

# ELECTRONIC

# design

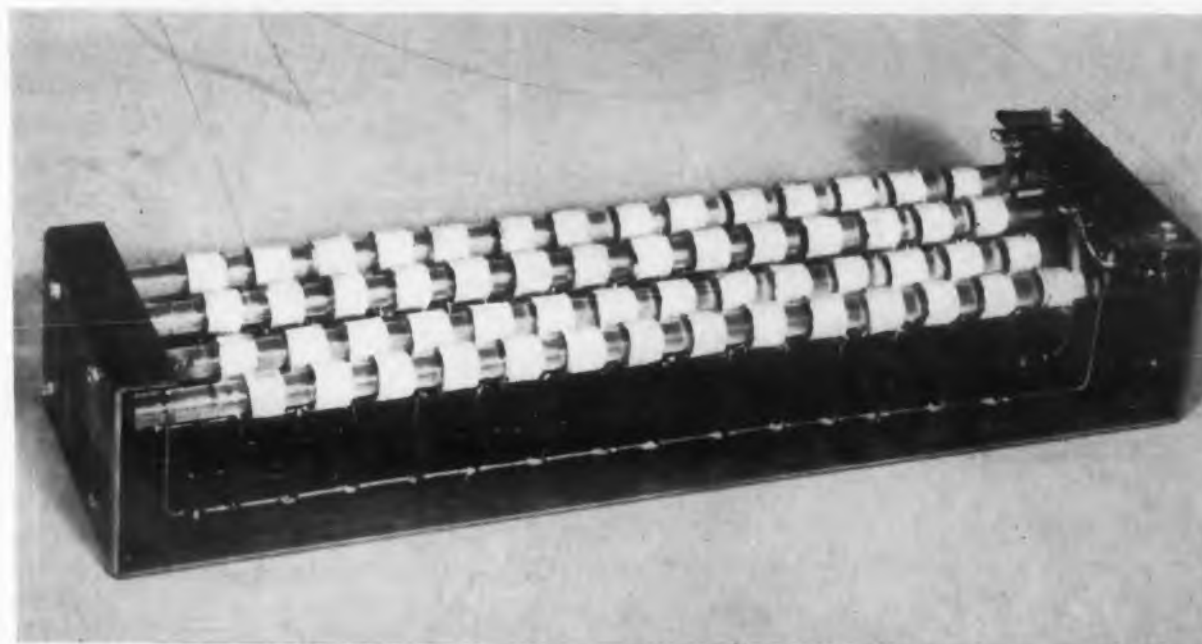
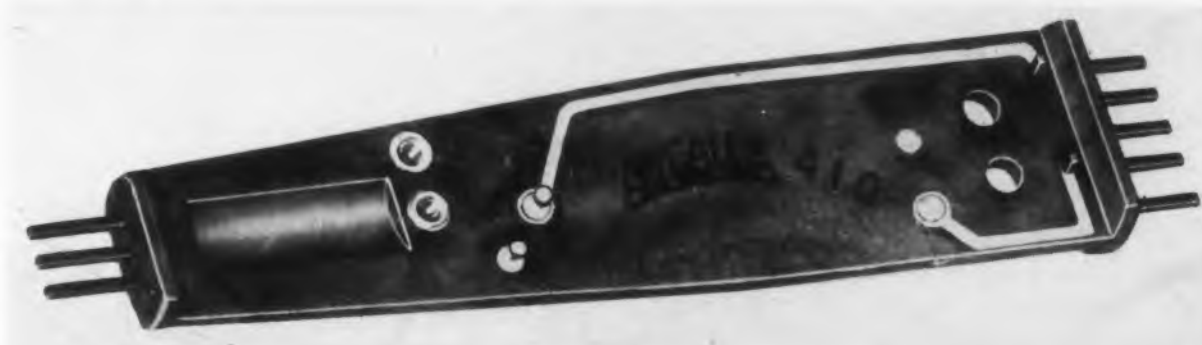
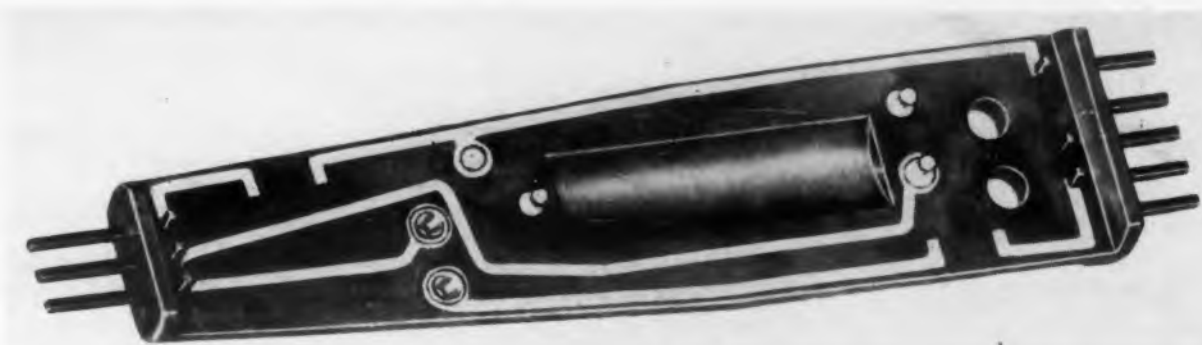
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## Lumped Constant Delay Lines

### Of Open Frame Construction

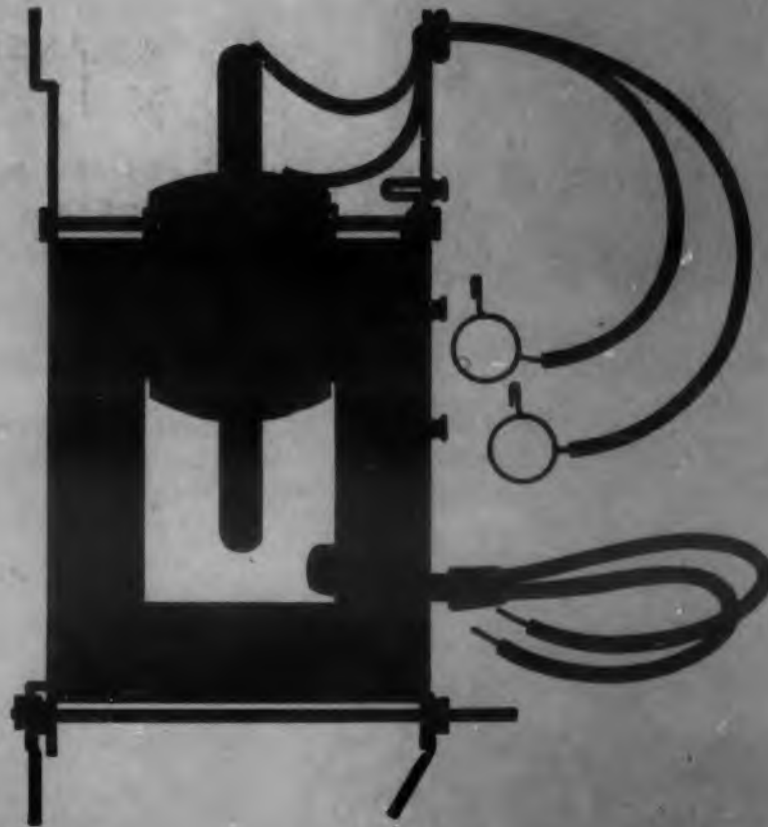
These low cost, laboratory built, Lumped Constant Delay-Lines are built to close tolerances in open frame construction. They feature low attenuation, low rise time, and accessibility which permits an easy choice of delay by tapping the line.

Illustrated is a typical line with 0.05 $\mu$ sec rise time, 300 ohm characteristic impedance, and 1.0 $\mu$ sec delay. Individual sections are constructed to permit adjustment of the filter network parameter  $m$ . May Engineering Co., Dept. ED, 6055 Lankershim Blvd., North Hollywood, Calif.

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ELECTRONIC DESIGN • March 1953

# ELECTRONIC

*DESIGN*

Vol. 1 ✓  
No. 3  
March 1953 ✓

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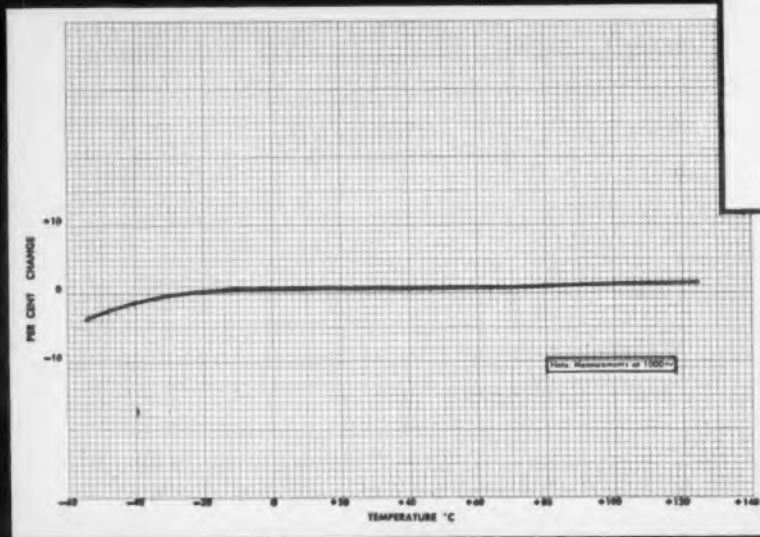
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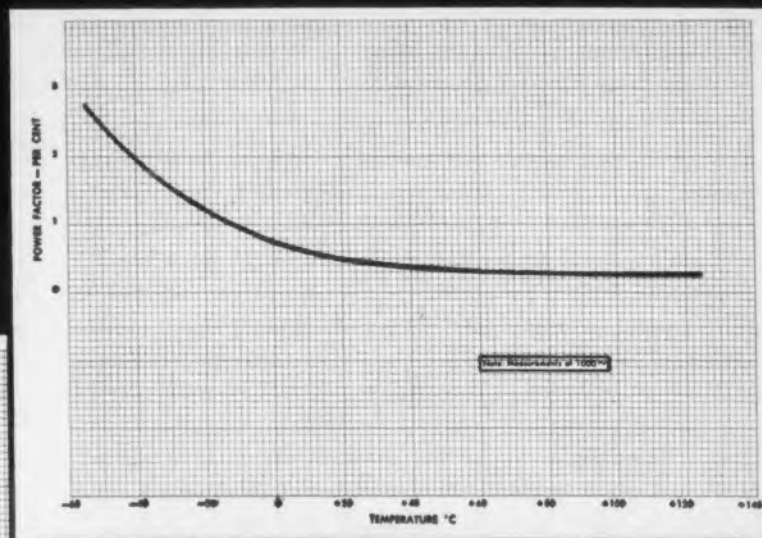


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## Design Ideas

Where does an electronic design engineer get his ideas? This is an intriguing question, and probably has as many answers as the number of designers attempting an answer.

Technical conferences, books and informal discussions all are possible sources for design ideas. Sometimes just a chance remark starts a mental chain reaction which results in a practical and workable idea.

An engineering friend told us the other day that a couple of sentences in a technical paper being presented at a symposium helped him solve a knotty problem that he had been working on for some time. The idea he needed was buried in two sentences covering a very minor facet of the subject of the paper—and the subject itself was one of little interest to him!

Of course, we think that one of the most fruitful sources for ideas is the technical magazine. However, just how fruitful this source is depends a great deal on how the articles in the magazine are written.

Stating the problem or general thesis, and then explaining how the problem was solved or developing the thesis to a logical conclusion, is the usual way most articles are constructed. Diagrams and illustrations support the author's argument and clarify points being made. This general plan is good and often results in excellent articles.

We would like to suggest an additional item often neglected by most authors—design possibilities. Somewhere in the piece the author should exercise his imagination and cite some of the possibilities suggested by his circuit, design, device, or whatever the subject happens to be. These suggestions or implications often are the most important part of the article as far as the general reader is concerned. They are the catalysts that start the mental chain reactions which produce new ideas, improved designs, and generally promote progress in the electronic industries.

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# Engineering Review . . .

**Nonlinear Circuit Analysis . . .** An international symposium on Nonlinear Circuit Analysis is to be held April 23 and 24th, 1953 at the Engineering Societies Building Auditorium (33 West 39th St.) in New York City. The meeting has been organized by the Polytechnic Institute of Brooklyn, with the cooperation of the IRE Professional Group on Circuit Theory, and the co-sponsorship of the Office of Naval Research, Air Research and Development Command, and the Signal Corps. It will cover basic nonlinear phenomena and fundamental mathematical methods of analysis, as well as illustrative applications to nonlinear electronic circuits, magnetic circuits, feedback systems, and feedback control systems. No registration fee will be charged, and the proceedings of the symposium will be available at a nominal fee. The program and further details can be obtained by writing to the Polytechnic Institute of Brooklyn, Microwave Research Institute, 55 Johnson St., Brooklyn 1, N. Y.

**Klystron Rentals . . .** An unusual marketing plan for Klystrons developed for u-h-f TV transmitters has been devised wherein the tubes will be leased to telecasters. Under the plan, the klystrons will be incorporated in the transmitters by transmitter manufacturers, but the tubes will be used under direct lease at a fixed rate per broadcast hour. In case replacement of a tube is necessary, it will be replaced with no change in the per-hour rental charge which also will include stand-by tubes for emergency service.

The tubes will have a maximum power output rating of 15kw, and the first klystron scheduled for commercial operation will be used in a 260w transmitter at Reading, Pa. (station WHUM-TV). This will be the most powerful u-h-f TV station on the air. The klystrons will make possible high power u-h-f telecasts with reception over ranges comparable to those of v-h-f stations now in operation.

**Spanish Radio Plant . . .** An American company has announced plans to build a factory for the production of phonograph records, record players, and TV receivers in Spain on a site overlooking Madrid. The project, which is expected to be completed in 1953, will help the Spanish worker as well as the Spanish artist. Appropriate laboratory equipment and research facilities are to be provided to enable Spanish engineers to make contributions to electronic progress as TV develops and other devices are created.

**Foreign Research for U.S. . . .** A number of U.S. industrial companies are seeking information about Western European scientific facilities with the view of utilizing foreign laboratories for their research programs. To obtain such data, a month's tour of technical centers in Italy, Switzerland, and France has been organized by Stanford Research Institute of Stanford, Calif. The party, consisting of research executives, will also visit universities in Italy for discussions with leading Italian scientists.

**Axle Tester . . .** Truck and bus axles can be checked by an electronically controlled axle testing machine which can simulate in a laboratory actual driving conditions that a truck weighing 80,000 lb and traveling at a speed of 60mph would experience. The equipment duplicates torques, stresses, and speeds that the truck or bus would encounter under both normal and strenuous loads.

The axles are checked by placing them on a test stand and subjecting them to highway conditions by means of a magnetic tape. The tape, when run through automatic cycling equipment causes large dynamometers to respond to impulses on the tape and exert the indicated speeds and stresses on the axle under test. The tape recorder provides repetition of the operator's speed and torque signals used in an initial manual test. As each stress is imposed, recording instruments indicate continuously the speed, torque, or load as well as provide a permanent record. The same test can be repeated many times until the durability or life expectancy of the axle is established. The recording tape can be filed, and the test can be repeated exactly at any time desired.

**True Mass Rate Flowmeter . . .** An instrument which can measure the true mass rate of flow of any material that will flow or fall through a pipe has been developed by the Control Engineering Corp. of Norwood 226, Mass. The device is unusual in that it responds to pounds and is totally insensitive to volume. The principle of operation is simple. Measurement is made of the torque necessary to give the flowing mass a Coriolis acceleration. This torque is dependent only on the dimensions of the flowmeter, a rotational speed, and the mass flow, so that all the usual volumetric troubles are eliminated. The device has a wide range of applications in the industrial control field, and it can measure flow independently of temperature or pressure.

**Billing Phone Toll Charges . . .** Although important improvements have been made in the process of billing 140 million toll messages a month to 17 million toll using customers, the mechanization phase of this work continues to remain a challenge to designers. Toll message volumes have more than doubled in the past 10 years, and further growth seems likely. The number of toll messages now recorded on automatic message tapes represents only about 3% of the total messages, (about 80% of them in New Jersey), but this amount is expected to double by the end of 1953.

The New Jersey Bell Telephone Company is the only one at present using punched cards for toll message billing, but the Illinois Bell Telephone Company and the New York Telephone Company are expected to adopt the system early this year, and three other companies are planning to introduce this type of billing later this year. In Newark, N. J., about 1,700,000 toll messages are processed monthly for 73,000 customers in the Newark and Patterson areas; 1,400,000 are processed at Elizabeth, N. J., and 75,000 at Pennsauken, N. J. (near Camden).

**Instrument Center . . .** Plans have been announced for the development of a light manufacturing community in Pasadena, Calif., to be known as "Instrument Park". Consolidated Engineering Corp. of Pasadena, Calif. recently acquired a 20-acre area near its present plant, and is petitioning the Pasadena Planning Commission for a zone change to permit light manufacturing. If the petition is granted, the company will landscape the area, providing for off-street parking, loading facilities, internal roadways, low modern buildings, etc. to attract instrument manufacturers to the site.

**Magnetic Tape Reader and Recorder . . .** A recently described magnetic tape reader and recorder has a number of interesting and novel features. It records and reads binary information in seven tracks on 1/2" wide tape at a longitudinal density of 100 to the inch. A tape speed of 75"/sec is used, and in order to handle short lengths of information efficiently, the tape is brought up to speed or stopped in less than five milliseconds. The device is described in a paper called "IBM Magnetic Tape Reader and Recorder" by W. S. Buslik of International Business Machine Corp., New York, N. Y.

A moving coil operated mechanism starts and stops a relatively short length of tape near the read-record head and uniform tape tension is maintained by storing short tape loops in vacuum columns. This arrangement affords a simple, almost inertia-free means of buffer storage of tape. Removable reels, which take up the tape, are driven and stopped by magnetic-powder type clutches and brakes which are smooth and noiseless in operation. While starting and stopping the tape for each 100 decimal digit record, 8500 such records can be written in less than 5min.

# Tube Applications for Increased Reliability

Walter R. Jones

Panel on Electron Tubes, Research and Development Board, New York, N. Y.

INCREASED reliability in vacuum tube performance can be achieved through the application of certain principles of d-c feedback when designing electronic circuits. This article covers some of the factors affecting reliability and what electronic designers can do to overcome these factors. For the purposes of this article, reliability has been achieved when (1) the circuit in which the tube is employed gives satisfactory performance with all tubes of that type which meet JAN Specs; and (2) when the tubes continue to give adequate performance over long periods of time without requiring replacement. If these conditions are met, the reliability of many tube applications in current military equipment can be improved considerably.

Before proceeding with a discussion of actual circuits, it would be pertinent to review the JAN specifications for a Type 6J5GT tube. The reason for selecting this particular tube is because it has been manufactured for a number of years and has been quite satisfactory in any application to which it has been applied. From the tube-maker's point of view, this tube represents a conservative tube design. The spacings are fairly wide between the elements, and the grid lateral wire diameter is fairly large (0.0035").

Table 1 shows the data on heater current, plate current, transconductance or mutual conductance, and amplification factor for this tube under rated operating conditions of 6.3v supplied to the heater, 250v applied to the plate, and 8.0v bias applied to the grid. The table shows that the heater variation is  $\pm 8.3\%$ , plate current variation is  $\pm 39\%$ , mutual conductance variation is  $\pm 20\%$ , and the amplification factor variation ranges from  $+15\%$  to  $-10\%$ .

Table 1. Type 6J5GT data for test conditions of 6.3v on the heater, 250v on the plate, and -8.0v grid bias.

Test	Min	Rating	Max
Heater Current (ma)	275	300	325 $\pm 8.33\%$
Plate Current (ma)	5.5	9.0	12.5 $\pm 39\%$
Transconductance ( $\mu$ mhos)	2075	2600	3125 $\pm 20\%$
Amplification factor ( $\mu$ )	18	20	23 $+15\%$ , $-10\%$

These tolerances seem very wide, and most everyone who has employed the tubes in circuits where attention is paid to the maximum and minimum limits often wonders why these limits should not be narrowed considerably. This is a fair question but before answering it, let us look at Table 2.

This table shows the variation in electrical characteristics for small changes in mechanical dimensions. Note that a 0.002" change in cathode diameter produces a change of 8% in plate current in the same direction as the cathode diameter change; 8% change in mutual conductance in the same direction; and no change in amplification factor. The same change in grid diameter produces a change of 2% in plate current in the same direction as the change, and an 8% change in mutual conductance and a 5% change of amplification factor in the opposite direction.

It was mentioned previously that this tube was selected because the grid lateral wires (the spiral wire which is wound around a pair of side rods and constitutes the grid itself), had a large diameter (0.0035"). Table 2 indicates that a change of 0.0001" in the diameter of this grid lateral wire will produce a change of 14% in plate current and a 5% change in mutual conductance in the opposite direction to the change in wire diameter, and a 4% change in amplification factor in the same direction.

Looking further we find that a one-turn-per-inch change in the grid winding also results in a number of tube parameter changes.

The heater wire employed in tubes of this type is specified as having a given weight in milligrams per 200mm of length of wire. The table indicates that a 1/2 milligram change in weight per 200mm length will produce a change in filament current of 5%.

From this information it is very evident that there is a definite limit to which tolerances can be held in vacuum tubes. An examination of the mica spacings would show that the mica dies are held to a tolerance of 0.0005" which is very good die work under most any circumstances. Most of the tubes currently employed in military equipment do not represent this conservative tube design. They have considerably decreased spacings between cathode and grid, and

grid and plate. The grid wire diameters are considerably less than 0.0035", and many tubes employ lateral wires of approximately 0.001"diam.

It appears that there are definite limits to which these tolerances can be held. For that reason it might be well to look at the circuit application to determine how these effects might be minimized while still employing tubes made within the JAN tolerances and in the quantities required. There are many possible approaches to the problem of minimizing the effects of plate current change, mutual conductance change, and amplification factor change. One of these is to use d-c feedback in the form of a self-bias cathode resistor for triodes and a series screen feed for pentodes. This same principle can be applied to all sorts of tubes, and in all types of circuits.

Fig. 1 represents the transfer characteristics for Type 6C4 tubes which have characteristics very similar to the Type 6J5 tube. Two plate current curves are shown: one for a tube having a maximum plate current limit, while the second curve shows the minimum current for a tube having the minimum plate current. When this paper was being prepared, three tube companies were asked to furnish the author with "limit" tubes for several types of tubes in order that the necessary data might be obtained. These companies gave excellent cooperation; however their individual production variations were not wide enough to cover the entire ranges involved. By selecting tubes of all three manufacturers it was possible to obtain tubes representing the maximum and minimum limits of plate current as specified by JAN 1A.

Rated grid bias for the Type 6C4 tube is 8.5v, and the plate current range is 14.5ma to 6.5ma at the rated bias for a 250v plate supply. In order to obtain 8.5v bias for 10.5ma plate current a cathode resistor of 810 ohms would be required. This resistor is shown in Fig. 1 as the line starting at the origin and having the slope equal to 810 ohms. If we follow up on the 8.5v bias line in a vertical direction we see that the limiting plate currents are 6.5ma and 14.5ma respectively. If, on the other hand, we follow the intersection of the line whose slope represents 810 ohms, and the minimum and maximum plate current curves, these intersections occur at 8.7ma and 11.8ma respectively. By employing d-c feedback through the simple means of a cathode resistor, the effective plate current spread has been reduced from 6.5ma-14.5ma to 8.7ma-11.8ma which is a considerable reduction.

Fig. 2 shows how  $G_m$  stabilization also is obtained with the use of d-c feedback by means of the cathode resistor. This curve shows the mutual conductance of tubes employing fixed-bias vs self-bias grid voltages for an average of 30 tubes of three manufacturers. All points would fall on a line at 45° if no compensation had been obtained. It will be noted that the line for self bias shows a lower mutual conductance for high mutual tubes and a higher mutual conduc-

since for low mutual tubes than when fixed bias was employed. Thus we get stabilization of mutual conductance by means of this same cathode resistor.

The stabilizing effect of self-bias on plate current as the filament voltage is changed is illustrated in Fig. 3 where the self-bias curve shows a much flatter plate current characteristic as the filament voltage is changed compared to the fixed bias curve. The mutual conductance curve is also flattened out considerably when self-bias is employed.

At this point, it should be noted that in many instances the tube has been rated to be operated under self-bias conditions. When this is the case and the tube is operated with fixed bias rather than the recommended self-bias, then the plate current limits which are specified in the JAN limits are the plate currents which are to be expected with self-bias. There will be a corresponding widening of the spread of plate current and mutual conductance if these tubes are operated with fixed bias rather than the recommended self-bias. Many times in military equipment this expedient is resorted to without realizing the penalty which one must pay for such application. It is very important to determine whether the circumstance requires this type of operation because of the wide differences in tube characteristics which will be encountered with this type of application.

Fig. 4 indicates the effect of employing another type of d-c feedback. This involves the use of a series resistor to supply screen voltage to the screen grid of the tube rather than fixed voltage as is often recommended in the tube rating. The tube in this application is a Type 6AU6 whose ratings include 250v on the plate, 150v on the screen, a 68 ohm cathode resistor, and 6.3v on the heater. In Fig. 4 the screen current spread for 150v fixed screen voltage is presented in the manner used in the previous curves. The maximum screen current is 6.45ma while the minimum screen grid current is 2.37ma.

If now we use a 23,200 ohm resistor in series with the screen grid lead and apply 250v to this resistor, then the voltage applied to the screen grid for a tube having rated screen current will be 150v as before. If, however, the screen current is less than the rated screen current, then the screen voltage will climb until it has reached 182v for the tube having the minimum screen grid current, while the screen vol-

**Table 2. Variations in electrical characteristics of a Type 6J5GT tube caused by small changes in mechanical dimensions.**

Variation in % Caused by:	$\Delta I_p$	$\Delta G_m$	$\Delta \mu$
0.002" change in cathode diameter	+8	+8	0
0.002" change in grid diameter	+2	-8	-5
0.0001" change in grid lateral wire diameter	-14	-5	+4
One turn/inch change in grid winding	-12	-4	+3
0.002" change in plate diameter	-15	-6	+5
0.5mg/200mm change in heater wire		$\Delta I_r = 5\%$	

tage will have dropped for the tube having the high maximum rated screen current, until it has only 127v applied to its screen. Under these conditions then the screen current limits are narrowed from 2.37ma-6.45ma to a spread of 2.95ma-5.29ma which again helps considerably in narrowing the range of operation. This will also level off the mutual conductance curves as was indicated previously.

The use of d-c feedback in this manner is very advantageous when a large number of tubes must be used in a fairly small space. If we were to use tubes having screen currents varying over the 6.45ma to 2.37ma range in this type of equipment, the heat dissipated by the various tubes would differ considerably. The decreased screen current range achieved by d-c feedback together with the fact that the plate current also will be stabilized, results in a more uniform temperature for each of the tubes, reducing the possibility of having several hot spots in the chassis. There are quite a number of military applications where this factor is very important.

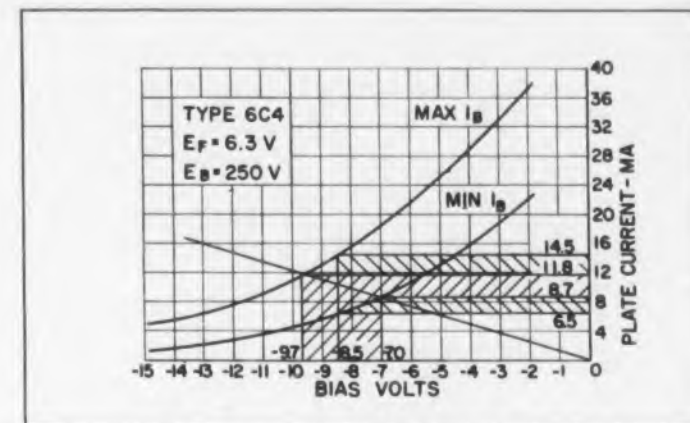
The particular type of d-c feedback covered in this article can be used in many applications. The prime purpose of this type of d-c feedback is to reduce differences in performance by reducing the differences in characteristics which the actual application circuit "sees."

In the interest of obtaining increased reliability there is a sort of "code of principles" which a circuit designer might use in his work. Four of these "principles", which could very well be applied to current military equipment, are the following:

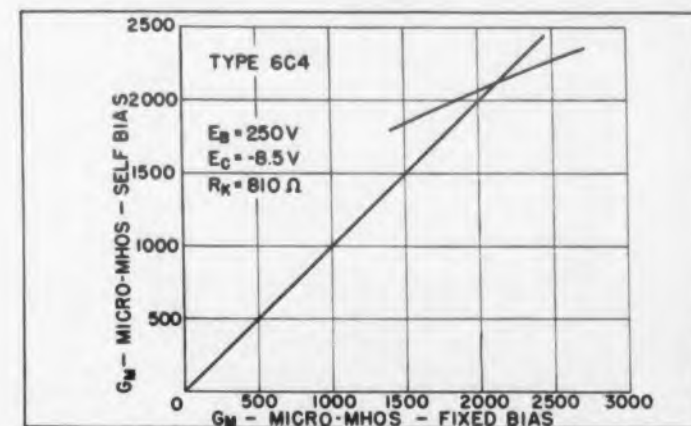
1. Select tubes appearing on the current preferred list.
2. Use the minimum number of tube types consistent with conservative tube duty requirements.
3. Apply tubes in circuits within their rated limits.
4. Explore unusual tube applications when proved desirable with tube manufacturers and develop data on such uses into tube specifications.

It is important to check the proposed tube application with vacuum tube engineers. There are 54 application engineers from the various tube companies who are available for this service, either as single representatives of their own company or in groups of two or three with a representative of the branch of the service under whose contract the equipment is or has been developed. The Application Committee of the Panel on Electron Tubes stands ready at all times to assist in furnishing help and advice in connection with any proposed circuits. Electronic designers can write to the PET office (139 Centre Street, New York, N. Y.) or to the author (School of Electrical Engineering, Cornell University, Ithaca, N. Y.) for help along these lines.

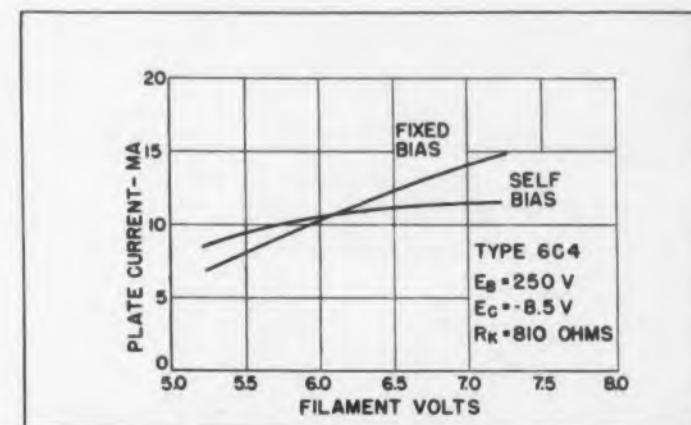
In conclusion the author wishes to thank the tube manufacturers who have cooperated in furnishing the sample tubes which were used in making the measurements described, as well as the several Cornell students who made measurements for this paper.



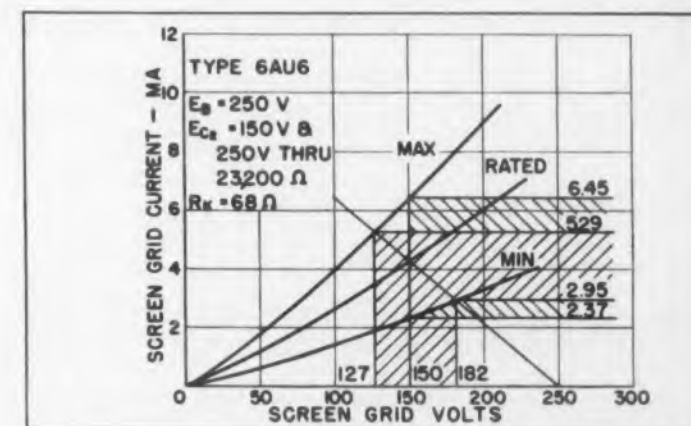
**Fig. 1. Transfer characteristics for tubes having maximum and minimum JAN IA plate current limits.**



**Fig. 2. Mutual conductance obtained by employing fixed-bias vs self-bias on 30 tubes.**



**Fig. 3. Plate current stability obtained by employing self-bias and fixed-bias operation.**



**Fig. 4. Screen current characteristics for tubes having maximum and minimum screen current limits.**

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# Minature Compression Type Hermetically Sealed Terminal

**A** NEW type of construction, an unusual sealing method, and a simple assembly technique are features which produce excellent performance and low cost in this compression type hermetically sealed terminal. Incorporated in a wide range of terminal header styles by Torwico Electronics, Inc., Newark, N. J., the unit withstands severe vibration and shock without affecting the seal.

Construction of the terminal is shown in the dia-

gram (Fig. 2). It consists of a tinned brass terminal stud, steatite insulators, and a silicone rubber seal. The silicone rubber is compressed between the steatite insulators and forms a seal by being displaced against an extruded hole in the cover plate and against the terminal electrode. The compression is held by an eyelet which is driven onto the end of the electrode and crimped securely. The eyelet serves as a lug for internal connection, and the entire assembly is only 7/32" diam x 5/8" long.

The exposed silicone rubber seal is water repellent and serves to break the moisture path from the terminal stud to ground. This greatly retards d-c plating, and temperature range of the unit is -65° to +500°F. The rubber seal also absorbs vibration and shock without affecting the seal.

One of the applications for the new terminal is for mounting components on a terminal board and providing protection for the components when the assembly is subject to shock and vibration. Fig. 1 shows such an application.

In Fig. 3, the terminal is shown in its most usual application—terminal header assemblies. These can be furnished in combinations for all standard MIL-T-27 cases, as well as in special arrangements as required. The darker colored terminal is used to identify the first terminal location. All metal parts have a hot tin dip finish for ease of soldering and for corrosion resistance.

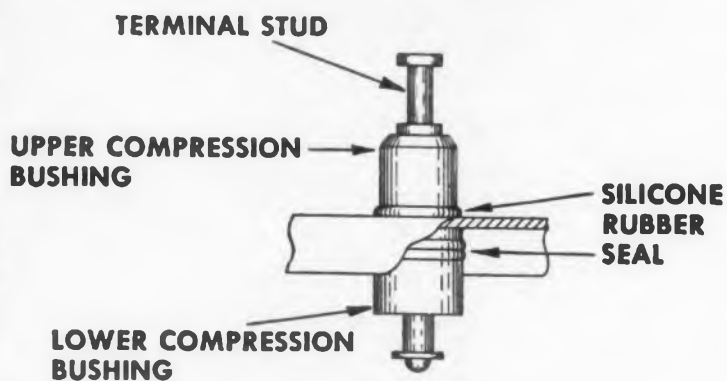


Fig. 1. (Top) Terminals installed on a mounting board protect components from vibration and shock.

Fig. 2. (Center) Construction of the terminal.

Fig. 3. (Bottom) Terminal headers using the new terminal.



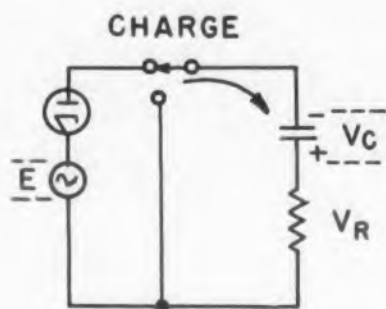


$\epsilon^{-\frac{t}{RC}}$	$\frac{t}{RC}$
.9510	.05
.9050	.10
.8610	.15
.8190	.20
.7790	.25
.7410	.30
.7050	.35
.6700	.40
.6380	.45
.6070	.50
.5770	.55
.5490	.60
.5220	.65
.4970	.70
.4720	.75
.4490	.80
.4270	.85
.4070	.90
.3870	.95
.3680	1.0
.3330	1.1
.3010	1.2
.2730	1.3
.2470	1.4
.2230	1.5
.2020	1.6
.1830	1.7
.1650	1.8
.1500	1.9
.1350	2.0
.1220	2.1
.1110	2.2
.1000	2.3
.0907	2.4
.0821	2.5
.0743	2.6
.0672	2.7
.0608	2.8
.0550	2.9
.0498	3.0
.0450	3.1
.0408	3.2
.0369	3.3
.0334	3.4
.0302	3.5
.0273	3.6
.0247	3.7
.0224	3.8
.0202	3.9
.0183	4.0
.0166	4.1
.0150	4.2
.0136	4.3
.0123	4.4
.0111	4.5

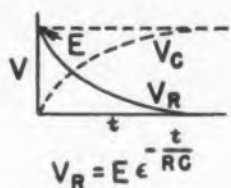
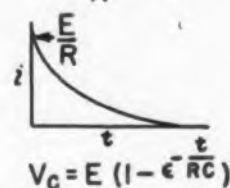
# RC Circuit Design

G. Donald Hendricks

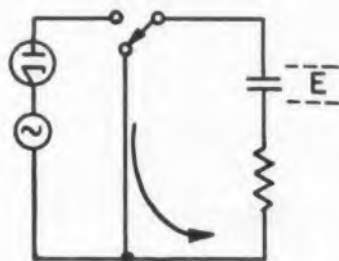
Electronic Design Engineer, Eagle Signal Corp., Moline, Illinois



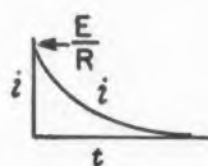
$$i = \frac{E}{R} \epsilon^{-\frac{t}{RC}}$$



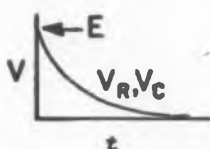
## DISCHARGE



$$i = \frac{E}{R} \epsilon^{-\frac{t}{RC}}$$



$$V_C = V_R = E \epsilon^{-\frac{t}{RC}}$$



THIS dissertation was prepared to simplify use of the mathematical formulas associated with design problems relative to the  $RC$  time constant.

## Discharge Timing Calculations

If  $V_c = E \epsilon \exp -t/RC$  then  $V_c/E = \epsilon \exp -t/RC$ , and the term  $\epsilon \exp -t/RC$  may therefore be defined as the percentage of  $E$  which  $C$  must discharge through  $R$  in order to reach  $V_c$  (the tube "fire" or work conduction point) in time  $t$ .

The design chart shows  $V_c/E$  or  $\epsilon \exp -t/RC$  plotted against  $t/RC$  on a Bar Graph. Mathematically speaking we have displayed an exponential table with  $\epsilon^N$  on the left and  $N$  on the right. Now  $N = t/RC$  and it may be seen that the transposition from  $V_c/E$  in percentage to  $t/RC$  enables the engineer to juggle this exponent to solve for time, resistance, or capacitance.

For instance: if a vacuum tube conducts sufficiently at  $-10v$  to close a relay which will perform a work function and reset a 2mfd capacitor every eight seconds, and a  $-150v$  charging source is available, let us determine the value of  $R$  needed.

Here  $V_c/E = 10/150 = 0.066$ , and from the graph,  $t/RC$  is equal to 2.7. Therefore  $2.7 = t/RC$  and by substitution,  $2.7 = 8/2R$  from which we find that  $R$  is equal to 1.48 megohms.

In production, a 1.5 megohm resistor would be used. This would give an  $RC$  time constant of 3 (1.5 megohms x 2mfd). Now 3 times 2.7 (as taken from the graph) equals 8.1 seconds, well within the usual production tolerance.

## Charging Calculations

If  $V_c = E (1 - \epsilon \exp -t/RC)$  for charging and  $V_c$  is the charge attained in time  $t$  and  $E$  is the applied charging potential, it follows that  $(1 - V_c/E) = \epsilon \exp -t/RC$  for purposes of using the design graph for charging calculations.

For example if a gas tube will fire at  $+80v$  and

Fig. 1. The bar graph at the left is used to simplify R-C Design calculations. Basic charging and discharging relations are shown alongside.

a 150v power supply is used together with a 5 megohm resistor and a 2mfd capacitor, what will be the rate of fire if the capacitor is reset to zero after each cycle?

Now,  $1 - V_c/E = 1 - 80/150 = 0.467$ , and at this point on the graph,  $t/RC = 0.75$ . From this relationship  $t$  turns out to be 7.5 seconds.

Using the graph and the method outlined above, many similar R-C timing problems can be solved.

## Nomenclature

The following is a summary of the nomenclature and the basic relations used in the calculations above.

$V$  = Charge or remaining charge on  $C$ .

$E$  = Initial charge on  $C$  or potential it seeks.

$i$  = Instantaneous current in milliamperes at any given time  $t$ .

$\epsilon = 2.718$

$t$  = Time in seconds to reach  $V_c$ .

$R$  = Resistance in megohms.

$C$  = Capacitance in microfarads.

Time constant = Time in seconds for  $E$  to fall to  $1/\epsilon$  or 36.8% of its initial value, or to rise to  $(1 - 1/\epsilon)$  or 63.2% of its final value.

$$V_c/E = \epsilon \exp -t/RC = E^{-N}$$

$$N = t/RC; \quad t = NRC; \quad R = t/NC; \quad C = t/NR.$$

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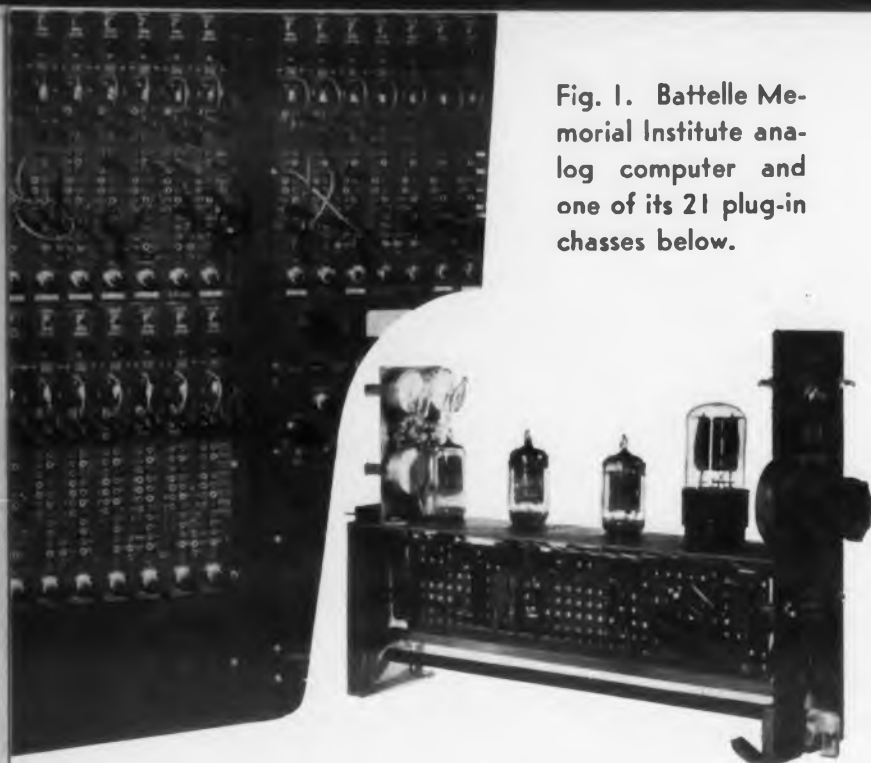
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CIRCLE ED-9 ON READER-SERVICE CARD FOR MORE INFORMATION

Fig. 1. Battelle Memorial Institute analog computer and one of its 21 plug-in chassis below.



# Plug-In Component Design Provides "Serviceability"

N. A. Denman

Application Engineer, Alden Products Company

**D**ESIGNING for serviceability is an important function of the modern design engineer, as pointed out by Eugene A. Anthony in his recent article in *ELECTRONIC DESIGN* ("Designing for Service Increases Product Acceptance", *ED*, Jan. 1953, pages 6-7). Mr. Anthony made a powerful point in favor of the re-examination and simplification of present television receiver design towards improvement in serviceability. It is the thesis of this article that this goal can be reached through careful design of the basic components used in every electronic device, and that the problems and solution not only apply to television, but to the whole field of electronics and especially to automatic electronic control equipment, where serviceability is of the utmost importance.

Progress in the application of automatic control theory has been hampered because of product acceptance and serviceability problems. Product acceptance is lagging because of the lack of serviceability in present and contemplated electronic control devices. Wherever poor serviceability prevents a critical control device from being replaced or returned to operation quickly, management's tremendous investment in plant and raw material is in jeopardy.

It is now recognized that automatic control equipment must be designed so that regular factory workers or supervisors can do instant servicing.

## Serviceability Requirements

Basic design requirements for good serviceability include (a) minimum service equipment, (b) simple servicing steps, (c) logical, easy-to-follow wiring, and (d) methods of indicating and measuring trouble quickly. With these requirements fulfilled, the circuit should be as easy to repair or replace as the component. For instance, anybody can replace a tube, because a tube has been designed for easy, rapid replacement. Thus, if serviceability is built into the basic component, then the circuit made up of these

components can be made readily serviceable. This thinking has been applied in the design of a number of components and the following sections of this article illustrate how they promote easy serviceability.

## Plug-In Chassis

One of Mr. Anthony's specific suggestions was "simplified cabinet back removal". This suggestion has been carried one step further by designing an open-sided chassis that can be removed completely from the rack or cabinet by merely turning a chassis lock handle. This automatically breaks all electronic connections and frees the chassis to be slid out of the rack. An excellent example is the 21 chassis console of the Battelle Memorial Institute analog computer shown in Fig. 1. Here the design requirements specified no "on the site" maintenance, minimum down-time for the replacement of defective components, and interchangeability. These were met by mounting the circuits on a series of 21, 2" chassis which in turn mount in the console with special ("serve-a-unit") locks that require no tools to operate. Back connectors make and break the circuits automatically as the lock is rotated to free the chassis. These back connectors carry power to the chassis.

Test point jacks mounted on the front of each panel provide simple, readily traceable interchassis connection. When maintenance or change in circuitry is required, the leads are pulled from the test point jacks, the chassis lock is rotated, and the chassis is completely free of the console, and the components mounted on both sides of the terminal board are completely accessible. The chassis then can be replaced by a standby unit or repaired rapidly.

In another application, a number of identical audio amplifiers had to be in operation in one console with only 20 second allowable down-time. The console was designed with each amplifier on a separate chassis with space and leads provided so that several spares could

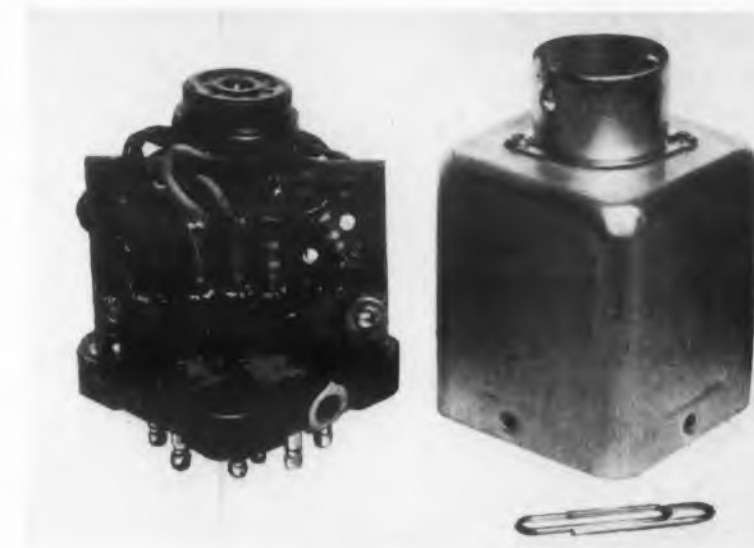
be stored in "ready" position with the filaments kept warm. Thus, a defective amplifier could be removed merely by turning a simple unlocking rejecting mechanism, sliding the chassis out and replacing with a spare whose filaments had no chance to cool. The result was practically no time "off the air".

Smaller plug-in chassis known as "plug-in kits" such as the one in Fig. 2 were built by Wickes Engineering Corporation utilizing small prepunched terminal boards on 20-pin plug-in bases. These were installed in a control tower transmitter to meet the requirement of practical serviceability by radio operators. When transmitter trouble develops, the operator replaces the indicated defective plug-in unit with a "ready-to-use" standby and the transmitter is quickly back on the air.

## Terminal Board Layout

"Rat's nest" wiring can be avoided by breaking down a wiring diagram into logical circuits, and plac-

Fig. 2. This small plug-in chassis unit, part of a control tower radio transmitter, is easily removed and replaced.

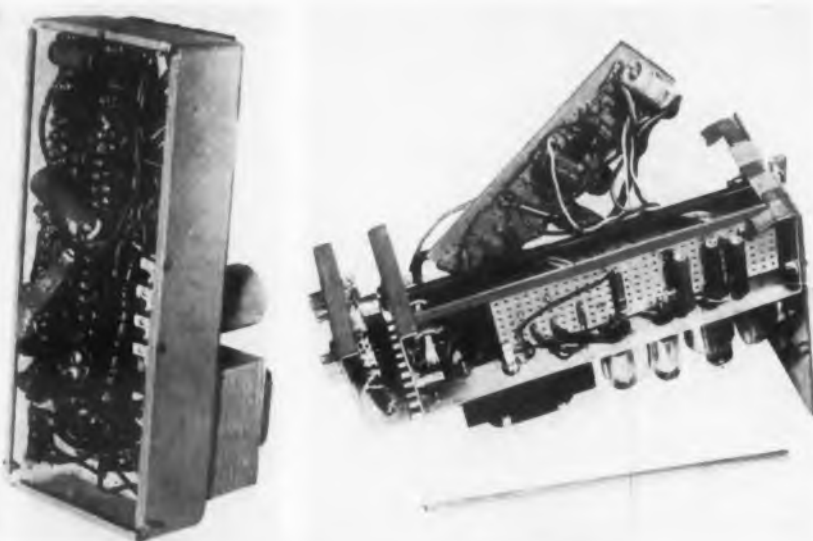


ing these circuits on prepunched terminal boards. The result is shown in Fig. 3. At the left is a translator (a recording and control instrument manufactured by Alden Electronics and I.R.E. Co.) showing typical "rat's nest" wiring with inaccessible terminals and crowded components. At the right is shown the result of applying a logical layout of circuits on prepunched terminal boards. When the tubes are pulled from the sockets, and the mounting rails snapped out of their spring brackets, the circuits mounted on the terminal boards can be swung up, as shown, from the chassis. All terminals are immediately available. The solder terminals have serrated inner edges, so that resistor leads can be pushed into place to make a good electrical connection. The resistor can be changed quickly until the correct value is determined. Then it is soldered in place, the terminal board snapped back into position, tubes replaced and the chassis is back in operation. This particular application of the terminal card mounting system permits all the heat-generating elements to be placed on one terminal board, with vertical alignment for efficient cooling, and where the heat radiated does not disturb heat-sensitive components mounted on the other terminal board.

#### Chassis Locks

The requirement of chassis removal without the use of soldering iron, screw drivers or other tools, as described in several applications above, meant the design of a simple, hand-operated, quick acting chassis lock. This is known as a "serve-a-unit" lock, and is shown mounted in a chassis in Fig. 4. These locks are designed so that finger pressure on the handle rotates the bullet nose on the end of the "serve-a-unit" lock shaft. As the bullet nose is rotated through 180° the helical cam groove machined in it is engaged by the stud in the circular opening in the back of the rack. When the full 180° have been reached, the chassis is displaced far enough forward in the rack to break

Fig. 3. "Rat's nest" wiring (left) becomes more serviceable when logically arranged on terminal boards (right).



all the electrical connections through the back connectors and only then is the chassis free to slide out of the rack. This is an important safety feature. Snap indents had been provided at both ends of the 180° travel of the "serve-a-unit" lock so that vibration will not loosen the lock from its fully open or fully closed position. Insertion of the chassis in the rack until the bullet nose engages its notch reverses the procedure, and the male back connectors are forced into their female clips on the back connectors mounted on the rack so the circuits are restored at the same time the chassis is locked in place. No tools at all have been required during the entire process.

Where screw fastenings are desired, such as in mounting the panel to the chassis, as in the 2" chassis shown in the insert of the Battelle Memorial Institute computer photograph, "target screws" and "captive screws" which are self-aligning are provided. The serviceability feature of these screws is the concave head, designed so that they can be removed or fastened with a coin. For positions inaccessible to a screw driver, the coin slot is invaluable, and the screw head is knurled to permit removal with the fingers. These screws are pointed, and the back connectors have "floating" clips, to provide easy alignment.

#### Sensing Elements

Since the test point jack provides a means of quickly locating trouble without the necessity of going behind the panel or under the chassis, it is classified as a sensing element. Other sensing element designs are shown in Fig. 5. These are the plug-in adapter, the small incandescent panel light, and the neon indicating signal. In this particular example the neon indicator is wired as an indicating fuseholder so that it will light up when the fuse is blown.

The small incandescent light provides a quickly noted visual signal of what is operating behind the panel or at a site remote from the panel. The adapter, only one model of which is shown, can be plugged

Fig. 4. Chassis lock makes chassis removal quick and easy without tools. An ordinary coin can be used.

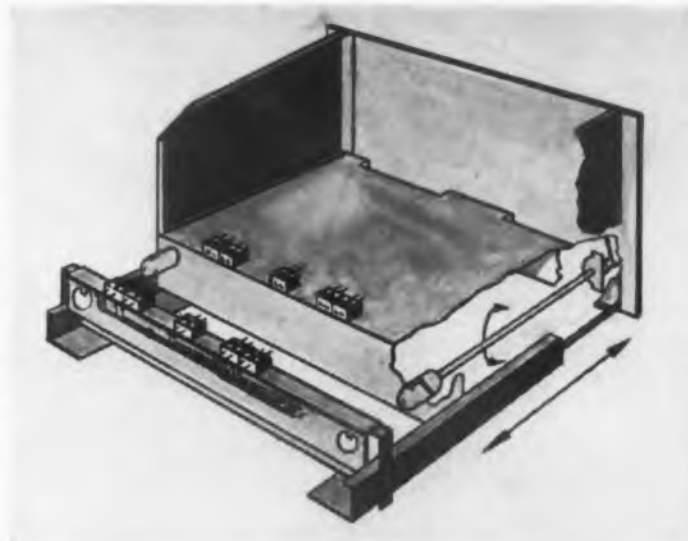


Fig. 5. Sensing elements: test point jack and plug-in adapter (upper left and right), panel light and indicating fuseholder (lower left and right) for locating trouble.

into the tube socket with the tube or relay plugged into its top, and measurements can be made from above the chassis while the circuit is in operation.

When wired into the circuit, visual indicators signal the malfunction of a plug-in kit or chassis, and with no electronic experience at all, the operator can observe the color coding, match it with the color coding on the chassis or plug-in kit handle, remove the defective plug-in unit and replace it with a spare having the corresponding color code. Numbering or alphabetized designations can be provided to anticipate possible color blindness in the equipment operator.

#### Dividends in Production

We have endeavored to outline here the component design considerations which make it practical and possible to package any electronic circuit, no matter how complicated, so as to provide serviceability and result in better product acceptance.

In practice, the application of these ideas not only improves serviceability but provides significant economies in manufacture, because ease of assembly usually means good serviceability. We have found that it also has materially assisted research and development since these terminal boards and open chasses are ideal for breadboard layouts. When the breadboard design is complete, it can proceed with a minimum of change to a prototype, preproduction model, and into production with resulting economies in time, inventory, and tooling.

Thus in meeting the basic design requirements for good serviceability: minimum service equipment, simple servicing steps, logical and easy-to-follow wiring, and methods of indicating trouble quickly, the needs of production are met also. This is so because the basic components previously described all have been designed with these requirements in mind.

# New Products . . .

Items marked with a ▲ will be displayed at the Radio Engineering Show (New York City, March 23-26, 1953)

## Regulated Power Supply

Output Variable From 0v to 1500v



The Model 1520 features a regulated high voltage d-c Power Supply with low ripple content and low output impedance, which makes it of interest to the electronic design, development, and research engineer.

The voltage is continuously variable from 0v to 1500v and current output ranges

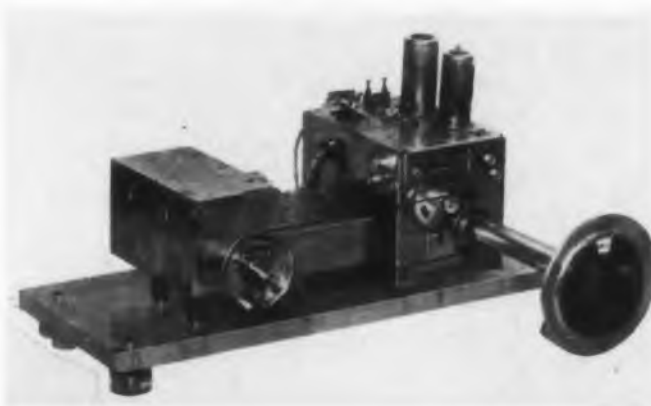
from 0ma to 200ma. In the 30v to 1500v range, the output voltage variation is less than 1/2% for line fluctuation from 105v-125v and load variation from minimum to maximum current. The ripple voltage is less than 30mv peak to peak. Kepeco Labs., Dept. ED, 131-38 Sanford Ave., Flushing 55, N. Y.

CIRCLE ED-11 ON READER-SERVICE CARD FOR MORE INFORMATION

## U-H-F Tuner

For Use With 3-Shaft V-H-F Tuner

The Model 60 U-H-F Tuner has been designed to complement the company's Model 48 (13 position) turret v-h-f 3-shaft tuner, which has a suitable built in reduction drive for fine tuning. Compact in size, the Model 60 has been designed for long life with ball bearings on tuning shaft.



Other features include no sliding contacts in critical tuning circuits, freedom from backlash problems, excellent tuning resetability, and a smooth low torque tuning.

A single tuning shaft may be brought out at either or both ends with any specified length, providing flexibility in location and a variety of tuning drive and dial indicator systems. Pulleys or gears of any specified size may be supplied on any shaft extension to accommodate tuning and dial indicator systems of various types.

The photograph illustrates the u-h-f tuner (left) being used in conjunction with the company's Model 48 13-position v-h-f tuner (right). General Instrument Corp., Dept. ED, 829 Newark Ave., Elizabeth 3, N. J.

CIRCLE ED-12 ON READER-SERVICE CARD FOR MORE INFORMATION

## Frequency Meter

Measures Frequencies to 42Mc



The Model 5570 Frequency Meter is a direct reading instrument capable of measuring frequencies from 0 to 42Mc. Mounted in a single, three-deck cabinet, the instrument is simple to operate and easy to read. There are no lights to add and no meters to read.

Possible accuracies of 1 part in  $10^7 \pm 1$  count can be obtained. The indicated frequency is displayed in digital form on eight banks of illuminated lucite number panels. For permanent recording of the displayed information, the unit can be connected directly to the company's digital recorder system.

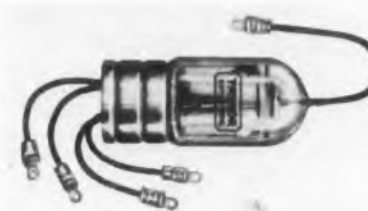
The instrument consists basically of two sections: a high speed events-per-unit-time meter ("EPUT") and a heterodyne unit. Frequencies of 2Mc and below are applied directly to the "EPUT" section and are read on the last six decade number panels. Frequencies from 2Mc to 42Mc are applied to the heterodyne section, with the megacycle selector knob turned to the proper harmonic, and the results read directly on the eight decade number panels.

Simplified adjustment of the heterodyne section selector knob is obtained by an output meter which indicates when the proper harmonic is reached. To obtain the accuracy of 1 part in  $10^7 \pm 1$  count, provision has been made for externally adjusting the crystal control unit to Station WWV. Berkeley Scientific Div., Beckman Instruments, Inc., Dept. ED, 2200 Wright Ave., Richmond, Calif.

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## Thyratron Rectifier Tubes

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Type C5F14/6278 and Type C3R14 rugged Thyratron Rectifier Tubes have metalized carbon anodes that provide more efficient plate dissipation and can absorb great overloads. Their rugged construction makes them especially applicable in high shock installations up to 200G's. They also are adapt-

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able to motor control, inverter circuits, and to various tuning and controlling functions.

Both tubes have 14v, 2.5amp heaters with indirectly heated cathodes. Average arc drop is 10v or less, and ambient temperature range is from  $-55^{\circ}\text{C}$  to  $-75^{\circ}\text{C}$ . They are 2" diam x 5", and base connections are made from flexible leads having closed No. 6 lugs.

The Type C5F14/6278 has a flexible anode connection. Average anode current is 5amp; peak anode current, 60amp; and peak anode voltage is 750v, with less than 200 $\mu\text{sec}$  deionization time.

On the Type C3R14, the extended anode connection is made through a medium cap without flexible lead. Average anode current is 3amp with a peak anode current of 30amp; peak anode voltage is 1000v; with less than 175 $\mu\text{sec}$  deionization time. Taylor Tubes, Inc., Dept. ED, 2312 W. Wabansia Ave., Chicago 47, Ill.

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### Illuminated Dials, Panels, Knobs

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These Laminated Panels, Knobs, Flat Dials, and Drum Dials have the required letters or figures processed into the background, so that they appear pure white against the non-reflecting black background. When lighted with red-filtered lamps inserted in the



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Laminated of methyl methacrylate and vinyl films which meet the standards of Specification MIL-P-7788, the dials and panels withstand all standard humidity and soft-spray testing. No change occurs in the overall efficiency of the materials when they are tested at temperatures varying between  $-65^{\circ}\text{C}$  and  $+85^{\circ}\text{C}$ .

This new method lends itself readily to quantity production at low prices. Colored panels and finishes also have been developed for applications other than in military use. Samples of these panels are available on request. Universal Aviation Equipment, Inc., Dept. ED, 187 Lafayette St., New York 13, N. Y.

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ELECTRONIC DESIGN • March 1953



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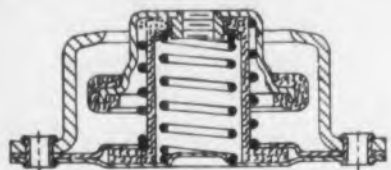
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## SHOCK AND VIBRATION NEWS



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CONTINUED SERVICE

The Barry Corporation announces two new ALL-METL vibration isolators, Type 7630 and Type 7640, specifically designed to eliminate loss of efficiency due to damper packing. These units are respectively JAN cup-type Size 1 and JAN cup-type Size 2.

Previous wire-mesh unit vibration isolators exhibited a definite loss of damping efficiency after a period in actual service, because the wire-mesh damper tended to pack down and become stiffer after repeated shock and vibration. The new unit Barrymounts are so designed that the load-bearing spring returns the damper to its normal position on every cycle, thus preventing packing and removing the difficulty.

Additional features of the new units are very light weight, a new hex top to simplify installation, high isolation efficiency, ruggedized construction, and wide temperature tolerance. Barry Product Bulletin 531, describing the isolators in detail, is free on request. For further information, write, wire, or phone The Barry Corporation, 775 Pleasant Street, Watertown 72, Mass.

CIRCLE ED-17 ON READER-SERVICE CARD FOR MORE INFORMATION

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## Your Helping Hand...



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For All Standard  
Electronic Equipment!

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Circle 6-4060

CIRCLE ED-18 ON READER-SERVICE CARD FOR MORE INFORMATION

## New Products...

### Waveguide Attenuator

Has Calibrated Range to 50db



The Type X382A Precision Attenuator is designed to operate independently of the frequency. Operating on a principle not previously applied to commercial units, the instrument employs three separate attenuator films located on the central axis of the waveguide. The two films located at the entrance and exit of the instrument are stationary, while the third central film can be rotated with respect to the other two.

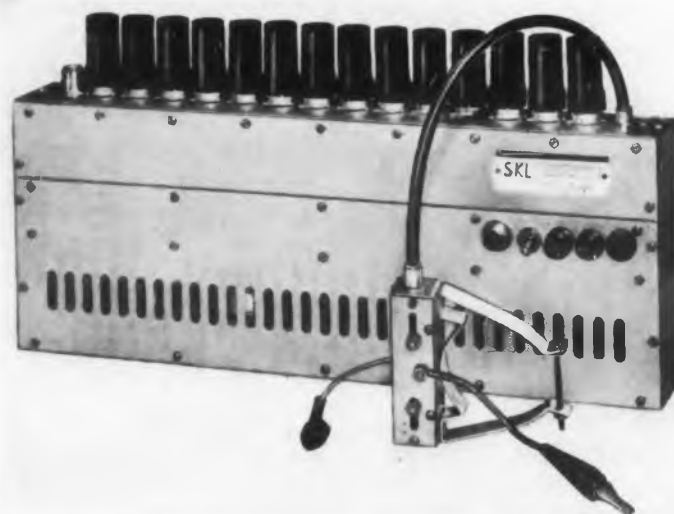
With all films in alignment, there is zero attenuation. As the central film is rotated with respect to the plan of the other two films, attenuation increases according to a cosine law. Attenuation does not depend on the specific resistance of the films, but is dependent only on the orientation of the central film.

Specifications for the device include a maximum attenuation of about 70db, a calibrated range of 0 to 50db, and a frequency range of 8200Mc to 12,400Mc. Hewlett-Packard Co., Dept. ED, 395 Page Mill Rd., Palo Alto, Calif.

CIRCLE ED-19 ON READER-SERVICE CARD FOR MORE INFORMATION

### Chain Pulse Amplifier

Has High Output Voltage



The Model 214B Chain Pulse Amplifier features reliability, fast rise time, and stability for use in the study of fast pulses in radar, nuclear radiation, TV,

and u-h-f research. Because the unit has good signal noise to ratio, it may be used in narrow band, as well as broad band application.

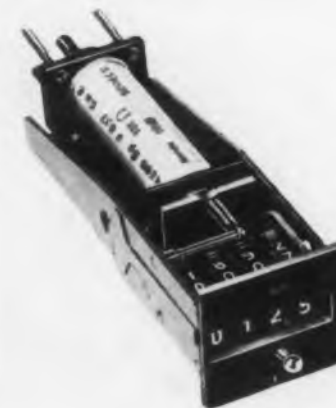
Fourteen Type 6AH6 vacuum tubes are used to obtain the maximum output voltage of 125v over a bandwidth of 200cy to 90Mc. Further specifications include a pulse gain of 30db and a rise time of better than 0.006 $\mu$ sec. The frequency response is flat within 1-1/2db from 500cy to 80Mc, and the phase response is substantially linear within the pass band. The power supply is stabilized to prevent fluctuations of gain due to variations in the signal duty factor.

This unit's output connection is at the end of 15" of coaxial cable, and is so designed to fit the neck of a cathode ray tube or to be connected to other equipment without alteration or special connectors. Two output impedances of 500 ohms and 5000 ohms are provided, and standard type N fittings are used. The unit is available for table or rack mounting. Spencer-Kennedy Labs., Inc., Dept. ED, 186 Massachusetts Ave., Cambridge 39, Mass.

CIRCLE ED-20 ON READER-SERVICE CARD FOR MORE INFORMATION

### Electromechanical Impulse Counter

Flush Panel Mounting Type



This compact, electrically-actuated Impulse Counter is designed for flush panel mounting where space requirements are at a premium. The entire assembly is about 4" long and mounts through a panel opening about 3/4" high and 1-1/4" wide.

Provided with two mounting holes, the front panel of the unit contains a 4-position counting index with white numerals 5/32" high, and with an instantaneous zero-reset button.

Seven types of coils are available for impulse voltages between 4v and 60v d-c (or rectified a-c). Power requirements range between 1.4w and 2.5w, depending on the voltage used. Maximum counting rate is 10 impulses per second; minimum impulse duration is 40 milliseconds; and minimum break between impulses is 50 milliseconds.

The units digit advances half a unit when the coil is energized and completes its advance when the coil is de-energized. Landis & Gyr, Inc., 45 W. 45th St., New York 36, N. Y.

CIRCLE ED-21 ON READER-SERVICE CARD FOR MORE INFORMATION

CONTINENTAL

MINIATURE  
*Precision*  
CONNECTORS

RACK TO PANEL TYPE

4 to 100 contacts



POSITIVE POLARIZATION • FLOATING CONTACTS • PRECISION MACHINED CONTACTS • VIBRATION PROOF • MINERAL FILLED MELAMINE BODY • FLAME RESISTANT • HI-DIELECTRIC AND MECHANICAL STRENGTH

CABLE TO PANEL TYPE

4 to 100 contacts



VOLTAGE BREAKDOWN (Sea level normal humidity) ..... 3600 V. RMS  
CURRENT RATING ..... 5 AMPS  
CONTACT SIZE ..... 20 AWG wire  
EFFECTIVE CREEPAGE ..... 1/8 in.  
MECHANICAL SPACING ..... 5/64 in.

CABLE TO PANEL TYPE



Hexagonal type is provided with positive polarization and a Vibration Ring and Spring with detent locking action. Voltage breakdown at Sea level normal humidity. — 1600 V. RMS.

CATALOG WITH COMPLETE DETAILS — AVAILABLE ON REQUEST. TO DEPT. ED-3



DeJUR AMSCO

45-01 NORTHERN BOULEVARD, L. I. C. P. I., N. Y.

CIRCLE ED-22 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 1953

## Automatic Cycling System

### Controls Exciter Table



The Model ACS-11 Automatic Cycling System is designed to provide automatic control of frequency and amplitude of the acceleration of an exciter table. It is particularly useful in work which requires following Government specifications in eye-lining.

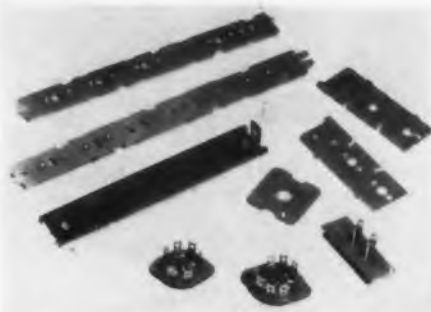
The unit is used with the company's Model C-1 or C-11 calibrator. Automatic cycling

provided is from 10-55-10cy in one minute intervals, and 10-500-10cy in 15 minute intervals. Other ranges also are available. MB Mfg. Co., Inc., Dept. ED, 1060 State St., New Haven 11, Conn.

CIRCLE ED-23 ON READER-SERVICE CARD FOR MORE INFORMATION

## "Textolite" Laminate

### Has 100,000 Megohm Resistance



Type 11541 "Textolite" Laminate retains superior insulation resistance under humid conditions, enabling greater tuning stability in TV and radio circuits. This phenolic paper base

material has been designed especially for electronic component parts. Several applications are shown in the illustration which displays a number of electronic components including two tube sockets.

The material has an insulation resistance of 100,000 megohms (min) after 96 hours in 90% relative humidity at 35°C. This high resistance is achieved with no sacrifice of the hot punching qualities and mechanical strength of conventional laminates.

Other features include good low loss properties and high dielectric strength. The material is available in sheets from 0.015" to 0.25" thick. General Electric Co., Dept. ED, 1 Plastics Ave., Pittsfield, Mass.

CIRCLE ED-24 ON READER-SERVICE CARD FOR MORE INFORMATION



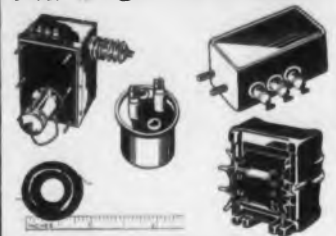
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 127 SUSSEX AVENUE  
 NEWARK 4, N. J.

*Motor speed ranges of 500 to 1 have been  
 obtained with this 16 amp. temperature-free  
 thyatron.*



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Driver Transformers  
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Modulation Transformers  
Blocking Oscillator Transformers  
Band Elimination Filters

## INSTRUMENTS



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NO. 1010  
COMPARISON  
BRIDGE

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OTHER FREED INSTRUMENTS  
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NO. 1110A Incremental Inductance Bridge  
NO. 1150 Universal Bridge  
NO. 1170 D.C. Supply  
NO. 1210 Null Detector and Vacuum Tube Voltmeter  
NO. 1140 Null Detector Amplifier  
NO. 1040 A.C.—V.T. Voltmeter  
NO. 1250 Decade Condenser  
NO. 1410 Harmonic Distortion Meter and Decade Inductors

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1727 Weirfield St., Brooklyn (Ridgewood) 27, N. Y.

CIRCLE ED-26 ON READER-SERVICE CARD FOR MORE INFORMATION  
WORKING WITH HIGH FREQUENCIES?

## THEN YOU'LL NEED THESE TWO RESISTORS



TYPE MP HIGH FREQUENCY RESISTOR

2 watts to 90 watts. For frequencies above those of conventional resistors. Thin film of resistance material, bonded to ceramic form provides a stable resistor with low inductance and capacity. Wide range of terminal types. Suited to critical UHF circuits.



TYPE MPM MINIATURE HF RESISTOR

Specially engineered for VHF and UHF applications. Miniature MPM's have resistance bodies  $\frac{1}{4}$ " long by 0.100" over cups. Thin resistance film permanently bonded to ceramic rods. Rated at  $\frac{1}{4}$  watt. Resistance values from 30 ohms to 1.0 megohm.



### INTERNATIONAL RESISTANCE COMPANY

Dept. D, 401 N. Broad St., Philadelphia 8, Pa.  
In Canada: International Resistance Co., Ltd., Toronto, Licensee  
Please send full data on the items checked below:

- Type MP High Frequency Resistors  
 Type MPM Miniature VHF and UHF Resistors

Name \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

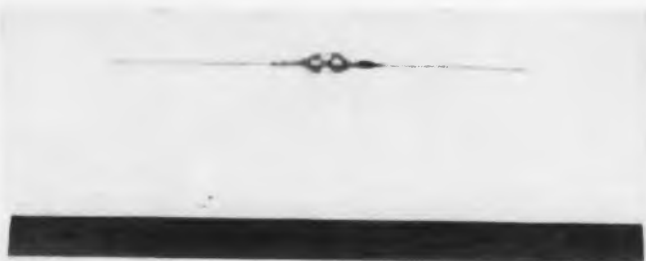
Wherever the Circuit Says

CIRCLE ED-27 ON READER-SERVICE CARD FOR MORE INFORMATION

## New Products...

### Germanium Diodes

#### Hermetically Sealed Glass Types



Three hermetically sealed glass type Germanium Diodes have been added to the company's line. These units have an ambient temperature range from  $-50^{\circ}\text{C}$  to  $+60^{\circ}\text{C}$  and have applications of interest to electronic design, development, and research engineers.

The Type 1N86, a general purpose unit, has maximum ratings which include an inverse voltage of 70v, a peak inverse voltage of 85v, a forward current of 50ma, and a peak forward current of 150ma. The Type 1N88, a d-c restorer diode, has a minimum forward current at +1v of 2.5ma, an inverse current at  $-50\text{v}$  of  $100\mu\text{amp}$  max, an inverse voltage for zero dynamic resistance of 100v min, a maximum permissible inverse voltage of 85v, and a maximum permissible current of 5ma.

The Type 1N87, for use as a video detector diode, has characteristics that include a maximum permissible peak inverse voltage of 30v, a rectified current at 5v rms, a 30Mc load resistance at 2000 ohms of 2.1ma min, and a damping resistance at 30Mc of 800 ohms min. Amperex Electronic Corp., Dept. ED, 230 Duffy Ave., Hicksville, L. I., N. Y.

CIRCLE ED-28 ON READER-SERVICE CARD FOR MORE INFORMATION

### Melamine Laminate

#### Made From a Glass Mat Base

Melamine-glass mat Industrial Laminate, Grade 115, can be used as a substitute material for the company's Grade 140. The new laminate is cheaper and is made from a glass mat base, while the Grade 140 is made from a continuous woven glass cloth.

Physical specifications for Grade 115, according to MIL-P-15037A test methods, include an arc resistance of 182 to 186sec; a density of 1.71gm/cc to 1.73gm/cc; a water absorption of 2.8% to 3.4%; an impact of 3.96 to 4.13 ft lbs/in notch; a flexural, A, of 14,500psi to 16,000psi; and bonding, A, of 1,135 lbs to 1,435 lbs.

This material is useful for panel board and similar applications. St. Regis Paper Co., Panelyte Div., Dept. ED, 230 Park Ave., New York 17, N. Y.

CIRCLE ED-29 ON READER-SERVICE CARD FOR MORE INFORMATION

Single and Double Pole "Toggle" Handle Type  
**AIRCRAFT SWITCHES**  
For Electronic and Communications Use

Made to joint Army and Navy specifications (JAN-S-23). For DC, or AC circuits up to 1600 cycles. Switching characteristics provide for changes in electric circuits by use of spst, spdt, dpst and dpdt. Has bakelite housing and only one mounting hole. Nuts and sleeve lock-washers supplied. Available with screw terminals (No. ST-40 series, Single Pole, and ST-50 series, Double), and with solder lugs (No. ST-42 series, Single Pole, and ST-52 series, Double).  
Write Dept. 105 For Bulletin

**KULKA** ELECTRIC MFG. CO., Inc.  
MOUNT VERNON, N. Y.

See our Exhibit IRE Show Booth 2-139.

CIRCLE ED-30 ON READER-SERVICE CARD FOR MORE INFORMATION

## RVC-2 Precision Potentiometers

featuring "UNITIZED" CONSTRUCTION



- RVC-2 "Unitized" Construction provides maximum versatility
- Units interchangeable
- Standardization of individual units
- Maximum Economy
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- Meet the most exacting standards of quality and performance

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CIRCLE ED-31 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • March 1953

## X-Band Reflex Klystrons

Have Frequency Range to 10,000Mc



Four X-Band Reflex Klystrons (Type V-260, Type V-270, Type V-280, and Type V-290) have been added to the company's line. Available in quantity production, these tubes are designed especially for radar

applications. Features include very low microphonics, extreme ruggedness against mechanical shock and vibration, and frequency stability regardless of ambient pressure changes.

Type V-260, a rugged local oscillator for mobile radar, is non-microphonic, with its shaft tuner, free from chatter and backlash, well adapted to motor tuned systems. Type V-280, especially suitable for radar, beacon, or low-power transmitter operation, has a lock-nut tuner that holds the tube on frequency under shocks of several hundred G's.

Type V-270 and Type V-290 are electrically identical to the other tubes, but have silicone-rubber-potted base and reflector connections. Varian Associates, Dept. ED, 990 Varian St., San Carlos, Calif.

CIRCLE ED-32 ON READER-SERVICE CARD FOR MORE INFORMATION

## Intervalometers

With Intervals of 1/8sec to 10min



A variety of remotely controlled Intervalometers is available with time spans over the range from 1/8sec to 10min, with increments ranging from 1/8sec in lower time ranges, to 15sec intervals for upper ranges.

A constant speed motor, rotary switch, and electrically operated clutch are used as a timing source. The motor input power requirements are 28v d-c, 60cy or 400cy, and 115v a-c.

The model illustrated is a dual unit, combining a 1/2sec to 20sec and a 15sec to 600sec intervalometer. Impulses are produced at any interval from 1/2sec to 600sec in 1/2sec intervals. PSC Applied Research Ltd., Dept. ED, 1450 O'Connor Drive, Toronto 13, Canada.

CIRCLE ED-33 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • March 1953

# CBS-HYTRON TRANSISTORS

## CBS-HYTRON PT-2A



ACTUAL SIZE



## CBS-HYTRON PT-2S

Moisture-resistant

Plug-in or solder-in

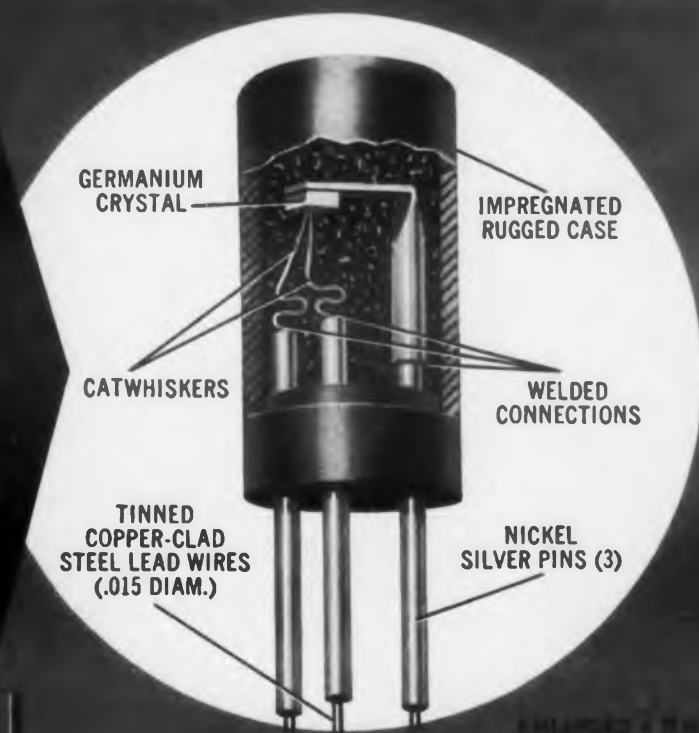
Sturdy triangular basing

Polarized base connections

Auto-electronically formed

Thoroughly stabilized

Operate up to 55° C



## AND YOU CAN BUY THEM NOW!

Already a major producer of germanium diodes, CBS-Hytron now offers you prompt delivery of transistors: Point-contact CBS-Hytron PT-2A (for amplifying) and PT-2S (for switching). Both have stable characteristics and are guaranteed moisture-resistant. Note flexible leads welded to base pins. You may solder flexible leads into circuit. Or snip them to use stiff base pins in CBS-Hytron type T-2 socket.

Triangular arrangement of base pins is stronger . . . avoids bent pins. Easy-to-remember basing layout simulates basing symbol (see diagram). Polarization makes socket connections foolproof. You are assured of uniformly optimum characteristics by electronic control of pulse forming. Thorough aging achieves maximum stability. You may operate these transistors up to 55°C. And you can order both CBS-Hytron PT-2A and PT-2S for immediate delivery.

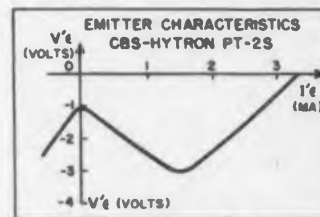
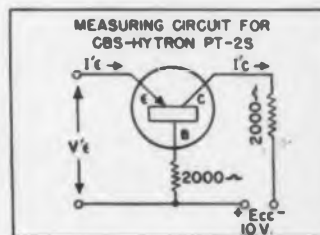
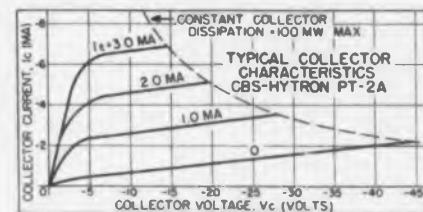
### MECHANICAL FEATURES

1. Single-ended construction gives maximum mechanical stability.
2. Rugged triangular basing design resists shock and vibration.
3. Dual-purpose connections permit use of flexible leads or stiff plug-in base pins.
4. Direct soldering of germanium wafer to base support guarantees positive contact, avoids flaking.
5. Glass-filled plastic case and high-temperature impregnating wax assure moisture-resistant, trouble-free operation.

### BASING AND SOCKET



Note similarity of pin layout to that of transistor symbol. CBS-Hytron type T-2 transistor socket features groove to guide pins into socket. Also anti-burn-out design to insure that base connection of transistor will always be made first.



# CBS



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HYTRON RADIO AND ELECTRONICS CO.

A Division of Columbia Broadcasting System, Inc.  
Main Office: Danvers, Massachusetts

WRITE FOR DATA. Complete free data on CBS-Hytron PT-2A and PT-2S . . . and the T-2 socket . . . are yours for the asking.

RECEIVING . . . TRANSMITTING . . . SPECIAL-PURPOSE AND TV PICTURE TUBES • GERMANIUM DIODES AND TRANSISTORS

CIRCLE ED-34 ON READER-SERVICE CARD FOR MORE INFORMATION

## clinch type ELASTIC STOP nuts



for attachment to thin section  
metal components



- Permanently installed by simple clinching or swaging.
- Self-locking and vibration-proof—because all ESNA Clinch Nuts have the famous red elastic locking collar.
- Permit precise screw adjustments: prevent loosening of component parts.

- WRITE for design information on Clinch Nuts and other special and standard ESNA fasteners. Address Dept. N35-357.



### ELASTIC STOP NUT CORPORATION OF AMERICA

2330 Vauxhall Road, Union, N. J.

DESIGN HEADQUARTERS FOR SELF-LOCKING FASTENERS  
CIRCLE ED-35 ON READER-SERVICE CARD FOR MORE INFORMATION

## CANNON PLUGS

for  
hermetic  
sealing



**SUB-MINIATURE U Series** plugs for miniature switches, relays, transformers, amplifiers and other sealed components have steel shells and Silcan insulation, cable relief and moisture resistant sleeve. Bayonet-lock coupling method. Rated 1700 v. D.C.; 5 a.—Have 3, 6, and 12 contacts—one plug style and two receptacles. Refer to U-2 Bulletin.

**GS TYPES** (Top, right) and **RKH Types** (Bottom, right) have fused vitreous insulation providing a true hermetic seal for relays, position indicators, etc. Cadmium finish steel and bleached Iridite shells with



Dural coupling nut. Resist thermal shock—300°F. to 600°F.; pressures 200 to 900 psi—specials to 7500 psi. See GS-3 section in AN-8 Bulletin and KH-1 section in K Bulletin.

## CANNON ELECTRIC

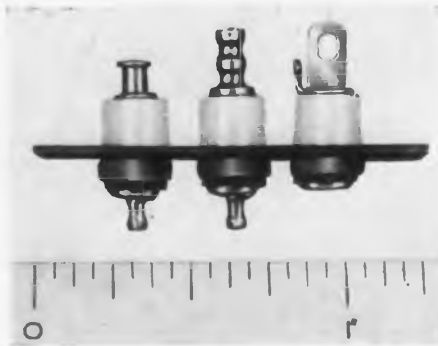
Since 1915  
Factories in LOS ANGELES, TORONTO, NEW HAVEN  
Representatives in principal cities. Address inquiries to Cannon Electric Co.,  
Dept. C143, Los Angeles 31, California.

CIRCLE ED-36 ON READER-SERVICE CARD FOR MORE INFORMATION

## New Products...

### Hermetic Terminals

Operate at 500v



The Series No. 199 Miniature Hermetic Terminals, constructed from "Teflon" and silicone rubber, have been designed for improved performance and simplified construction. The new design

avoids the need of expensive secondary operations, such as specially extruded holes for mounting. Minimum center distance is 15/64", and ample wiring space is still provided.

Designed for operation at a conservative rating of 500v, with a test voltage of 1500v rms, the unit has a current rating of 8amp. For oil-filled units, the inner insulator is of neoprene instead of silicone. These units have passed cycling tests under MIL-T-27 specifications. Assembly is accomplished by clinching in a press or by a drive fit of the electrode with a press. The hermetic seal is completed by soldering at the time leads are attached.

The units are available in three electrode styles: the hollow electrode with eyelet for minimum internal clearance, solid electrode with single turret, and solid electrode with double turret. Lundey Associates, Dept. ED, 694 Main St., Waltham 54, Mass.

CIRCLE ED-37 ON READER-SERVICE CARD FOR MORE INFORMATION

### Low Frequency Time Calibrator Has 1.5v Pulse Amplitude



The Type 190 Low-Frequency Time Calibrator is a synchronous-motor driven device furnishing pulses at intervals of 0.01sec, 0.1sec, or 1sec. It has been designed for use with oscilloscopes

and various types of recording equipment in electronic, electrical, and mechanical investigations.

The unit provides a pulse amplitude of 1.5v and measures 5-1/4" x 3-1/4" x 3". Owen Labs., Dept. ED, 412 Woodward Blvd., Pasadena 10, Calif.

CIRCLE ED-38 ON READER-SERVICE CARD FOR MORE INFORMATION

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CIRCLE ED-39 ON READER-SERVICE CARD FOR MORE INFORMATION

## UHF and MICROWAVE ENGINEERS

This rapidly growing organization in South Central Wisconsin, which is approximately 100 miles from Chicago, Ill., has several openings for Junior and Senior Engineers in the UHF and Microwave Field.

### UNUSUAL SALARY OPPORTUNITIES

exist under ideal working conditions in large well equipped laboratories. Personnel benefits such as sickness, accident and life insurance in addition to a very liberal pension system are offered.

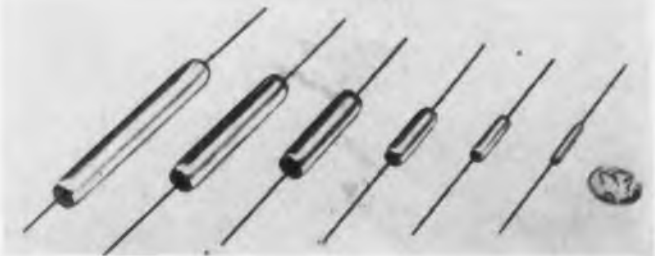
For more information concerning the positions that are open, we invite you to write to

**Personnel Director, Dept. A.  
GIBBS MANUFACTURING  
& RESEARCH CORP.  
Janesville, Wisconsin**

CIRCLE ED-40 ON READER-SERVICE CARD FOR MORE INFORMATION

## Tantalum Capacitors

Have Long Shelf Life



The Type TAN Tantalum Electrolytic Capacitor is a compact, rugged unit with no corrosive electrolyte. Compared to aluminum foil electrolytic capacitors, this capacitor has a lower leakage current (in microamperes) making for a longer operating life. Further characteristics include a very long shelf life, a lower power factor at room temperature, and a good power factor at temperatures as low as 55°C.

The unit will operate at +85° and exhibits a very low leakage current at this temperature.

The capacitor is available in a variety of capacity and voltage ratings. Both polarized and non-polarized types are made with voltage ratings up to 150v. Cornell-Dubilier Electric Corp., Industrial Div., Dept. ED, South Plainfield, N. J.

CIRCLE ED-41 ON READER-SERVICE CARD FOR MORE INFORMATION

## Miniature Slide Switch

Rated 0.5amp at 125v



This miniature dpdt Slide Switch rated 0.5amp at 125v combines improved snap action with small size for application in radios, TV receivers, instruments, and similar electronic equipment.

Measuring 1-3/8" long x 17/32" wide x 11/32" deep, this switch is considerably smaller than the company's previous types. Though dpdt switching action is provided, the unit is manufactured with the same mounting centers as that employed in conventional spdt switches.

Separate indenting for each pole assures positive, smooth snap action, and a fiber-surface laminated bakelite base greatly reduces arcing and increases the safety factor. Specially prepared switches also are available where high leakage resistance between contacts and case is required. Stackpole Carbon Co., Dept. ED, St. Marys, Pa.

CIRCLE ED-42 ON READER-SERVICE CARD FOR MORE INFORMATION

# REDUCE SET-BUILDING COSTS..



"BUILT-IN EYELETS SPEED PRODUCTION... SAVE DOLLARS!"

"ANOTHER IMPROVED PART BY SYLVANIA"

## with this New Sylvania Integral Eyelet Socket

You'll speed up radio and television set assembly and pare down costs with this new Sylvania socket!

The eyelets are formed into the saddle and *actually function as rivets*. Just 2 simple operations and these sockets are firmly secured to the chassis. You save rivet costs, save time, and get a sturdy, durable, top-quality job.

### Made with 3 types of bases

These new Sylvania sockets are now available with 7-pin, octal, or 9-pin bases. Insulators are either general-purpose or low-loss phenolic.

For prices and full information about this latest Sylvania quality part, write today to: Sylvania Electric Products Inc., Dept. 3A-4003, 1740 Broadway, New York 19, N. Y.

# SYLVANIA



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CIRCLE ED-43 ON READER-SERVICE CARD FOR MORE INFORMATION

**Jennings**  
RADIO  
ANALOG ELECTRONIC COMPONENTS

## VACUUM CAPACITORS

now available in such varieties of types, sizes, and electrical characteristics that you can design your next circuit around these units with ease. Our development laboratory is available to design and produce units for specialized application.

Voltage: Up to 65 KV  
Current: Up to 400 AMP  
Capacitance: Up to 2,500 MMFD  
Rate of change: Up to 100:1

SEE US AT THE MARCH 1 R. E. ELECTRONICS SHOW, BOOTH 4-211  
JENNINGS RADIO MANUFACTURING CO. - 970 McLAUGHLIN AVE.  
P. O. BOX 1278 - SAN JOSE 8, CALIFORNIA

CIRCLE ED-44 ON READER-SERVICE CARD FOR MORE INFORMATION

## SPLIT-SECOND ELECTRONIC TIMING

with no-filament tube!

Split seconds the EASY way — use a CK Electronic Timer

### Easy Starting . . .

No warm-up, through use of cold-cathode tube. Immediate re-cycling possible. Momentary contact operation if desired.

### Easy Setting . . .

Short intervals can be spread over the entire dial. Standard ranges: 1.5, 3, 6, and 12 seconds.

### Easy on space . . .

Only 3 7/8" wide by 3" deep by 4 7/8" high.

### Easy on cost . . .

\$29.00, or \$32.00 with momentary-contact feature.

— For full details, write, wire, or phone —

Farmer

ELECTRIC COMPANY

WABAN, MASSACHUSETTS

CIRCLE ED-45 ON READER-SERVICE CARD FOR MORE INFORMATION

## New Products . . .

### Germanium Diodes

With High Forward Conductance



A point-contact Germanium Diode, which combines both high back resistance and high forward conductance, has been added to the company's line. While the back characteristics of the new units correspond to those of existing types, the forward currents have been radically increased in the new units. Types 1N116, 1N117, and 1N118 are designed for use where moderately high back resistance is required at a medium voltage and high forward conductance.

Features include protection against humidity by the use of glass-to-metal seals, resistance to heat by avoiding all materials that soften below 300°C, and a sub-miniature size. Hughes Aircraft Co., Dept. ED, Florence Ave. & Teale St., Culver City, Calif.

CIRCLE ED-46 ON READER-SERVICE CARD FOR MORE INFORMATION

### Miniature Blowers

For Cooling Electronic Equipment



A series of Miniature Blowers, designed primarily for cooling industrial and airborne electronic equipment, is now available in 4 sizes: No. 1-1/2, No. 2, No. 2-1/2, and No. 3 (the numbers indicate the diameter of the blower

wheel). The units have a scroll which directs the flow of air, and a suitable back plate.

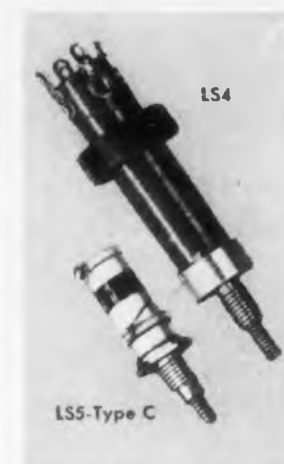
Other features include a low water absorption rate and good electrical properties. The scrolls withstand instant temperature changes from -55°C to +125°C without crazing or being damaged in any way. The blower wheels are available in aluminum or cadmium plated. Wheel hubs are furnished in any standard bore, and the blowers are driven by miniature 400cy or variable frequency electric motors. Electroflow Pumps Inc., Dept. ED, 4811 Anaheim-Telegraph Rd., Los Angeles 22, Calif.

CIRCLE ED-47 ON READER-SERVICE CARD FOR MORE INFORMATION

(Advertisement)

## COILS TO SPECIFICATION

When C.T.C. winds your slug tuned coils, you can be sure your requirements will be faithfully and expertly met in every detail. Single layer or pie type windings. All materials, methods and processes meet applicable government specifications.



### COIL FORM SPECIFICATIONS

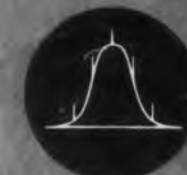
Coil Form	Material	Mounting Stud Thread Size	Form O.D.	Mounted O.A. Height
LST	L-5 Ceramic	8-32	3/16"	1 1/2"
LS6	L-5 Ceramic	10-32	1/4"	2 1/2"
LS5	L-5 Ceramic	1/4-28	3/8"	1 1/8"
LS8	L-5 Ceramic	1/4-28	2 3/4"	2 1/2"
LS7	L-5 Ceramic	1/4-28	1/2"	1 1/8"
LSM	Paper Phenolic	8-32	1/4"	2 1/2"
LS3	Paper Phenolic	1/4-28	3/8"	1 1/8"
LS4	Paper Phenolic	1/4-28	1/2"	2"

Note: Types LS5, LS6, LS7, LS8 have slug locking springs. Type LST available with slug locking spring as type LSTL. Type LS4 has fixed lugs — all others have adjustable ring terminals.

Coil forms made of quality paper base phenolic or grade L-5 silicone impregnated ceramic. Slugs and mounting hardware furnished. Mounting bushings are cadmium plated brass; terminal rings of silver plated brass protected by water dip lacquer. Silicone fibreglas collars which permit 2 to 4 terminals per coil form, are available for LST, LS5, LS6 and LS7 — specify type C. A table of frequencies and permeabilities for slugs used in above coil forms is in Catalog 400. Send for your copy.

CAMBRIDGE THERMIONIC CORPORATION  
457 Concord Ave., Cambridge 38, Mass.  
CIRCLE ED-48 ON READER-SERVICE CARD FOR MORE INFORMATION

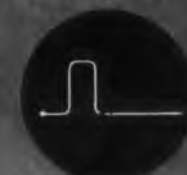
## NEED INSTRUMENTS TO SOLVE ELECTRONIC PROBLEMS?...



RADA-SWEEP  
Radar IF Amplifier Alignment



MEGA-MATCH  
Measurement of Reflection Coefficient



MEGA-PULSER  
Transient Testing Video Amplifiers



MARKA-SWEEP RF-P  
TV Tuner Alignment



RADA-PULSER  
Radar IF Transient Testing



CALIBRATED MEGA-SWEEP  
Wide Range Sweeping Oscillator Single Band Tuning

CONSULT THIS LATEST 64-PAGE CATALOG

Write

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KAY ELECTRIC CO.

14 MAPLE ST.

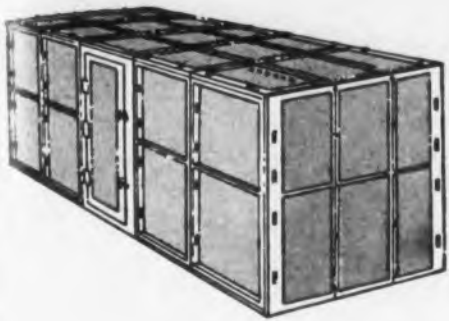
PINE BROOK, N. J.

CIRCLE ED-49 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • March 1953

## Double-Shield Screen Room

Minimizes Electronic Interference



This Double Shielded Screen Room uses a double screen design in which the outer and inner screens are physically and electrically insulated from each other

to assure minimum interference for testing and evaluating many types of electronic equipment.

The lightweight pre-fabricated panels (31" x 91"), are easily assembled to various dimensions, and the screening is of heavy copper, securely attached to the panel frames. Of portable construction, the unit can be dismantled easily and moved to any desired location. Six power line entrances are provided, as well as a special copper-covered power line filter section on which entrance filters are mounted. Erik A. Lindgren & Associates, Dept. ED, 4515 No. Ravenswood Ave., Chicago 40, Ill.

CIRCLE ED-50 ON READER-SERVICE CARD FOR MORE INFORMATION

## Square Wave Generator

1000cy or 400cy Output



Designed for use as a modulator for r-f measurements, the compact Square Wave Generator also is useful for general laboratory work wherever a 1000cy or 400cy square wave is required. The instrument produces a square wave at either 400cy or

1000cy over a range of  $\pm 10\%$  by means of a front panel control. The output is adjustable from 0v to 50v peak-to-peak at no load, or to 12v peak-to-peak into a 600 ohm load. American Electronic Labs., Inc., Dept. ED, 641 Arch St., Philadelphia, Pa.

CIRCLE ED-51 ON READER-SERVICE CARD FOR MORE INFORMATION

## Correction

The description of the "Precision Potentiometer" (manufactured by G. M. Giannini & Co., Inc., of Pasadena, Calif.), on page 20 in the February, 1953 issue, carried an incorrect standard linearity tolerance rating of  $\pm 3\%$ . The correct value is  $\pm 0.3\%$ .

ELECTRONIC DESIGN • March 1953

IBM  
TRADE MARK

Announces

# A Great New Engineering Research Laboratory



Model of new IBM Research Laboratory now under construction at Poughkeepsie, N. Y.

In this building, ideas will be born, developed, and become part of America's future. Here, engineers and scientists will have facilities for creative work such as were undreamed of yesterday.

In IBM's other fine engineering laboratories in Poughkeepsie and Endicott, N. Y., and San Jose, Cal., engineers and scientists are working on exciting projects for the future. These include electronic digital computers, electronic and electric business machines and time systems, and electric typewriters.

IBM's continuous program of research, development, and manufacture has created a constant flow of new services for business, industry, science, and the nation.

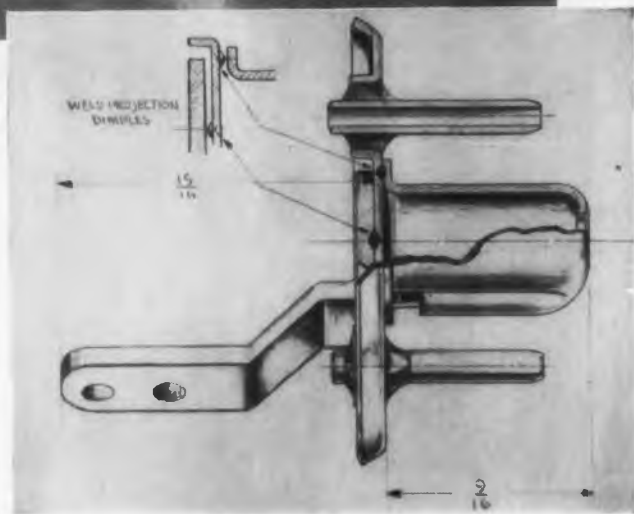
Today there are opportunities in IBM for development engineers, physicists, and design engineers. You are cordially invited to investigate these opportunities. Inquiries should be directed to Mr. W. W. McDowell, Director of Engineering, International Business Machines, Room 167, 590 Madison Avenue, New York 22, N. Y.

CIRCLE ED-52 ON READER-SERVICE CARD FOR MORE INFORMATION

**Problem:** The Advance Electric and Relay Co. of Burbank, California was called upon by the military to produce a hermetically sealed relay to very tight size and weight specifications. This called for eliminating traditional internal bracing.

**Solution:** A Fusite glass-to-steel plug-in type hermetic terminal played a large part in the design of the Advance "Tiny Mite" Relay. Working in close cooperation, Fusite adapted its standard octal plug-in terminal to a projection welded bracket on which the entire relay mechanism was hung. Thus the terminal became a structural part as well as a seal.

Because of their extreme rugged construction, Fusite terminals are often being called on to do more than conduct electricity in and out of sealed units.



**Moral:** When you have a problem in hermetic sealing, let the Fusite engineers in on it early in the game. Chances are we can save you time and money in the design of your electrical product.

WRITE for catalog or tell us your needs for actual samples Dept. L-1.



Visit the Fusite Display at Radio Engineering Show N. Y. C. March 23-26. Booth 3-109.

**THE FUSITE CORPORATION**  
6000 FERNVIEW AVENUE  
CINCINNATI 13, OHIO

CIRCLE ED-56 ON READER-SERVICE CARD FOR MORE INFORMATION

## New Literature . . .

### Thermistors 57

A 36-page data book presents detailed information on the company's line of thermistors, which are used in wire communications, radio, radar, TV, etc. Various types are illustrated by photographs and circuit diagrams, and descriptions provide such information as types of construction; thermal, electrical, and physical characteristics; and temperature-resistance, voltage-current, and current-time characteristics. Typical uses are described, and a section of the booklet provides technical data on the units. Victory Engineering Corp., Springfield Rd., Union, N. J.

### Miniature Choppers 58

This 4-page, 2-color brochure describes and illustrates the company's miniature choppers. Specifications are included, along with information on their general performance. Data sheets, providing information on other choppers, also are available. The description on these sheets includes application, construction, dimensions, weight, rating, contact capability, ambient temperature, humidity, altitude, etc. Oak Mfg. Co., 1260 Clybourn Ave., Chicago 10, Ill.

### Cans and Covers 59

A 12-page, 2-color catalog provides technical descriptions and dimensional drawings of the company's complete line of MIL-T-27 and standard cans and covers. In addition to the information on cans and covers, there are data on the company's hermetic seal bushing assemblies. A special section also describes brackets, channels, and end bells. Helder Mfg. Corp., 225 Belleville Ave., Bloomfield, N. J.

### Capacitors 60

A 16-page capacitor catalog (No. C-10) lists a wide variety of capacitors, including transmitting and receiving mica, molded paper, wax tubulars, bathtub styles electrolytics, oil filled transmitting, ceramics, as well as trimmers, padders, and other variable type capacitors. Dimensions, prices, and other information are provided. Wells Sales, Inc., 833 West Chicago Ave., Chicago 22, Ill.

### Insulated Wire and Cable 61

Vol. No. 353 is a 42-page, 2-color catalog describing all the company's products, which are designed for use in communications, radio, aircraft, sound reproduction, etc. A listing is included of the company's types of wires and cables, along with a description and general specifications. Cord, cord sets, and power supply cords are similarly described and illustrated. Photographs and circuit diagrams provide illustration of the various tubings available. An appendix includes a section on definitions, and a series of tables on temperature conversion, size comparison of wire gages, decimal equivalents, etc. Phalo Plastics Corp., 25 Foster St., Worcester, Mass.

### Precision Test Equipment 62

This bulletin provides information on such precision test equipment as attenuators, transmission line components, frequency measuring devices, signal sources and receivers, and v-h-f and u-h-f test equipment. Applications for these instruments include power and attenuation measurement, terminal loads in impedance measurements, and reduction of power level of available signal sources. Each device is described and illustrated, and specifications also are included. Polytechnic Research and Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.

### Stabilized Crystals 63

"Crystals for the Critical" is an 8-page, 2-color catalog listing the company's types of stabilized crystals. Each model is described and illustrated by a circuit diagram. Also included in the catalog is a description of the Type FD-12 frequency and modulation monitor and the Type FS-344 frequency standard. The James Knights Co., Sandwich, Ill.

### Contract Production Facilities 64

An 8-page, 2-color brochure, entitled "Contract Production", outlines the company's facilities for design, development, and manufacture of a wide range of industrial products, many of which fall within the electronic field, such as sliding contacts, r-f circuits, electro-mechanical devices, etc. Included are illustrations of the various types of products. P M Industries, Inc., Stamford, Conn.

## COMPUTERS

**P 2: COMPUTERS AND AUTOMATION** (formerly THE COMPUTING MACHINERY FIELD). Monthly (except June, Aug.). Contains articles on computing machinery, automatic control, cybernetics, robots, etc., and reference information, including up-to-date roster of over 150 organizations making or developing computing machinery, Who's Who, etc. Annual subscription. \$4.50

**P 6: CONSTRUCTING ELECTRIC BRAINS.** Reprint of the series of thirteen articles by E. C. Berkeley and Robert A. Jensen published in "Radio Electronics", Oct. 1950 to Oct. 1951. Explains simply how an automatic computer is constructed; how to make it add, subtract, multiply, divide, and solve problems automatically, using relays or electronic tubes or other devices. Contains many examples of circuits. \$2.20

## ROBOTS

**P 1: CONSTRUCTION PLANS FOR SIMON,** the Smallest Mechanical Brain. Complete plans, circuits, essential wiring diagrams, parts list, etc. Also recent changes, enabling Simon to handle numbers up to 255, and to perform nine mathematical and logical operations. Simon has been described in "Scientific American", Nov. 1950, and in "Radio Electronics", Oct. 1950, March and April, 1951. \$5.50

**P 3: CONSTRUCTION PLANS FOR SQUEE,** the Robot Squirrel. Complete plans, circuits, wiring diagrams, parts list, etc., for constructing Squee, the Robot Squirrel, described in "Newsweek", August 27, 1951, and in "Radio Electronics", Dec. 1951 and Feb. 1952. Squee rolls over the floor, picks up "nuts" in his "hands", takes them to his "nest", there leaves them, and then goes hunting for more nuts. \$4.00

**P 10: THE CONSTRUCTION OF LIVING ROBOTS.** Pamphlet. Discusses the properties of robots and of living beings. Outlines how to construct robots made out of hardware which will have the essential properties of living beings. Gives circuit diagrams. \$1.00

## SYMBOLIC LOGIC

**P 5: BOOLEAN ALGEBRA (THE TECHNIQUE FOR MANIPULATING 'AND', 'OR', 'NOT', AND CONDITIONS) AND APPLICATIONS TO INSURANCE; also DISCUSSION.** Reprint of the 1937 paper by E. C. Berkeley, and discussion (1938) by T. N. E. Greville, H. M. Sarason, and E. C. Berkeley. Explains in simple language: what Boolean algebra is; how to recognize the relations of Boolean algebra when expressed in ordinary words; and how to calculate with it. Contains problems, solutions, comments, discussions. \$1.20

**P 4: A SUMMARY OF SYMBOLIC LOGIC AND ITS PRACTICAL APPLICATIONS.** Pamphlet. Rules for calculating with Boolean algebra. Other parts of symbolic logic. Applications of Boolean algebra to computing machinery, circuits, and contracts. Many complete problems and solutions. \$2.50

**P 14: CIRCUIT ALGEBRA—INTRODUCTION.** Pamphlet. Explains simply a new algebra (Boolean algebra modified to include time) that applies to on-off circuits, using relays, electronic tubes, rectifiers, gates, flip-flops, delay lines, etc. Covers both static and sequential circuits. Applications to control, programming, and computing. Problems and solutions involving circuits. \$1.80

**P 16: SYMBOLIC LOGIC—TWENTY PROBLEMS AND SOLUTIONS.** Report. Contains twenty complete problems and solutions in Boolean algebra and other parts of symbolic logic, some by Lewis Carroll and John Venn (out of print), and others new. Guide to using symbolic logic in actual situations. \$1.80

Your money is returned at once if you are not satisfied. You can see these for almost nothing—why not take a look at them? Send request direct—not through a dealer. (P.S. We also offer 9 more publications, and 26 courses by mail. We have students in 39 states, 10 countries. Ask us for information.)

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Name and Address.....

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ELECTRONIC DESIGN • March 1953

## Scientific Photography

66

"Photography for Science and Industry" is the title of a 26-page, 3-color brochure that illustrates many industrial and scientific applications for the company's line of cameras. The "Praktiflex FX" is illustrated and described, along with photographs of the many applications it has had in industry and in laboratories. Accessories for this camera are also described and illustrated. A separate price list of the equipment for "Praktiflex FX" is included. The Praktica Co., Inc., 48 W. 29th St., New York 1, N. Y.

## Precision Resistance Instruments

67

This 36-page folder lists the company's electronic devices and electrical resistance instruments. The instruments described include various types of attenuators, potentiometers, faders, impedance matching networks, meter multipliers, gain sets, decade resistance boxes, etc. Specifications for each item are provided, along with illustrations and circuit diagrams. The material is contained in a soft cover loose leaf binder for convenient filing. Tech Labs., Inc., Bergen & Edsall Blvds., Palisades Park, N. J.

## Terminal Boards

68

"Ceramic-Insulated Terminal Boards" is the title of a 4-page, 2-color brochure describing terminal boards designed for use in airborne receivers and transmitters, in signal generators, and in other industrial electronics equipment where reliable, long operation under extremes in temperature and moisture is important. The terminal boards are made of a special ceramic material in the steatite class with a silicone coating which gives sustained resistance to heat and moisture. Diagrams and photographs of the boards are featured, as well as illustrations of typical applications. Aircraft Radio Corp., Boonton, N. J.

## Printed Circuits

69

Printed Circuits, their function, fabrication, and application, are outlined and described in an 8-page brochure. These circuits are useful in micro-wave plumbing, radio and TV chassis, i-f strips, antenna filters, terminal boards, wiping switches, flush commutators, etc. Included in the brochure is information on methods of application, materials, electrical characteristics (with tables of values), and assembly methods. Components, such as capacitors, resistors, tube sockets, switches, etc., are described. The possibilities of profitable redesign of equipment also are discussed. Photocircuits Corp., Glen Cove, N. Y.

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**TOROIDAL COMPONENTS...**

Think of  
**COMMUNICATION  
ACCESSORIES CO.**



## UNCASED COILS ADJUSTED TO YOUR SPECIFICATIONS

A wide variety in physical size, power capacity and frequency range is offered. Coils are wound to comply with customers' requirements and specifications. Engineering assistance and suggestions are offered without charge.

Coils may be supplied to a tolerance of plus or minus one percent, or matched to a standard inductor to a tolerance of one-tenth percent, or one turn.

Coils may be supplied with temperature coefficient of 180 parts per million per degree Centigrade, or may be supplied with 0° C. coefficient through a limited temperature range.

## MOISTURE PROOF PLASTIC COATED TOROIDS

To eliminate the possibility of damage to the exposed winding during assembly, we offer toroids coated with tough thermal setting plastic coating. These coated toroids are recommended where coils are subject to high humidity and where coils must be mechanically mounted. Plastic coating is available in all types of toroidal coils.

## STEEL CASED TOROIDS AND FILTERS

C.A.C. engineers, with years of experience in the design of filter networks are at your service to design or help you design the proper networks for your requirements. Where space requirements are severe, filters may be miniaturized by the use of wedding ring toroids and special capacitors. Typical filter cases are shown. However, cases may be fabricated to your specifications.

Write for our  
latest catalog

**COMMUNICATION ACCESSORIES**  
Company

HICKMAN MILLS, MISSOURI

CIRCLE ED-70 ON READER-SERVICE CARD FOR MORE INFORMATION





## NEW! – JOHANSON Concentric High Ratio Air Capacitor

Capacity Ratio: 1 mmfd-35 mmfd

*Gives you these advantages:*

- Low minimum capacity of 1 mmf for use where minimum capacity must be held down.
- Capacity ratio of 1 mmfd to 35 mmfd allows wide range of adjustments to be made accurately.
- High Q makes it efficient at higher frequencies.
- Linear capacity characteristic makes it possible to predict adjustment required for a given capacity.
- Constructed of brass and Pyrex glass for mechanical stability.

*Specifications*

Low minimum capacity, 1 mmf.  
High Q—better than 10,000 at 15 mc.  
Vernier action—better than 8 turns to accomplish the capacity change.  
High maximum capacity, 35 mmf.  
Voltage breakdown over 500V DC.  
High ratio—capacity at maximum is 35 times its minimum capacity.

*Write for further information*

*Johanson*

**MANUFACTURING CORPORATION**  
16 Rockaway Valley Rd., Boonton, N.J.

CIRCLE ED-71 ON READER-SERVICE CARD FOR MORE INFORMATION

### END CAPS FOR CONDENSERS . . . HERMASEAL OFFERS THREE SIZES TO FIT MOST NEEDS



When you need End Caps for Condensers that must meet *high quality* standards . . . yet cost is a factor . . . and, you need them in a *hurry* . . . call on Hermaseal!

**HERMASEAL** — is a top specialist in Hermetically Sealed Terminals, Sealed Headers, and allied parts for the radio-electronics industry.

**COMPLETE CATALOG** — Just off the press, a new catalog with descriptions and specifications for most of Hermaseal's stock Terminals and Headers. Write for your copy today! And let us quote you on your End Cap requirements. No obligation, of course.

*Hermaseal*

**THE HERMASEAL CO, Inc. Elkhart 45, Indiana**

# New Literature . . .

## Electronic Buying Guide

73

This cross-indexed, illustrated electronic buying guide and reference book known as "Radio's Master", contains descriptions of 80,000 electronic products. It is a hard cover, permanent edition containing 1220 pages which provides accurate, authentic descriptions of all items as approved by each manufacturer. The catalog is available through local electronic parts distributors, or from United Catalog Publishers, Inc., 110 Lafayette St., New York 13, N. Y.

## Precision Bearings

74

A portfolio includes a number of engineering sheets describing the company's miniature precision ball bearings, for use in small precision mechanisms. The engineering sheets provide graphic specification information, bearing installation information, and information on clearances, tolerances, etc. Numerous charts provide further specification data. Miniature Precision Bearings, Inc., Keene, N. H.

## Video Generator

75

The Model 650 video generator is described and illustrated in a 4-page, 2-color brochure. This unit provides an electronically accurate bar or dot pattern on the screen of any TV receiver, independent of station operation, and an r-f output directly calibrated in microvolts for sensitivity measurements. Various bar or dot patterns for localizing TV receiver troubles are illustrated. Technical characteristics, including r-f output, video output, sawtooth output, video amplifier, modulation, basic meter movements, meter ranges, attenuator circuits, and specifications, are included. Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 5, Ohio.

## Germanium Diodes

76

Outstanding features of the company's germanium diodes are discussed in an 8-page, 2-color brochure. Several types are described, and the information provided includes mechanical and physical specifications, maximum ratings, electrical characteristics, and typical applications. Also described are welded germanium quads (combinations of four specially selected germanium diodes with matched characteristics), for bridge and ring modulators and for bridge rectifiers. Photographs, illustrations, and charts provide further information on each of the products listed. General Electric Co., Electronics Div., Electronics Park, Syracuse, N. Y.

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**CONTINENTAL**

**MINIATURE**  
*Power*  
**CONNECTORS**

**SERIES 16**

**RACK TO PANEL TYPE**

7-10-15-18 CONTACTS



**LIGHTWEIGHT FOR AIRCRAFT & PORTABLE EQUIPMENT USE • POSITIVE POLARIZATION • PRECISION MACHINED NON-ROTATING CONTACTS • MINERAL FILLED MELAMINE BODY • HIGH DIELECTRIC AND MECHANICAL STRENGTH • TELESCOPING BARRIERS FOR UNUSUALLY LONG CREEPAGE PATH**

**CABLE TO PANEL TYPE**

7-10-15-18 CONTACTS



**SPECIFICATIONS**

MAXIMUM WIRE SIZE . . . . . #16 AWG  
Creepage between contacts . . . 7/32" MIN.  
Air Space between contacts . . . 3/32" MIN.  
Breakdown voltage between contacts with connector engaged at sea level, normal conditions . . . . . 5500 V.R.M.S.

**CABLE TO PANEL TYPE**

7-10-15-18 CONTACTS



**ALUMINUM HOOD AND CABLE CLAMP IS AVAILABLE FOR ALL TYPES, DESIGNATED BY ADDING "H" TO TYPE DESIRED, i.e.: 7-16 PH, Plug with Hood, 7-16 SH, Receptacle with Hood, 7-16 H, Hood only.**

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45-01 NORTHERN BOULEVARD, L. I. C. I., N. Y.



LITTELFUSE MINIATURE FUSE EXTRACTOR POST FOR 3AG FUSES LITTELFUSE, INC., 1865 MINER STREET, DES PLAINES, ILLINOIS BURTON BROWNE ADVERTISING

## Capacitors and Filters 79

Fixed paper capacitors and radio noise filters are described and illustrated in a 22-page, 2-color brochure. The types of capacitors included are the bathtub style, transmitting style, tubular, special types, and radio noise filters. Photographs and tables illustrate the construction and operating characteristics of each type, and specifications for each are included. The radio noise filters range in ratings from less than 1amp to 200amp. The Potter Co., 1950 Sheridan Rd., North Chicago, Ill.

## Power Generating Systems 80

The company's continuous power generating systems are described in a 4-page, 2-color brochure. Designed for use in communications, signaling, telemetering, and other electronic applications, these systems are illustrated by photograph and circuit diagrams. A data sheet included presents specific operating data. The various systems presented include magnetic-amplifier controlled power, motor generator set, automatic control unit, engine driven generator types, as well as accessories. Bogue Electric Mfg. Co., 52 Iowa Ave., Paterson 3, N. J.

## Thread Inserts 81

Suggested ways to improve products and reduce production cost by using stainless steel wire thread inserts in tapped holes are contained in an 8-page foldover booklet, Bulletin 660. The text discusses design, production, marketing, and maintenance advantages. Photographs show a variety of products protected by these inserts in various fields. Heli-Coil Corp., 1303 Shelter Rock Lane, Danbury, Conn.

## Electronic Components 82

The 1953 Catalog contains a listing of electronic components and equipment, as well as a product index and manufacturers index for convenient reference. Included in the listing are tubes, relays, powerstats, transformers, connectors, resistors, switches, panel meters, test equipment, etc. There is also a section on audio and sound equipment. Melvin Electronics Inc., 238 Chicago Ave., Oak Park, Ill.

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◀ CIRCLE ED-78 ON READER-SERVICE CARD

to the

**ELECTRICAL  
ENGINEER**

or

**PHYSICIST**

with experience in

**RADAR**

or

**ELECTRONICS**

*Hughes Research and Development Laboratories, one of the nation's leading electronics organizations, are now creating a number of new openings in an important phase of their operations.*

*Here is what one of these positions offers you:*

**THE COMPANY**

Hughes Research and Development Laboratories, located in Southern California, are presently engaged in the development and production of advanced radar systems, electronic computers and guided missiles.

**THE NEW OPENINGS**

The positions are for men who will serve as technical advisors to government agencies and companies purchasing Hughes equipment—also as technical consultants with engineers of other companies working on associated equipment. Your specific job would be essentially to help insure successful operation of Hughes equipment in the field.

**THE TRAINING**

On joining our organization, you will work in the Laboratories for several months to become thoroughly familiar with the equipment which you will later help users to understand and properly employ. If you have already had radar or electronics experience, you will find this knowledge helpful in your new work.

**WHERE YOU WORK**

After your period of training—at full pay—you may (1) remain with the Laboratories in Southern California in an instructive or administrative capacity, (2) become the Hughes representative at a company where our equipment is being installed, or (3) be the

Hughes representative at a military base in this country or overseas (single men only). Compensation is made for traveling and moving household effects, and married men keep their families with them at all times.

**YOUR FUTURE**

In one of these positions you will gain all-around experience that will increase your value to our organization as it further expands in the field of electronics. The next few years are certain to see large-scale commercial employment of electronic systems. Your training in and familiarity with the most advanced electronic techniques now will qualify you for even more important future positions.

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*If you are under thirty-five years of age, and if you have an E.E. or Physics degree, write to the Laboratories, giving resumé of your experience.*

*Assurance is required that relocation of the applicant will not cause disruption of an urgent military project.*

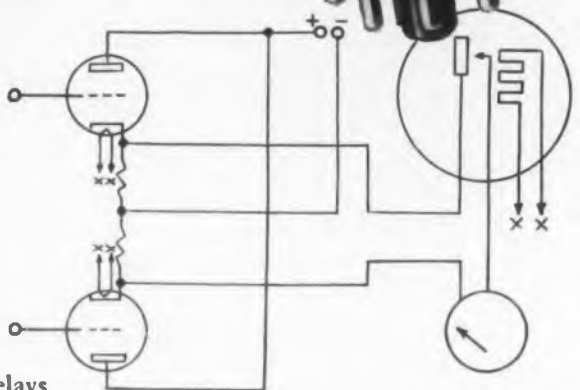
## Sensitive Galvanometer Used in Guided Missile Research...



## ...Protected by an EDISON Time Delay Relay

Malfunction or failure of recording equipment when a guided missile is fired can result in the loss of invaluable research data. The requirement of complete reliability of components used in conjunction with this equipment resulted in the selection of an EDISON Time Delay Relay as a vital part of the Model 46A Sub-Carrier Discriminator manufactured by Electro-Mechanical Research, Inc., Ridgefield, Conn.

The Edison Time Delay Relay is used to protect the sensitive galvanometer in the associated oscillographic recording unit, by allowing the power tube filaments to reach proper operating temperature before the application of high voltage. The thermal action is independent of line voltage variations since the delay characteristics vary in the same proportions as the heating of the filaments. Because of their cooling rate, EDISON relays prevent loss of equipment operating time due to momentary power interruptions.



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# Patents . . .

By John Montstream

Bohleber, Fassett & Montstream, New York

## Frequency Discriminating Amplifier

Patent No. 2,622,157. J. P. McGuire, No. Tarrytown, et al.

(Assigned to General Precision Laboratory, Inc.)

This frequency discriminatory amplifier is designed to reject a frequency band while passing all other frequencies. A circuit for "sharp" rejection of audio frequencies ordinarily requires the use of expensive high Q reactances. The circuit of the patent accomplishes low frequency rejection by using electron tubes and ordinary inductances and capacities.

The circuit is particularly applicable to reject the 120cy frequency resulting from using commercial 60cy power for tube heater circuits and incandescent lamps. This frequency is particularly troublesome in reproducing the sound from a motion picture sound track and for this reason the exciter lamp has often been operated on direct current or a super audible frequency of alternating current which requires relatively expensive equipment.

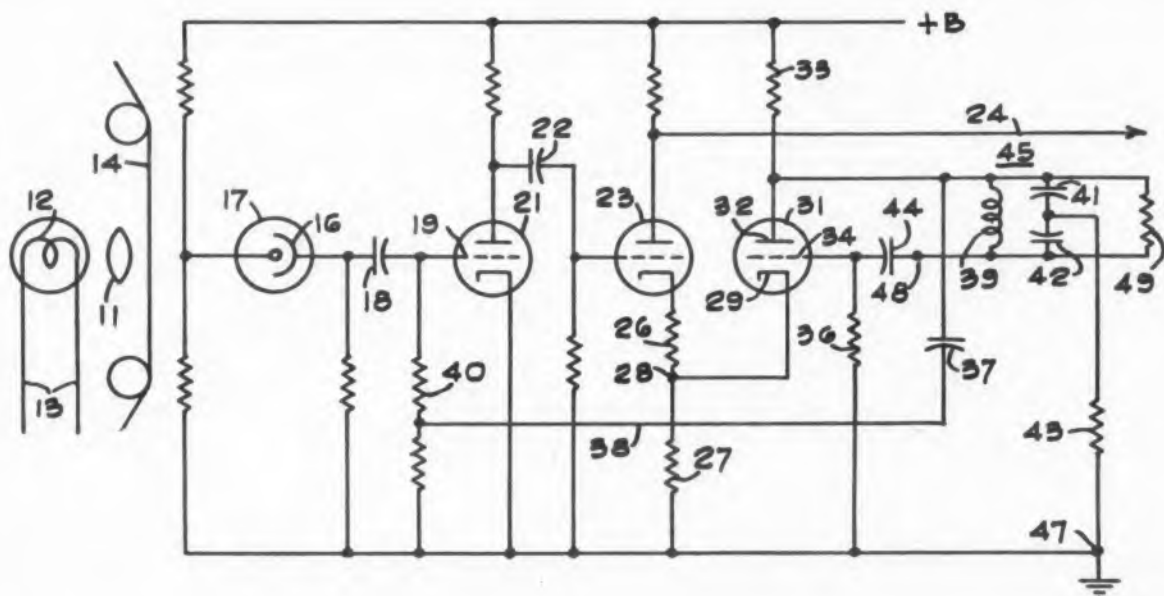
In the circuit the sound track of the film 14 is illuminated by an incandescent filament lamp 12 connected with a 60cy source. The light, passing through the sound track, falls upon the cathode 16 of a phototube 17 which is connected with an amplifier including a first and a second

amplifier tube 21 and 23. The output of the amplifier is connected with a loudspeaker.

The frequency rejection circuit includes two cathode resistors 26 and 27 connected in series and in the cathode circuit of the second amplifier tube 23. The junction point 28 between the resistors is connected with the cathode 29 of a triode 31 so that it operates as a linear amplifier of variations in its cathode potential without a change of phase at the anode 32.

A resonant circuit 45 is connected between the anode 32 and the control grid 34 of the triode through a coupling condenser 44. The resonant circuit is designed to resonate at a frequency of 120cy so that its impedance is high, and little if any energy at this frequency is fed back from the anode 32 to the grid 34. The triode 31 consequently amplifies the 120cy frequency which is negatively fed back to the amplifier through a connection 37, 38 and 40 between the anode 32 of the triode 31 and the input grid 19 of the first amplifier tube 21. The gain of the amplifier is therefore depressed at 120cy and adjacent frequencies.

The resonant circuit acts as a low impedance connection between the anode and grid of the triode for all other frequencies with the result that the amplification of the triode 31 is negligible and only a relatively small amount of the energy at these



other frequencies is fed back to the input grid of the first amplifier tube. With this circuit, the undesired 120cy hum is eliminated and there is no detectable loss of frequency response.

### Superregenerative Superheterodyne

Patent No. 2,623,166. B. D. Loughlin, Lynbrook, N. Y.

(Assigned to Hazeltine Research, Inc.)

An improved design of a superregenerative superheterodyne circuit has been devised which reduces the wave signal energy produced by "back conversion" and secures this result with simple and inexpensive components. The "back conversion" results from the presence of both i-f and heterodyne signals in the input circuit of the tube which is performing the frequency conversion function. A reverse modulation action takes place and produces pulses in the input circuit having approximately the frequency of the received wave signal.

The circuit includes a regenerator tube, whose anode and control grid are coupled by a frequency determining circuit having a resonant frequency which corresponds with the oscillatory frequency of the superregenerative circuit which is lower than the received signal frequency. A local oscillator provides the heterodyning frequency and a quench means such as a network for producing superregenerative amplification. The regenerator tube includes in the cathode circuit a resistor shunted by an r-f choke coil which presents a high impedance to signals of the frequency of the received signal.

This tends to maintain the input capacitance of the regenerator tube substantially constant during the oscillatory build up interval. This substantially avoids any modulation of the heterodyne signal caused by the changing input electrode impedance of the regenerator tube and reduces the undesirable back conversion to a very small value. Because the choke coil shunting the cathode resistor has a low impedance for audio frequency components, the superregenerative superheterodyne system is permitted to develop an output signal of large amplitude. The circuit has application to both a-m and f-m types of received signals.

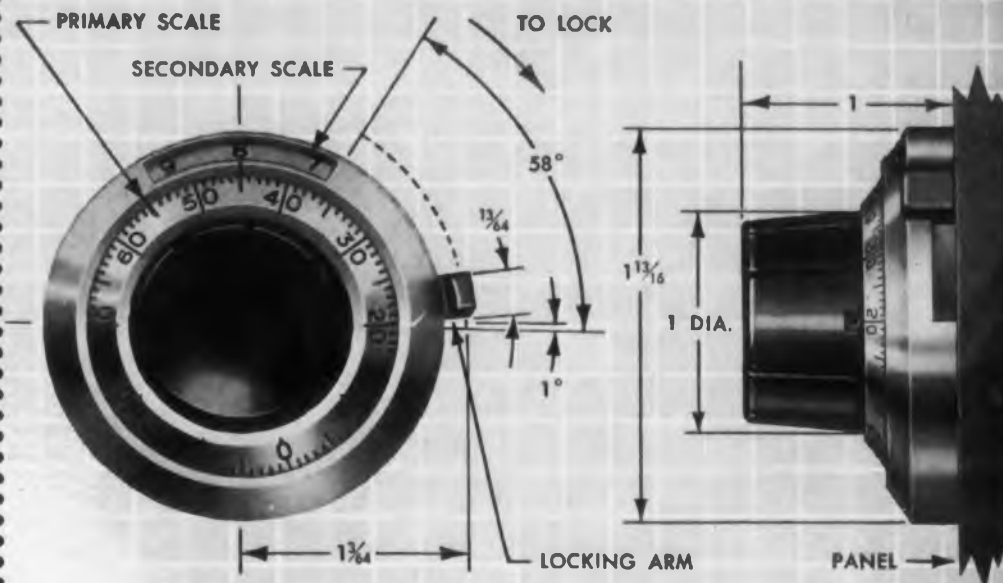
CIRCLE ED-85 ON READER-SERVICE CARD ➤

ELECTRONIC DESIGN • March 1953

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*Instant, accurate readings*  
distinctive beauty... quality "feel"... simple installation!



The new RA DUODIAL—product of the world's largest manufacturer of precision potentiometers—establishes a new standard of beauty and quality in multi-turn indicating dials. Finished in satin-chrome, with non-metallic parts of black nylon, the unit adds a distinguished appearance of quality and excellence to the finest instrument panels—and its precise operation gives a smooth "feel" that is unequalled. From every standpoint—readability, appearance, operation, construction—here is a dial worthy of the highest quality electronic instruments!

#### Unique Jump Mechanism

With its glare-proof satin finish and recessed black numerals that will not wear off, the RA DUODIAL is not only beautiful but is unusually easy to read. Moreover, the secondary dial is driven by a unique jump mechanism that keeps the dial stationary until the primary dial has completed a full revolution—then the turns-indicating dial "jumps" to the next numeral. Thus, the index always points *directly* to the number showing the particular helical turn on which the slider is positioned, eliminating errors in dial readings and settings.

Another convenience feature—three numbers show in the window at all times so that the operator knows instantly in which direction the dial is to be rotated to make the next setting. And with 10 turn potentiometers, readings are made directly in decimal equivalents of the slider position on the resistance winding—simply, accurately, and with maximum convenience for any resistance range.

#### Vibration-Proof Lock

All RA DUODIALS are equipped with a positive *vibration-proof* locking mechanism that can be easily and instantly set by the same hand that is adjusting the knob. Locking is accomplished by means of a cam actuated brake shoe which acts radially against an inner drum. This arrangement eliminates any possibility of dial movement during or after setting.

#### Easy To Mount On Panel

The RA is unusually compact—only 1-13/16" diameter (the same as a Model A HELIPOT)—and comes completely assembled, with mounting parts and hex wrench included. Installation is extremely simple. Set the dial and potentiometer at zero. Place the shaft through panel hole. Place lug plate over shaft, and mounting nut on potentiometer bushing. Then place the RA dial over shaft, lining up the register hole with lug—and tighten set screws. *It's as easy as that!*

In addition, the mounting nut is so designed that it is adaptable to thin (1/8" and under) or thick panels by simply reversing ends. No problems of adapting the unit to your particular panel requirements!

#### Finest Construction Throughout

In all respects the RA DUODIAL is built to maintain its attractive appearance and quality "feel" throughout its long life. Metal parts are machined from die-cast alloy and plated in accordance with specifications MIL P6871 and QQ P416 (1) for corrosion resistance. Non-metallic parts are made of long-lived nylon, with nylon jump gear to assure smooth quiet operation of the

secondary dial. And since the primary dial is connected directly to the potentiometer shaft, no wear or backlash can affect the accuracy of the settings.

Two allen-head set screws—positioned at 90°—lock the dial to the potentiometer shaft, and the black nylon knob insulates the instrument from hand capacity.

The RA DUODIAL is primarily designed for use with the 10-turn Model A HELIPOT. However, it is equally ideal for use with the 3-turn Model C or the ultra-precision models AN and CN when these potentiometers are equipped with bushing mounting. Additional numerals provided on the secondary dial make the RA adaptable for readings up to 15 turns for special applications.

An RAJ version of the RA Precision DUODIAL is available for use on the miniature Model AJ 3/4" 10-turn HELIPOT. The RAJ also fits other multi-turn devices with 1/8" shafts.

Contact your nearest HELIPOT representative for complete details—or write direct.

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## New Books . . .

**Electronic Analog Computers . . .** By Granino A. Korn and Theresa M. Korn. 378 pages, McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. \$7.00.

The authors of this book have gathered into one convenient volume a wide range of technical information on d-c analog computers. Those engineers who are not familiar with the subject will find the principles clearly explained in the first chapter, which is a general introduction to the subject.

For the engineers who know the details of computer design, the book provides valuable data on applying computer techniques to the solution of problems. Such topics as how to set up a d-c analog computer to solve a given set of differential equations, computer setups for solving a number of practical problems, how to administer a computer installation, as well as a discussion on new developments in the fields of analog multiplication and function generation are included. No mathematics beyond that taught in an elementary course on differential equations is required to read this book.

The experience of many workers and laboratories is cited, and circuit diagrams of actual equipment are presented. A bibliography of some 94 references, as well as an appendix on some properties of parallel-feedback-type operational amplifiers, also is included.

**Measurements at Centimeter Wavelength . . .** By Donald D. King. 327 pages, D. Van Nostrand Co., Inc., 250 Fourth Ave., New York 3, N. Y. \$5.50.

A great deal of interest among electronic engineers these days is centered around radio waves of very short wavelength, and this book serves as an excellent reference work on the problems of measurement in the centimeter range (3 meters to 10mm).

Beginning with a brief introduction to the subject, the author proceeds to a discussion of transmission theory, covering line theory and the various elements useful in transmitting power at these high frequencies. Then instruments for measuring power and frequency and various kinds of generators for centimeter waves are covered in detail, and a discussion of the properties which an ideal signal generator should possess are covered in detail.

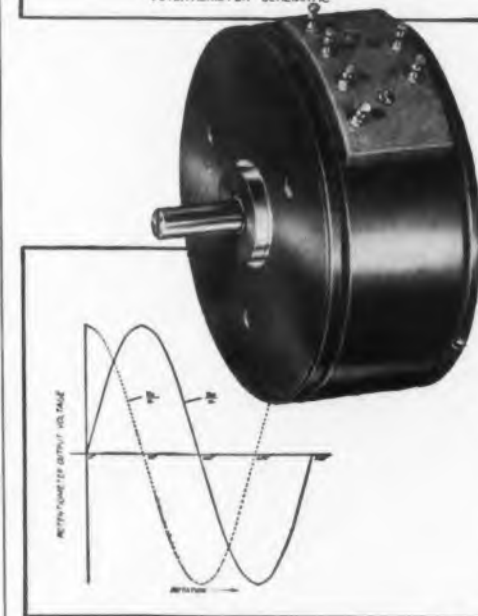
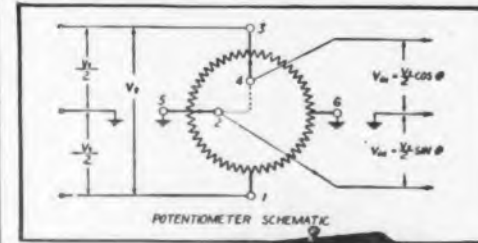
The final chapters deal with measurements that generally require elaborate circuits. A number of methods for measuring impedance are presented together with an evaluation of each. Here also radiation measurements are considered, including antenna impedance and field pattern, as well as general measurements of surface currents, scattering, and field strength. A glossary of symbols is provided.

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ELECTRONIC DESIGN • March 1953



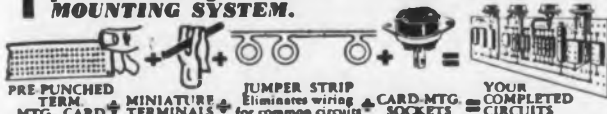
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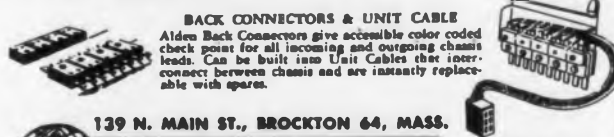


Alden components provide standard plug-in or slide-in housings — with spares, your circuits become units replaceable in 30 seconds.

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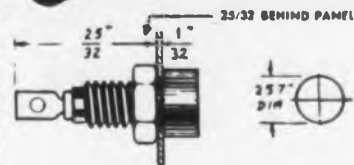
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## Meetings

- Mar. 16-18: IEE (Institution of Electrical Engineers) Symposium on Insulating Materials, London, England.
- Mar. 23-26: IRE National Convention, Waldorf-Astoria Hotel and Grand Central Palace, New York, N. Y.
- Apr. 11: NEREM (New England Radio Engineering Meeting), University of Connecticut, Storrs, Conn.
- Apr. 16-17: 9th Joint Conference of RTMA of United States and Canada, Ambassador Hotel, Los Angeles, Calif.
- Apr. 18: IRE Seventh Annual Spring Technical Conference, Cincinnati, Ohio.
- Apr. 26-30: SMPTE (Society of Motion Picture and TV Engineers) 73rd Convention, Hotel Statler, Los Angeles, Calif.
- Apr. 27-May 8: British Industries Fair, Birmingham & London, England.
- Apr. 28-May 1: NARTB (National Assn. Radio and Television Broadcasters) 1953 Convention, Biltmore Hotel, Los Angeles, Calif.
- Apr. 29-May 1: Electronic Components Symposium, Shakespeare Club, Pasadena, Calif.
- May 11-13: 1953 National Conference on Airborne Electronics, Hotel Biltmore, Dayton, Ohio.
- May 18-21: 1953 Electronic Parts Show, Conrad Hilton Hotel, Chicago, Ill.
- May 18-23: 3rd International Congress on Electro-heat, Paris, France.
- May 24-28: NAED (National Assn. of Electronic Distributors) 45th Annual Convention, Conrad Hilton Hotel, Chicago, Ill.
- May 24-28: Scientific Apparatus Makers Assn. Annual Meeting, The Greenbriar, White Sulphur Springs, W. Va.
- June 15-19: AIEE Summer General Meeting, Chalfont-Haddon Hotel, Atlantic City, N. J.
- June 15-19: Exposition of Basic Materials for Industry, Grand Central Palace, New York, N. Y.
- June 16-24: International Electro-acoustics Congress, The Netherlands.
- June 20-Oct. 11: German Communication and Transport Exhibition, Munich, Germany.
- Aug. 19-21: WESCON (Western Electronic Show and Convention), San Francisco Municipal Auditorium, San Francisco, Calif.
- Aug. 29-Sept. 6: West German Radio and TV Exhibition, Duesseldorf, Germany.

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## Why you can expect plus performance from standard RCA receiving tubes...in every field

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- ☆ The cathode base metal and the carbonate coatings are individually matched for each tube type to provide superior performance. Both are continuously RCA-engineered for maximum quality control.
- ☆ The specially processed carbonized nickel-coated anodes developed and used by RCA provide 97% of the radiating effectiveness of a true black body as compared with the 68% figure for the older-style carbonized nickel-plated anodes. This increased effectiveness means better life for RCA tubes because the anodes operate at lower temperatures.
- ☆ Lead-glass envelopes at a cost differential of about 10 to 1 compared to lime-glass envelopes are used by RCA for certain capped types which operate at very high voltages. Such use results in much better life performance.
- ☆ Gold-plated grids are used in certain RCA tube types for better control of critical tube characteristics.
- ☆ The RCA-developed "A" frame construction—used in 6 of the popular metal types—gives rigidity to the tube elements and provides increased resistance to vibration, thus reducing microphonics and stabilizing tube characteristics.
- ☆ Strict mica tolerances, tighter than usual in the industry, provide improved stability and freedom from microphonics.
- ☆ Certain RCA tubes incorporate cathode clips and inverted-pinch cathodes to provide improved ability to withstand vibration; as a result there is greater freedom from microphonics. RCA types for battery operation use a filament damper bar to minimize microphonics.
- ☆ RCA not only uses the highest quality mica but also utilizes a higher percentage of sprayed micas than industry in general. These precautions provide greater freedom from leakage noise and other internal leakage effects.
- ☆ Double-helical coil heaters are used in many types to provide more reliable performance and to insure greater freedom from hum.
- ☆ Each RCA receiving tube has been designed to minimize the number of welds. With such designs there are fewer points at which possible failure can develop. As an additional precaution, RCA welding is done on accurately timed unit welders to insure that each weld has maximum strength and uniformity.