Sept. 7-8: Automatic Control, Joint Conf., ASME, IRE, AIEE, ISA, MIT, Cambridge, Mass.

Sept. 8-9: Conference on Technical Communications, Society of Technical Writers and Editors, Univ. of Dayton, Dayton, O.

Sept. 9-10: Communications: Tomorrow's Techniques—A Survey, IRE, Roosevelt Hotel, Cedar Rapids, Ia.

Sept. 11-16: American Chemical Society, Annual, Statler Hilton, New York City.

Sept. 13-14: Bionics Symposium, Applying Biological Principles to Engr. Design, ARDC, Wright Air Devel. Div., Dayton Biltmore Hotel, Dayton, O.

Sept. 14-15: Industrial Electronic Test Equipment Symposium, Armour Research Foundation, Chicago.

Sept. 15-16: Engineering Management Conf., IRE, Morrison Hotel, Chicago.

Sept. 15-17: Upper Midwest Electronic Conf., Twin Cities Elec. Wholesalers, Civic Auditorium, Minneapolis.

Sept. 19-21: Data Transmission, International Smp., PGCS of IRE and Sectie Voor Tele. of Koninklijk Ins. van Ingonieurs, Delft, Neth., Contact B. B. Barrow, Benelux Section, IRE, Postbus 174, Den Haag, Nederland.

Sept. 19-22: Space Electronics and Telemetry, Nat. Symposium, Shoreham Hotel, Washington, D. C.

Sept. 21-22: Industrial Electronics, Annual, PGIE of IRE, AIEE, Sheraton-Cleveland Hotel, Cleveland.

Sept. 23-24: Broadcasting Symposium, PGB of IRE, Willard Hotel, Washington, D. C.

Oct. 10-12: National Electronics Conf., Hotel Sherman, Chicago.

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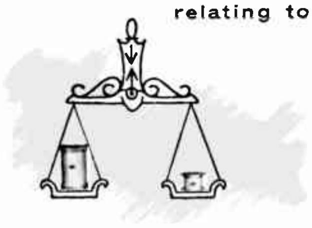
a continuing series on technical topics relating to electronic applications

Folio 11 REFERENCE DATA FILE SANGAMO



Considerations In Selecting Mica Capacitors

Mica Capacitors may have identical capacitance and voltage rating on their name plates, yet one may be up to a hundred times larger than another—why? It is the purpose of this article to discuss how the dc voltage rating, rf voltage rating, rf current rating, corona starting voltage, and pulse application affects size and physical configuration of mica capacitors. Examples will be given showing typical Sangamo types that are used to account for these electrical environmental variations.

DC Voltage Rating — Many electronic applications require that a mica capacitor be used in a circuit of moderate to high-voltage dc with a slight ac voltage superimposed on it. Because mica exhibits a very low dissipation factor, very little heat is generated due to the small amount of ac. Of primary concern is the dc voltage stress. Mica has a very high dielectric-strength capability. Hence, required capacity can be contained in a package that is significantly small such as Sangamo's Types D, DR, KR, CR, H and A. (Figure 1)

Fig. 1

Type-DR Type-H Type-A

RF Voltage and Current Rating — Like the small mica capacitors described above, capacitors of a larger size are frequently required to operate with a comparable dc voltage across their terminals. However, in transmitting rf oscillator tank circuits, radio frequency is predominant and the primary requirement is the ability to handle a large magnitude of rf current. It is therefore necessary to use a capacitor that can dissipate the heat generated

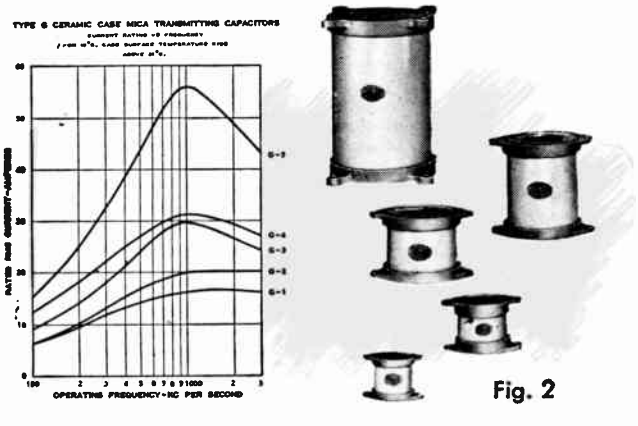


Fig. 2

by the rf field. Because these factors are so important, transmitting capacitors are rated in rms current and peak working volts. They are usually potted in a material that has a high thermal conductivity and packaged to have a large surface area. Sangamo's Types E, F, and G are examples of high rf current application capacitors Figure 2 shows, for example, the relative size and current-carrying ability of Types G1, G2, G3, G4 and G5.

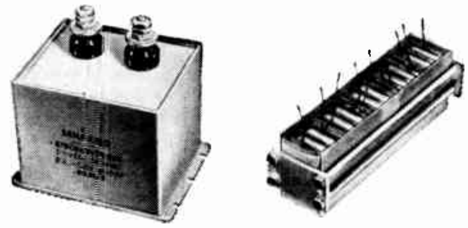
Corona Starting Voltage — Corona can occur in any capacitor where the conditions are right. Capacitor manufacturers are aware of this and design accordingly. Where amplitude and frequency of ac voltage across the capacitor are relatively low, a wax impregnant can be used. However, when voltage is low and frequency is high, a liquid impregnant is used. The difference is due to the physical nature of the impregnant. The wax, when cooling, leaves holes and promotes corona, while a liquid impregnant is homogeneous. A typical example of a liquid impregnated capacitor that is used for miniaturization, low distributed inductance, and high frequency applications is the Sangamo Button® Capacitor. (Figure 3)

Fig. 3

Type M-23 Type M-63 Type M-72

Pulse Application — Unfortunately there are no industry standards on capacitor ratings for pulse applications. Design and testing of these capacitors follow individual specifications at the present time. Applications involving high-frequency pulse operation should be reviewed carefully with regard to corona and peak stresses. These two factors are very closely related to life expectancy of the capacitor. With the growth of pulse circuitry, users and manufacturers must begin to develop meaningful specifications, standards, and test procedures for pulse capacitors. Figure 4 shows typical examples of Sangamo Capacitors designed for pulse applications. The Type N-87 is a multiple-section Sangamo mica capacitor designed for packaging with other components in a hermetically sealed, oil-filled enclosure.

Fig. 4



Type N-38 Type N-87

Your inquiry for more complete information on special applications of Sangamo mica capacitors is invited.

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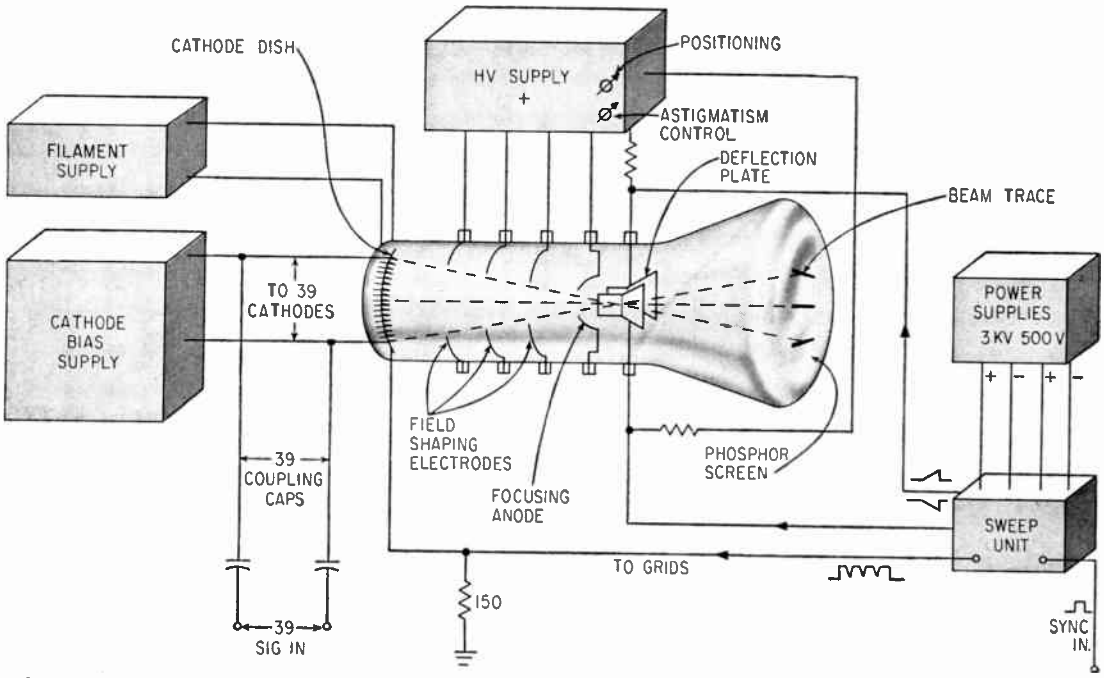


FIG. 1—The multibeam cathode-ray tube and its external test circuit

Multibeam Cathode-Ray Tube Aids Shock-Wave Studies

This cathode-ray tube, which displays a raster of thirty-nine traces originating from separate electron injectors, is useful in research where amplitudes can be presented as time durations

By LLOYD MANCEBO,
Lawrence Radiation Laboratory,
University of California,
Livermore, California

ALTHOUGH CATHODE ray tubes with dual guns are in common use and some special purpose ten-gun tubes are commercially available, for shock-wave studies in which a hundred signals are compared a crt with many more guns is needed. However, when forty or fifty of the standard commercial guns, each with its own focusing and deflection systems, are stacked side by side a tube of formidable dimensions results. To scale down a standard gun to diminutive size is impractical because the electron beam intensity would be reduced and mechanical tolerances could not be easily maintained. Moreover, all that is required for shock-wave studies is a bar-graph display with an on-off, time-dependent trace.

Out of such considerations there evolved a common, spherical lens system that focuses the beams from multiple injectors and affords a common crossover point permitting a single pair of deflection plates to sweep all of the beams. A tube of reasonable size was possible only after techniques were developed that allowed the fabrication of a miniature, grid-controlled electron injector. The tube, which displays a raster of thirty-nine traces and has a time resolution of one part in a thousand, excels in one-shot, fast-transient, diagnostic work.

A single lens with low aberrations and little bulk has been described.[1] The lens is essentially two concentric spheres, but since the image produced is virtual, a small hole is provided in the smaller sphere (anode). In this lens, as adapted, an electron emitted at the cathode dish arrives at the anode and passes through the hole. As it passes through, it experiences the divergent lens effect of the aperture and crosses through a point slightly

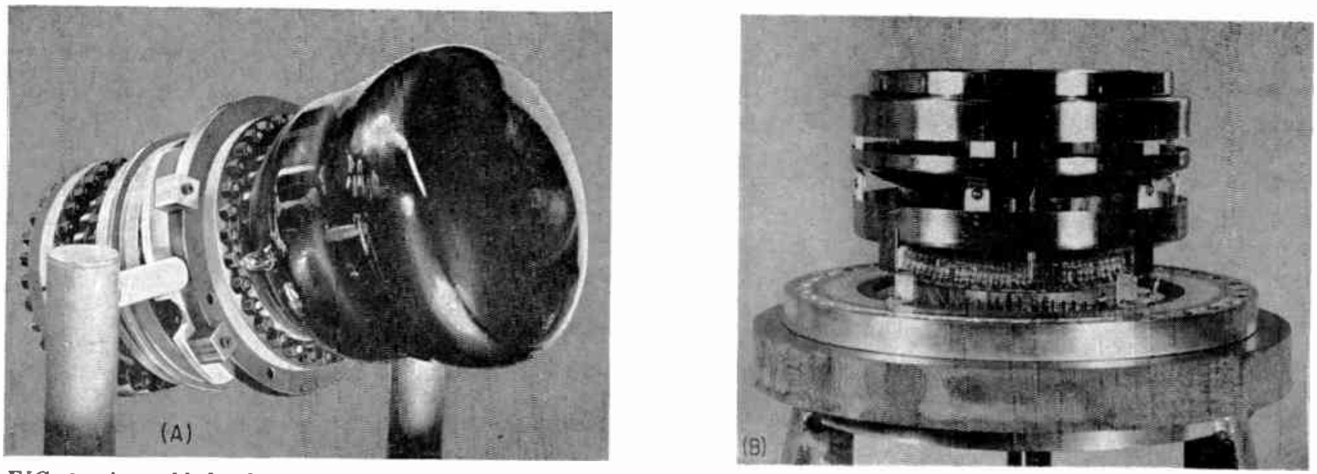


FIG. 2—Assembled tube on its test stand (A), and a closeup of the lens and mounted electron injectors (B)

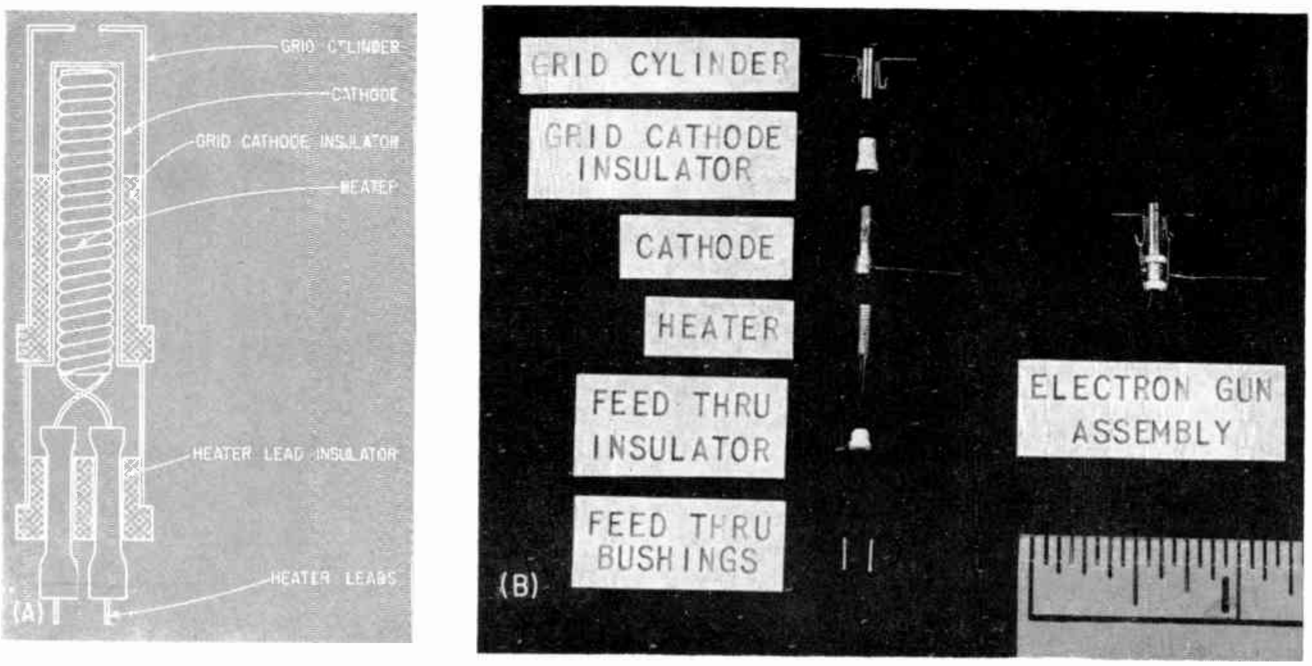


FIG. 3—Single electron gun assembly (A), and exploded view in (B) showing actual components

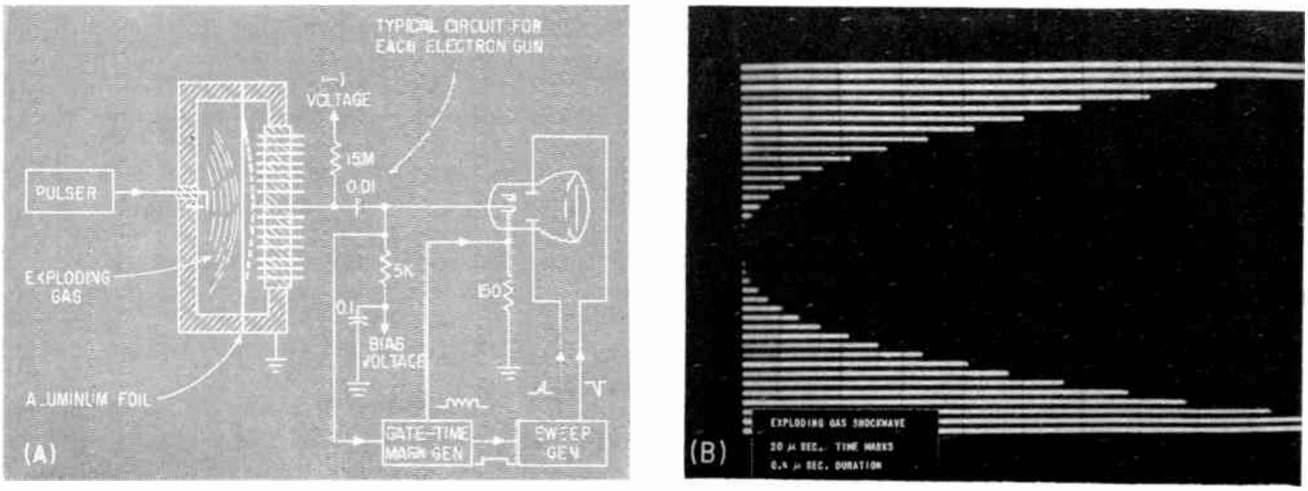


FIG. 4—Exploding gas in chamber is used to test the multibeam tube (A), and a typical raster photographed during such a test (B)

beyond the geometrical center. All the beams from the electron injectors, which are along a segment of the cathode dish, pass through this crossover point, so it is here that the deflection plates have been located.

Only that portion of the cathode dish radially opposite the anode hole is useful, but removing the unused portion distorts the spherical field. However, the field can be restored with a cascade of field-shaping electrodes between the cathode dish and the anode. The electrode voltages can be closely determined in a tank with a wedge-shaped electrolyte. This electrode configuration is shown in Fig. 1.

An injector in this tube is an indirectly heated electron emitter spaced behind an aperture in the grid cylinder. The injector is mounted on the outside of the cathode dish by spot welding the grid cylinder to the dish. This technique permits the grids to be electrically grounded through a low common impedance, thereby shielding the individual cathodes and decreasing the crosstalk. The cathode-to-grid spacing is large (0.020 inch rather than the more usual 0.005 inch) to insure a good mechanical tolerance in such a small assembly and to provide a good cutoff characteristic. The aperture in the grid cylinder focuses the electron beam approximately 1/10 inch inside the cathode-dish radius. It is this crossover that the lens focuses on the screen. Because the electrons at the cathode dish have such small components of velocity tangential to the cathode dish, the circle of confusion on the screen is small despite high electron energy.

The tube (Fig. 1) consists of a vacuum envelope, 39 electron injectors, field-forming electrodes within a spherical lens, a pair of horizontal deflection plates and phosphorescent screen. The tube is 24 inches overall and has a maximum diameter, that of the screen, of nine inches. Total weight is about 100 pounds. Figure 2A is a picture of the tube on a test stand.

The vacuum envelope is glass and Kovar with demountable steel flanges and copper gaskets to permit disassembly without rebuilding.

A settled P-11 phosphor (zinc sulfide with a silver activator) forms the screen. The first screen employed was an evaporated P-5 (calcium tungstate) phosphor that had better resolution and less halation than the P-11. The settled phosphor, however, has a greater luminescent efficiency. An aluminum film, approximately 1,000 A thick, was evaporated over the phosphor to prevent electron sticking and to complete the shielding for the field-free region between focusing anode and screen.

A photograph of the lens and electron injectors before enveloping appears in Fig. 2B. The anode and the cathode dish radii are one and eight inches respectively. The hole in the anode is approximately $\frac{3}{4}$ inch in diameter and is 10.6 inches from the screen. The injectors are mounted radially on approximately 1/10-inch centers along a four-inch segment of the cathode dish.

These electron injectors are only $\frac{1}{2}$ inch in length and 0.110 inch in diameter. The assembly is sketched in Fig. 3A and the components are shown beside the injector in Fig. 3B. The emitting surface is a barium-strontium-calcium oxide. It is indirectly heated with a bifilar winding of three-mil tungsten wire spray coated with two mils of RCA Alundum for insulation. The alumina insulators are cast in carbon molds and the nickel cathode and grid are electroformed. The focal length of the aperture is approximately 0.100 inch, neglecting space-charge effects. In future tubes the cathode emission surface will be made concave to increase the beam current and to prefocus the electrons in the gun. The beam current in the present model is approximately 5 microamperes.

In operation, the start of an event to be measured triggers the sweep generator and turns on the beams. (Figure 1 shows the external test circuit.) Some time later a positive pulse applied to the cathode of the individual injector shuts off the trace. The length of the trace is proportional to the duration of the event and is measured with time marks superimposed on the trace. The tube can be used in one-shot, on-off applications or it can be electrically or mechanically cycled over short durations.

The cathode heaters are operated in parallel at five volts and draw a total current of 15 amperes. The cathode bias, approximately one volt, is adjusted for each gun so that each trace is equally bright on the screen. A sweep length of eight inches requires that a push-pull sawtooth of two Kv be applied to the deflection plates. The deflection sensitivity is approximately 500 volts per inch. The anode voltage is 10 Kv. An astigmatism correction is applied in the direct-current positioning circuit.

The lens system yields a trace with extremely good depth of focus with minor aberrations, a small pin cushion distortion being the most prominent. When a square pulse is applied to one of the guns, the raster shows a time resolution of one part in a thousand or 0.1 percent. Spot size is 0.015 inch.

The tube and circuits were tested with an exploding gas contained in a cylindrical chamber. A cross-section of the chamber and the circuit for the middle pin is shown schematically in Fig. 4A. Each of the other pins was similarly tied to an injector but not to the gate-time mark generator. A spark ignited a mixture of oxygen and propane and a compression wave was generated. The expanding wave front pressed an aluminum foil against the row of projecting pins, grounding them. The center pin, slightly longer than the rest, acted as the sweep and time mark generator trigger. As successive pins were grounded, the corresponding guns were turned off. A raster photographed in this experiment is shown in Fig. 4B.

This tube, although designed for shock-wave diagnostic work, will find application in any field where amplitudes can be presented as time durations.

ACKNOWLEDGMENTS

The author acknowledges the help of the technicians who constructed and tested the tube: D. Stewart, W. Tindall and A. Maddux. He thanks H. M. Owren for ideas and encouragement, and E. Sikorsky, for design of the test circuit. This report was prepared by G. A. Leavitt.

Work on this project was done under the auspices of the U. S. Atomic Energy Commission.

REFERENCE

(1) P. Schagen, H. Bruining and J. C. Francken, A Simple Electrostatic Electron-Optical System With Only One Voltage, *Philips Res Repts*, 7, p 119, April 1952.

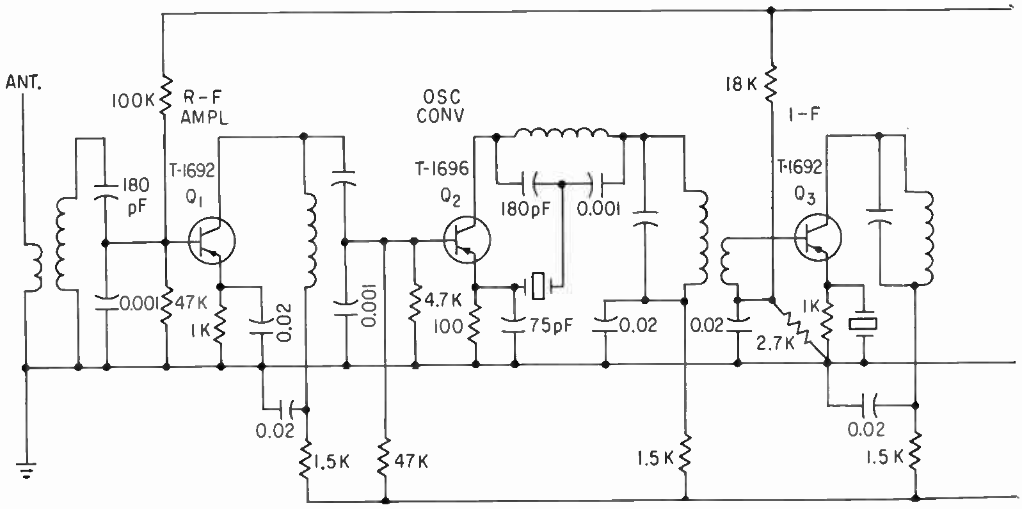
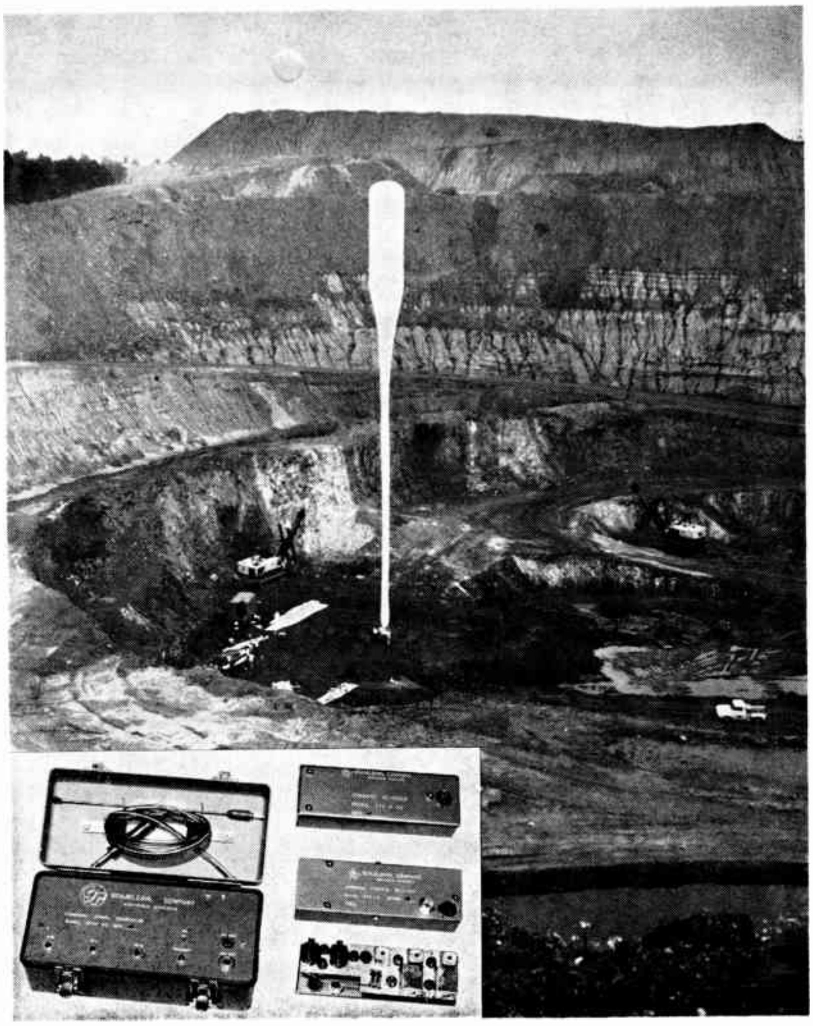


FIG. 1—Crystal-controlled balloon-borne receiver uses crystal filters as i-f emitter bypass elements to produce desired selectivity curve. Tone signals activate resonant-reed relay K_1 which in turn drives four-layer diode D_1 to turn output relay K_2 on or off. Relay K_2 energizes balloon-borne equipment

Radio Command Set for

Lightweight command receiver uses tone signals to activate balloon-borne gear. Combination of resonant-reed relay and four-layer diode permits positive reception on crowded military radio channel



200 ft high-altitude balloon being launched at Crosby, Minnesota. Inset shows ground transmitter and balloon-borne components of command set

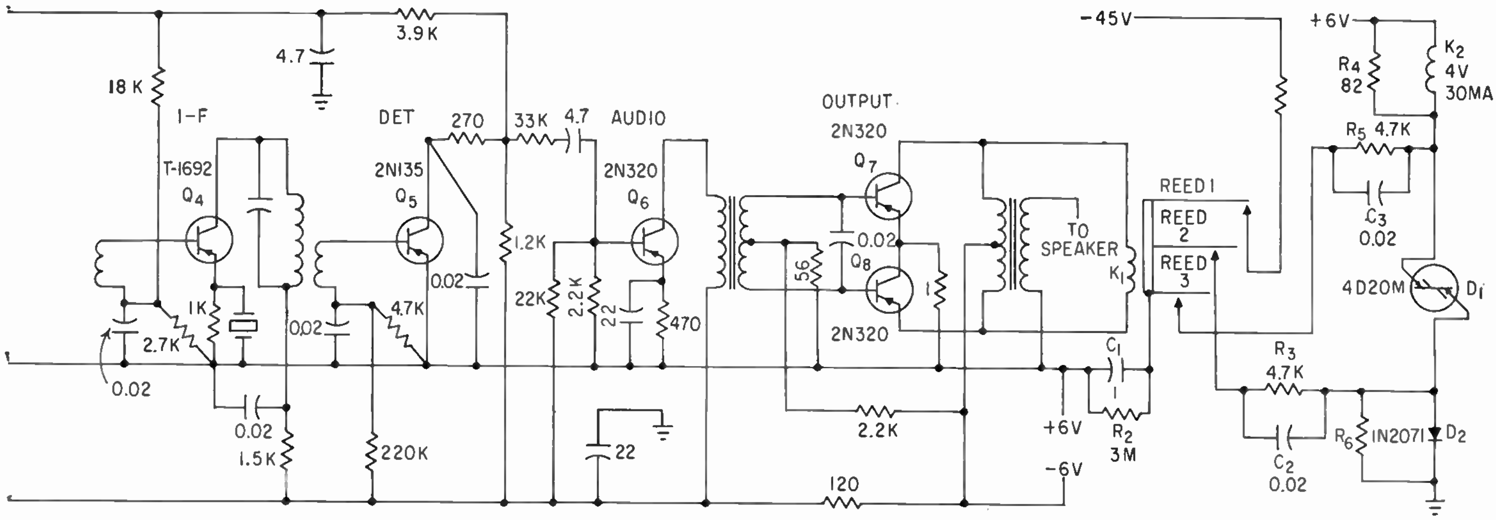
UNMANNED HIGH ALTITUDE balloon flights require light-weight and reliable radio command equipment.

The frequencies normally used to communicate with the high-flying balloons are the high-frequency bands between 3 and 18 Mc, so the command system must not operate on voice modulation or the usual clutter of skip signals and heterodynes usually found within this portion of the frequency spectrum.

Other requirements are high sensitivity for operation over long skip paths and a broad overall selectivity to allow for the small variations in carrier frequency found in military field communication transmitters.

The device consists of three parts: the ground transmitter, balloon-borne receiver and its associated decoder.

The airborne receiver, shown in Fig. 1, is a crystal-controlled superheterodyne using MADT germanium transistors in r-f stage Q_1, autodyne converter Q_2 and i-f stages Q_3 and Q_4. The selectivity of the i-f stages is greatly improved by the use of crystal filters in the emitter



High-Altitude Balloons

By R. W. FRYKMAN,
Schjeldahl Co.,
Northfield, Minnesota

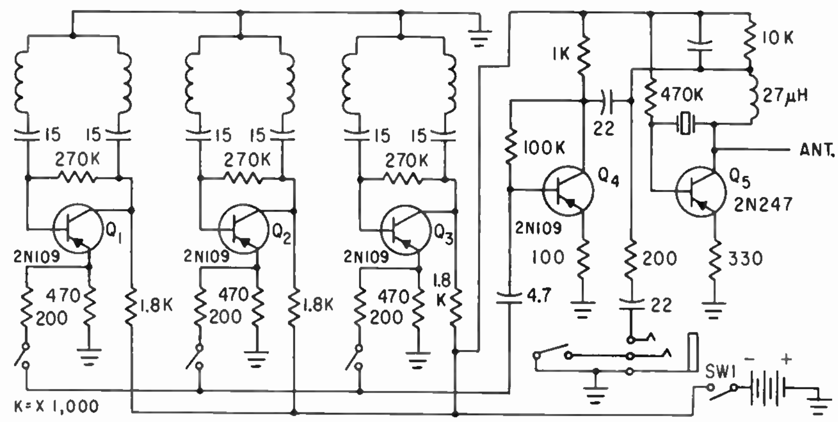


FIG. 2—Ground-based transmitter can be tone-modulated by either of three tones, each corresponding to a particular reed of receiving relay K_1

bypass circuits. This results in a symmetrical selectivity curve 5 Kc wide at the 3-db points.

Triode second detector Q_5 is used because it provides stronger agc signals than the usual diode detector. An input signal range of 55 db from 5 μv results in an audio-signal level change of 3 db. The signal-to-noise ratio is 20 db below 1 μv.

Audio signals from the receiver are applied to 3-reed resonant relay K_1 as shown in Fig. 1. When excited by its particular audio frequency, each reed makes intermittent closure with its associated contact.

The command transmitter, shown in Fig. 2, consists of three stable audio oscillators and a low-powered crystal-controlled transmitter. The three audio signals are generated by Q_1, Q_2 and Q_3 at frequencies between 200 and 500 cps determined by the feedback network of each oscillator.

Audio amplifier Q_4 acts as the modulator for the low-power crystal-controlled carrier generator as well as an impedance matching network for the microphone input.

When the arming pushbutton of the ground transmitter is depressed, the received audio signal causes reed-1 of relay K_1 to make intermittent contact to charge capacitor C_1 through resistor R_1. The duration of the charge on C_1 is determined by resistor R_2. This time constant is 3 seconds.

When the operating pushbutton on the ground transmitter is depressed (within 3 seconds of applying the arming signal), the audio tone causes resonant reed 2 to operate thus applying the negative potential from C_1 through coupling network C_2 and R_3 to the junction of four-layer diode D_1 and silicon diode D_2.

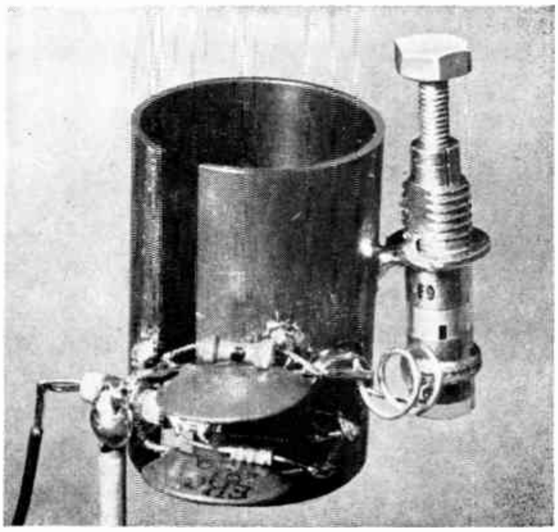
This momentary negative pulse is in excess of the four-layer diode striking potential causing it to conduct heavily through the parallel combination of R_4 and the coil of output relay K_2. Operation of relay K_2 turns on the desired balloon-borne equipment.

The load current, thus relay K_2, can be turned off by operating the arming signal for 3 seconds and then operating resonant reed 3. This reed is connected to the junction of the load and the four-layer diode through R_5 and C_3. The resulting momentary negative pulse depresses the four-layer diode current below its minimum holding value causing it, and relay K_2 to turn off.

Resistor R_6 dissipates any charge built up on C_2 by random excitation of the resonant-reed relay by noise or voice signals.

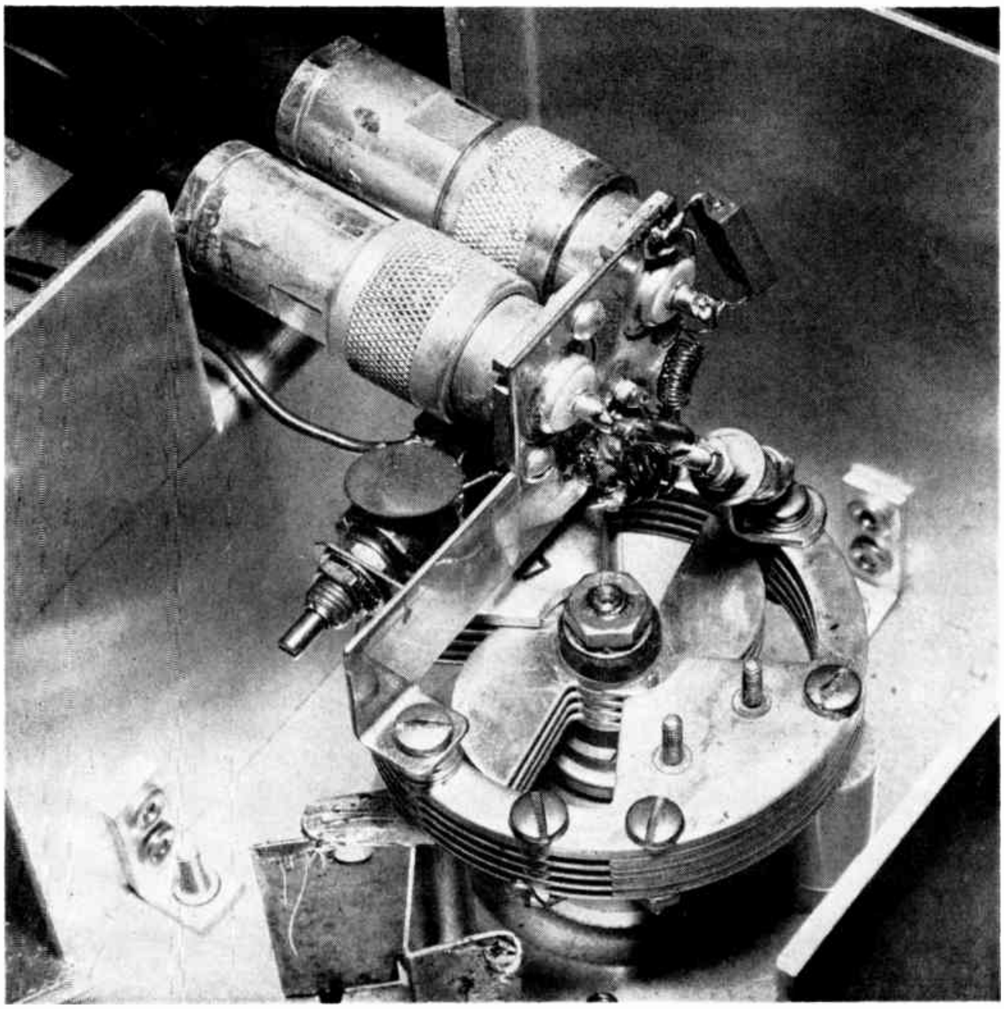
TRANSISTOR OPERATION

By V. W. VODICKA,
Lenkurt Electric Co., Inc., San Carlos, Calif.
R. ZULEEG,
Hughes Semiconductor Laboratory,
Newport Beach, Calif.



Low-power microwave transmitter uses 1.56-Gc modulated oscillator circuit

Experimental setup uses butterfly resonator in 450-Mc converter circuit



BEYOND CUTOFF FREQUENCY

Special converter circuit allows useful amplification considerably beyond the normal frequency. The technique is useful mainly with high-frequency transistors

THE HIGH FREQUENCY performance of a transistor can be defined without ambiguity as the frequency at which the gain drops to unity.[1] In a straightforward application of transistors to previously known circuits, useful gain with existing transistor types is limited to about 700 Mc. By impurity gradients in the base of a transistor,[2] that cause drift rather than the slow diffusion of minority carriers, the frequency performance is extended. However, even with the development of the mesa transistor,[3] frequency response is limited by the geometry of the structure. By shrinking the size, better performance can be obtained but power handling capabilities are sacrificed. Diffusion-type transistors with graded base widths have a theoretical frequency response in the gigacycle range but the limitations on high frequency performance are the capacitances of the *p-n* junctions. These capacitances are proportional to the junction area, so that reduction in size helps; on the other hand, smaller size generally decreases power rating.

Practical limits in commercially available transistors are a maximum frequency of oscillation around 1 Gc and 30 to 50 mw power dissipation (2N700, 2N502), although experimental values of 3 Gc at 50 mw have been reported.[4]

A new mode of operation makes it possible to extend the useful frequency range of certain types of transistors. The technique uses a converter or mixer circuit.

Taking advantage of oscillatory conditions of a transistor and the complex phase relation of the currents in existing loops, a stable mode of operation is established whereby the undesirable capacitances apparently are removed by incorporating them into tuned elements. Thus the transistor operates under conditions that show a true frequency performance that is limited only by the transit time of minority carriers across the effective base width.

Transistors with f_{max} equal to 600 Mc produced gains at 1.4 Gc; others with 1 Gc f_{max} had gains in the 2.3 Gc region, well beyond their normal cutoff limits. Relatively no sacrifice in power dissipation was made and a better frequency performance was obtained even at the same power dissipation.

The circuits are given in Fig. 1A and 1B. The basic circuit is an oscillator. Oscillation requires that input and output be 180 degrees out of phase and that the loop gain be unity or greater. Feedback is applied through capacitance C_F, Fig. 1A. The feedback loop reflects the input impedance into the output and the tuned circuit sees a negative impedance in the region of oscillation. The input impedance Z_{in} is negative, equivalent to a capacitive reactance. For the converter circuit, the input blocking resistance R has been replaced by inductance L_s (Fig. 1C) and a second resonance circuit L_D, C_D added

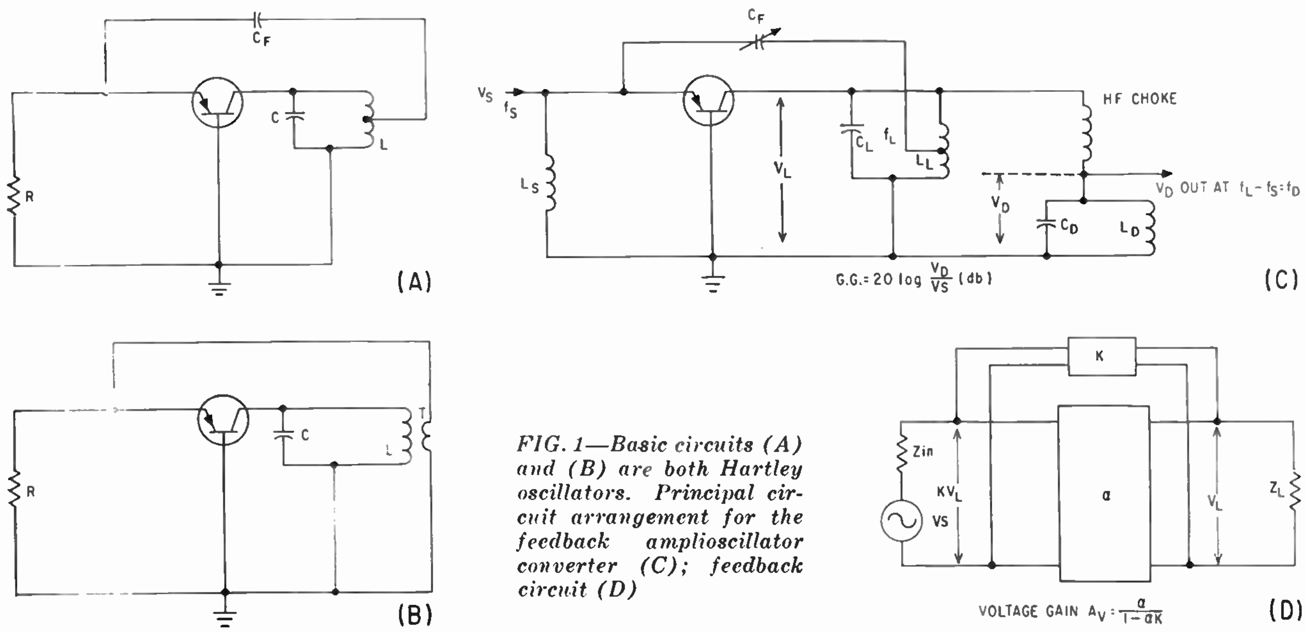


FIG. 1—Basic circuits (A) and (B) are both Hartley oscillators. Principal circuit arrangement for the feedback amplioscillator converter (C); feedback circuit (D)

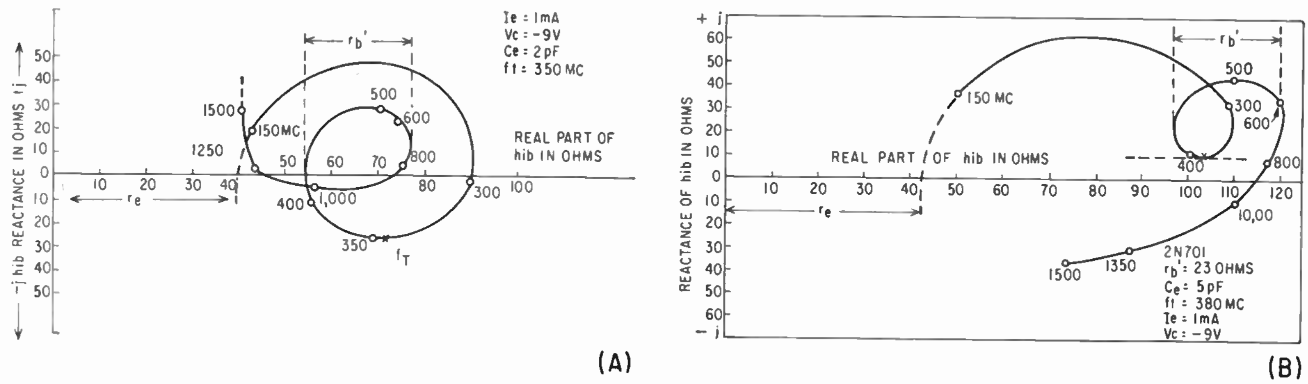


FIG. 2—Complex input impedance for Hughes GXG4 npn transistor (A); input impedance for pnp mesa transistor (B)

in the collector. The transistor is oscillating at frequency f_L (smaller than the f_{max}); with f_L determined by tank circuit L_L and C_L.

The input of the transistor is then current tuned to give maximum conversion gain for signal frequency f_s. Capacitor C_F controls the amount of feedback and therefore the conversion gain. The requirements on the transistor are that during current-tuning of the input, oscillation must be maintained. These conditions are met by only a few high-frequency types. However, conversion is merely a function of the external circuit elements. The circuit can be made extremely stable at high gains if matching conditions are satisfied. Figure 1C shows the circuit.

For frequency conversion, assume that only oscillation frequency f_L and signal frequency f_s are of appreciable amplitude. Applying the square law and superposition:

$$[\sin(2\pi f_L t) + \sin(2\pi f_s t)]^2 = \sin^2(2\pi f_L t) + 2\sin(2\pi f_L t)\sin(2\pi f_s t) + \sin^2(2\pi f_s t) \quad (1A)$$

Only the cross-product between the frequencies is interesting and can be written

$$2\sin(2\pi f_L t)\sin(2\pi f_s t) = \cos[2\pi(f_L - f_s)t] + \cos[2\pi(f_L + f_s)t] \quad (1B)$$

Frequency f_L modulates a nonlinear network—the input impedance of the transistor—so that the network transfer function at f_s, the signal frequency, includes a major term proportional to sin $(2\pi\ f_L\ t)$. The parameter to describe such a function quantity is the conversion gain, defined as the ratio of an output voltage V_D at the difference frequency ($f_D = f_L - f_s$) to an input voltage V_s at f_s. The output represents therefore a high impedance, which depends upon the Q of the L_L C_L circuit and other shunt impedances. The input impedance is low and close to the real part of the emitter input impedance for a particular current level $r_e \approx [KT/q][1/I_e]$). The voltage V_D across the L_D-C_D circuit can therefore appear only at a frequency $f_D = f_L - f_s$, if the output of the active network, the transistor, contains a component of the signal input voltage V_s at f_s. This is the case when a signal, V_s, is applied to the emitter input.

Referring to the theory of feedback amplifiers[5] and to Fig. 1D, the overall voltage amplification factor A_V, is given by

$$A_V = \frac{\alpha}{1 - \alpha K} \quad (2)$$

where α is the amplification factor of the active network and K the feedback ratio of output to input voltage of the passive feedback network.

In general, α and K are complex. Assume that K can be adjusted and is therefore a constant. Amplification factor α is then a complex parameter and can be approximated by[6]

$$\alpha = \alpha_0 \frac{\exp[-jm(f/f_c)]}{1 + j(f/f_c)} \quad (3)$$

where

α_0 = low frequency α of the transistor,
f = amplifier frequency of operation,
f_c = angular cutoff frequency of transistor, and
m = phase factor (0.21 for diffusion transistors, greater than 0.21 for drift transistors).

Inserting Eq. 3 into Eq. 2 and rearranging,

$$A_V = \alpha_0 \exp[-jm(f/f_c)] / \left\{[1 - \alpha_0 K \exp[-jm(f/f_c)]][1 + j(f/f_c)]\right. \left.\frac{1}{(1 - \alpha_0 K \exp[-jm(f/f_c)])}\right\} \quad (4)$$

Equation 4 reveals that by adjustment of K, to compensate for the term of the phasor exp$[-jm(f/f_c)]$ at a particular frequency, resemblance to Eq. 2 can be restored. On the other hand an apparent increase in frequency response has been obtained of $1/\{1 - \alpha_0 K \exp[-jm(f/f_c)]\}$ when comparing with Eq. 3. Likewise,[7] noise of such an amplifier is reduced by the same fraction. Both increase of frequency response and reduction of noise are confirmed by experimental data.

When applying the feedback principle to the circuit of Fig. 1C, signal V_s can be amplified arbitrarily by changing the feedback that contains the term 1/2 cos $[2\pi(f_L - f_s)t]$ and converting it into a signal V_D at $f_D = f_L - f_s$. A calculation of V_D in terms of intrinsic transistor parameters and external circuit elements will not be attempted here. However, when comparing the new mode of operation with conventional circuits,[8] the local oscillator, which is the transistor itself, can be operated with much higher power and is not restricted to the condition $V_s\ q/KT \leqq 1$ to to avoid substantial distortion. Conversion gain is then merely a function of the feedback amplifier and is almost independent of transistor parameters up to frequencies beyond normal cutoff, if the conditions of oscillation and input current tuning are met for the frequency of operation.

The upper limit of frequency,

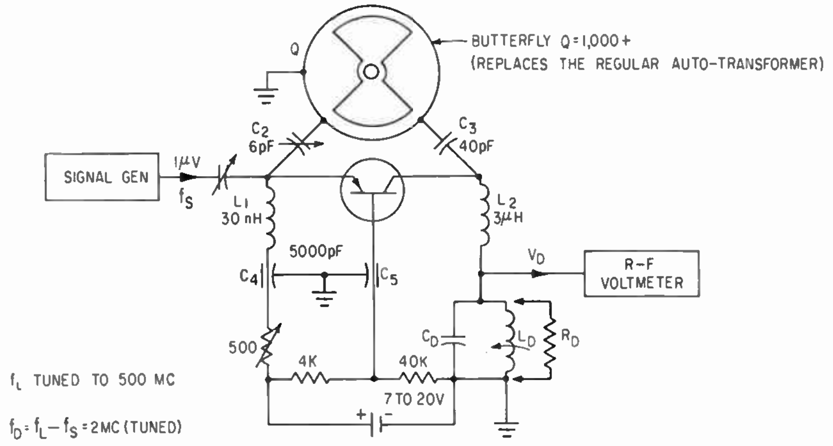


FIG. 3—Circuit for measuring conversion gain

TABLE—Best Results (With Approximately 2 Mc)

f_s	Bandwidth	Conv Gain	Input dbm	Z	µV	s/n	Noise Fig
450 Mc	20 Kc	70 db	−106	40	1	21 db	5 db
	150 Kc	60 db	−107	50	1	10 db	6 db
	750 Kc	49 db	−107	50	1	3 db	6 db
Average results							
450 Mc	150 Kc	56 db	−107	50	1	7 db	8.5 db

f_{max}, at which oscillations may be maintained is usually expressed by[9]

$$f_{max} = \sqrt{\frac{\alpha_0 f_{c\alpha}}{8\pi r_b' C_C}} \qquad (5)$$

Where

α_0 = low frequency current amplification factor,
$r_b' C_C$ = extrinsic base resistance collector layer capacitance product, and
$f_{c\alpha}$ = alpha cutoff frequency of transistor.

For maximum gain in the converter circuit, it is necessary to tune the input impedance with a d-c current. This is not possible for most high-frequency transistors. For maximum output gain, the input circuit has to produce matching whereby minimum input impedance is established. This effect was demonstrated experimentally. The complex behavior of the input impedance, h_{ib}, has been studied and correlation with circuit performance indicates that best stability and maximum gain is obtained for transistors with $|h_{ib}|$ minimized. Measurements of a Hughes experimental *pnp* mesa transistor showed excellent stability and performance (see Fig. 2A); *pnp* mesa transistors exhibited instabilities in the

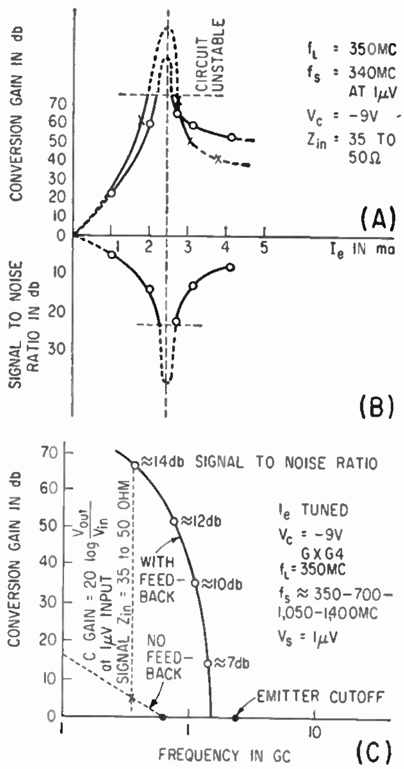


FIG. 4—Conversion gain (A) for two transistors (both type GXG4) in the circuit of Fig. 3. Signal-to-noise ratios for one of the transistors is shown in (B). Conversion gain with and without feedback (C) for same type transistor

circuit and require critical bias adjustment (see Fig. 2B). Besides the two transistor types mentioned, good results were obtained with the Philco madt 2N502, a transistor partly limited by the maximum allowable dissipation. The input impedance measurement offers a simpler way than transfer function measurement to study the frequency cutoff properties of the device, since the alpha-circuit generator is implicitly in the base lead resistance, yielding

$$h_{ib} = r_e(f) + r_b'(1 - \alpha) \qquad (6)$$

Where

α = the complex form of Eq. 3 and
$r_e(f)$ = emitter differential resistance, shunted by depletion layer and diffusion capacitance.

Thus the emitter capacitance is important to assure good amplification at harmonics of the fundamental frequency.

Measurements have been made with a Hughes GXG4 transistor with input impedance characteristics as plotted in Fig. 2A. The test circuit for conversion gain data is shown in Fig. 3.

Figure 4A is a plot of conversion gain of the Hughes GXG4 units at a local-oscillator frequency of 350 Mc with a 1-µv input signal at 348 Mc. The emitter current was used as a variable to demonstrate the current tuning effect at a fixed collector voltage of −9 volts.

Figure 4B gives the corresponding signal-to-noise ratio of one transistor and confirms optimum noise performance at maximum conversion gain. From a circuit performance with no feedback mechanisms, a gain of approximately 5 db can be predicted for f_{max} = 600 Mc and a 6-db per octave slope. Figure 4C shows a plot of gain against frequency with and without feedback and reveals the gain bandwidth.

Figure 5A shows the results for another transistor with an f_{max} of approximately 1,000 Mc. The tank had a high Q at the third and fourth harmonics but the input was untuned. When the input was tuned to resonate at almost the input signal frequency, the gain increased 12 db. The oscillator was at 450 Mc, the input signal at 1,350 Mc.

Figure 5B shows that best results are obtained when f_s is close to f_{osc}. When the mixer is used as a synchronous detector, the gain was approximately 6 db above the curve for the 2 Mc i-f. The gain-bandwidth products shown are not the best obtainable, as the extension of the bandwidth was achieved by loading the L_DC_D resonance circuit by a noninductive resistor R_D.

When using the mixer circuit (Fig. 3), the transistor has a tendency to oscillate at unwanted frequencies, sometimes determined by the C_DL_D resonant circuit and sometimes at frequencies where L_1 and L_2 play a role. Proper matching to the resonant circuit Q (butterfly, split cavity or other resonator) is essential. The resonant circuit should preferably have a higher Q at the second, third or higher harmonics than at the fundamental. Sufficient neutralization must be provided for the demodulated frequency; this can best be accomplished by determining the correct constants of C_2, C_3 and C_4.

Matching and selection of transistor parameters produced the results shown in the Table. The results are for $f_L \approx 2$ Mc and are the best that were obtained. Experiments were also conducted with f_s of 1.56 and 1.9 Gc. With the device used as a harmonic power generator at the same frequencies, efficiency exceeded 5 percent.

Useful gain can be produced well beyond normal cutoff at frequencies that are multiples of the local oscillator frequency. The conclusions are supported by the theory of harmonic power generation in nonlinear networks and can be seen from Eq. 1, which contains the terms of πf_L. Extrapolations of the measurements to predict ultimate performances in the mode are subject to speculation. However, matching in the test circuits has not been fully perfected and transistor designs have not been fully explored, so the extension of the useful frequency range of available transistors into the 5 to 10 Gc region is a possibility.

Some of the applications of the circuit include use as a front-end mixer oscillator for uhf and microwaves, local oscillator, pump pówer, synchronous detector (phase lock), particularly with pulse modulation techniques and as a harmonic generator.

Considerable gain with the mode is obtained beyond the normal cutoff region, both for the fundamental frequency of oscillation and for harmonics of that frequency. All the advantages of a feedback amplifier, even under oscillatory conditions, are preserved, including increase in gain-bandwidth, noise reduction, and reduction in the influence of transistor parameter variations on gain.

Although feedback amplification and current input impedance tuning do agree qualitatively with the experimental data, a quantitative analysis that includes the mathematical model of the transistor is desirable. This evaluation is now under way but is not yet completed. The prevailing conditions of oscillation establish a state of extreme changes in the nonlinear elements of the transistor and it is the nonlinear variations that are mainly responsible for the conversion properties. Specifically, the displacement currents in transistor input and output capacitances require attention. This attention is directed toward the intrinsic transport factor (alpha current generator) and the feedback factor

$$\mu = \frac{KT}{q} \times \frac{1}{W} \times \frac{dW}{dV_C}$$

The analysis is concerned in application of this up-conversion gain to harmonic power generation. The simultaneous presence of sweeping fields across the base widths, W, offer possibilities that have to be confirmed by theory and experiment.

The authors are grateful to R. A. Gudmundsen and G. M. Lebedeff for valuable discussions and support in technical matter.

[Ed. Note: In Mr. Vodicka's letter accompanying galleys, he comments: "(Since submitting the manuscript to you,) we have conducted further experiments which produced still better performance and better results at higher frequencies; useful gain at 3.2 Gc with commercial transistors, without coaxial cases."]

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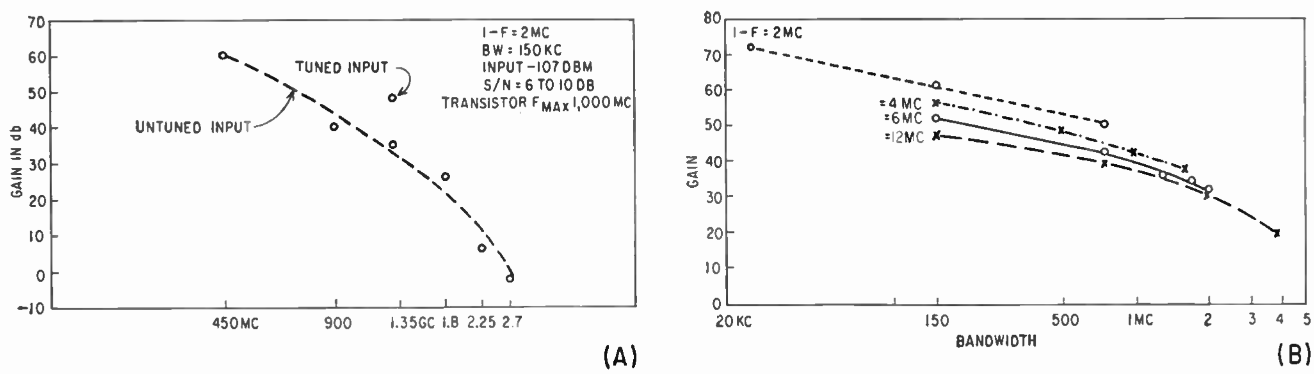
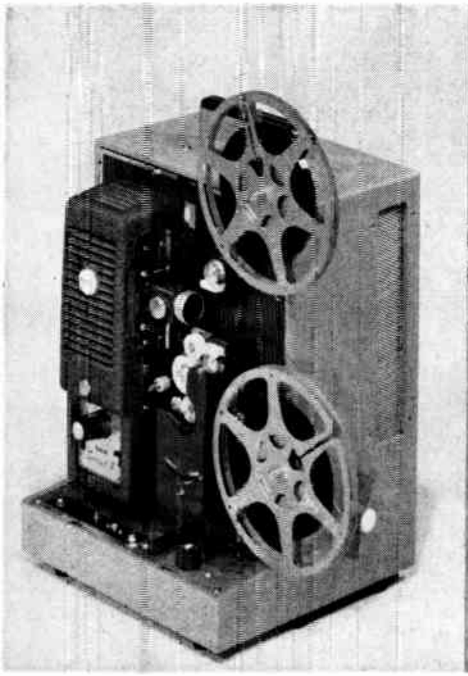
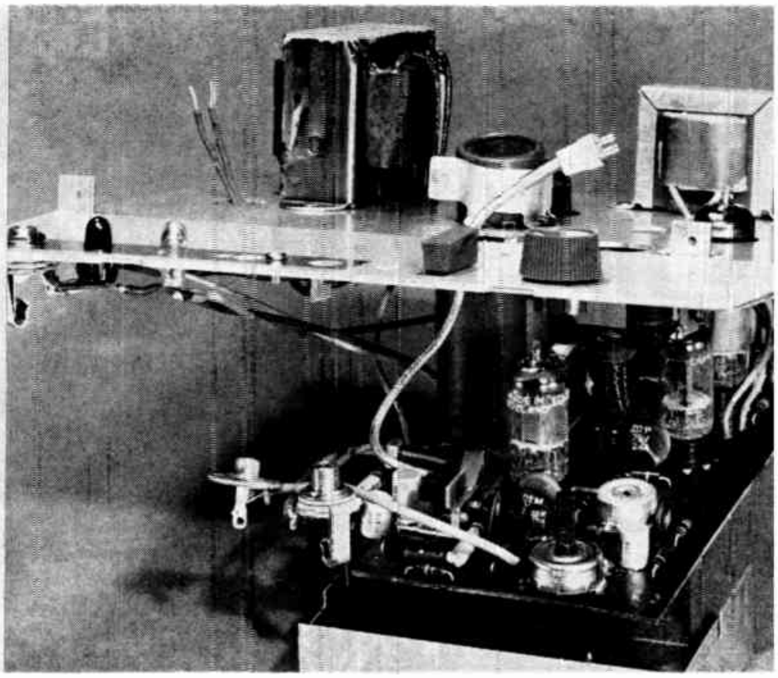


FIG. 5—Conversion gain with feedback, for input signal at harmonics of the oscillator frequency (A). Conversion gain decreases as the i-f band increases (B)





Complete projector (left) uses amplifier assembly (right). Slide switches are mechanically interlocked to operate simultaneously

Magnetic Sound Track For 8-MM Home Movies

Basic incompatibility of film drive and tape transport requirements in a magnetic stripe-on-film system is overcome by care in head and film transport design. High-quality sound is achieved by equalization techniques

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HOME MOVIES of the 8-mm variety can be made more useful by adding a sound track. This article describes a system for providing a sound record on a magnetic stripe applied to conventional 8-mm movie film. The magnetic stripe is approximately 0.030 in. wide located about 0.002 in. from the edge of the sprocket-hole side of the film.

Film drive systems that meet the requirements of picture projection fall short of satisfying the needs of a magnetic audio tape transport. Furthermore, the location and dimensions of the magnetic stripe on the film require a record-playback head designed for this application. Added to these problems, is the need for determining satisfactory equalization.

The film transport system is shown schematically in Fig. 1A while Fig. 1B shows its electrical analogy. The system is a low-pass filter that attenuates the flutter and some of the wow generated in the film at the sprocket. Flutter is produced by engagement of the sprocket teeth with film perforations and by irregularities in the driving gear train. Wow is generated by gross irregularities in the sprocket drive system. In practice these can be tightly controlled, and therefore a minimum of wow is easily attained.

Mechanical filtering is done by using the film as a compliance member that drives sound drum *D* loosely coupled to flywheel *M* through a friction clutch. The clutch allows slippage of the sound drum relative to the flywheel during the starting transient.

The compliance of the film between the sprocket and support roller *H* is indicated by C_1. Unless damped, this compliance will act with the flywheel moment of inertia and cause the flywheel to oscillate at a frequency determined by the values of compliance and inertia.

The damping mechanism, the two closely-spaced, fixed support rollers *R* and *H*, prevents flexing in all part of the film path except that

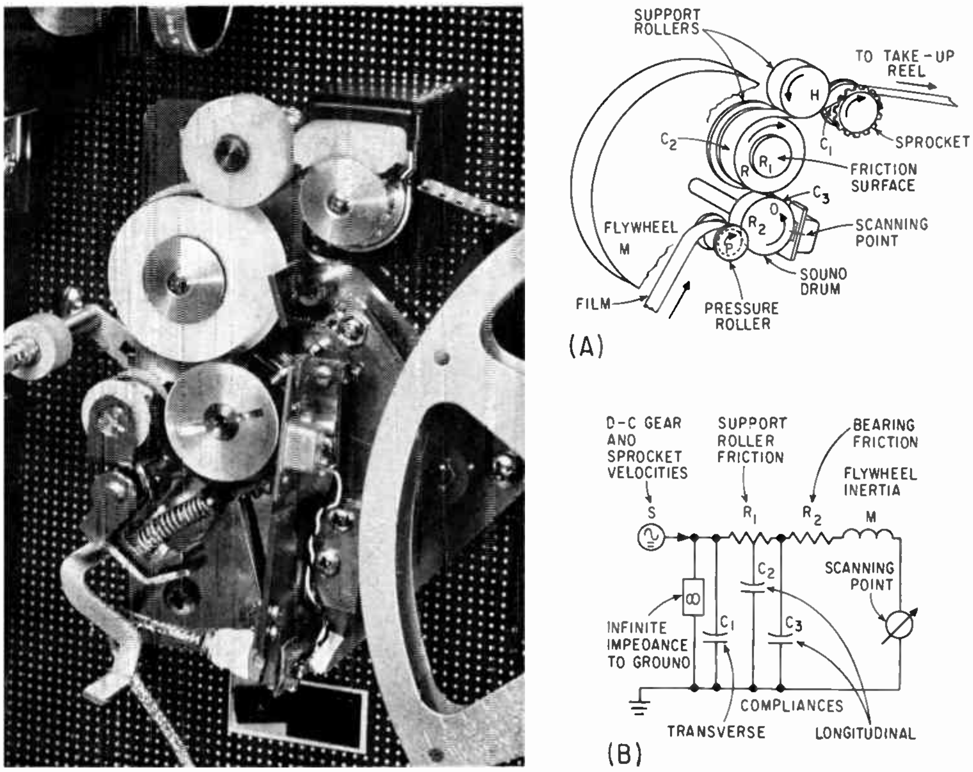

FIG. 1—Tight loop film transport system mechanical arrangement (A) and photograph, with its electrical analogy shown in (B)

immediately adjacent to the sprocket (C_1). The tendency of the film next to the sprocket to sustain oscillation is eliminated by supplying large support roller R with a spring-loaded friction surface that uniformly resists film motion between the sprocket and sound drum. This resistance-damped support roller serves another function if its resistance is adjusted to be greater than maximum take-up reel torque —it causes the sprocket to function as a drive sprocket, rather than a holdback sprocket. This reduces the need for carefully controlled bearing clearances in the rest of the system to provide sufficient film drag to assure the same drive sprocket operation.

The system reduces flutter produced at the sprocket to under 0.16-percent rms at the scanning point with 8 mm film traveling at linear speeds of 2.7 and 3.6 inches per second (corresponding to 18 and 24 frames per second, respectively).

This offers very rapid damping of the starting transient (within one second) and is very stable.

Oscillations that may be caused by splices or other inhomogeneities completely dampen out within one-quarter of a second.

The system is a low-pass filter, and can be represented by the equivalent circuit of Fig. 1B. High-frequency disturbances generated at S are substantially attenuated by C_1 and M, and to a lesser extent by C_2 and C_3. Oscillation between M and C_1 and C_2 is damped by resistance R_1, while oscillation between M and C_3 is dissipated by R_2.

One of the major difficulties in designing an 8-mm sound projector is the tremendous abrasion to which the necessarily small pole pieces of the record-playback head are subjected. This problem was overcome through the selection of an aluminum-iron magnetic alloy known as Alfenol, because of its desirable magnetic and wear-resistant properties. The material was formulated by the Naval Ordnance Laboratories. The gap is shimmed with 0.00025-in. beryllium copper. Molded nylon bobbins support and position the windings, which consist of 350 turns on each bobbin connected so as to cancel hum voltages due to any stray external field. No spacer is used at the back gap. The head is potted in a mumetal cup which serves both as a container and as a magnetic shield.

The record-playback amplifier is shown in Fig. 2. The record amplifier consists of a two-stage voltage amplifier V_1 which drives output tube V_2. To linearize frequency response and reduce distortion to an acceptable level, 10 db of negative feedback from the secondary of the output transformer is used. Oscillator V_3 supplies bias and erase current at 40 Kc. Transistor Q_1, connected as a common emitter amplifier, serves as a playback preamplifier to provide required playback equalization and gain.

Two input connectors are provided for recording. The microphone input is designed to accommodate ceramic and crystal microphones, or any high impedance program source requiring the gain available at this jack. The voltage gain from microphone input to the nominal loudspeaker load is 54 db, with a frequency response of 70 cps to 10 Kc at ± 2 db.

The phonograph input enables the recording of background music, sound effects, or other program material from sources not requiring the high gain at the microphone input. Voltage gain from the input to loudspeaker load is 14 db. The same socket can also be used as an output jack to drive an external power amplifier or sound system, since the playback signal is equalized ahead of this point.

In the record mode the signal to the internal loudspeaker is reduced by R_1 to a comfortable listening level permitting its use as a monitor loudspeaker. The jack for the external loudspeaker permits selecting either the internal or the external speaker, or both.

Two neon lamps provide a visual display for monitoring the recording process. Red neon lamp I_1 lights whenever the record-playback switch is in the record position. This warns the operator against accidental erasure. Clear neon lamp I_2 has a calibrated firing voltage which functions as a record level indicator. The lamp fires at peak signal levels exceeding the maximum distortion level.

Of all the parameters that contribute to high quality magnetic recording performance, good record and playback equalization is one of the most important. The medium must be used to its maximum capability to optimize performance with respect to distortion, signal-to-noise ratio and frequency response. Since these three characteristics are interdependent it is necessary to achieve the best overall compromise. Having determined an equalization it must then be defined so as to be reproducible and useful as a tool for measurement.

Equalization may be defined by specifying the response-frequency characteristic of the playback system. Alternately, the response versus frequency characteristic on the magnetic track can be defined. The choice of one of these dictates what the other must be to yield a smooth overall response.

The ideal contour of the recorded surface induction versus frequency curve should permit the same maximum distortion (usually 2 or 3 percent) for all frequencies within the passband. Stated differently, all frequencies recorded should ideally just saturate the tape to the 2 or 3 percent distortion level. This yields the best signal-to-noise ratio by recording at the maximum permissible level.

The peak audio energy for a wide variety of program material is greatest in the 300 to 600-cps region falling off below and above this. The peak audio energy determines the saturation level on the tape, therefore the peak energy distribution should influence equalization.

Best results are obtained when treble preemphasis is supplied during recording and bass boost is supplied as part of playback. Treble boost is supplied by the network of R_2, R_3 and C_1. Resistor R_2 is a high impedance current source for the record head, with the parallel network R_3 and C_1 providing the treble boost at high frequencies. The frequency at which treble boost begins is determined by the time constant of this network. Playback equalization is provided by losser network R_4 and C_2 at the output of preamplifier Q_1.

The curve of playback amplifier response is shown in Fig. 3. Note the agreement between this curve for 8-mm sound tracks at 24 frames per second (3.6 inches per second) and that used by many tape recorders at 3.75 inches per second.

Switching from record to playback requires transferring a number of circuits. Since these include low-level input circuit as well as the high-level output and the bias-erase oscillator, it is necessary to prevent coupling between circuits. This is done by separating the circuits to be switched, using three separate dpdt slide switches and locating them where they logically fit in the circuit. The sliders of all three switches are then linked with a common actuating bar. The part of the actuating bar that extends up through the support deck is step notched so that it locks the actuating bar in the playback position. To transfer the switch to the record position it is necessary to lift upward on the knob, lifting the notch up above the support deck, and then to pull back. This requires a conscious effort, and thus guards against accidental erasure.

The phenolic circuit board is mounted parallel to the steel support deck. The amplifier is completely assembled and wired prior to dip soldering. After soldering, the circuit board is cleaned of flux residue and the tubes inserted.

This approach requires that the circuit board be firmly mounted in its ultimate location before dip soldering. Warping or deformation due to thermal shock is thus constrained. Furthermore, no subsequent additional stress is imposed on the board by forcing it to conform to a plane different from that which it assumes as a result of the thermal strains of soldering. Even if it becomes necessary to separate the circuit board from the support plate for repair or servicing it can be safely reassembled since it is a prestressed circuit board naturally conforming to its mounting position. This technique yields a reliable circuit board, completely free of hair line cracks or delaminations.

The steel plate supports the transformers, and acts as a magnetic shield between them and the circuit board. Further shielding can be applied selectively.

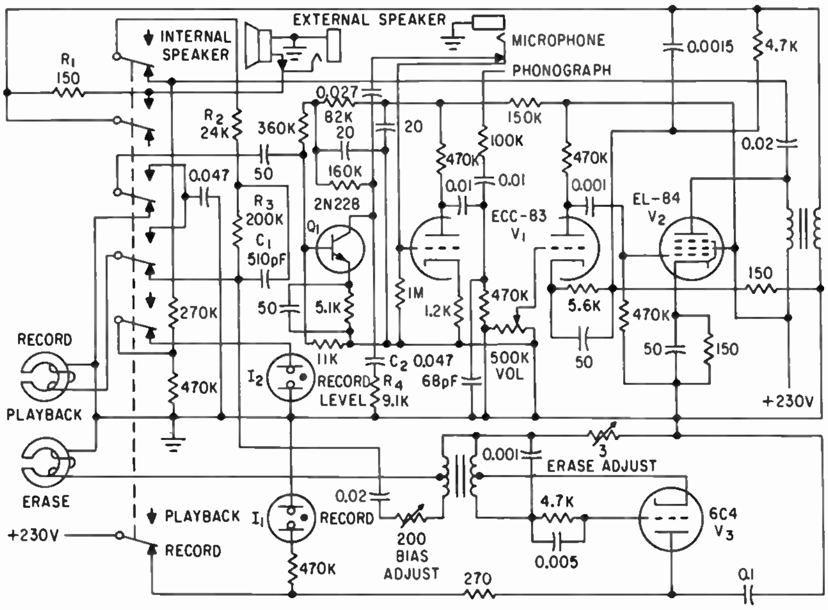

FIG. 2—Vacuum-tube amplifier uses transistor preamplifier for playback only

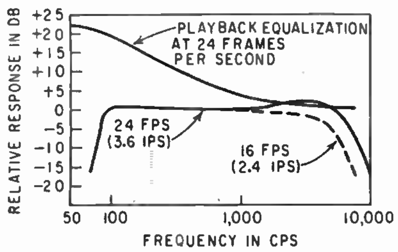

FIG. 3—Frequency response and equalization curves for amplifier

SEMICONDUCTOR CLAMP

Usual barrier potential difficulties associated with semiconductor components are overcome by a bridge configuration, permitting the circuit to sample signals down to a 10 millivolt level

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SEMICONDUCTOR CLAMP and detecting circuits of the conventional type are subject to inaccuracies when applied in the millivolt range, owing to their barrier potential nonlinearities. The purpose of the circuit described is to provide a method for clamping pulses in the millivolt range to any d-c level even though these pulses are below the barrier potentials. It is also useful for sampling pulse amplitudes in the millivolt range and to store the sampled amplitude in a memory capacitor.

Use of semiconductor devices in circuits involving sampling measurements of low voltages is complicated by a characteristic inherent to the semiconductor itself. At all temperatures above absolute zero a barrier potential exists due to the formation of the depletion layer at the *p-n* junction. This depletion layer in essence is a dielectric medium since it is a region depleted of both majority and minority carriers. The electrostatic potential which exists across the depletion layer is a function of the temperature

$$V_b = [kT/q]\,[\ln (NP/D_i^2)]$$

As the temperature increases the depletion layer becomes wider and the barrier potential increases.

In the circuit of Fig. 1, the barrier potential problem is cancelled by a bridge type balanced detector. Storage is obtained by using zener diodes in two arms of the bridge, since these zeners prevent discharge of the storage capacitor.

The clamp circuit consists of a four-diode bridge, the upper two diodes of which are conventional silicon diodes while the lower two are zeners. A signal whose amplitude is to be clamped, or sampled, is applied at input II; a second, gate signal, which occurs during the interval of the first signal, is applied at input I. An emitter follower is used to obtain a low driving impedance for the bridge.

When the blocking oscillator in Fig. 1 is fired by the input gate, a short-duration pulse is applied across the bridge by the oscillator tertiary winding. This pulse keys the bridge for the pulse duration of the blocking oscillator, the upper diodes then conduct in the forward direction, while the lower (zener) diodes are placed in the region of zener conduction.

During this keyed interval, if the bridge is balanced, points *A* and *D* will be virtually connected, and the output capacitor will be charged to the peak value of the signal at *A*.

The sampled signal at *A* may be small in amplitude but the output storage or memory capacitor will be charged to that amplitude since the barrier potentials of the diodes are cancelled.

Upon the termination of the blocking oscillator pulse, the output capacitor will remain charged and may discharge only through the reverse impedance of the diodes, which impedance is deliberately arranged to be high.

A detailed schematic of the circuit is shown in Fig. 2A. In this circuit a potentiometer is employed in the bridge to compensate for

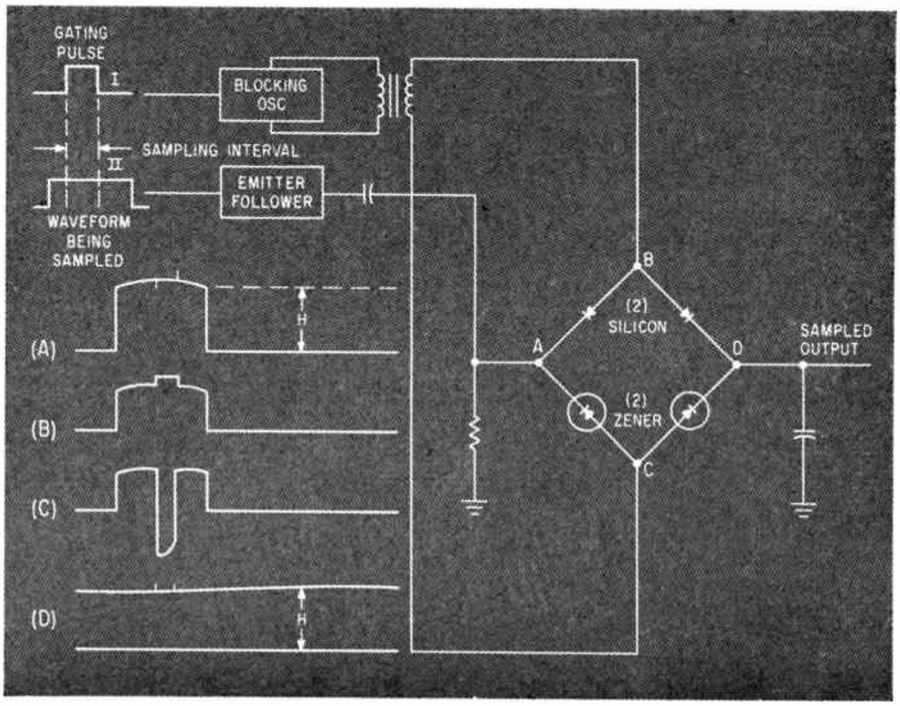


FIG. 1—Peak voltage of imput waveform is stored on the memory capacitor; waveforms appear at bridge points indicated

HANDLES MILLIVOLT SIGNALS

slight differences in the voltage drops across the diodes; in addition, resistors are included in series with the tertiary winding to limit the diode current during keying.

It is usually desirable in employing circuits of the sampling and storage type to have a memory of infinate time constant. With practical circuit elements this is not feasible. Careful circuit design and selection of components will, however, provide a leakage resistance suitable for most applications. In general, a readout circuit having a minimum of shunt loading of the memory is employed in this application. Ideally, the circuit would be applied to the grid of a vacuum tube. For storage times of longer than one second, special consideration of tube types would be required to insure a grid conduction of sufficiently small value.

Since the storage device of Fig. 2A has the advantage of permitting the use of semiconductor components, it would be desirable to employ a readout circuit of semiconductors, also. To do so the input impedance of the readout circuit should be at least ten megohms and preferably higher. Measurements made on the circuit of Fig. 2A have indicated the performance which may be expected at various signal levels. A graph of input gate amplitude versus d-c output, Fig. 2B, shows that good linearity ranging from 9 volts down to 10 millivolts was obtained from the breadboard model.

Data for the linearity curve shown was taken at room temperature. Since the barrier potential of the diodes will vary with temperature, it is indicated that compensation elements should be included in the legs of the bridge for satisfactory operation over a wide temperature range. These would be, typically, thermistors or Sensistors placed in series with the individual diodes. In employing this clamp circuit with gates having fast switching times, where the capacitance of the diodes is significant, the addition of small capacitors across each leg of the bridge would be helpful in balancing out high-frequency switching transients.

In addition to the advantages of analog storage at low-voltage levels, the capability of increased dynamic range is attractive. Assuming a minimum voltage of 19 millivolts, which is well above the minimum value observed during tests, and a maximum voltage level of 10 volts, a linear dynamic range of 60 db is easily obtainable. In circuits where the barrier potential is a limiting factor, a maximum output level of 1,000 volts would be required for a 60 db dynamic range.

The advantage of operation in the millivolt range, then, is clear when a wide dynamic range is required.

The disadvantage in using signals in the millivolt level, other than noise problems, are: the necessity to use devices for coupling elements similar to the clamp under consideration and the difficulty in handling the full dynamic range on an amplitude basis with a simple device other than digital.

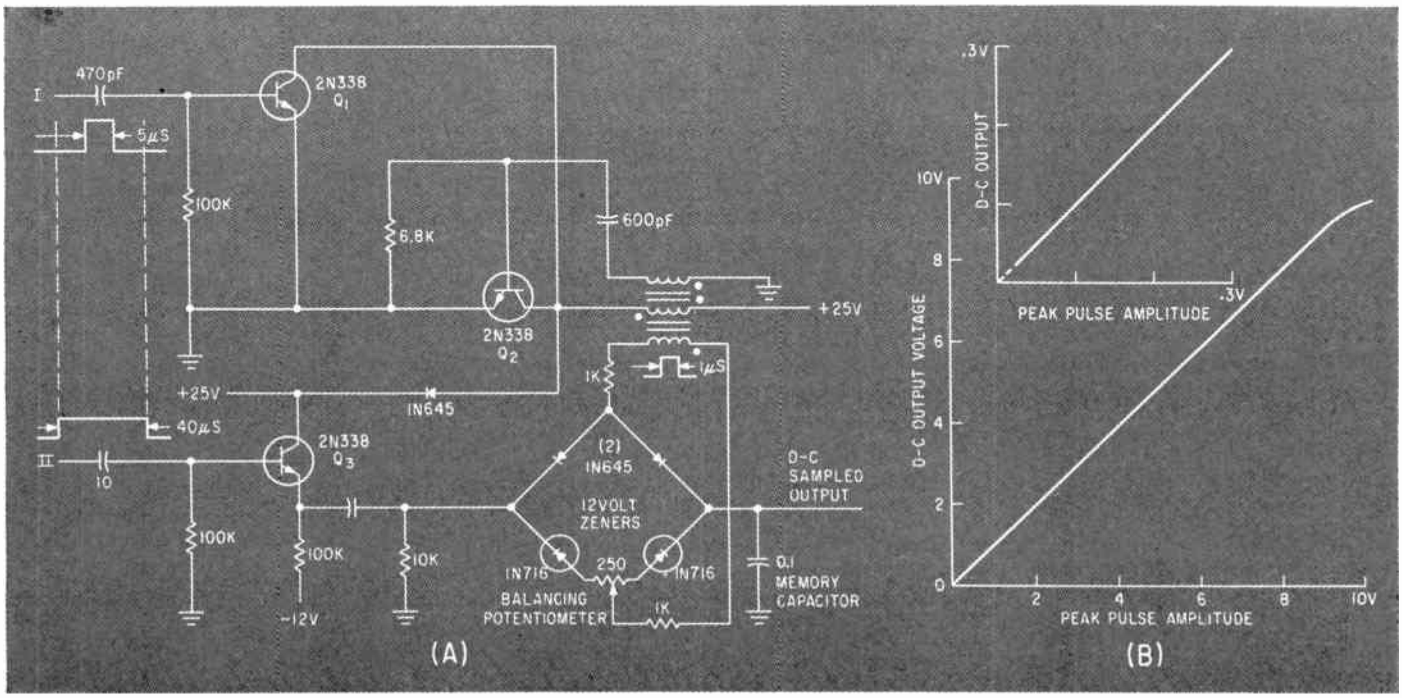


FIG. 2—Balancing potentiometer compensates for individual variations in characteristics of bridge components (A); linearity of circuit operation extends over 10-millivolt to 10-volt range (B)

Method for determining the acoustic characteristic of lecture halls and auditoriums requires an integrated reading of reflected sound patterns. Since sound energy is proportional to the square of the incident amplitude, the microphone output is squared before passing to the integrating circuits

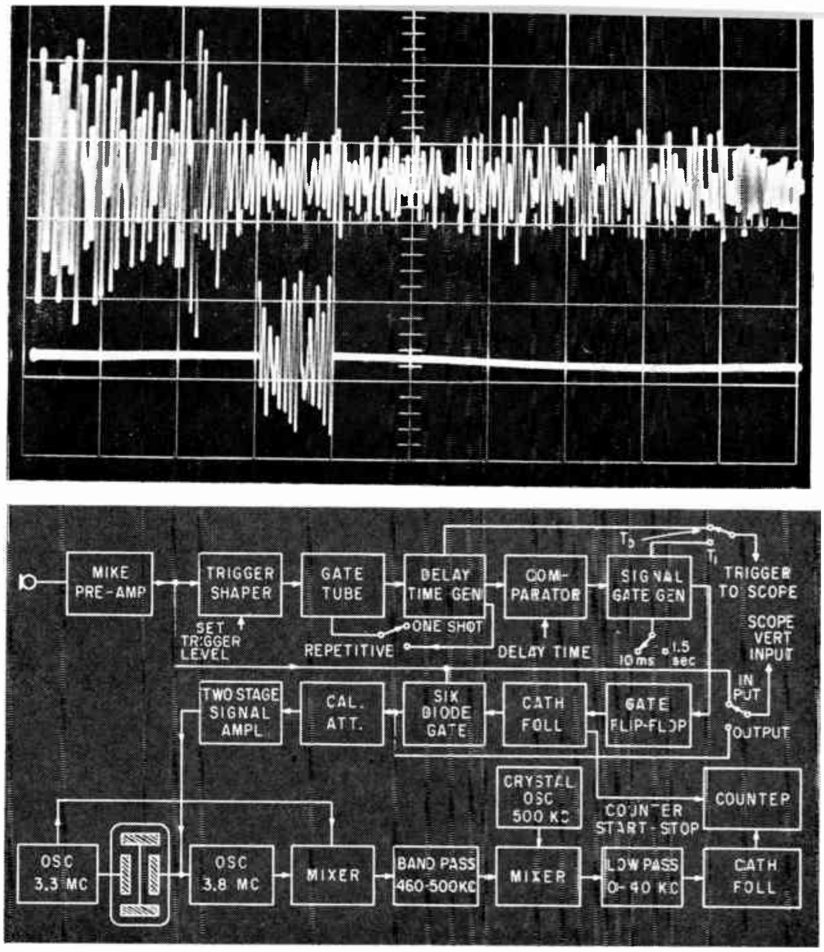


FIG. 1—Upper photograph shows oscillogram of reflected sound pattern and (same photo) portion of the waveform selected for integration; the lower illustration is overall block diagram showing squarer and integrator

Electrostatic Squarer for Acoustic

A CONVENTIONAL method of gaging the acoustic characteristics of lecture halls and other auditoriums consists of reading special words to observers within the hall, who then write down what they hear. Echos and other forms of distortion reduce the intelligibility of these words, so a measure of the hall's acoustic acceptibility is the percentage of words correctly understood. Unfortunately, this method is time consuming and subject to error.

Recently, research work on the mechanism of human hearing has given insight into the operation of the ear, and in particular, to its integration and masking characteristic.[1] Knowing more about the ear's operation, it is now possible to deduce from an analysis of sound patterns produced by each auditorium, just how acceptable that auditorium is to listeners[2].

Sound patterns from the auditoriums are analyzed by the present equipment, which integrates indirect sounds that arrive after the first sound from the source is received. Integration takes place over a predetermined interval, while a variable delay caters to reflections arriving up to 120 milliseconds after the initial signal.[3]

Integrator output which is a measure of sound energy over the period, is read out on a digital indicator, and permits the hall's acoustic characteristic to be mapped.

The design of this equipment is based on the fact that the force exerted on the plates of a capacitor is proportional to the square of the voltage applied between the plates. The squaring unit consists of a thin Duralumin diaphragm between two electrodes. The signal is applied between one electrode and the diaphragm causing a diaphragm deflection proportional to the square of the applied voltage (provided this deflection is small). Deflection causes a differential frequency deviation of two r-f oscillators that are controlled by the capacitances between the diaphragm and electrodes. The sum of the frequency deviations on either side of quiescent frequency is proportional to the deflection of the diaphragm, again provided that this deflection is small. Hence, over a range, the sum of the frequency deviations is proportional to the square of the applied voltages. The sum of the frequency deviations is measured by mixing circuits, gates, and an electronic counter, so that the energy within a certain period is given by

$$E = K \int_{t_1}^{t_2} F\,dt \qquad (1)$$

where K is a constant and F is the sum of the frequency deviations.

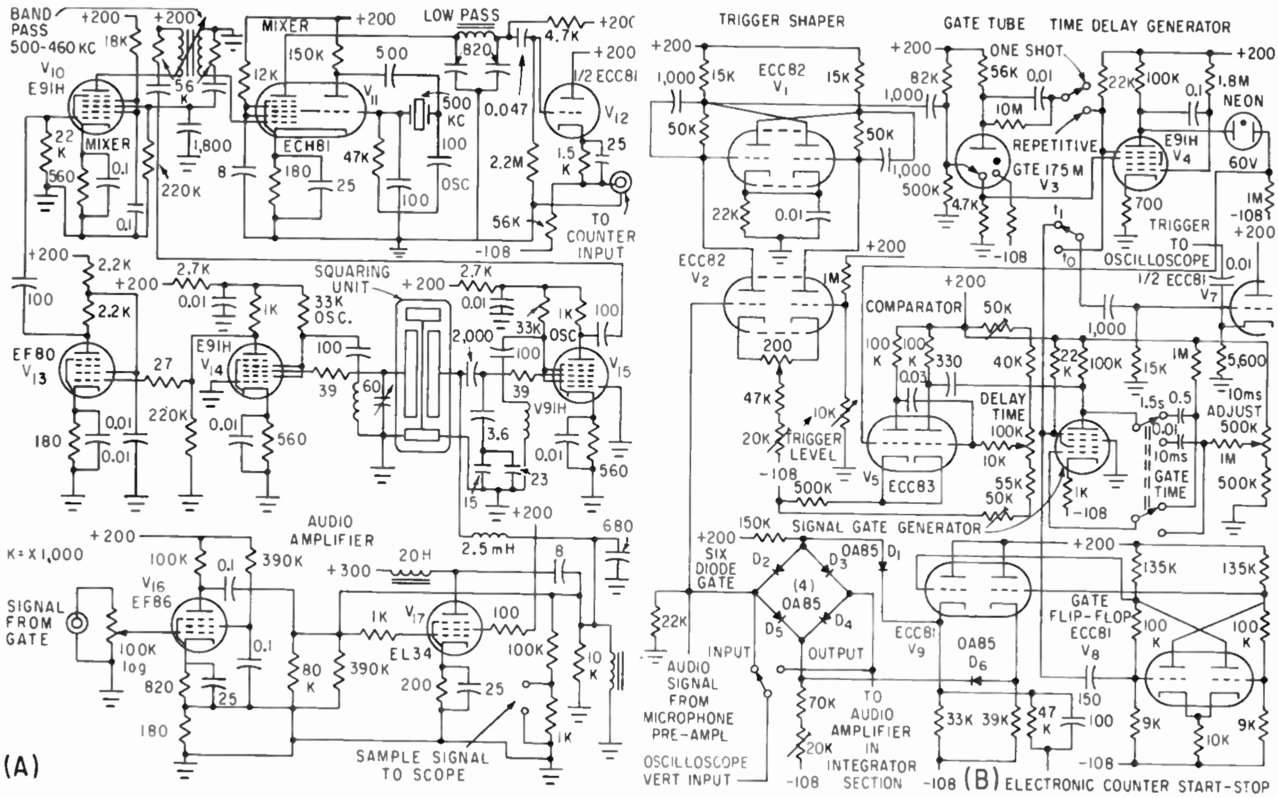


FIG. 2—Timing circuit can be set to accept any portion of the incoming sound signal; moreover, the time-period of the accepted signal is also variable (B). Chunks of the sound signal passed on by the timing circuits are first squared by the electrostatic squarer, they are then handed on to the digital counter for final integration (A)

Measurements

By J. P. A. LOCHNER and P. MEFFERT,
National Physical Research Laboratory, Pretoria, South Africa

A block diagram of the complete sound energy integrator circuit is given in Fig. 1. The circuit can be divided into two sections: the timing section including the signal gate, and the integrator section with its associated audio amplifier.

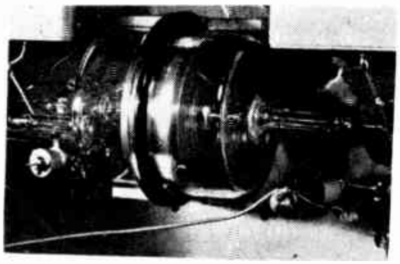
The incoming signal from the microphone preamplifier triggers the timing circuit which opens the six diode gate for a predetermined period at a preselected delay after arrival of the first signal. The incoming signal is supplied through the gate, calibrated attenuator, two-stage feedback amplifier, and r-f choke, to the one electrode of the electrostatic transducer. The two capacitors of the electrostatic squaring unit control the frequencies of two oscillators that are mixed in a double heterodyne system to give a zero beat when no audio signal is applied. With a signal applied, a frequency deviation between the two oscillators occurs in proportion to the square of the applied voltage. The number of cycles is counted over predetermined periods by an electronic counter switched by the square wave which actuates the gate.

An oscilloscope may be triggered at either the beginning of the timing cycle or at the moment the gate is opened. The audio signal can be checked at the input or output side of the gate or at the amplifier output.

The electrostatic squaring transducer is shown in photograph at the top of p 68. This device consists of a 0.025 mm thick Duralumin diaphragm stretched tightly between two electrodes 2.6 cm in diameter leaving gaps of 0.05 mm on either side between electrodes and diaphragm. The entire unit is sealed into a glass container evacuated to eliminate air damping of the diaphragm and to reduce the effect of temperature variations to a minimum.

A frequency response curve of the electrostatic unit connected as electrostatic actuator and capacitor transducer is given in Fig. 3A.

A circuit diagram of the integrator section is given in Fig. 2A. This section consists of the electrostatic squarer, which incorporates the frequency determining elements of two transitron negative resistance oscillators working at about 3.3 Mc and 3.8 Mc. The inductors and other components of the two oscillators are similar to keep their drift alike. After amplification the signals from the two oscillators are mixed to obtain a difference frequency of 500 Kc. This difference signal is passed through a 460 to 500-Kc band-pass filter and mixed with a 500-Kc signal from a crystal oscillator to give an output fre-



Electrostatic squarer in its evacuated envelope

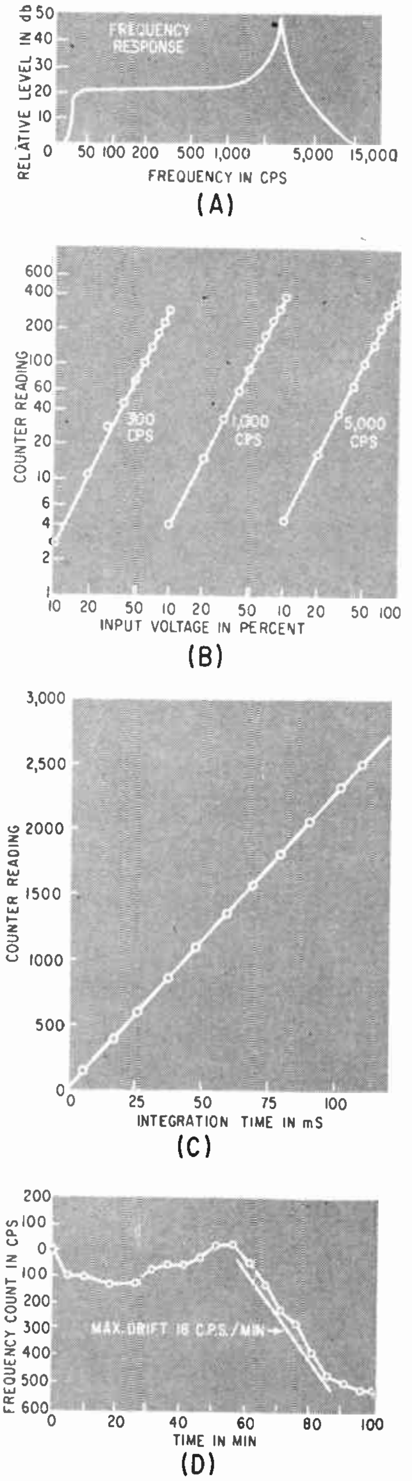


FIG. 3—Calibration curves of squarer and integrator are discussed in text

quency varying from zero to about 35 Kc for maximum deviation of the transducer diaphragm. This output signal is fed through a low-pass filter and cathode follower to the electronic counter input.

A circuit diagram of the timing section is given in Fig. 2B. This section passes the selected portion of signal from the microphone preamplifier through to the integrator section, and at any delay after the first pulse of incoming sound.

The incoming signal from the microphone preamplifier feeds the gate input and trigger shaper, this latter being a two-tube bistable circuit giving sharp pulses whenever the input signal exceeds the setting of the trigger level control. The gate tube is a cold-cathode type giving visible indication of being ON. The time base consists of a phantastron saw-tooth generator and a comparator, giving a delay time linearly variable from zero to 120 milliseconds. The comparator triggers the integration time phantastron, which can be accurately adjusted to the integration period. The integration period in the instrument is switched to either 10 millisec or 1.5 sec.

The signal gate consists of a bistable multivibrator triggered from the phantastron screen grid, plus two cathode followers and six crystal diodes. In the OFF position, diodes D_1 and D_6 are conducting, thereby biasing D_2, D_3, D_4 and D_5 to cutoff. In the ON position D_1 and D_6 are cut off while D_2, D_3, D_4 and D_5 are heavily conducting, allowing the audio signal to go through. Once it has been balanced, the gate passes audio signals with negligible switching transients.

To give an energy reading, the counter reading over any fixed period should be proportional to the square of the applied voltage. Figure 3B shows curves of counter reading against percentage of input voltage at 300, 1,000 and 5,000 cps. The points are experimental and the straight lines are theoretical square law lines.

Figure 3C is a curve of counter reading against integration time for a constant input voltage of 330 mv at 1,000 cps. Again, the points are the experimental values and the solid line the theoretical straight line. This curve shows that for constant voltage bursts the energy registered by the instrument is directly proportional to the integration time, even for times as short as 5 milliseconds.

The frequency response of the instrument is the frequency response of the feedback audio amplifier feeding the integrater section and is flat to within ±½-db from 50 to 15,000 cps.

The energy reading on the instrument should be independent of the wave shape of the applied signal. To test this, the reading obtained from a random noise signal having a bandwidth of 160 cps to 7,000 cps was compared with the reading obtained from a 1,000-cps sine-wave using a thermocouple meter as transfer standard. The agreement was within 0.1 db.

It was also found that the dynamic range of the instrument was reduced to 15 db by using white noise as a signal. This was because overloading of the audio amplifier occurred sooner because of the high peaks in the signal.

One of the limitations of any beat frequency instrument is frequency drift. To investigate to what extent drift could upset readings with this instrument, the zero frequency drift was measured for 100 minutes and the results presented in Fig. 3D. The maximum drift registered is only 18 cps a minute, which represents a negligible error due to drift.

Apart from its intended application the instrument should be useful for analysis of all sorts of signals within the audio range, especially because of its wide range of integration periods and low drift. Since it is a true rms device and can be made frequency-independent over a large range, the electrostatic squarer holds possibilities for use as a transfer standard.

The authors acknowledge the permission of the *Journal of the Acoustical Society of America* to publish this review article.

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(2) J. P. A. Lochner and J. F. Burger, The intelligibility of speech under reverberant conditions, Submitted for publication in *Acustica*.
(3) J. P. A. Lochner and P. Meffert, *J. Acoustical Soc. Am.* 32, p 267, 1960.

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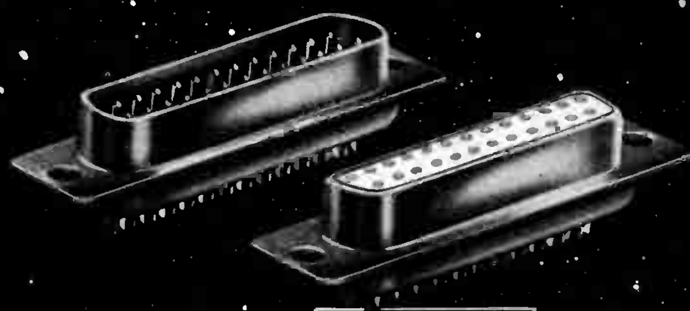

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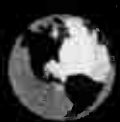

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Obtaining Equivalent Circuits Of Inductors Graphically

Simplified method for determining the dynamic characteristics of inductors or parallel circuits in wideband applications is useful in design of matching circuits

By W. P. CZERWINSKI, Antenna Research Engineer
U. S. Army Signal Research & Development Laboratory
Fort Monmouth, New Jersey

IN APPLICATIONS that involve narrow frequency ranges, it does not matter greatly how large the distributed capacitance of an inductor is, while furthermore, the effective inductance can be obtained easily by direct measurement. If wide frequency bands are involved, it is important to know the distributed capacitance. Presented is a convenient and accurate method of quantitative analysis of an inductor in respect to true inductance, self-capacitance, parallel resonance, plus dielectric and copper losses. While the method itself is not new,[1] it is presented here in a more comprehensive form.

The analysis is based on the equivalent circuit of Fig. 1. In this parallel resonant circuit, C_S represents the effective stray capacitance. From Fig. 1 it follows that

$$\omega C = -1/\omega L + \omega C_s \quad (1)$$

$$\text{or } L = 1/[4\pi^2 f^2 (C_s - C)] \quad (2)$$

$$\text{Defining Slope} = (C_s - C)/(1/f^2) \quad (3)$$

$$\text{gives } L = 1/(4\pi^2 \text{ Slope}) \quad (4)$$

Figure 2 illustrates the parameters. A presentation such as Fig. 2 is made up by marking a linear scale of $1/f^2$ as a base line on graph paper. The values for the ordinate, which is a linear scale also, depend on the inductor. These values are obtained from admittance bridge readings for the frequency range. The ordinate is marked off to accommodate the range covered by the susceptance readings of the inductor. For greatest accuracy, frequencies should be chosen that yield susceptance readings on both sides of a zero susceptance line.

A straight line is drawn through the plotted points and extended to intersect the ordinate (point X). The value on the ordinate scale at X represents C_S, the self-capacitance of the inductor. The intersection of the curve with the zero susceptance line, when projected down to the base line, identifies f_o, the resonant frequency.

To calculate the true inductance, the slope values are taken from the graph in the following manner: A convenient point, Z, at the low end of the curve is selected. The corresponding values for C (point Y) and $1/f^2$ are determined; the slope is then the

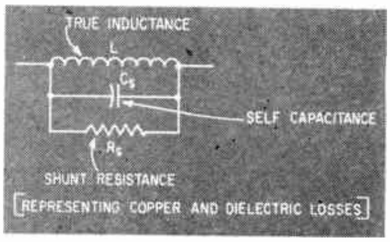

FIG. 1—Equivalent circuit of coil defines terms used in derivation

total capacitance from X to Y over the value of $1/f^2$ at Z. Point Z has been selected as shown to give higher accuracy. If a point higher up had been selected, the relative accuracy in reading $C_S - C$ and in reading $1/f^2$ would have been less.

The conductance G is obtained directly off the admittance bridge in millimhos and converted to R_S in ohms by

$$R_s = 1{,}000/G \quad (5)$$

EXAMPLE—The numerical values shown in Fig. 2 are for a Q-2 ferrite-core inductor. Measurements of positive and negative capacitance values were obtained by making three or four admittance bridge readings of the sample inductor in the frequency range. From the plot C_s = 12 pf,

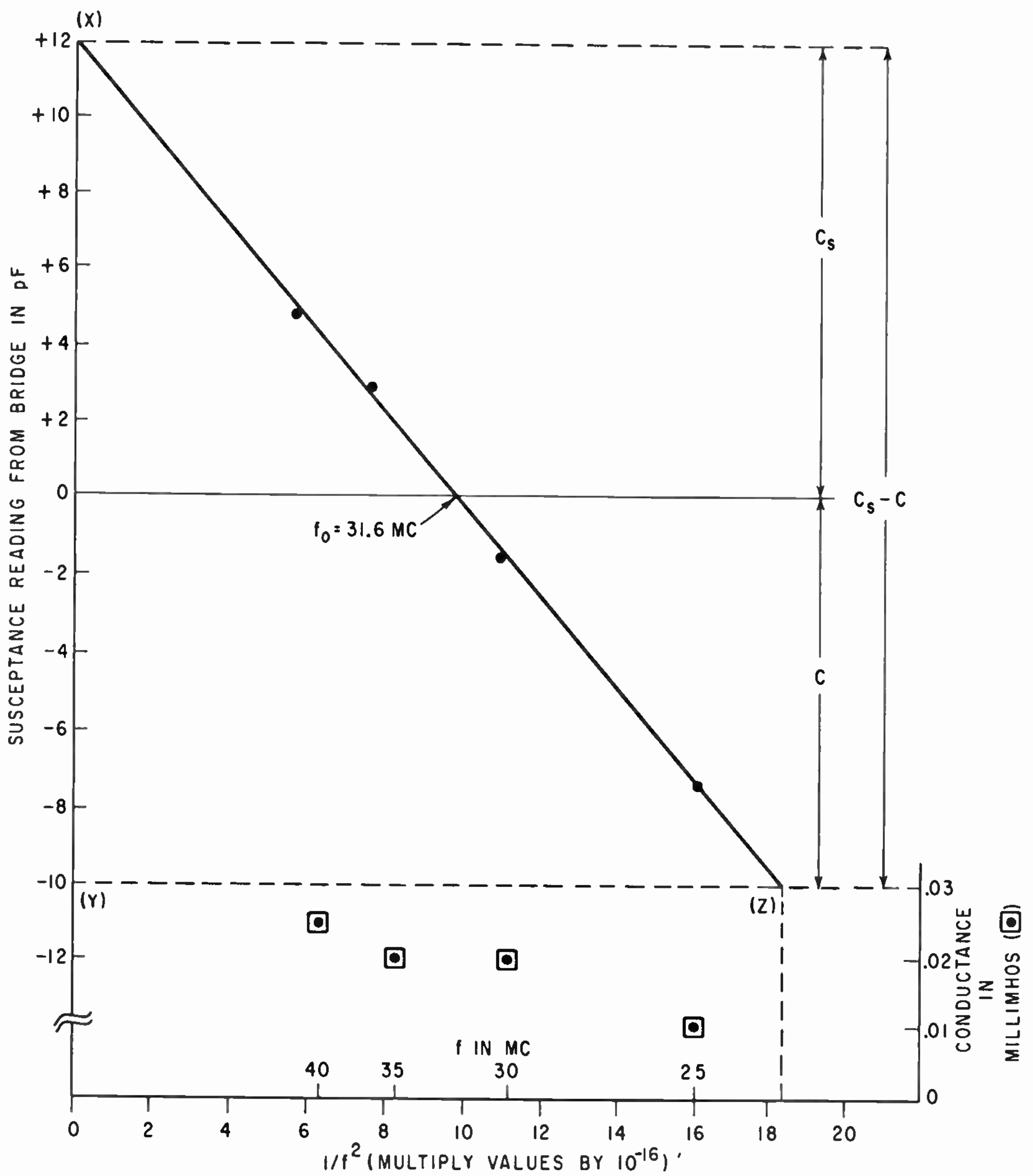

FIG. 2—Graph reduces need for laborious calculations and can pinpoint incorrect bridge readings

$C = -10$ pf, and G at 31.6 Mc $= 0.02$ millimhos.

Using Eq. 3

$$\text{Slope} = \frac{22 \times 10^{-12}}{18.3 \times 10^{-16}} = 1.20 \times 10^4$$

and with Eq. 4

$$L = \frac{1}{39.5 \times 1.20 \times 10^4} = 2.11 \times 10^{-6}$$

$$L = 2.11 \ \mu\text{h}$$

Using Equation 5 the shunt resistance is

$$R_s = 1{,}000/0.02 \text{ (millimhos)}$$
$$R_s = 50{,}000 \text{ ohms}$$

An important advantage of this kind of plot is that erroneous readings show up as deviations from a straight line. Inaccuracies can be averaged by drawing the straight line to minimize the sum of the square of the errors. If the readings lie on a curved line, then this indicates that the equivalent circuit concept of one lumped capacitor in parallel to the inductor does not apply to the inductor measured. Of course, this method can be applied to an actual parallel circuit.

In practice, the conductance is plotted as shown in Fig. 2. Thus, all pertinent data and calculations relating to the inductor under test can be recorded on a single sheet.

The suggestions of Helmut Brueckmann are gratefully acknowledged.

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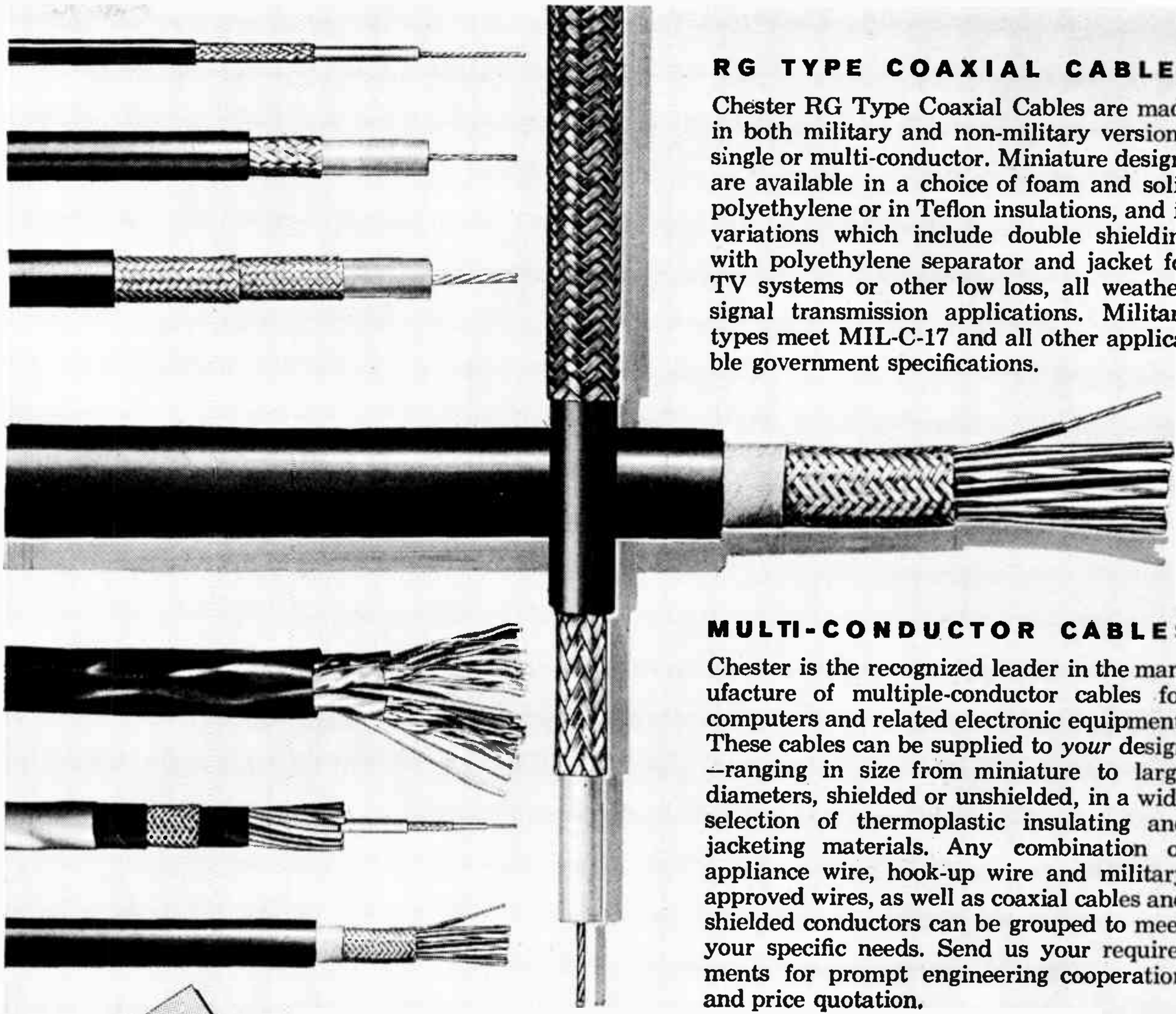

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Lack of Standards Hampers Development

RESEARCH and development of electronic equipment is being seriously hampered by lack of adequate standards. (See ELECTRONICS, p 90, Sept. 11, 1959.) This need was underscored at the 1960 Conference on Standards and Electronic Measurements at the Boulder Laboratories of the National Bureau of Standards. Specifically, Aerospace Industries Association with representatives from 15 different firms indicated to NBS a critical need for better standards for measuring microwave power and attenuation.

Needs of military and space programs are requiring unprecedented measurement accuracies. Standards for the higher frequencies now finding increasing use are also urgently needed.

Surveys conducted during the past year by AIA indicated accuracies currently required by industry in different areas of measurement. Based on these surveys, the series of AIA-NBS conferences have been initiated. Each field of measurement will be probed in depth to determine the most urgent needs and how they can best be met.

A primary purpose of the meeting was to suggest action that might be taken to correct specific situations described by industry. For example, the million-dollar development of radomes is proceeding more by trial and error rather than through measurement and analysis because precise phase and amplitude measurements do not exist in the required frequency range.

One firm must use its precision measurement laboratory facilities to test sections of coaxial cable from the production line because adequate production-line standards do not exist. This test requires 11 hours for a single section of cable.

Klystrons are being over-designed to ensure that they generate sufficient power because there is no way to measure precisely peak microwave power. Costs and equipment size are increased, production schedules slowed and expensive equipment is not being used at its optimum capacity or range.

A few years ago, radar performance was evaluated on the basis of two or three measurements. To measure performance of present-day radars requires testing many new complex devices. Often the radar is assumed to have failed when the fault is actually with test instruments.

Crash missile programs are being impeded because measurements of microwave power made on different days by the same instruments may vary by fifty percent. Some radars are operated at near maximum capacity. To avoid breakdown, power must be limited to a given level dependent on measurement accuracy. One speaker said that a five percent error in power measurement can make the difference between operating or not.

Discussion of these problems indicated that in a few cases NBS can provide interim standards with present facilities that will greatly help many users. Calibration can now be provided of microwave power-measuring instruments between 8,200 and 12,400 Mc. Using different techniques, calibration can be extended to lower frequencies soon. Although accuracy will be somewhat less, it will help meet many immediate needs.

However, many standards cannot be extended to new frequency ranges even though techniques are known because equipment and personnel are lacking. Industry urgently needs an extension of a current microwave attenuation standard to three higher frequency ranges. To evaluate this technique at even one new frequency in the millimeter wave region requires $11,000 worth of new equipment. This figure exceeds the present total annual equipment funds allotted to the project involved.

Another limitation is time. NBS representatives were asked to estimate time required at the present level of activity to develop minimum acceptable standards not now in existence for frequencies to 100 Gc and other most-needed quantities. However, accurate estimates are impossible until techniques have been developed.

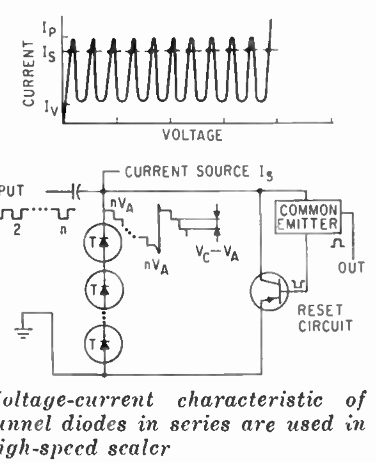
Estimates, varying with the measurements involved, ranged from five to ten years for most quantities. Even with substantial increases in funds, hiring capable personnel and their initial training take considerable time. These estimates also make no provision for new needs that will arise during the next few years.

To estimate the urgency of the needs, industry representatives indicated their reasons for requiring certain standards. NBS described and discussed for each field the present status of research, development and calibration. From the discussions, tentative recommendations evolved for action by all interested groups. These recommendations will be reviewed by AIA before official presentation.

Discussion revealed the difficulty of discovering whether expressed needs were realistic. Extreme accuracies were sometimes specified simply to play it safe.

High-Speed Scaler Uses Tunnel Diodes

GALLIUM ARSENIDE tunnel diodes are used in a newly developed high-speed scaler. Double pulse resolution for switching between intermediate states is said to be less than 14 nanoseconds. The device was developed by Philco's Re-



Voltage-current characteristic of tunnel diodes in series are used in high-speed scaler

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Collector Voltage BV_{CES} ($I_C=0.3A$)	70	70	50	50	45	45	40	40	Volts
Emitter Voltage BV_{EBO}	60	60	40	40	30	30	20	20	Volts
Collector Current I_C	15	15	15	15	15	15	15	15	Amp
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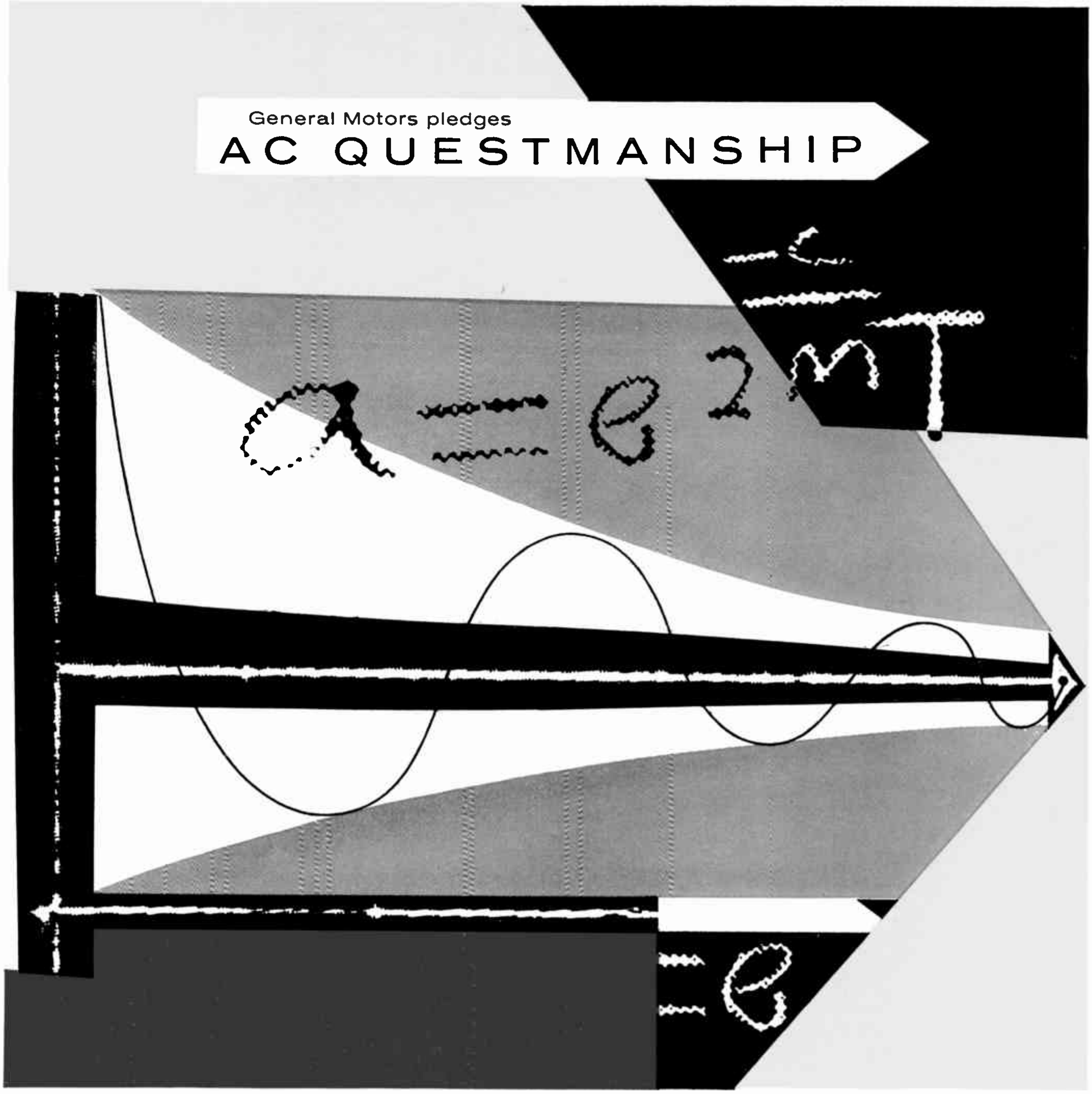

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Operation of the scaler is based on a characteristic of tunnel diodes connected in series. Voltage is a multi-valued function of current. as shown in the voltage-current curve in the figure. Gallium arsenide tunnel diodes were chosen because of their wide voltage swings and because they have peak-to-valley current ratios $(I_P:I_V)$ exceeding ten-to-one. In addition, switching time is less than one nanosecond.

When current I_S is initially applied to the stack of series-connected diodes in the figure, voltage across the stack is at minimum. Each input pulse of proper amplitude increases voltage across the stack by an amount $V_C - V_A$ to the next higher level. The transistor reset circuit is biased to operate when voltage across the stack reaches maximum $(nV_C - nV_A)$. An output pulse is provided and voltage across the stack is returned to its original minimum level.

In addition to high switching and reset speeds, the tunnel diode scaler provides significant reductions in space, weight and power requirements compared with beam-switching tubes or cascaded transistor binary circuits used in similar applications.

Spectrometer to Study Neutrons and Protons

MILLION-WATT magnetic spectrometer may provide a better understanding of the structure of matter. The new instrument for studying nuclear particles is the result of three years of effort. It can handle billion-volt electrons from targets bombarded by a large linear accelerator.

The 150-ton spectrometer will be used at the High Energy Physics Laboratory of Stanford University by Professor R. Hofstadter and his associates in attempts to probe to the cores of protons and neutrons. The project is being supported by the Office of Naval Research, the Atomic Energy Commission and the Air Force.

Three years ago this research team made precise measurements which demonstrated that protons and neutrons are of equal magnitude magnetically but that the size of their electrical charge is not equal. The spectrometer used in that investigation was only half the size and required only one-fifth the power of the present instrument.

It had been assumed that the neutron was a mirror image of the proton in its outer parts. This assumption was proved to be true magnetically but not electrically. The much smaller electrical charge of the neutron presents an anomaly in that magnetic phenomena seem to be explained perfectly. Some scientists believe that existing theories may not be valid for particles as fine as protons and neutrons.

The earlier measurements demonstrated that both type particles have a radius of 8×10^{-14} cm. Each particle seems to be composed of a cloud of mesons, believed to hold the nuclei together, that becomes denser toward the center. The former spectroscope could not probe to the cores of the neutrons and protons but could reach to within 3×10^{-14} cm of them. The new equipment may permit penetration to the cores of both type particles. Even if it does not solve the problem of magnetic versus electrical charge size, it is expected to provide much other valuable information.

The new spectrometer, primarily a large electromagnet, is mounted with the older spectrometer on a wheeled carriage that rides on a circular rail. By allowing full 360-degree rotation of the spectrometers, the magnets can pick up electrons scattered at all angles from the target. The magnets bring the electrons to the top of the apparatus. Behind heavy radiation shielding, Cerenkov counters and multiplier phototubes determine their numbers and energy.

Counters in the new equipment are set in parallel to permit simultaneous counting of five times as many electrons as before. Rotating coils inside vacuum chambers in the magnets allow easy variation of field strengths. Both refinements will increase considerably the speed of gathering information for study and computer analysis.

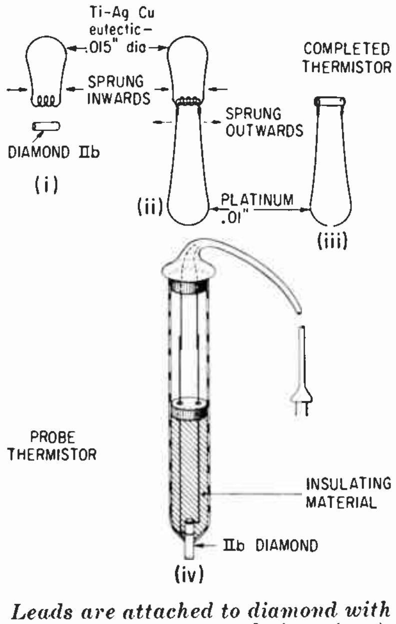
Blue Diamonds Make Rugged Thermistors

BLUE DIAMONDS (Type IIb) are extrinsic p-type semiconductors, and have a high negative temperature coefficient from below 200 K up to approximately 500 K. Past that point the temperature coefficient decreases, rapidly becoming zero, and then going positive in the region 600 K to 700 K.

G. B. Rodgers, Diamond Research Laboratories, Crown Mines, Johannesburg, S. Africa, reports that, when provided with suitable ohmic contacts, a blue diamond can be used as a thermistor over a wide temperature range. A diamond thermistor is in operation at DRL measuring coolant temperature in a diffusion pump.

Diamond has certain physical properties that make it an excellent thermistor material. These include low specific heat, high heat conductivity (greater than copper at room temperature), and high physical strength, as compared with conventional oxide thermistors. Diamonds are non-hygroscopic, and are highly resistant to corrosive fluids and high temperatures.

These attractive physical properties suggest that in many applications, the diamond thermistor can be placed in actual contact with the medium to be measured. In this manner, the heat dissipation constant can be increased, and the thermal time constant reduced.



Leads are attached to diamond with titanium wire weld technique (top). Diamond in probe type mount (bottom)

Thermal time constant, which determines the response time of a thermistor to rapid changes of temperature, is inversely proportional to the heat dissipation constant.

For a thermistor in air, the dissipation constant is determined mainly by the exposed surface area. Thin wafers, and thin cylinders, have the highest dissipation constants. Thermal conductivity is not an important factor, as most thermal impedance is as the surface, from thermistor to air, and internal impedance is negligible in comparison.

The high heat conductivity of diamond is important in a probe type thermistor, using a cylindrical diamond, as shown in sketch. Electrical connections to the diamond are remote from the heat source, and heat must diffuse through the cylinder from the point of contact.

True ohmic low resistance contacts between the diamond and leads must be made to insure accurate temperature readings. Additional resistance in series with the element can swamp the small change of resistance, lowering sensitivity. The extra ohmic heating will raise the ambient temperature, and produce a false reading.

Early research developed the process of coating diamonds with a mixture of titanium and silver, that is used to mount diamonds for various applications. As titanium is a group IV element (as is carbon), it seemed likely that a true ohmic contact might be obtained by welding or alloying titanium with the diamond.

Using a titanium weld, a successful method was developed at DRL for attaching platinum leads to small diamond cylinders. As shown in the diagram, a small bridle of silver-copper eutectic wire, .015 in. in diameter, having a titanium metal core, is fitted over the ends of the cylinder. A loop of .01 in. platinum wire is attached to the cylinder over the Ti-Ag-Cu wire.

The entire assembly is placed in a furnace and heated to 1,200 C for 2 minutes. During heating the assembly is bathed in a stream of argon to prevent oxidation of the diamond. At 1,200 C the Ti-Ag-Cu wire melts, and fuses the platinum wire, which doesn't melt, onto the ends of the diamond cylinder.

Quantity of Ti-Ag-Cu wire used in the process depends on the length of the diamond. Excess wire will melt, forming a thin film that shunts the thermistor action, ruining the device.

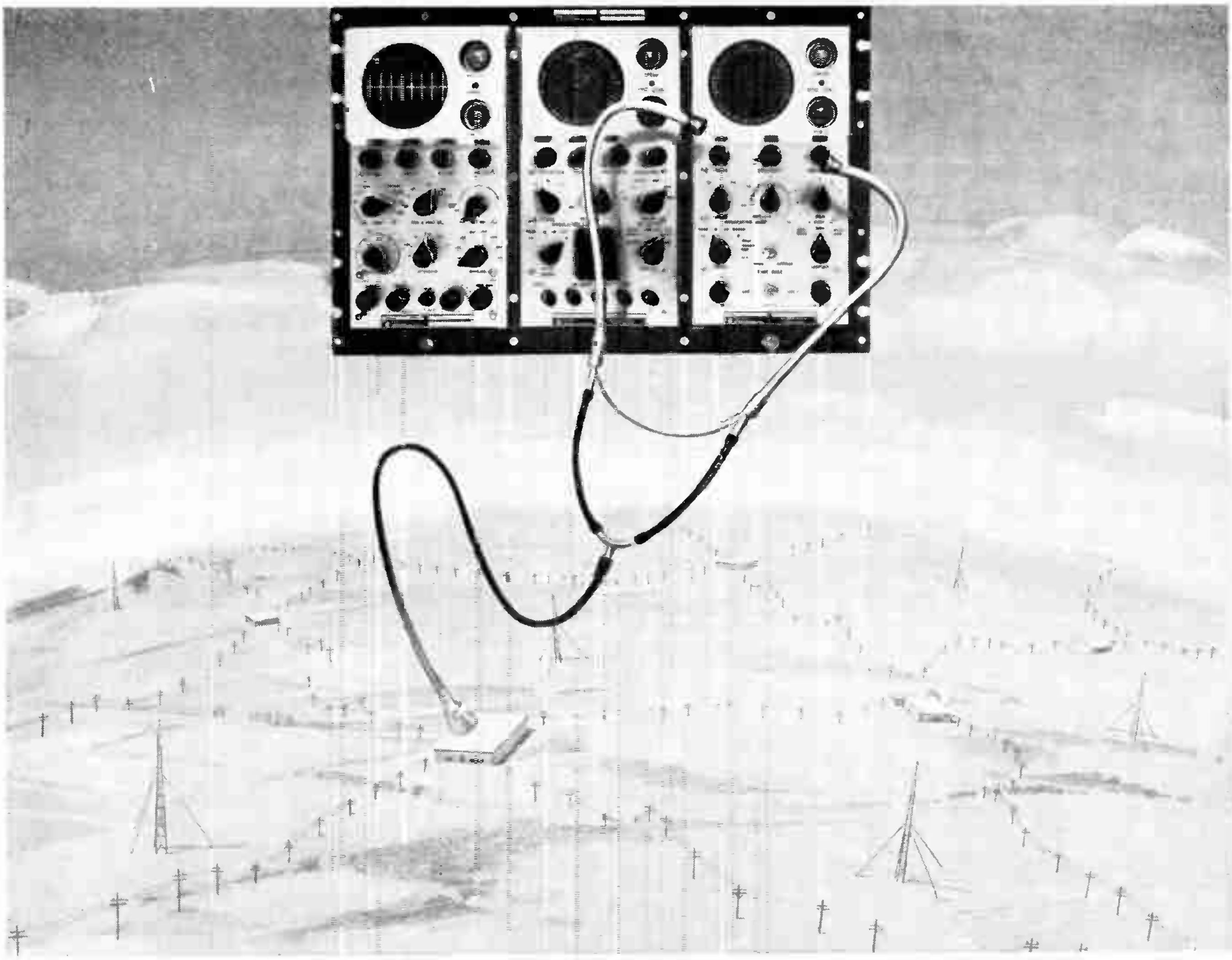
Prototype thermistors used diamond cylinders measuring 2.5 to 5 mm in length, and 1 to 1.5 mm in diameter. The diamonds were shaped by polishing and drilling. No crystal lattice orientation was required, as diamond is an electrically isotropic material.

Diamond thermistors are useful over a wide range of operating temperatures, and under severe operating conditions. They therefore may be more desirable in many applications than silicon, germanium or oxide units. Silicon and germanium thermistors operate in the intrinsic temperature ranges of greater than 200 C and −15 C respectively. Diamond units will operate from below −70 C to about 300 C, with a negative temperature coefficient. Although not useable above this maximum temperature, a diamond thermistor could survive environmental temperatures of up to 600 C, if oxidizing conditions are not present.

Cost of the devices would depend on the availability of IIb diamonds, and the wastage in preparing suitable thermistor shapes.

Metal-Composite Laminates For Automatic Post Office

METAL-COMPOSITE laminated plastics for applications requiring intermittent electrical contact have



MONITOR...TEST...ANALYZE...

telegraph and data transmission systems without interrupting traffic

Circuit downtime is lost time. Save it by diagnosing the trouble in communications links *while they are operating*. Radiation's new Telegraph Distortion Measuring and Monitoring System permits on-line testing and wave-form analysis of telegraph and data transmission circuits. Thus, the trouble in a deteriorating link can often be diagnosed and remedied without interrupting message traffic.

With miniaturized components for space saving compactness, the TDMS can replace most test equipment now required. This permits a reduction of test equipment costs and increases maintenance efficiency. Portability is achieved at the "push of a button."

For complete technical data on the TDMS and its many capabilities, write for Bulletin E-100B to Radiation Incorporated, Dept. EL-8, Melbourne, Fla.

THE ELECTRONICS FIELD ALSO RELIES ON RADIATION FOR...

RADIPLEX 89—a 48-channel low-level multiplexer with broad data processing applications. Features rugged solid-state circuitry, almost unlimited programming flexibility, unique modular construction for compactness and exceptional ease of operation and maintenance.

RADICORDER—Multistylus recorder provides high-speed instantaneous readout for wide range of data acquisition or processing systems. Eliminates necessity of electronically translating complete data, thereby reduces computer work loads.

TELEMETRY TRANSMITTER—Model 3115 is a ruggedized 215-260 MC unit with extremely linear FM output under the most severe environmental conditions. With its record of outstanding performance in many missile programs, Model 3115 is specified by leading missile manufacturers.

RADIATION
INCORPORATED

CIRCLE 79 ON READER SERVICE CARD

been developed by Taylor Fibre Co., Norristown, Pa.

With the metal embedded in strong, durable insulation material, copper-clad laminates ordinarily used for etched printed circuits the need for metal-laminate combinations where the more intricate, close-tolerance printed circuits are not required.

Typical of possible applications for metal-composite laminates is their use as tray code readers in new automated equipment being installed by the United States Post Office. Attached to the sides of mail-bearing trays, the coded readers signal electrically-activated mechanisms went to shunt the tray to a branch conveyor for a given geographical area.

Among other end-uses for metal-composite laminates is a model seascape on which Navy and Marine officers can simulate the maneuvering of as many as 100 radio-controlled models of naval vessels. The giant 70 × 24 foot device is made up of 36 × 36 inch sections of copper strips embedded $\frac{1}{4}$ inch apart in $\frac{3}{64}$ inch thick phenolic-paper laminate. The flatness of each section is held to plus or minus $\frac{1}{64}$ inch over the entire area, and the spacing between the strips is also held to $\frac{1}{64}$ inch tolerance.

Taylor Fibre has supplied these laminates in three ways: with the metal inserted in windows which are cut in the top layers of the laminate; with the metal pressed flush into the laminate; and with a sandwich of metal foil between two layers of laminates which have been cut out at designated locations where electrical contact is desired.

Although initial work in this field has been done with copper, cold rolled steel, and stainless steel, virtually any metal can be used in making these laminates.

Due to the large number of possible product variations, all composite laminates are custom-engineered to fit a specific application.

Organic Gaskets for High Temperatures

A NEW FAMILY of gasketing and packing materials made of flurocarbon resins and inorganic fibers, has been announced by Armstrong

Cork Co., Industrial Div. The materials can be used at temperatures from −425 F to over 500 F with excellent torque retention.

The new sheet materials, called Flurocarbon Accopacs, are inert to most chemicals over a wide range of temperatures, and have a low coefficient of friction which makes them useful as seals and packings in contact with moving parts.

The material is reported to have good dielectric properties, and excellent thermal dimensional stability.

Components make of the material can be adhesively bonded to other surfaces with either thermoplastic or thermosetting cements.

The materials consist of combinations of flurocarbon resins and asbestos or other inorganic fibers in different proportions and densities. Flurocarbons are characterized by having good dielectric properties, extreme chemical inertness, high heat resistance, and toughness over a wide temperature range.

Despite these useful qualities, the flurocarbons have inherent disadvantages, the most pronounced of which are high coefficient of thermal expansion, and low resistance to deformation under load at high temperatures. Addition of fibers to the pure resins overcomes these disadvantages, and produces a useful material for a variety of gasketing and packing applications.

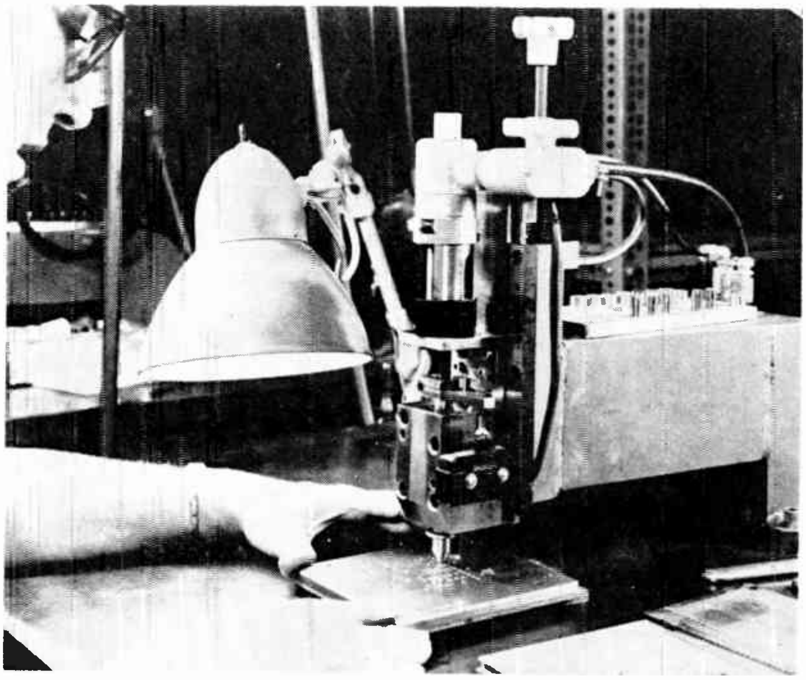
During Accopac process each fiber is given a thorough coating of resin, and the fibers are evenly distributed to form a uniform material.

These materials have potential applications in several industries. Uses in the aircraft and missile field include gaskets for fuel systerm, hydraulic systems, and baffles and fire walls in high temperature areas up to 500 C, and as components in cyrogenic materials handling systems.

Applications in the electronics field include gaskets for high temperature ("H" type) equipment, including dry transformers, converters, circuit breakers, motors and switches, and as terminal bars and spacers in these devices. As in the aircraft industry, low temperature stability is useful for cryogenic applications.

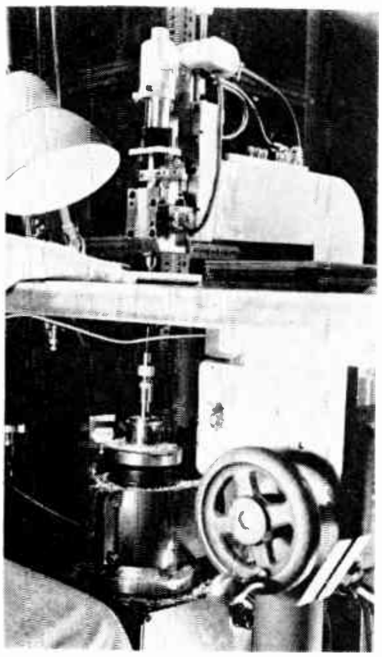
CIRCLE 81 ON READER SERVICE CARD

Patterned Fixture Guides P-C Driller



Finger drops in indentation, locating hole position over drill. Etched pattern traces path from hole to hole

UNDER-THE-TABLE DRILL and a drilling fixture that provides positive positioning of the drill are combined in a semiautomatic machine in use at Librascope Division, General Precision, Inc., Glendale, Calif. Boards are drilled 5 at a time and hole locations are precise enough for automatic component insertion.



Drill rises when finger is centered and operator presses toe switch

Librascope, which designed the machine and had it built by subcontractors, reports that it has increased operator output while cutting rejects. The boards are aligned in the fixture with alignment holes drilled before etching. The same holes also serve in other production steps requiring alignment. Boards made are used in computers and other industrial-military equipment.

The operator stacks 5 circuit boards in the positioning fixture. This fixture is a rigid metal plate backed by reinforced plastic. The surface of the plate contains a drilling path or pattern etched into the metal, with positioning indentations corresponding to the holes to be drilled.

The loaded fixture is placed, metal plate up, on the drill table. A positioning finger located above the tabel is guided along the pattern. When the fixture is positioned so the finger drops into an indentation, the operator presses a toe switch. The carbide drill below the table automatically rises at a controlled rate, spinning at a preset speed. Safeguards prevent the drill from operating unless the finger is centered in an indentation. The drilling stroke ends in the fixture's plastic backing. On completion of the stroke, the drill returns to rest position and the operator locates the positioning finger in the next indentation.

Computer-Prepared Lists Serve as Wiring Diagrams

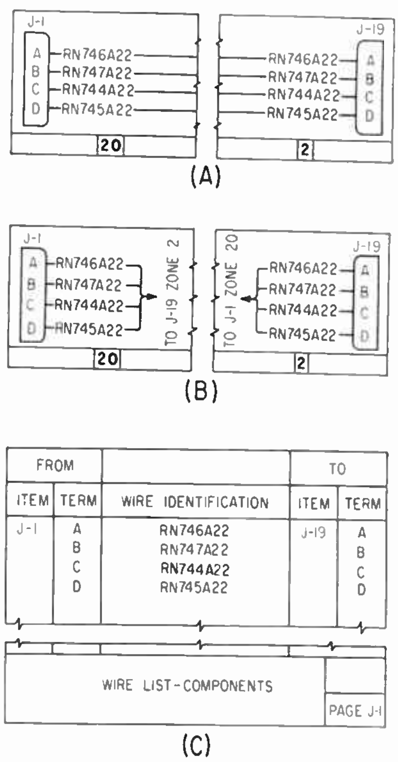
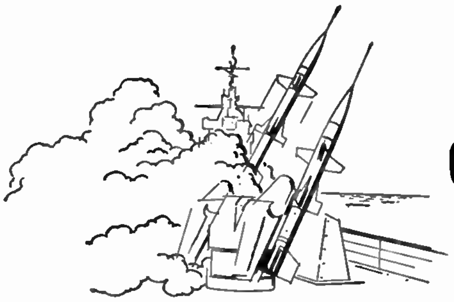


FIG. 1—Evolution of wiring list from wiring diagrams

WIRING DATA LISTS prepared on electronic data processing machines are being used instead of wiring diagrams for aircraft electrical-electronic wiring systems. North American Aviation, Inc., Los Angeles, Calif., says the lists permit the discard of conventional pictorial diagrams.

Because aircraft wiring systems



HANDY & HARMAN SILVER FLAKE

Coats Lighter, More Effective Plastic Lens For Long Range Missile Control System

An exciting new application in the missile control field is the development by the Surface Armament Division at Sperry Gyroscope Company of a silver-coated plastic lens for use with the Navy's Talos missile. As compared to earlier metal versions, the new lens weighs substantially less and provides twice the signal gain at the same production cost! The Talos delivers, with extreme accuracy, a high explosive or nuclear warhead to any altitude at which airplanes now fly, as well as far beyond the range of human visibility.

The silver coat imparts RF reflectivity and electrical conductivity to the lens and is applied in paint form. As the silver base for this paint, Sperry uses Handy & Harman's Silver Flake. An important quality of this flake is that its waferlike particles are asymmetrical and overlap on the surface of the lens, affording up to 35% of the conductivity of an equivalent weight and shape of fine silver.

Handy & Harman Silver Flake finds use throughout the electronic and electrical industries...it is ideal for pigments to make conductive coatings on such non-conductors as ceramics, glass, mica, plastic and paper, as in the manufacture of capacitors, thermistors, carbon resistors, printed circuity and electrostatic shields.

Handy & Harman has available every form of silver useful to manufacturers and fabricators—flake, powder, paint, paste, sheet, strip, wire bimetals, silver oxide, divalent oxide, etc. Our Research and Engineering Department is always available to assist you in the selection or use of any silver form for any application from brazing to conduction coating. **Below are listed six of our Technical Bulletins. Please indicate their numbers for prompt attention.**

Fine Silver	**Bulletin A-1**
Silver-Copper Alloys	**Bulletin A-2**
Silver-Magnesium-Nickel	**Bulletin A-3**
Silver Conductive Coatings	**Bulletin A-4**
Silver Powder and Flake	**Bulletin A-5**
Vacuum Tube Grade Brazing Alloys	**Bulletin 25**

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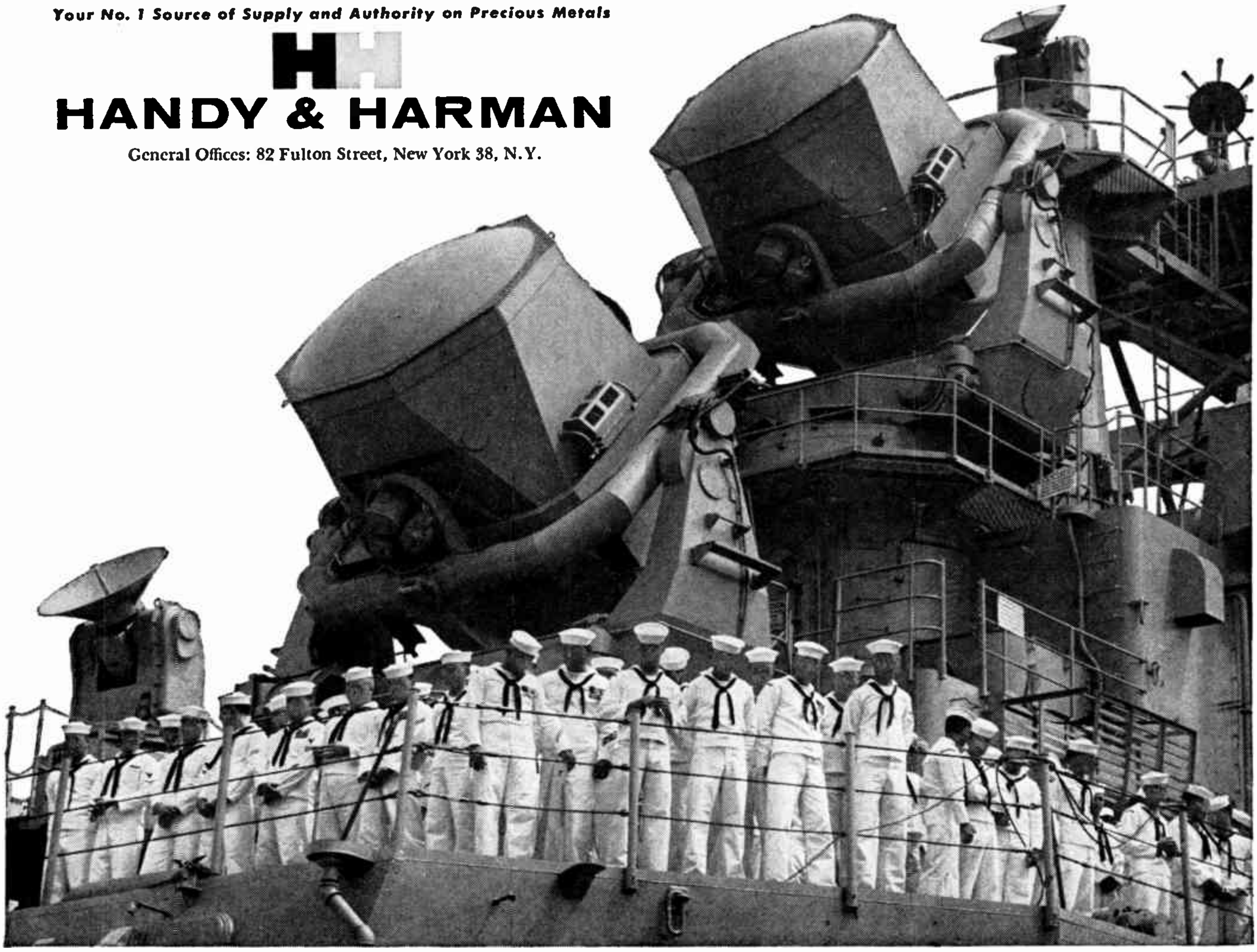


have become so large, NAA points out, massive collections of often huge diagrams became necessary. This became costly to prepare and difficult to follow, change and break down into wiring lists for various specialized purposes.

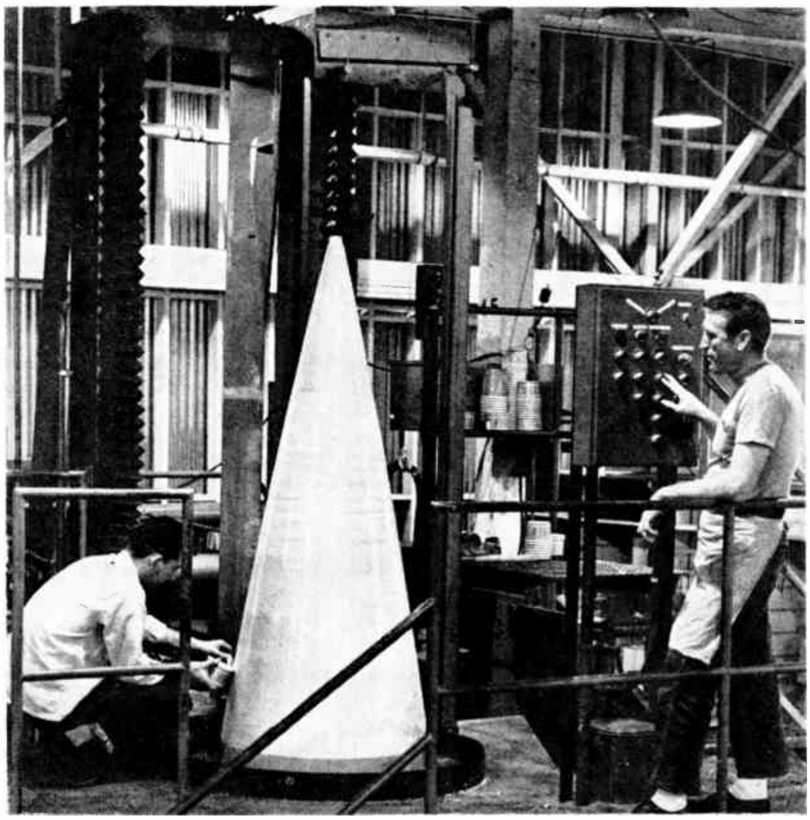
Under the system now used, the wiring data is taken off the designers' rough sketches by a wiring data group. The data is punched on cards and transferred to a magnetic tape memory. The data processing equipment (IBM 709) is programmed to prepare specialized lists for designers and production personnel.

Evolution of the system used by the firm is shown in Fig. 1. Fig. 1A shows the old method in which every circuit was shown continuously. Fig. 1B eliminates trunk lines by cross-referencing wire destinations.

The data list method of Fig. 1C eliminates the diagram. Each end of the wire is seen on the same line. The actual wiring lists contain much additional data. Included are component identifications, wiring function, lists of materials, military specifications, wire lengths, callout drawings, remarks, revision dates and so forth, depending on the requirements of the personnel using each list.

Among advantages are savings in engineering and drafting, speed in issuing wiring instructions and change orders, automatic rejection of erroneous orders and automatic preparation of wiring data for maintenance handbooks. The chief disadvantage is that the cost of preparing the memory tapes and programs is justified only when wiring diagrams would be voluminous and complicated.

Nose Cone Mandrel Winds Its Own



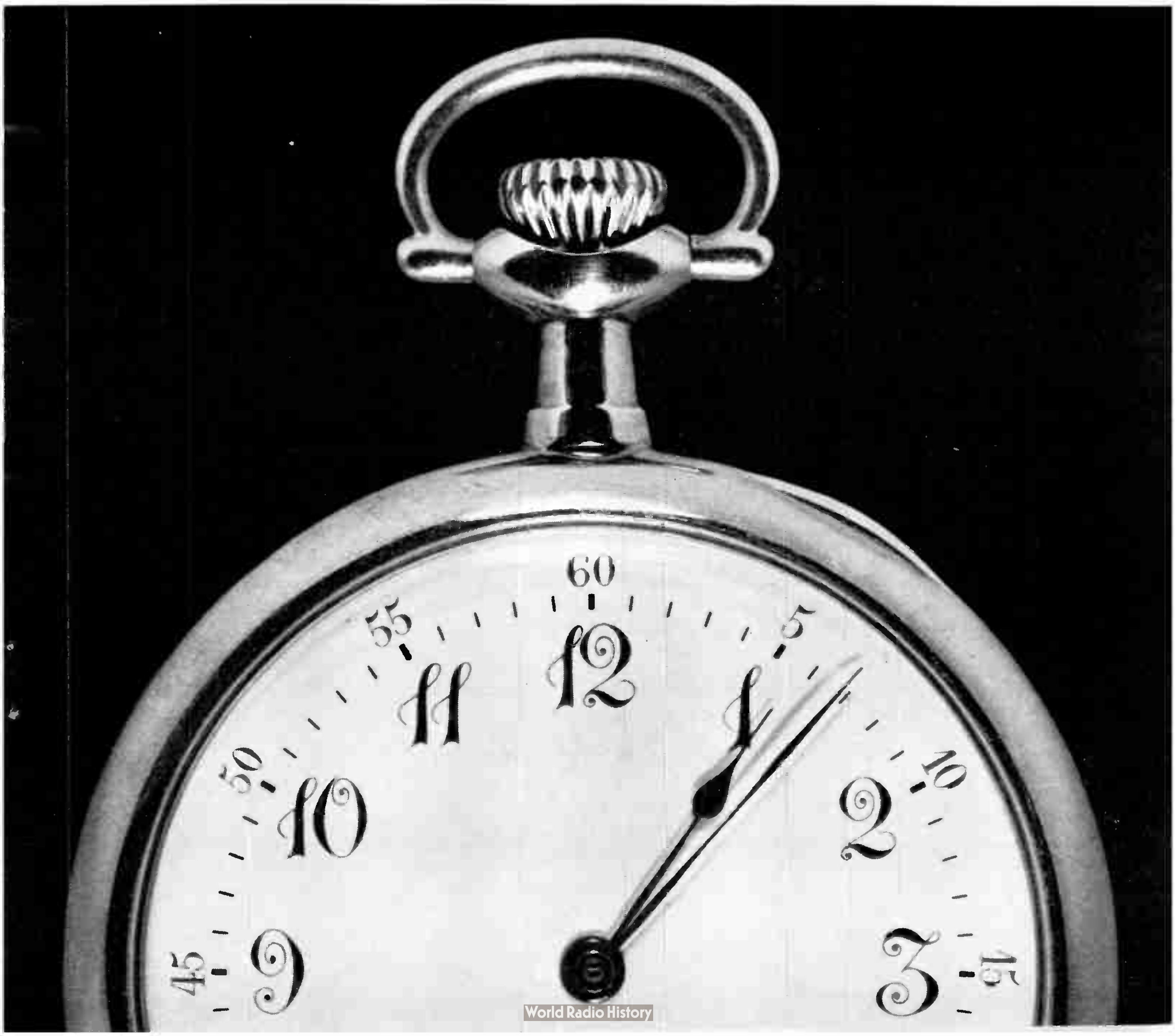
Lockheed's California Division uses a revolving mandrel to wind radar nose cones for the F-104. Spinning on a controlled-speed base, the tool pulls glass fiber strands through a resin bath. Some 18 layers of 15-mil glass strands are woven into the cone. After threading and curing, the inner and outer layers are ground to exact dimensions. Small deviations discovered during testing are corrected with glass fiber tape. Corrections can be incorporated in the tool by remachining it. Man at left in photo is scraping off excess resin

TIME means both money and reputation to system builders. To help customers save both, over 10,200 klystron and traveling wave tubes have been shipped ON TIME from Sperry's Gainesville, Florida plant. If prompt tube delivery is vital to your system, call Gainesville, FRanklin 2-0411 collect, for full information about Sperry capabilities.

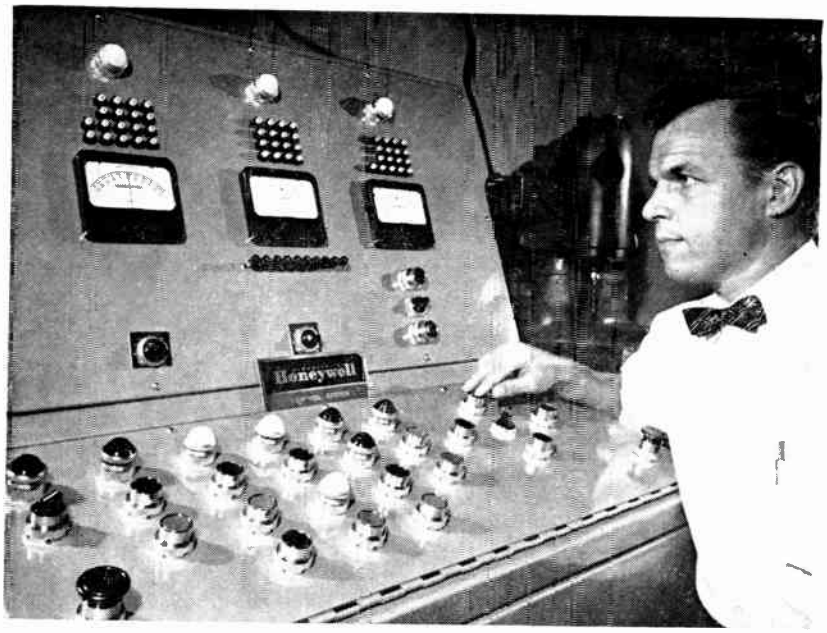
SPERRY | **ELECTRONIC TUBE DIVISION**

Gainesville, Florida • A Division of Sperry Rand Corporation

SPERRY'S FAMILY OF TRAVELING WAVE TUBES covers P through X Bands with unusually high output and light weight. These characteristics, combined with the inherent ruggedness of metal-ceramic construction, conduction cooling and wide-range thermal compensation, make Sperry traveling wave tubes particularly suitable for airborne applications.



New On The Market



Machine Tool Controls

NUMERICAL TAPE AND AUTOMATIC TRACERS

A SERIES of advanced automatic control systems are being introduced by Minneapolis-Honeywell, Machine Controls Division, 2747 Fourth Avenue South, Minneapolis, Minnesota. Included are both numerical tape and automatic tracer control systems that are capable of automating many machining operations.

Three electrohydraulic control systems will be shown at the National Machine Tool Builders Show in Chicago (Sept. 6-16). The systems will be displayed by several manufacturers on a variety of machine tools. The control systems are highly versatile and require a minimum of setup time, thus are economically feasible for a small machine shop operator. Previously, only the large manufacturer with a highly skilled crew of programmers and large-volume production runs could afford sophisticated automatic machine control equipment.

An attractive console is used with each of the control systems. The consoles are completely transistorized and utilize modular construction techniques to simplify maintenance and keep machine down time at a minimum. Each of the systems can produce parts at accuracies of 0.001 inch.

The numerical control system will control any three-axis machine used in turning, milling, punching, drilling, slotting, or routing operations. Known as an absolute point-to-point numerical positioning and speed control system, it feeds taped information into the control system in the form of exact *X* and *Y* axis dimensions. The tool path between any two programmed points is governed by speed control of each axis. A typewriter is used to prepare the tape from blueprint information.

The multimode tracer system is capable of operating in full contouring control through 360 degrees and full die sinking with automatic pick and feed without requiring a change in machine setup, template or tracing head. The electrohydraulic control system makes it possible to automatically machine any contour on a lathe—including turning squares on a lathe—without changing cutting tools. It gives an engine lathe many of the capabilities previously available only with an automatic milling machine.

CIRCLE 301 ON READER SERVICE CARD

Portable Oscilloscopes

TRANSISTORIZED

A NEW LINE of transistorized, portable oscilloscopes, measuring only 2¾ by 3¼ by 5½ inches, and weighing as little as two pounds (for the 1-inch model 150), has been announced by the EI Labs Division of Electro Instruments, Inc., 1165 Morena Blvd., San Diego, Calif.

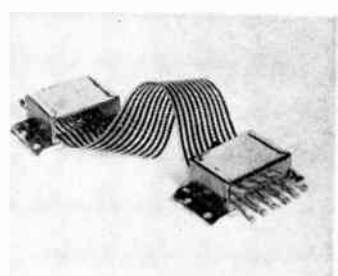
The oscilloscopes will operate on internal rechargeable batteries, a-c power line, or low voltage d-c, providing a precision, 1-, 2- or 3-inch display equivalent to a laboratory instrument. Performance and reliability, combined with portability, make these particularly useful to the service engineer.

Symmetrical vertical deflection amplifiers provide high-voltage and high-frequency deflection potentials. The sweep is generated by a gated, constant-current generator

with a variable charging capacitor. Cost of the model 150 oscilloscope is less than $500. Delivery can be made within 90 days.

Specifications of the model 150 include sensitivity from d-c to 1.5 Mc, with input impedance of 1 megohm.

CIRCLE 302 ON READER SERVICE CARD



Tape Connector

BARBED CONTACTS

NEW FLEX-TAPE CONNECTORS provide a simple means of terminating, splicing or tapping unterminated non-prepared flexible conductive tape. Electrical continuity, positive gripping, and strain relief are all

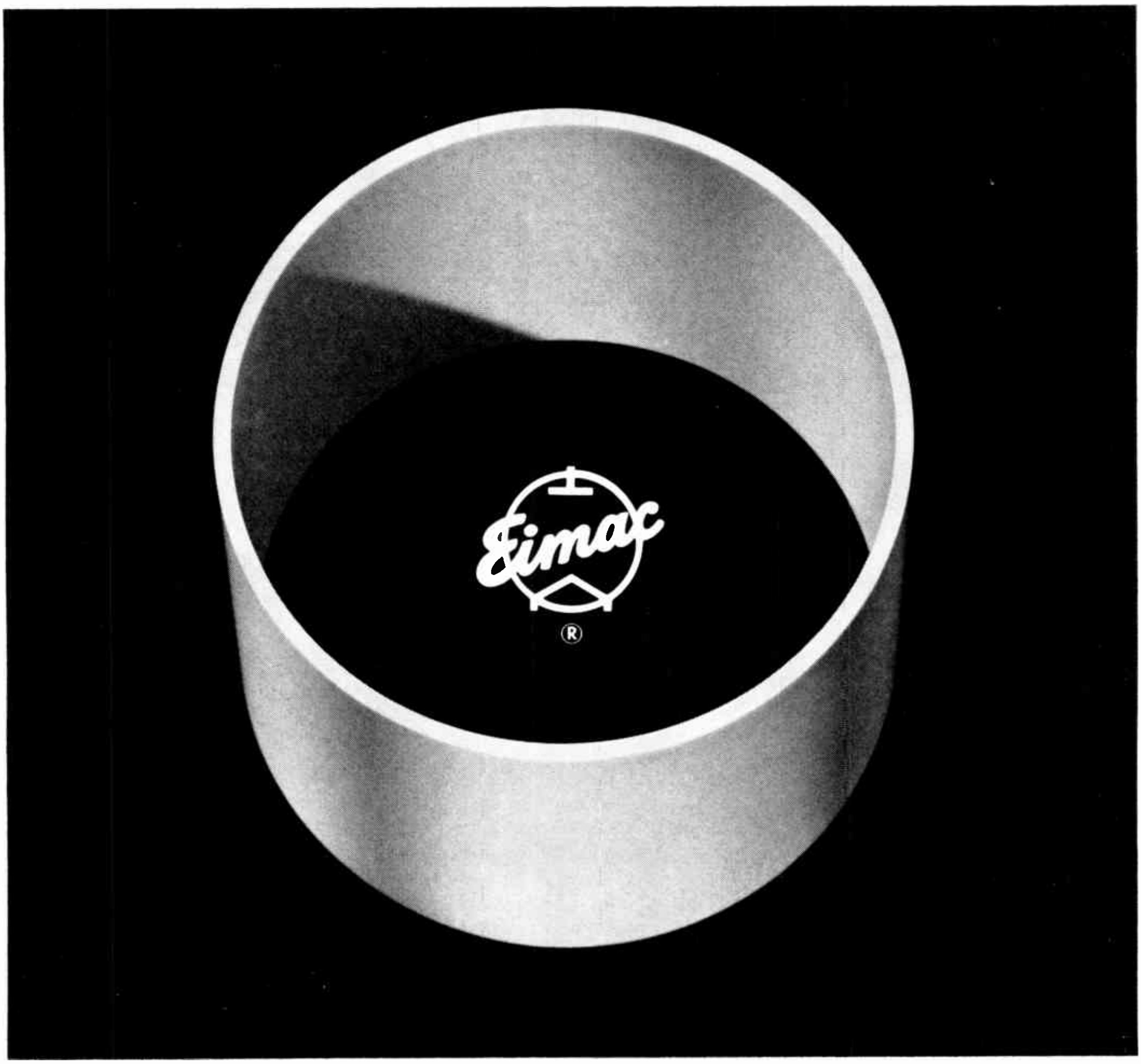
FROM EIMAC:

Breakthrough in tube technology opens up new range of reliability

You are looking at a major advance in tube design. This ceramic envelope is made with *beryllium oxide*—an amazing insulating material now introduced by Eimac for electron tubes. It offers thermal conductivity *ten times* greater than any other material in use today. It provides low losses, high breakdown strength and a comparatively low dielectric constant for improved bandwidth in critical applications such as output windows.

With the introduction of beryllium oxide, Eimac breaks through the problem of dissipating ever larger amounts of heat in dielectrics. And opens a new chapter in power-output capabilities of high power microwave and certain negative grid tubes. The result: a whole new spectrum of tube reliability and performance. Beryllium oxide is now being used in several Eimac production tube types generating ten kilowatts and above.

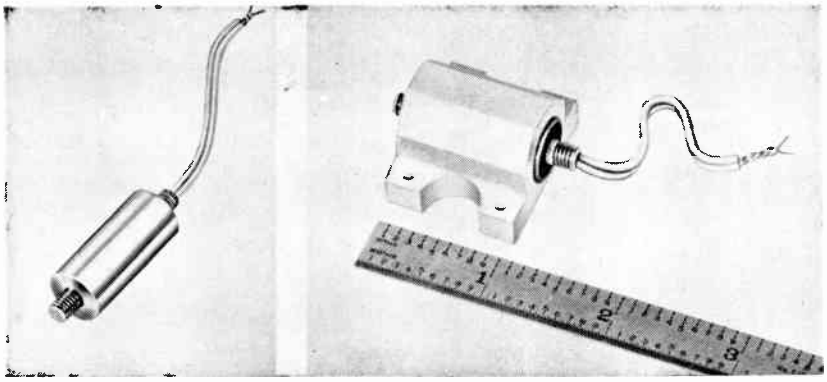
This significant advance in the state of the art of manufacturing electron tubes has been pioneered by an Eimac sponsored research program. Eimac sponsored research has also resulted in the recent introduction of the first practical quartz-to-metal seal. Eitel-McCullough, Inc., San Carlos, California.



obtained with a single cam adjustment.

Multiple barbed contacts are forced through the conductive metal, as well as the insulation on both sides of the conductive strips, and firmly implanted into a holding block. The connector may be used repeatedly without damage. The device is being manufactured by Digital Sensors, Inc., 6443 N. Figueroa Street, Los Angeles, California.

CIRCLE 303 ON READER SERVICE CARD



Explosive Switch

NO MOVING PARTS

AN ADAPTABLE miniature explosive switch manufactured by the Mimx Corporation of 1505 Gardena Avenue, Glendale, California, has no moving parts, has a reliability factor of 99.997 percent, will withstand unlimited g-force, shock and vibration, both before and after contact is completed, and is suitable for environmental temperatures ranging from −100 F to 400 F. In operation an explosive charge establishes a large-area permanent contact, providing virtually failure-proof completion of the circuit.

The switch provides a contact capacity of 20 amps, and the firing current may be adjusted to specific needs by modifying the explosive element or bridge wire. Redundant bridge wires are optional.

External contacts also may be modified to use solder pots or any other type of junction. A delay factor, adjustable to ten seconds, is available if the switch is to be used as a timer.

The explosive switch has a fully self-contained reaction and does not contaminate its environment. A spst switch, it may be modified to accommodate multiple circuits. Configuration and size of the switch also may be modified to satisfy particular requirements.

CIRCLE 304 ON READER SERVICE CARD

Brushless D-C Motor

SMALLER SIZE

A SIMPLIFIED d-c motor in which brushes, brush racks, springs, slip-rings, commutators, and other mechanical components have been eliminated, has been developed and is undergoing advanced testing by Yuba-Dalmotor Division, Santa Clara, California. In this motor, d-c current is commuted by transistors, which form the heart of an oscillating system. In earlier transistor-commutated d-c motors the motor has constituted the load on the oscillator. Here the winding in the motor is an integral part of the circuit; there is no separate toroid. Operational life is limited only by the bearings.

This simplified design not only allows a drastic decrease in motor size, but also eliminates radio noise and environmental problems formerly encountered in operating direct-current motors in explosive gases, fuels or in outer space.

Motor speed can be varied through an infinite range, and only mechanical factors due to centrifugal force determine maximum limits. Small units can be operated up to 250,000 rpm, and by voltage change, speed can be varied linearly to provide analog-type stepless control.

Size of the motor is 3 inch outside diameter by 2½ inch long; power is about ¼ hp. The brushless d-c motor, therefore, could be important for the systems engineer who has thus far developed other components to minute fractions of their former size only to be stymied by a relatively large motor. Prototypes are now being tested by the missile and tape recording industries. Production is scheduled for the fourth quarter of 1960.

CIRCLE 305 ON READER SERVICE CARD

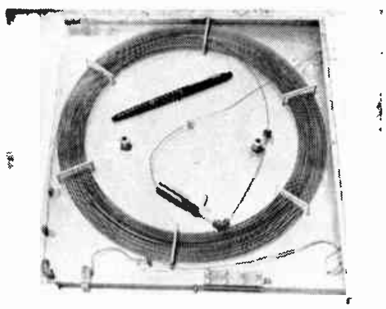
Sonic Delay Lines

GIVE DELAYS TO 20 MS

VERSATILE new wire sonic delay lines, with substantial improvements in insertion loss, bandwidth, temperature stability and package size, now are available to military electronics design engineers through the General Electric Company's Heavy Military Electronics Department, Court Street Plant, Syracuse, New York.

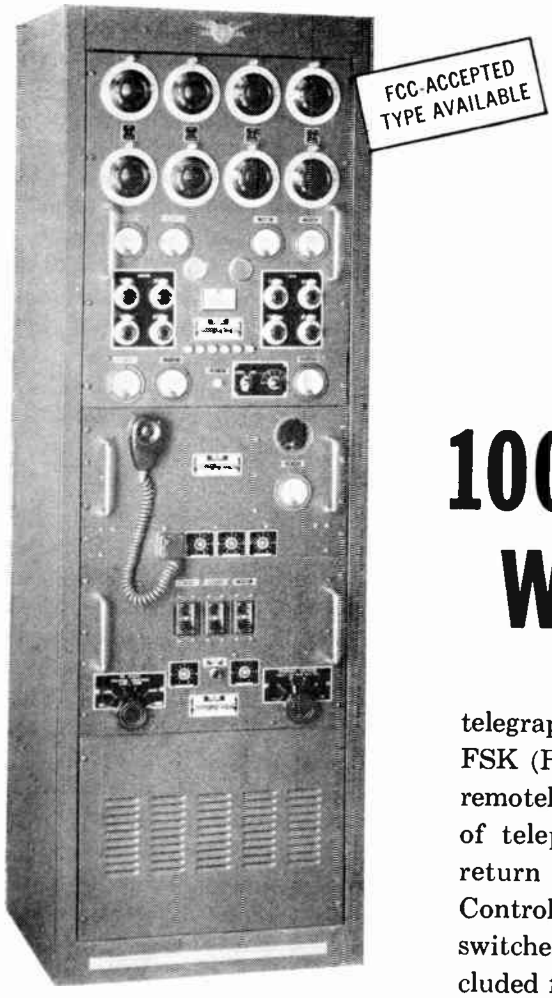
The sonic delay lines operate by the propagation of ultrasonic stress waves through a special alloy wire. They can provide delays from 2 microseconds to 20 milliseconds.

Relatively low insertion loss is made possible by the use of piezoelectric transducers, with typical



loss for a 1 millisecond fixed delay, at 1 megacycle, of 30 to 35 db. Where a relatively narrow bandwidth is specified, a tuned input/-output technique permits insertion losses of less than 15 db.

Maximum bandwidth presently available is 1.25 Mc; temperature coefficients of delay are now about 1 ppm per degree C. Typical military applications include computed data storage, radar target simulator, signal processing, video pulse, car-



The world-famous

AEROCOM 1046 TRANSMITTER

1000 W CARRIER POWER WITH HIGH STABILITY

The Aerocom 1046 Transmitter is designed to give superior performance for all point-to-point and ground-to-air communications. It is now in use throughout the world in climates ranging from frigid to tropical (operates efficiently at −35° to +55° Centigrade).

As a general purpose High Frequency transmitter, the 1046 supplies 1000 watts of carrier power with high stability (above −10° Centigrade: ±.003% for telegraph and telephone. Temperature controlled oven for FSK). Multi-channel operation is provided on telegraph A1, telephone A3 and FSK (Radio Teletype). It can be remotely controlled using one pair of telephone lines plus ground return with Aerocom Remote Control Equipment. Front panel switches and microphone are included for local control.

Four crystal-controlled frequencies (plus 2 closely-spaced frequencies) in the 2.0 - 24.0 megacycle range can be used one at a time, with channeling time only two seconds. Operates into either balanced or unbalanced loads. The power supply required is nominal 230 volts, 50 - 60 cycles, single phase.

The housing is a fully enclosed rack cabinet of welded steel, force-ventilated through electrostatic filter on rear door.

Telegraph keying (A1): Up to 100 words per minute. Model 1000 M Modulator (mounts in transmitter cabinet) is used for telephone transmission; a compression circuit permits the use of high average modulation without over-modulation. Model 400 4 Channel exciter is used for FSK.

Output connections consist of 4 insulated terminals (for Marconi antenna) and 4 coaxial fittings Type SO-239, which can be used separately or in parallel in any combination. For 600 ohm balanced load, Model TLM matching network is used, one for each transmitter channel.

As in all Aerocom products, the quality and workmanship of Model 1046 are of the highest. All components are conservatively rated. Replacement parts are always available for all Aerocom equipment.

Complete technical data on Aerocom Model 1046 available on request.

AER-O-COM

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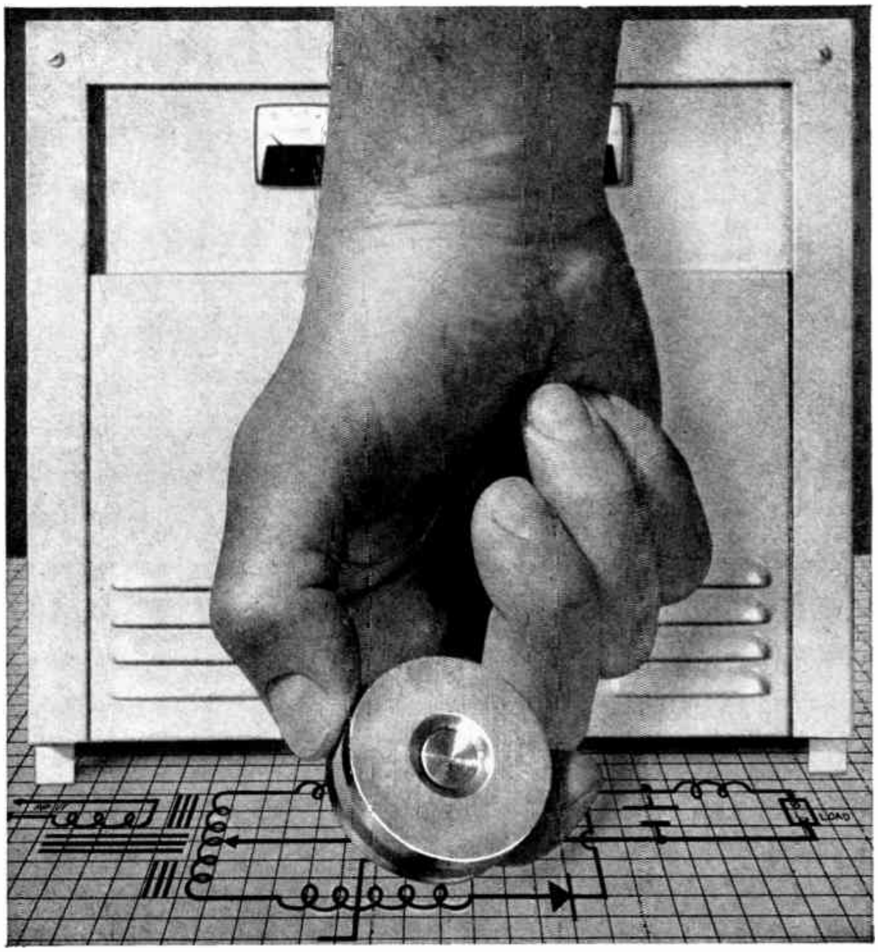

rier, or modulated carrier, integrating circuits, correlation circuits, pulse-timing and signal-to-noise improvement.

Designed for stable operation over wide temperature ranges and built to withstand extreme shock and vibration conditions, the wire sonic delay lines, operating at 1 megacycle, have been packaged in units weighing 3 ounces and measuring 4 by 4 by ¼ inch thick for 1,000 microseconds delay. The delay lines are available in both sample and production quantities, at 4 to 6 weeks delivery.

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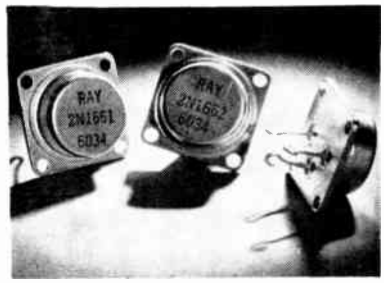

Two NPN Transistors
HIGH-VOLTAGE TYPE

TWO NEW high-voltage, high-gain transistors have been added to the Raytheon line of *npn* diffused, silicon power transistors. The 2N1661 and 2N1662 supplement the 2N1660 which was introduced in May and form a family of devices especially designed for reliable high-frequency power handling.

Collector-to-emitter voltages have been increased from 60 to 80 and 100 volts, respectively, in the 2N1661 and 2N1662. The new transistors have a maximum collector current of 2 amps, a minimum beta frequency of 25 Mc, and a power output of 85 watts.

The transistors are particularly well suited for regulated power supplies, power switching, power amplifiers, power oscillators, core drivers, and servo amplifiers.

Full specifications are available from Semiconductor Division, Raytheon Company, 215 First Avenue, Needham, Massachusetts.

CIRCLE 307 ON READER SERVICE CARD

Solid State Relay
LAYER-CAKE DESIGN

A modular construction solid state relay, with a life of millions of cycles, has been announced by the Controls Division of Leach Corporation, 5915 Avalon Blvd., Los Angeles, California. The new relay, SR-101-1A, is designed for high reliability in space and air vehicles or for computers, factory automation, materials handling systems, data processing or other analog or proportional control systems.

Layer-cake construction allows quick adjustments for special purpose designs. The relay has fast response, no contact bounce, isolated contacts, snap action and high shock and vibration resistance. Some specifications are: max. operating voltage of 30 v d-c, spst normally open contact, approximately 10 microsecond operate time and 50 microsecond release time. The relay will operate to 1,500 times per second; ambient range is from −55 to 71 C.

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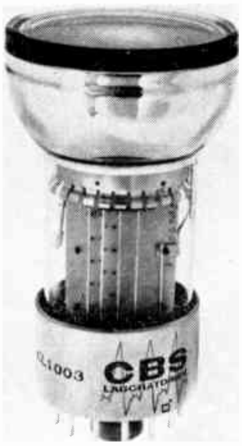


Multiplier Phototubes
TWO MODELS

CBS LABORATORIES, High Ridge Road, Stamford, Conn., announces two new 10-stage multiplier phototubes sensitive to the visible portion of the spectrum and designed to withstand shock and vibration. The CL-1002 and CL-1003, 2 in. and 3 in. diameter respectively, are end-on 10-stage multipliers with special linear dynode structures. The faceplate is plano-concave with S-11 photocathode (visible response) deposited on a curved surface to insure excellent uniformity of response across the face of the tube. Result is an extremely short transit time spread and very high photoelectron collection efficiency. Special Inconel spring support and rugged construction assure increased re-

CIRCLE 91 ON READER SERVICE CARD

sistance to shock and vibration. The tubes are designed for use in scintillation counting, spectroscopy, photometry and flying spot scanner applications.

CIRCLE 315 ON READER SERVICE CARD

Static Converter

60 CPS TO 28 V D-C

VARO MFG. CO., INC., 2201 Walnut St., Garland, Texas. Model 3078 static d-c power supply is used in applications requiring conversion of 60 cps 115 v a-c power to 28 v d-c power. Unit is designed for continuous maintenance free operation in missile checkout systems, fire control systems, computers, and for general instrumentation. It is ruggedized and conforms to exacting environmental specifications.

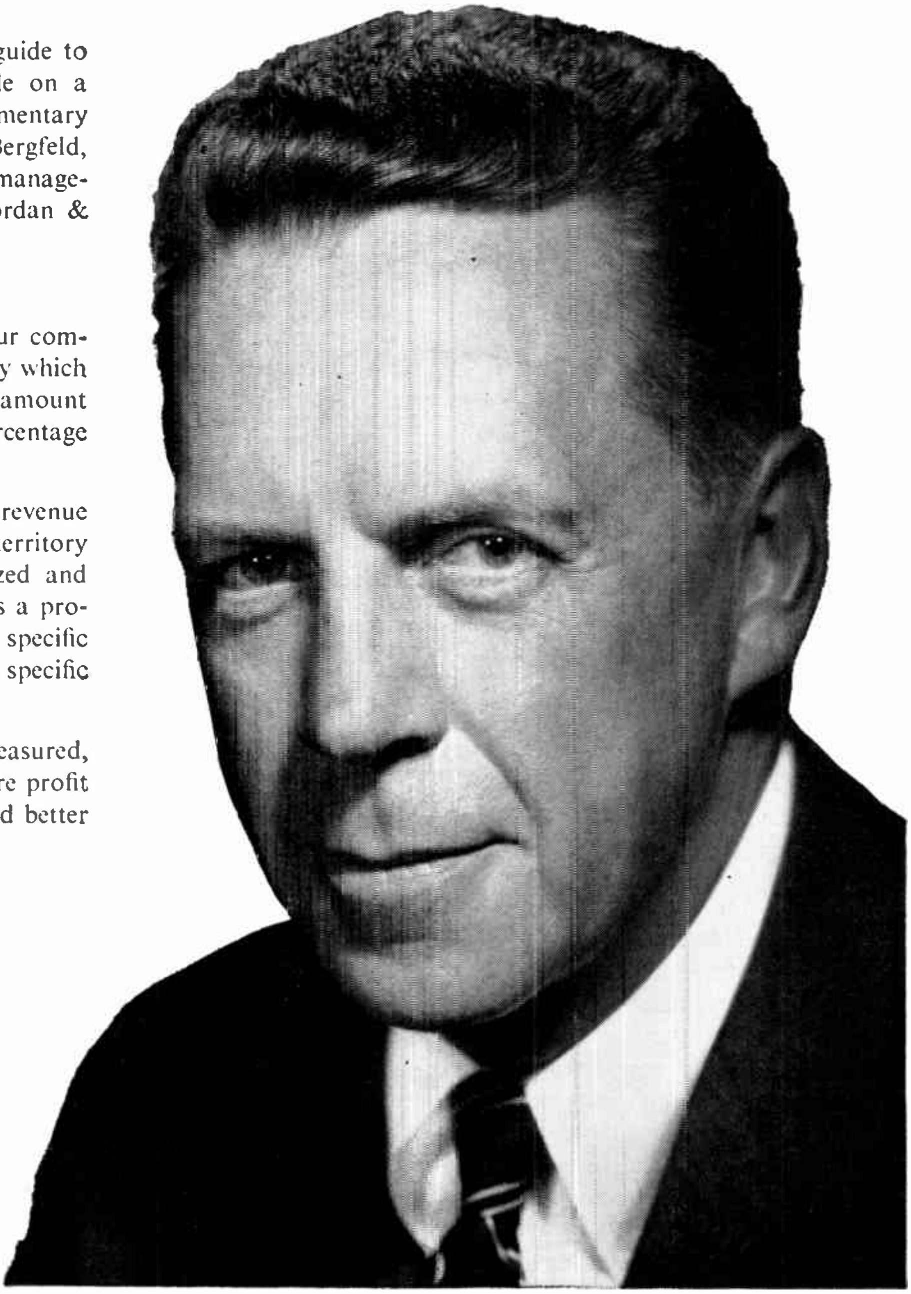
CIRCLE 316 ON READER SERVICE CARD

Beam Power Tube

PERFORMS TO 175 MC

WESTINGHOUSE ELECTRIC CORP., P. O. Box 284, Elmira, N. Y. The WL-7371 r-f beam power pentode is designed for communication transmitters and adaptable for ssb linear amplifier service. Input power ratings of 300 w and plate dissipation of 75 w are applicable for continuous commercial service. A maximum signal power dissipation of 125 w applies for ssb service. Per-

"What's so bad about basing the ad budget on last year's shipments?"



Management men, seeking a reliable guide to advertising appropriations, often settle on a percentage of sales. The following commentary on this practice was written by A. J. Bergfeld, President of the internationally known management consultant firm of Stevenson, Jordan & Harrison, Inc.

"Past practices of your own or of your competitors will produce no magic ratios by which you can either judge or budget the right amount of advertising automatically as a percentage of past sales.

"Plans for increasing sales volume, sales revenue and resulting profits by product and by territory or by divisions, can better be analyzed and approved by considering advertising as a programmed cost to be associated with specific profit plans and to be measured against specific results.

"Programming advertising costs as a measured, reasoned and integrated part of a future profit plan usually results in a better plan and better actual future profits."

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formance of the new tube extends to 175 Mc. Reliable service and high efficiency are obtained by the thoriated tungsten cathode. Also, good isolation between input and output circuit is provided by the tube's construction. A rugged screen grid gives ample dissipation for all types of communication service.

CIRCLE 317 ON READER SERVICE CARD

Preamplifier
TELEMETRY TYPE

LEL, INC., 380 Oak St., Copiague, L. I., N. Y. Using newly developed high gain- bandwidth ceramic triodes, the TP-5 telemetry preamplifier provides a gain of 26 db, a nominal noise figure of 3.5 db over the passband of 215-260 Mc telemetering band. The integral power supply provides regulated heater voltage. The entire assembly, contained in a weather-proof housing for antenna tower mounting, requires a mounting space of 6½ by 6½ by 6 in. and weighs 6 lb. The TP-5 is also available rack mounted.

CIRCLE 318 ON READER SERVICE CARD

Relay Drivers
DUAL UNITS

ENGINEERED ELECTRONICS CO., 1441 E. Chestnut Ave., Santa Ana, Calif., announces two new transistorized relay drivers that provide the power to operate moderately sensitive relays, indicator elements, or resistive loads. The T-134 and T-135 are dual units. Each will switch a resistive load at frequencies up to 50 Kc at currents up to 50 ma, maximum, and voltages up to 28 v maximum. The drivers will also operate with relays when diode clamping is provided to protect against back surges. The units are actually germanium switching transistors that may be operated directly from EECO T-Series germanium digital modules. The turn-on signal for the T-134 is −11 v nominal: turn-off is − 3v nominal. The T-135 operates on the opposite signal polarities—turn-on signal is − 3 v nominal and turn-off signal is − 11 v nominal. Both units have the same power requirements (± 12 v d-c), maximum load (− 35 v at 100 ma, each output), and operating temperature range (− 55 C to + 71 C).

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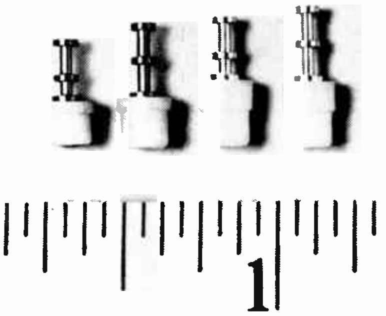

CAMBION®

Standoff Terminals
DOUBLE-TURRETED

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass., announces four new double-turreted Teflon insulated standoff terminals. They are available in the following heights when mounted: No. 4025, $\frac{1}{4}$ in.; No. 4026, approximately $\frac{9}{32}$ in.; No. 4027, approximately $\frac{5}{16}$ in.; and No. 4028, $\frac{11}{32}$ in. They are 0.148 in. in diameter and press fit into a 0.136 in. ± 0.002 in. hole, accommodating panel thicknesses from $\frac{1}{16}$

in. to ¼ in. Terminals are brass and finished in 0.0003 in. silver plate or 0.0003 in. electro-tin lead plate. They are available in natural Teflon or 8 different code colors.

CIRCLE 320 ON READER SERVICE CARD

Hydrogen Thyratron
CERAMIC-METAL

ITT COMPONENTS DIVISION, P. O. Box 412, Clifton, N. J. The Kuthe type Ku-74 ceramic-metal hydrogen thyratron has been specifically designed to meet the requirements of long pulse, high average power radars. Rated at 33 megawatts peak power this tube is capable of operation at an average anode current of 4.0 amperes at an rms value of 90 amperes. Design features include the use of internal heat sinks to maintain proper operating temperatures of the grid and reservoir. A unique anode design prevents local hot spotting of the anode. No artificial cooling of this tube is necessary under ordinary ambient condition during full power operation.

CIRCLE 321 ON READER SERVICE CARD

D-C/D-C Power Supply
FOR TELEMETRY USE

NETWORKS ELECTRONIC CORP., 14806 Oxnard, Van Nuys, Calif. A new d-c/d-c power supply which combines the features of close tolerance regulations, high temperature stability and galvanically isolated input and output terminals has been designed for bridge excitation and other telemetry applications. It has an output of 5 v d-c, adjustable ±5 percent, and features regulation of ±¼ percent for combined line, load and temperature variations. Rated output on the unit is 100 ma, but the device will maintain regulation to 200 ma. Maximum ripple under rated load is less than 0.1 percent rms. Input voltage is also filtered to prevent switching-current pulses from feeding back into the line. Temperature ranges are available from −55 to +100 C. Overload and short-circuit protection are inherent in the design. Input is 28 v d-c ±4 v with a maximum current drain, under any conditions, of 220 ma.

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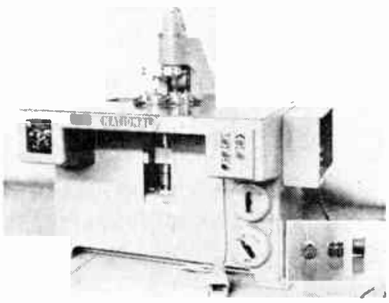


Transistor Welder
AUTOMATIC MACHINE

NATIONAL ELECTRIC WELDING MACHINES CO., 1846 Trumbull St., Bay City, Mich. This console type automatic transistor welder is essentially a basic unit which uses standard key components and which can be tooled for either dial feed or single point operation. A 3 ft by 4 ft table, 32 in. high, forms the top of the unit's base and is designed specifically to accommodate a standard dry box. An operator, seated at the console and hand-loading a six-station dial, can produce 2,000 transistors an hour. A major design feature is the location of the welding transformer in the base of the unit. This not only makes for greater compactness but permits a user who has a single point machine to convert to dial feed later with minimum changeover.

CIRCLE 323 ON READER SERVICE CARD

Literature of

THERMISTOR PROBES Fenwal Electronics, Inc., 51 Mellen St., Framingham, Mass., has released a new 8-page folder on its standard line of thermistor probes. It contains more than 50 outline drawings showing dimensions, and gives a description and primary use for each.
CIRCLE 350 ON READER SERVICE CARD

MODULAR POWER SUPPLIES Dressen-Barnes Corp., 250 North Vinedo Ave., Pasadena, Calif. A data sheet describing a series of 24 new modular power supplies shows photographs of the unique packaging method designed to dissipate transistor and transformer heat without use of auxiliary dissipators.
CIRCLE 351 ON READER SERVICE CARD

MICROWAVE OSCILLATORS Menlo Park Engineering, 711 Hamilton Ave., Menlo Park, Calif. Electronically swept microwave oscillators covering the frequency ranges from 1,000 to 12,400 Mc are described in a recent catalog sheet.
CIRCLE 352 ON READER SERVICE CARD

RECORDERS & REPRODUCERS Westrex Corp., 6601 Romaine St., Hollywood 38, Calif. The RA1500 series of magnetic film recorders and reproducers is described in a four-page illustrated brochure.
CIRCLE 353 ON READER SERVICE CARD

ENVIRONMENTAL TESTING Webber Mfg. Co., Inc., P. O. Box 217, Indianapolis 6, Ind. Latest data on environmental testing and other applications for controlled atmospheric conditions is the subject of new 32-page brochure No. 600.
CIRCLE 354 ON READER SERVICE CARD

IMMERSIBLE TRANSDUCERS National Ultrasonic Corp., 111 Montgomery Ave., Irvington, N. J. A catalog sheet now available describes the bulkhead type and end fitting type immersible transducers offered by the firm.
CIRCLE 355 ON READER SERVICE CARD

INSTRUMENT DRIVE Insco Co. Division of Barry Controls Inc., Hollis St., Groton, Mass. Application data sheet No. 5 describes the Auto-Scan, a drive system for the tuning condensers of a receiver used in a missile detection system. The instrument described is based on the versatility of the step-function speed reductor principle, also using various other linkages and mechanisms.

CIRCLE 356 ON READER SERVICE CARD

BASIC SWITCHES Micro Switch, Freeport, Ill. Data sheet No. 175 is a four-page folder covering three series of basic switches with gold contacts. It includes photographs, mounting dimension drawings, mechanical characteristics, electrical ratings and pricing as well as other helpful information.

CIRCLE 357 ON READER SERVICE CARD

PLANAR DIODES Fairchild Semiconductor Corp., 4300 Redwood Highway, San Rafael, Calif. Catalog No. SL-201/1 is an eight-page, two-color brochure containing essential data on more than 200 planar diodes.

CIRCLE 358 ON READER SERVICE CARD

POTENTIOMETERS Basic Electronic Controls Div., Wells Industries Corp., 6880 Troost Ave., North Hollywood, Calif. Four-page two-color brochure describes three basic lines of potentiometers in production—subminiature trimming, precision rotary and linear motion potentiometers.

CIRCLE 359 ON READER SERVICE CARD

CONSTANT-CURRENT CONVERSION Electronic Measurements Co., Inc., Eatontown, N. J. Technical Note 23 describes the simple external connection required to convert Regatran programmable power supplies from voltage-regulated to current-regulated output, and explains the method employed for control.

CIRCLE 360 ON READER SERVICE CARD

BIDIRECTIONAL TRANSISTORS Radio Corp. of America, Somerville, N. J. Bulletin ICE-213 covers the types 2N1169 and 2N1170 bidirectional germanium alloy-junction transistors for switching applications in military and industrial data-processing systems.

CIRCLE 361 ON READER SERVICE CARD

CIRCLE 101 ON READER SERVICE CARD

MIT to Widen Vistas in Solid State

EXTENSION of solid state research is under way at Massachusetts Institute of Technology as the institute shapes plans for a new Magnet Laboratory to be built on the campus with $9,502,000 provided by the Air Force.

The national research center will provide advanced experimenters with unprecedented facilities for use of one of the most significant modern research tools—very high magnetic fields (ELECTRONICS, p 43, Oct. 2, 1959). Scientific applications of the powerful instrument will range from sub-atomic particle research to cosmological studies.

Expected to be in full operation in 1964, the facility will house the world's most powerful magnet and is expected to become an international center of work on very high magnetic fields. "We view it as an Institute for Advanced Experimental Research, analogous to Brookhaven and the Institute for Advanced Study," says Benjamin Lax (shown at left), who will be director of the lab. Lax is now head of the solid state division at MIT Lincoln Laboratory.

Construction will start in mid-1961, a few months before the first International Conference on High Magnetic Fields is scheduled to convene at MIT in November of next year.

Design and construction of the laboratory will be directed by Prof. Francis Bitter (right), a pioneer in the development and application of high field magnets. Simultaneously, Bitter will begin new studies and research at MIT on the magnetization of the sun and its planets and on the role of magnetic forces in the evolution of the solar system. He will become professor of geophysics at MIT.

Two motor generators at the facility will be capable of producing 8 megawatts of continuous power, 32 megawatts of pulsed power, for creation of continuous magnetic fields up to 250,000 gauss. Twenty years ago, Prof. Bitter developed a 1-inch-caliber, 100,000 gauss magnet, and this has been duplicated in several laboratories.

Some 4,000 gallons of water per minute will be pumped from the Charles River nearby to cool the magnets in the new MIT lab. Eight stations will be built into the center, for simultaneous experiments by staff members and visiting scientists.

In solid state research, plans are being made for detailed experiments with tunnel diodes, including exploration of the basic phenomenon of tunneling. Prof. Bitter's old lab is being used as a testing ground for some of the solid state experiments.

The higher magnetic fields, in combination with microwave, millimeter and infrared radiation, are expected to yield significant data for electronic applications. They will provide a versatile instrument for research in plasmas, solid state and low temperature physics, high resolution spectrometry, cyclotron resonance in semiconductors, studies of the optical properties of solids, nuclear physics and magnetohydrodynamics.

Monitor Products Appoints Engineers

TWO recent appointments have been announced by Monitor Products, South Pasadena, Calif., manufacturers of oscillators, crystals and ovens for more than 25 years.

David Collins has been named chief oscillator engineer. He recently came from JPL, where he was attached to spacecraft control group. He was with Hughes Aircraft, as senior research engineer in the communication division.

A second appointment is Charles Ryan as production coordinator. Ryan, formerly with the New Haven plant of A. C. Gilbert Co., as product development and commercial control engineer, will handle the expediting of Monitor's products.

Shelton Heads Up New Eimac Division

EARL J. SHELTON has been appointed manager of a newly-formed high-power tube division at Eitel-McCullough, Inc., San Carlos, Calif.

His appointment to this position centralizes the management responsibility for Eimac's extensive engineering and production facilities for high-power klystrons, super-power tubes and accessory hardware. These facilities include the high-power microwave tube laboratory and manufacturing plant which were formerly functions of the development division and the manufacturing division.

Shelton, with 14 years of electron-tube development experience, joined Eimac in February of this year as the director of development and held that position until his re-

cent advancement. Before coming to Eimac, he was manager of the high-power tube laboratory of Raytheon's Spencer Laboratory in Waltham, Mass., where he was instrumental in the development of high-power, broad-band microwave amplifiers.

Forms International Consulting Service

TO HELP smaller electronics companies participate in the European markets without making substantial investments or diverting time and personnel from their domestic effort, Stephen V. Hart recently formed a consulting service, Electronic Engineers International, with headquarters in Wilton, Conn. Offices have been established in Germany, France and England.

All the team are scientists and professional electronics engineers with an average of twenty years' technical and managerial experience. The group is dedicated to certain specific aims: (1) Study and investigate the market conditions that affect a client's competitive standing. (2) Find parallel interests, interview foreign companies that complement the client's interests and establish an exchange of know-how and technical liaison that leads to licensing contracts. (3) Seek new products, related to the client's existing line, to be imported and marketed through already-established distribution channels.

The founder of EEI, Stephen V. Hart, was previously associated with the Perkin-Elmer Corp., Norwalk, Conn., as manager of development engineering, Electro-Optical division. Amongst his other duties was the evaluation of new products and inventions submitted by Perkin-Elmer's German subsidiary, Bodenseewark. Before that, as vice president of Electronic Control Corp., Detroit, he set up that company's field staff in Europe and the U. S.

USECO Promotes Richard Douglas

U. S. ENGINEERING CO., Van Nuys, Calif., a division of Litton Industries, recently named Richard Douglas chief engineer.

This is a newly-created post and Douglas will direct research and development programs as well as continuing supervision of engineering support activities.

Douglas joined USECO in 1958 as production manager for printed circuits and terminal boards. From 1950 until 1958, he was with the Bevil Co. of Los Angeles, as production manager and plant manager.

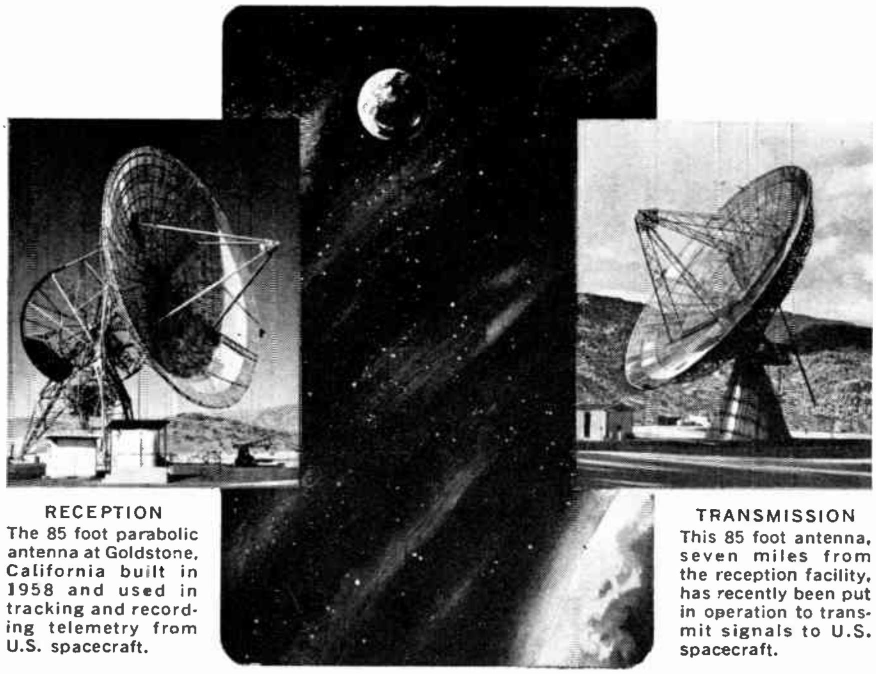
Amperex Completes New Wing

AMPEREX ELECTRONIC CORP., Hicksville, Long Island, N. Y., has announced the completion of a new wing to the present Amperex building.

This new wing adds 13,000 sq ft of production area to the 123,000 sq ft of the present building. Last year a 23,000 sq ft engineering wing was completed.

"The engineering wing completed last year enabled Amperex to enlarge its engineering staff. The added personnel have now made it feasible for us to enlarge our production facilities; therefore, the need for the new wing", according to Frank Randall, president. "We expect now to markedly increase production of our highly successful line of frame grid tubes, both PQ types for military and industrial applications as well as entertainment types," he said.

LUNAR and PLANETARY COMMUNICATION



RECEPTION
The 85 foot parabolic antenna at Goldstone, California built in 1958 and used in tracking and recording telemetry from U.S. spacecraft.

TRANSMISSION
This 85 foot antenna, seven miles from the reception facility, has recently been put in operation to transmit signals to U.S. spacecraft.

SENIOR RESEARCH SPECIALISTS

New opportunities involving advanced research and development projects are now open at JPL in the Laboratory's Telecommunications Division for engineers and scientists capable of assuming a high level of technical responsibility.

SOME SPECIFIC OPENINGS IMMEDIATELY AVAILABLE

Communication Specialists Execution of RF tracking and communication system projects.	**Radio Research Engineers** Design of advanced RF transmitter/receiver equipment.
Antenna Specialists Analysis, design and evaluation of giant Antenna Structures and Servo Systems.	**Research Scientists** Digital data and control system analysis and synthesis.

Mathematicians or Communication System Analysts
Analog and Digital system analysis. Noise, coding, information theory. Linear and non-linear filter theory.

Several openings also exist for supervisors of Research and Advanced Development Projects performed by industry for JPL.

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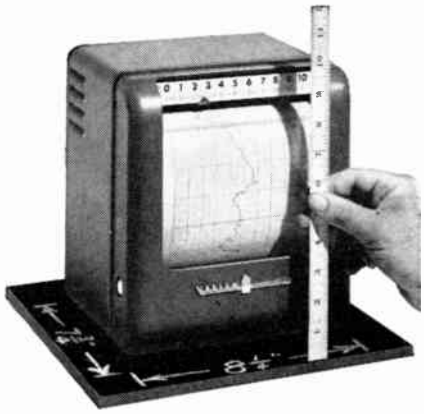

3. ANYWHERE USED, THEY

SAVE SPACE

Equipment manufacturers praise the Varian G-11A because it fits neatly into instrument panels, occupying ¼th the space of a conventional-sized recorder. Lab men appreciate Varian's portable versions because they add so little clutter to bench or table.

1% limit of error; 1 or 2½ second full-scale balancing time; ranges from 0-9 millivolts to 0-100 volts; wide choice of speeds, accessories and charts; prices from $365. For all the facts, write the Instrument Division.

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SATIN

An Experimental Environment for Semi-Automatic Air Traffic Control

SATIN (SAGE Air Traffic Control Integration) is the experimental electronic surveillance and control system which MITRE is engaged in designing and evaluating for the Federal Aviation Agency. The design incorporates advanced data processing techniques and equipment for enroute air traffic control.

The major elements of SATIN include a large scale digital computer, its specially prepared program, and associated radar, communications and display equipments. The goal is positive control of high speed jet aircraft at high altitudes under all weather conditions.

Projects such as SATIN are typical of the large scale system engineering tasks in which MITRE is engaged.

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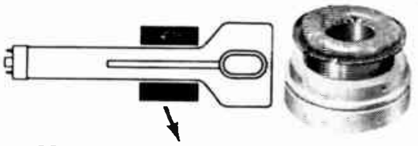

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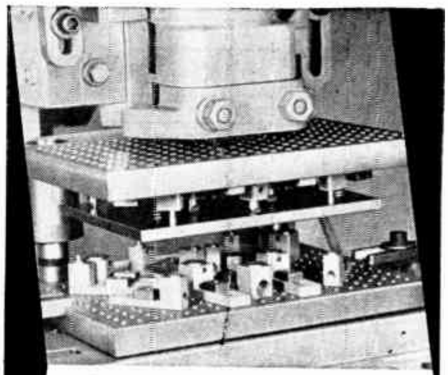
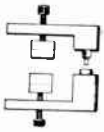
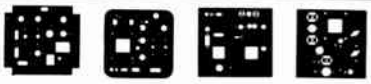




Punch Multiple Holes in One Operation with REUSABLE DI-ACRO ADJUSTABLE PUNCHES AND DIES



Di-Acro Adjustable Punches and Dies offer you an inexpensive means of rapid tooling for multiple punching of holes of a variety of shapes and sizes. They will do the job in a fraction of the time it would take using a single station punch press and at a fraction of the cost of standard tooling. All tooling can be arranged in a countless number of patterns so that most multiple hole punching jobs can be accomplished in one operation. Tooling can be reused again and again. Holes can be as close together as ¾" on centers. A template locates your punches and dies accurately. All Di-Acro punches and dies are concentric, readily interchangeable. Standard rounds, squares, rectangles, ovals, D's and other shapes in a variety of sizes are available from stock.

See Di-Acro Machines In Action. Booth 259-65 Production Engineering Show, Navy Pier, Chicago, September 6-16

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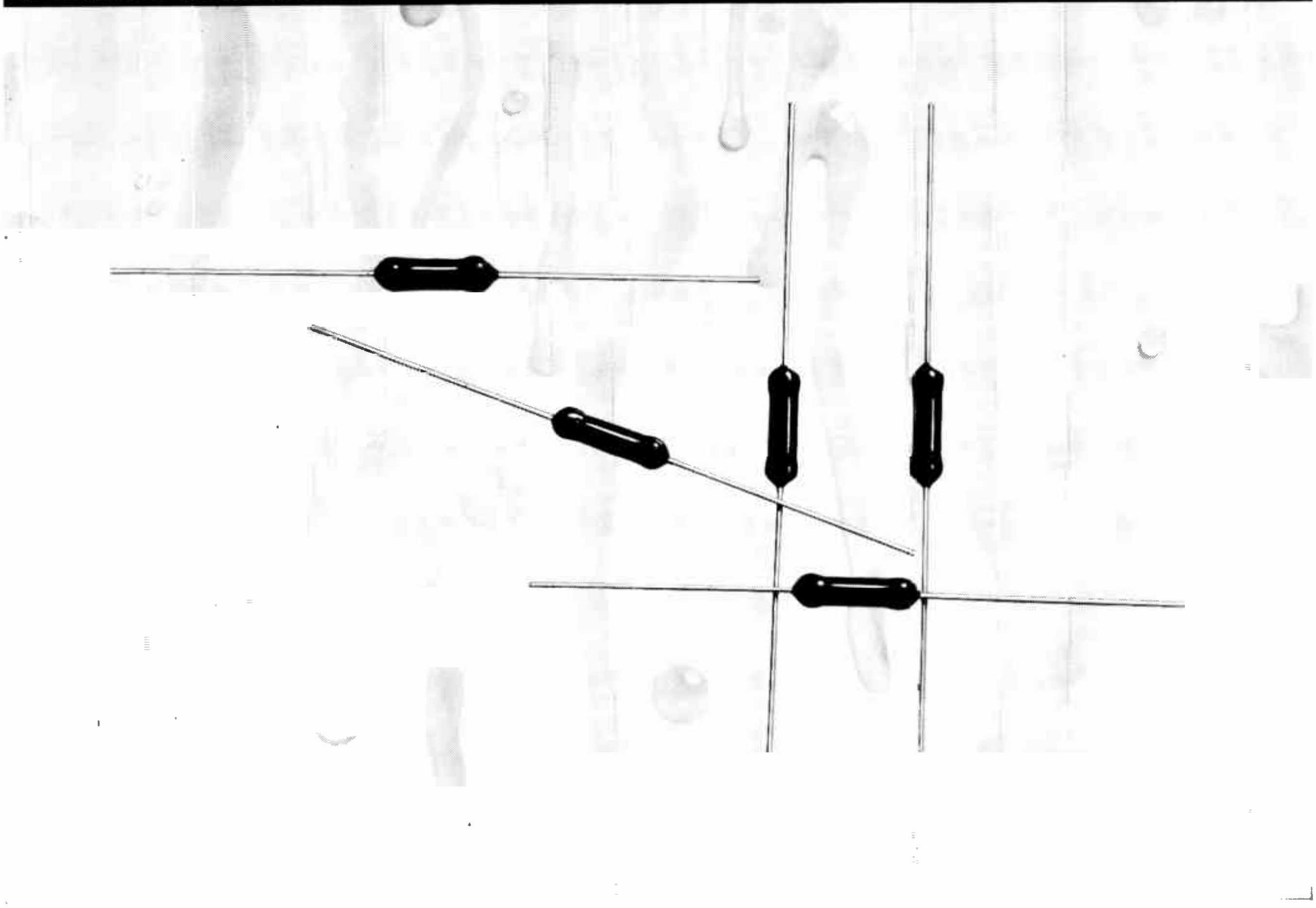
di-acro PRECISION METALWORKING EQUIPMENT

In PRECISION FILM RESISTORS | **if it's news, expect it first from IRC**



New M* COAT for resistors takes 30 cycles of MIL moisture

Moisture Resistant—Resistors with M Coat withstand 30 cycles of moisture, 300% of the MIL-R-10509C Characteristic B requirement, tested in accordance with MIL Standard 202. No other RN20X style film resistor on the market matches this performance.

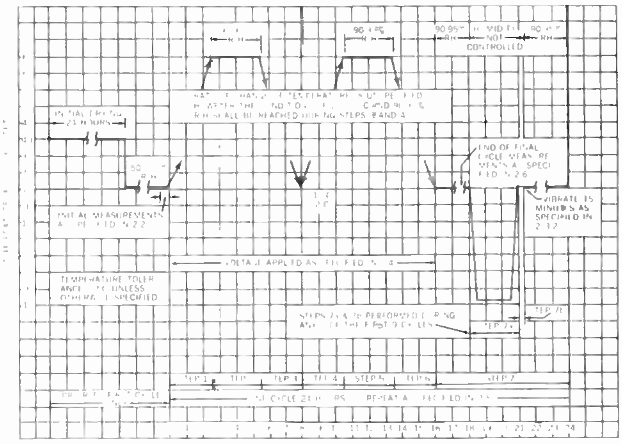
Damage Resistant—M Coat adds greater protection for the resistance element, eliminates handling and assembly damage.

Superior Insulation—over 100 megohms *after* 30 cycles of moisture.

M Coat is currently available in the ½ watt size of IRC Precision Film Deposited Carbon Resistors, a type already noted for superior temperature characteristics, close tolerances, accuracy, and stability at high frequencies.

Rating: ½ watt at 70°C Ambient
Standard tolerance: ±1%
Range: 10 ohms to 2.49 megohms
Max. continuous working voltage: 350

Recommended Applications: Computer, amplifier, metering, and voltage divider circuits.



Graphical representation of moisture resistance test.

Write for Bulletin AE-15, International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

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RCA-50EH5—

a high power-sensitivity audio-output pentode for low-cost stereo amplifiers, radios, and 1-tube phonographs

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RCA-50EH5 is a 7-pin miniature power pentode with extremely high transconductance – 14,600 micromhos – and high power sensitivity at very low plate and screen voltages. This RCA workhorse delivers 1.4 watts power output with only 110 volts plate supply and a driving signal of only 3 volts peak.

Many design features contribute to the high performance of the 50EH5. New cathode base material minimizes inter-element leakage, cuts noise and hum, prolongs life and improves reliability. Improved heater material extends heater life. Special plate material minimizes gas-current runaway. And *EVERY RCA-50EH5 is thoroughly tested* for power output, hum, noise, shorts and continuity, emission and gas.

HIGH POWER-SENSITIVITY FOR LOW-COST STEREO!

Discover for yourself how this superlative performer points the way to better low-cost audio circuits. See your RCA Field Representative, or write directly to RCA Electron Tube Division, Commercial Engineering, Section H-19-DE-4, Harrison, N. J.

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