

ELECTRONIC

design

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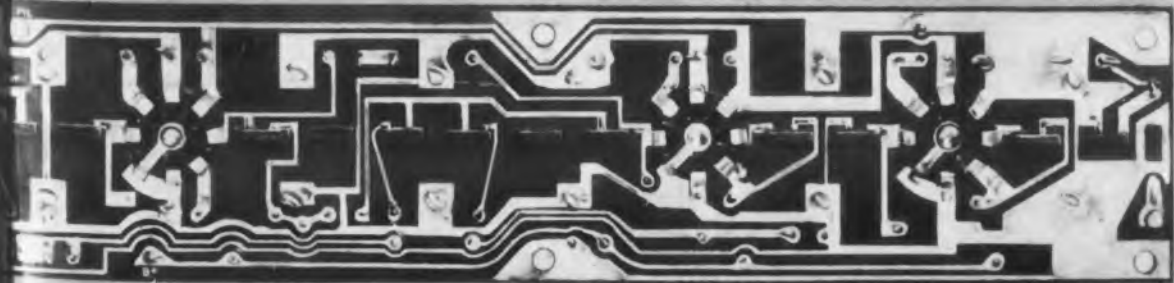
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Printed Circuit I-F Amplifier

The first ready-to-use, prealigned i-f amplifier, complete with electron tubes and printed circuit components (right). It saves design and production time, and eliminates costly alignment operations.



(Below) Bottom view of the new i-f amplifier showing the printed circuit connections. The unit employs printed circuit i-f transformers, coils, and traps, three 6BC6 tubes, and a crystal diode mounted on a plastic panel measuring less than 9" long by less than 2" wide.



August 1953



NEW "M" TYPE TOROIDS Maximum Q Minimum Size

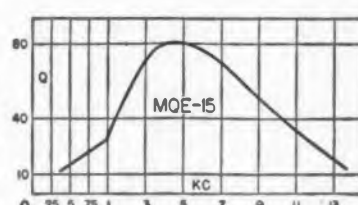
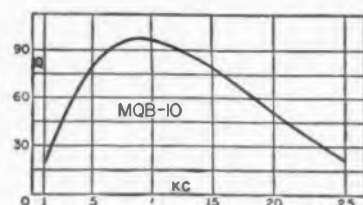
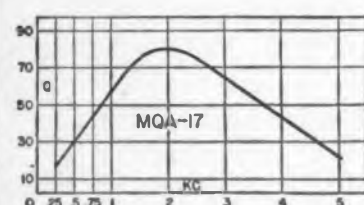
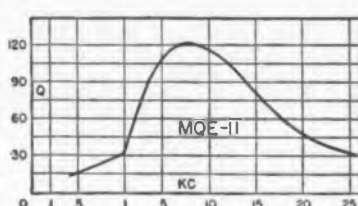
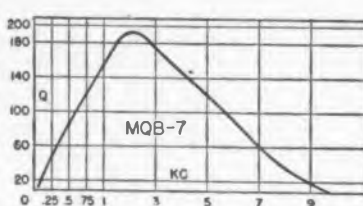
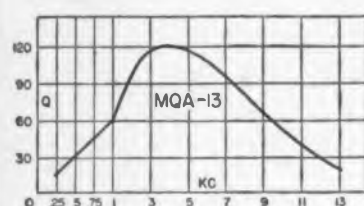
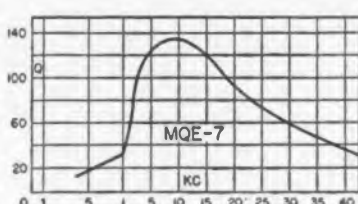
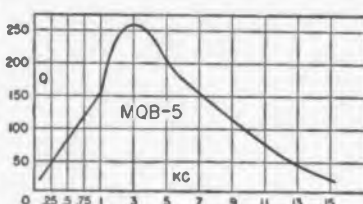
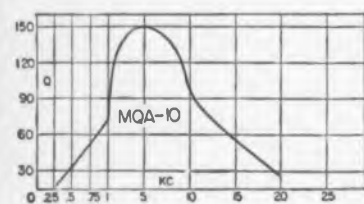
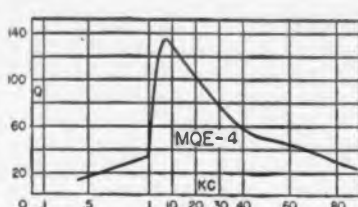
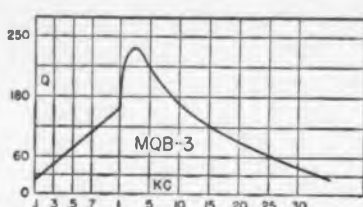
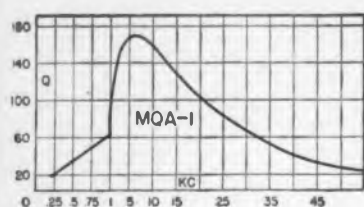
UTG Permeability Band Toroids have been the standard of the industry for over 12 years. The M type toroids will provide the highest Q factor in their class (see curves below), with dimensions comparable to other toroids commonly used in RF-CO specifications.

The stability is excellent. For the MQE toroids, change in Q is less than 1% for a change in inductance of 3 volts. The MQB toroids change less than 1% for applied voltages from 1 to 20 volts. The MQA toroids change less than 1% for applied voltages from 1 to 20 volts. Q is practically constant through the full inductance range. Inductance is virtually independent of frequency, temperature and altitude.

These toroids are extremely low loss in the audible frequency spectrum, with stability extending upward into the GHz range. At high permeability, offering additional stability and low loss, they are available in a wide range of permeability values, offering additional stability and low loss. The permeability values being approximately 5000.

Other values of permeability than those listed are available on special order at the price of the next higher permeability.

TYPICAL Q CURVES



MQA TYPES

Type No.	Inductance	*DC Max.
MQA-1	7 mhy.	250
MQA-2	12 mhy.	200
MQA-3	20 mhy.	150
MQA-4	30 mhy.	125
MQA-5	50 mhy.	100
MQA-6	70 mhy.	80
MQA-7	120 mhy.	60
MQA-8	.2 hy.	50
MQA-9	.3 hy.	40
MQA-10	.5 hy.	30
MQA-11	.7 hy.	25
MQA-12	1 hy.	20
MQA-13	1.5 hy.	17
MQA-14	2.5 hy.	13
MQA-15	4 hy.	10
MQA-16	6 hy.	9
MQA-17	10 hy.	7
MQA-18	15 hy.	5
MQA-19	22 hy.	4

MQB TYPES

Type No.	Inductance	*DC Max.
MQB-1	10 mhy.	400
MQB-2	30 mhy.	250
MQB-3	70 mhy.	170
MQB-4	120 mhy.	120
MQB-5	.5 hy.	60
MQB-6	1 hy.	40
MQB-7	2 hy.	30
MQB-8	3.5 hy.	22
MQB-9	7.5 hy.	16
MQB-10	12 hy.	11
MQB-11	18 hy.	9
MQB-12	25 hy.	8

MQE TYPES

Type No.	Inductance	*DC Max.
MQE-1	7 mhy.	135
MQE-2	12 mhy.	100
MQE-3	20 mhy.	80
MQE-4	30 mhy.	65
MQE-5	50 mhy.	50
MQE-6	70 mhy.	40
MQE-7	100 mhy.	35
MQE-8	150 mhy.	30
MQE-9	.25 hy.	22
MQE-10	.4 hy.	17
MQE-11	.6 hy.	14
MQE-12	.9 hy.	12
MQE-13	1.5 hy.	9
MQE-14	2 hy.	8
MQE-15	2.8 hy.	7.2

*This value of D.C. (MA) will drop the coil inductance 5%. Values of D.C. below this will show proportionately (linear) less inductance drop. For example, MQE-1 will drop 1/2% in L with 13.5 MA.



MQE CASE

Length 1 1/16"
Width 1/2"
Height 17/32"
Unit Weight 1.5 oz.



MQA CASE

Length 1 9/32"
Width 1 1/16"
Height 1 23/32"
Unit Weight 4 oz.



MQB CASE

Length 2 9/16"
Width 1 13/16"
Height 2 13/16"
Unit Weight 14 oz.

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Editorial . . .

Two articles which certainly are "must reading" for engineers, engineering executives, and personnel people who hire engineers have recently come to our attention. Both deal with problems perennially interesting to engineers and are especially important in these days of "engineer shortage".

"What Scientists Look for in Their Jobs" by Theresa R. Shapiro is the title of one of these articles and it appears in the June 1953 issue of the *Scientific Monthly*. It is one of a group of studies conducted for the U. S. Bureau of Labor Statistics as part of its continuing program of studies of scientific personnel. Although the study is based on interviews with 407 men physicists, biologists, and chemists all of whom held doctorates, the findings might very well apply to engineers. Among the questions asked of the group were why they voluntarily left a job, why they selected a particular job offer in preference to another, and why they preferred to remain on a particular job despite opportunities existing elsewhere. In answering these, the most important considerations governing the decision made were the interest of the work, the earnings and opportunities for advancement it provided, and the working conditions on the job. The men were most interested in attacking a challenging research problem, preferably in their own specialty, and in making a contribution to knowledge or to humanity.

The other article appears in the *Newsletter* of the IRE Professional Group on Engineering Management (No. 4, June 15, 1953), and is titled "Engineers and Education: A Pattern and Prognosis", by Ellis F. King. In trying to evaluate the attributes of an engineering education, it was decided to survey the work habits, educational background, and technical needs of some of the successful engineers in industry.

The results of the survey were quite revealing. Among other things it turns out that 53% of these men have B. S. degrees, 18% have Ph.D.'s, 9% have M. S. degrees, and 20% have no formal degrees. To keep abreast of current technical developments the men took extension or college level work (3% on a time basis), read current technical literature (11% on a time basis), attended technical sessions (7% on a time basis), and the remaining 79% was listed as "other" (which included such activities as on-the-job activity, conferences, consultation, company seminars, etc.). The most important outside activity listed as having played an important role in the individual's achievements was membership or active participation in a professional society (76% reported this as the most important).

Many other interesting data about scientists and engineers are presented in these two articles. They are very worth while reading. The more we learn about the men who make up the electronic industries, the faster and healthier will these industries grow.

Engineering Review . . .

Tube Techniques Conference . . . Papers are being solicited by the Sub Panel on Tube Techniques of the Committee on Electronics (an agency of the Department of Defense) for presentation at the first National Conference on Tube Techniques to be held October 13, 14, and 15, 1953 in the auditorium of the Western Union Telegraph Company in New York City. Electron tube making techniques, processing, and materials are the general fields that will be covered, and in particular, papers on cathodes, phosphors, vacuum techniques, glass-to-metal seals, insulation, ceramic field, welding, brazing, chemical cleaning and processing, getters, new tube designs resulting from new techniques, etc. are desired.

Material to be presented can be of a fundamental or applied nature, and all subject matter should be unclassified. All papers and abstracts can be sent to Dr. Harold Jacobs, Thermionics Branch, Evans Signal Laboratory, Belmar, N. J. Titles to be presented should be sent in as soon as possible, and abstracts by September 15, 1953, so that they may be made available for distribution at the conference. It is planned to publish a proceedings of the conference.

Wire-Wrapping Tool . . . A wire-wrapping tool, jointly developed by Bell Telephone Laboratories and Western Electric Co., produces without the use of solder, a gas-tight joint between terminal lug and the connecting wire in the assembly of electrical, electronic, and electromechanical equipments. It is a hand held gun, air or electrically operated, that has a rotating spindle with an axial opening that receives the wire terminal and a smaller axial opening into which the skinned end of the connecting wire is inserted. The gun rotates its spindle, which shoots the wire around the terminal in a tight helix, making a firm mechanical metal-to-metal joint.

Rectangular terminals, having sharp edges are wrapped with about six turns of wire without the application of heat. Contact pressure in the finished connection is at least 15,000psi which produces an indentation at each of the four terminal corners that requires a 10 lb force to strip. Although Western Electric Company does not plan on producing the tool, it will be made commercially available to radio, TV, communications, and other electronic manufacturing companies through licensed manufacturers.

ADRAD . . . A machine for converting voltage data into numerical form used by automatic digital computers handles 50 variables with an accuracy of one part in a thousand and saves thousands of man-hours of computing. Known as "ADRAD" (Automatic Digital Recorder for Analog Data), it was developed by Arthur D. Little, Inc., (30 Memorial Drive, Cambridge, Mass.). It records numbers in typewritten form for easy reference, at the same time preparing a punched tape for use in automatic computing, and the data can be transmitted over a Teletype system to distant computers.

Circuit Checkers . . . High speed, reliable, automatic circuit checkers that are used to detect wiring discrepancies and reduce test time to a minimum have been developed by Federal Telephone and Radio Corp. of Clifton, N. J. A typical unit can be used to thoroughly check 44 complex circuits in less than three minutes and comparatively unskilled personnel doing the job. The tester automatically checks circuits for transposition, continuity, ground, and proper value of resistance. In case of trouble, it clearly indicates the location of the fault.

Standard circuit checkers can automatically test up to 100 circuits, and facilities for larger numbers can be provided.

The testers can be simply adapted to check many types of equipments such as signal installations, telephone switchboards, communications receivers and transmitters, radio and TV chassis, and cable forms and harnesses. Used with an electronic bridge, the units can check the resistance of all components wired in various circuits.

Electronic Totalizing Scale . . . High speed scale readings are relayed automatically to business machines or "IBM" units by the Type ETS-7 Electronic Totalizing Scale (Industrial Electronic Engineers, 3973 Lankershim Blvd., North Hollywood, Calif.). The device controls conveyor, monorail, or hopper delivery across scales; and records weight readings as fast as one unit per second. Weights are itemized, subtotaled and totaled as desired and printed automatically on tape or business forms. Information also can be stored, subtracted, multiplied, or extended in any manner to perform a wide range of functions.

Commercial Calculator . . . The IBM Magnetic Drum Calculator recently announced by International Business Machines (590 Madison Ave., New York 22, N. Y.) combines one of the memory devices and the stored program concept of the company's large "701" machine with the high speed reading capacity in conventional punched card equipment to provide a powerful commercial and engineering data processing machine. In addition to its accounting and computing applications, this commercial electronic decimal calculator will also serve to familiarize business and industry with the stored program principles fundamental to electronic data processing equipment.

A numeric decimal machine, it has up to 20,000 memory positions and can accept as many as 2000 individual operating instructions to facilitate commercial and scientific computations. It consists of a magnetic drum unit with electronic calculating components, an input and output unit, and a converter, and occupies approximately the same area as two ordinary office desks and a filing cabinet. All the calculator's arithmetic operations are controlled through a program which may be entered either automatically from punched cards or manually from the operator's console and stored in the form of magnetized spots on a 12" x 4" diam drum rotating at 13,000rpm. The arithmetic unit operates at electronic speeds and has an input rate of 200 punched cards/min and a separate output of 100 cards/min.

"Dacron" Insulation . . . High degradation by heat, low moisture pickup, resistance to chemicals, and great stretch resistance and strength are characteristics that make "Dacron" polyester fiber (manufactured by E. I. Du Pont Co., Wilmington, Del.) an excellent possibility for many types of electrical insulation. It is now undergoing wide commercial evaluation as a cover for dry transformer conductors. It can be made tougher than asbestos and is easy to apply as an insulating cover. In the manufacturing process, "Dacron" yarn is being twisted for insulating purposes by such firms as Cheney Bros., of New York, and sold by them to such wire manufacturers as Kinnecoth Cable Co., and Phelps Dodge Corp. "Orlon" acrylic fiber, another textile product, also is being used as an insulating material. In 75, 100, and 150-denier weights it is being used mainly as an insulation for magnet wire. It winds more readily than some other materials, and it resists weathering and outdoor exposure to acid gases in the air.

Information Please . . . Readers desiring further information on the items reviewed in this department should send their requests directly to the organization involved. Mention of the subject and the issue of ELECTRONIC DESIGN in which the item appeared will help obtain a speedy response.

Electron Tube Ratings and the Equipment Designer

A. L. Wilson

Product Development Laboratories,
Sylvania Electric Products Inc.
Kew Gardens, N. Y.

IN the field of electronic equipment the electron tube necessarily has a major role. Its successful operation in fulfilling this role is determined largely by the thoroughness of the work done by the equipment designer and the tube manufacturer.

The manufacturer has his major requirements spelled out for him in the form of an inspection specification which lists in detail all the tests the tubes must pass. How well he does his job is very directly affected by the activity of the production and quality control departments in the plant. For government use the tubes are also required to pass the inspection of an inspector attached to one of the military services.

In recent years the tube manufacturers have developed tubes for more reliable operation as the services and more complex equipment demanded. Numerous surveys and customer contacts have pointed out as never before that failure to attain the required reliability has too often been the result of misuse of tubes because of the lack of understanding of tube specifications and ratings on the part of the circuit designer. This kind of information is not usually offered to the student designer in the present-day university curriculum. Instead, he must often learn it in the field of bitter experience, and early misconceptions of tube usage are often not corrected. When applied in equipment design demanding high reliability, the results are unsatisfactory.

The most complete information on tubes available to the circuit designer is to be found in the recent brochures and manuals now being published for reliable type tubes. These contain limits which are used in the tubes acceptance specification for all characteristics tested by the manufacturer, plus curves and application recommendations on circuits and environmental conditions. The manufacturer's recommendations on such things as operating limits, mounting methods for best temperature conditions, and a discussion of individual tube characteristics are contained therein. The designer will find these

useful in familiarizing himself in a general way with that particular line of tubes. It is imperative that he follow these recommendations to the fullest extent possible to attain dependable circuit operation.

For most tube types, however, the best information at hand the designer can use is contained in the JAN or MIL-E-1B specification. It is recognized that these specifications do not ordinarily contain as much information as the designer would like. However, the MIL-E-1B specification is an acceptance specification for the tube manufacturer. When used by the circuit designer in conjunction with the Basic MIL-E-1B, which defines the tests made and mechanical requirements, plus whatever drawings may apply, he can acquire an appreciation for the limitations of a type.

Possibly the most prevalent misuse of tubes is the violation of maximum ratings. In most other fields of engineering the designer reduces the possibility of failure by using safety factors with so much success that the collapse of a bridge becomes a news item of national interest. The electronic designer, on the other hand, often exceeds the tube maximum ratings with little consideration for the tube's ability to withstand such treatment for a period of time. Electron tube manufacturers in the MIL-E-1B specifications for more recent reliable type tubes have felt it necessary to insert a note of warning against exceeding maximum tube ratings.

JAN or MIL-E-1B specifications carry at the top of the sheet a row of absolute maximum ratings. These include such ratings as the voltages, current drains, dissipation levels, and operating temperature intended as limiting values. They are not necessarily test conditions for the manufacturer but are included specifically for the use of the circuit designer. They are recommended guides, based on the manufacturer's experience and data, for values which should not be exceeded if satisfactory performance is expected.

The designer should know that it is then his responsibility to set the operating conditions of his circuit at a point below these values such that varia-

tions from tube to tube and condition fluctuations such as line voltage and load variations will not result in operation of any tube in that circuit beyond these values. All maximum ratings are not necessarily attainable simultaneously. In fact, it is seldom, if a number of different types are examined, that such will be the case.

The probable length of time of satisfactory operation of a tube if these ratings are exceeded is dependent on the degree to which they are surpassed. Individual tubes operated at some point beyond the absolute maximums may give satisfactory performance for a period that will be sufficient in certain relatively short lived applications and not have satisfactory life under the same conditions in an application requiring long life. The amount by which any of the maximum ratings are exceeded, if the designer insists, should be the result of his judgment in relation to the life requirement. He should recognize that surpassing certain ratings will mean an accelerated but steady reduction in tube performance while others, such as control-grid voltage or heater-to-cathode voltage, will mean sudden tube and circuit failures. The information on reduction in life when ratings are exceeded may not be readily available on a specific type, and the manufacturer is usually adamant in his recommendation against it. At or below these rating points, deterioration still exists, but in a degree not too serious to most classes of tube users. However, those tube users having complex or unusual tube usages may find it highly desirable to apply an additional safety factor and keep well below the absolute maximum ratings. It is generally wiser for the designer to err on the conservative side, if in doubt.

The designer should definitely be aware that no two tubes of a given type are alike. Like characteristics of all other manufactured articles, a specific tube characteristic such as plate current varies from tube to tube.

The specification shows the limits within which

Each tube characteristic must lie, and the circuit should be designed so that tubes at the upper and lower limits of the important characteristics will operate satisfactorily. There have been cases where circuits have been developed with a few random tubes of a given type. At a later date serious difficulties arose in production when the circuit was not producing sufficient output in many equipments. It was then learned that the design was not capable of satisfactory performance with near limit tubes which were encountered in large shipments. It should be pointed out, in addition, that the characteristics on the specification are the only ones the manufacturer controls. The designer should attempt to make his circuit insensitive to variations in other characteristics which are not in the specification and not checked in production.

For a large quantity of tubes each characteristic has a typical distribution which will usually be normally distributed, or bell shaped. (A few are J shaped, where the values tend to crowd around some limiting point such as zero.) If the manufacturing tolerances and processes are well controlled, the distribution centers around the rated value for that characteristic.

For example, the MIL-E-1B specification may give the minimum S_m value as $6000\mu\text{mhos}$ and the maximum at 8000. The center value in this case would be assumed at $7000\mu\text{mhos}$. Any tube can have a value for S_m which will fall between these values, but if a large group of tubes were tested it would be found that the majority had S_m values close to 7000. The number of times higher and lower values were found would be reduced as the limits 6000 and 8000 were approached.

These distributions indicate the possibility that some small percentage of the tubes will have S_m values which will fall below and above these limits since the curve does not cut off at these points. This is actually the case, and the MIL-E-1B specification gives an indication of the percentage of tubes which may lie in these outside specification regions by the presence of asterisks, other symbols, or the lack thereof in front of the characteristic.

A discussion of the statistical sampling plans and acceptable quality limits the production lots must meet is a field in itself and not pertinent to the subject of this article. Let it suffice to state that certain characteristics are read on every tube while others, because of their secondary nature, economic factors, or the destructive nature of the test, are checked on a sample from the lot. For those who may be interested, these plans and the acceptable quality levels can be found by reference to the basic section of MIL-E-1B and the Inspection Instructions for Electron Tubes.

It is, of course, impossible for the tube specification writer to specify test conditions which will be the same as the many operating conditions the tube

will encounter in all applications. Each tube is intended to satisfy some general requirement such as an audio amplifier, oscillator, or power output tube. The testing conditions are therefore set at an operating point which is representative of these requirements and so approximates the majority of the operating conditions. The limits on the specification can be used by the designer as indications of probable characteristic spreads he will encounter at his somewhat modified conditions for large group of tubes. Since the application conditions may vary considerably from the manufacturer's testing conditions, he cannot give assurance of the same spreads, as defined by his characteristic limits, at the application condition. It behooves the designer to investigate the ability of limit tubes to meet his conditions satisfactorily before the design is final.

Present trends in circuit design have increased the designer's problems by imposing more severe environmental conditions. To a greater extent than heretofore, he is required to meet higher standards of dependability at higher temperatures and more severe mechanical conditions. It means that tubes as well as other components must be designed for dependable operation to meet these conditions, and much effort has been expended in that direction.

The designer should know the environment by measurements. He can then often reduce the effect of the environment imposed. In the mechanical field his chassis and component mountings should be such as to reduce the g-levels of vibration and shock. The frequency of vibration and its high amplitude harmonics should be checked and adjusted, if possible, so that the resonant frequencies of the tube structures are avoided. He should be familiar with the information available on the tube's ability to withstand steady state stresses.

Again the performance of a particular tube type under certain conditions may be indicated by the MIL-E-1B conditions for vibration, fatigue, resonant frequency, and shock tests specified.

Vibration noise output is usually tested at a fixed frequency, amplitude, and electrical conditions. This test is run only long enough to read the noise level and is not a fatigue test. The limit specified on the MIL-E-1B specification is the maximum noise permitted. If this value is 100mv rms, it indicates approximately 20 or 25mv rms. The distribution of this noise in tubes is not symmetrical. It has a peak to the left of center and slopes less steeply to the right; i.e., highly skewed to the right, and a small percentage produce noise outputs at the maximum limit. If the specification limit is higher than 100mv it is to be assumed that the average noise is proportionately higher also.

The information to be derived from this test by the designer will probably be limited, since his application frequency may not be near the test frequency, or he may be concerned about a range of frequencies.

A comparison of the noise outputs of tube types will help him select the type which he would logically expect to perform best in his application. He would find it informative in this respect to test a number of tubes at the conditions to be encountered. The circuit should, of course, be made as insensitive to noise as possible.

The shock test is conducted on a specified shock machine which has inherent shock wave and time characteristics. Most often, the tubes are tested at 500G's with a time-to-peak acceleration of one millisecond. During test, the manufacturer checks for shorts between elements but does not call instantaneous shorts failures. The tubes must meet certain electrical limits afterward. The designer can use the specified shock test as an indicator of operation in his circuit after avoiding resonant frequencies and reducing the shock transferred.

The effects of temperature should be reduced as much as possible by ventilation, position of the tube with respect to other components, methods of shielding, and the efficiency of heat conduction from the tube to the chassis. As ambient operating temperature is raised, the failure rate of tubes increases exponentially. Hence, reliability is highest with the most conservative temperature obtainable. Many acceptance life tests on production lots of tubes are now conducted at elevated ambient temperatures. The allowable failures in these tests are being constantly better defined, so the designer is given more specific information about life expectations.

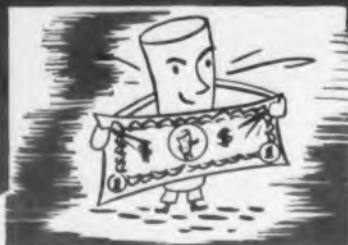
One facet of circuit design which is too often not utilized and whose importance is gaining wider recognition, is in the application of statistics. The trend to higher reliability is coincident with more complex equipment requiring many more tubes. The demands of complexity appreciably reduce the probability that reliability will be obtained, since the probability of no failures in the equipment is one minus the failure rate of one tube raised to the power of the number of tubes, if they have the same failure rate. Expressed mathematically, $P_0 = (1 - r)^N$. It is apparent that even if the designer adheres to all the best practices of reliable design, success can be beyond his reach because of equipment complexity. Information of rate of failure of tubes during life is being collected by manufacturers and more specific data will be obtainable. For other tube characteristics the specified acceptance quality limits will indicate information on failures.

An appreciation and knowledge of the laws of probability can be directly applied to the problems of reliability. The designer who acquaints himself with this engineering tool will learn that its proper use can point out the reasons for not attaining reliability and will increase his design efficiency. Without it he may find himself unable to fix responsibility for poor performance or, perhaps, learn too late that his work was inadequate.

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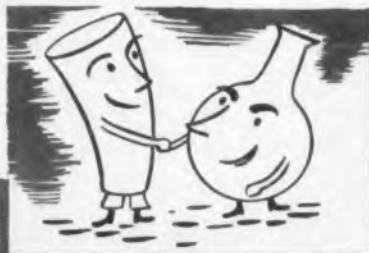


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CIRCLE ED-4 ON READER-SERVICE CARD FOR MORE INFORMATION

"Cellular" Electronic Construction

PRINTED electronic circuits in which conducting patterns etched on plastics take the place of conventional wiring have come into fairly wide use. For the problem of connecting components and tubes to the printed sheets several solutions have been offered. However, the diversity of these solutions and their in-

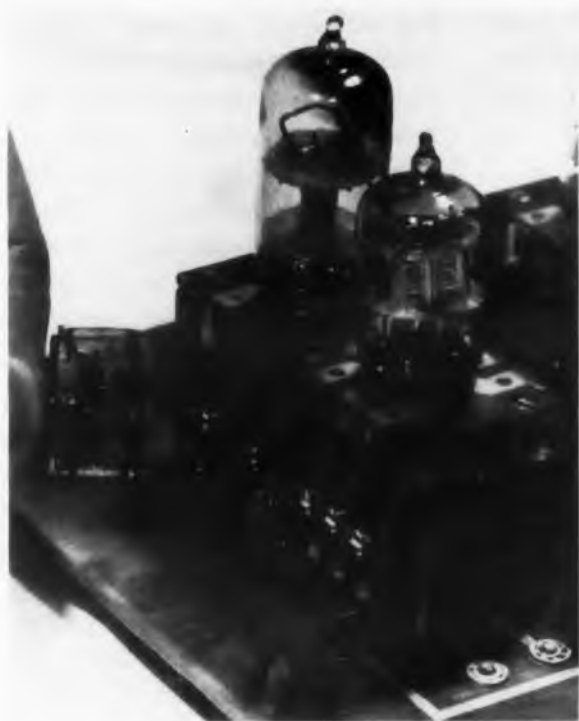


Fig. 1. Individual molded cells containing components are easily inserted into the circuit.

ability to gain widespread acceptance indicates that the optimum answer has not yet been found.

In a novel approach to the problem currently being investigated by the National Bureau of Standards, small 3-contact molded blocks or cells, each containing one or two circuit elements—resistors, capacitors, inductors—are pressed against the etched circuit pattern by means of springs that are extensions of the tube socket contacts. No soldering is needed. This experimental technique is one of a number under study at the Bureau in a program, sponsored by the Navy Bureau

of Aeronautics, for improving construction and maintenance of electronic equipment. Proposed by Dr. P. J. Selgin of the NBS engineering electronics laboratory, the cellular assembly method has several features that could prove advantageous.

The individual molded cells (shown in Fig. 1), are about $7/8$ " high x $1/2$ " wide x $1/4$ " thick. Each has three contacts, one on the top and two on the bottom. The cells are grouped together in "building blocks," each comprising two tubes and twelve cells held in a compact bundle by means of a suitable frame. The top surface of the block consists of a spring assembly containing the tube sockets and the necessary spring contacts (Fig. 2). When the block is fastened to the printed base plate by means of screws, springs in the spring assembly apply substantial pressure to the top terminal of each cell and hold the two bottom terminals firmly in contact with the printed circuit pattern. Positive and noise-free electrical connection is further assured by the application of a thin film of grease to the cell contacts.

The two-tube block is considered an optimum-sized subassembly in the NBS system. Any number of the blocks can be mounted on a suitably-printed base plate of sufficient area. Potentially inexpensive, they are compact (about $2-1/4$ " x 1 " x $1-3/16$ ", exclusive of tubes) and are easy to store and to handle. They are extremely rugged, and as long as a block is secured to the base plate none of the cells can vibrate or shake loose.

A noteworthy feature of the technique is the achievement of quick replaceability—of both blocks and cells—without the use of plugs or connectors. If conventional "plug-in" assemblies were made as small as these blocks, the plugs would add substantially to both size and cost. The elimination of both soldering labor and multiple connectors results in a double saving.

In case of trouble, an entire block can be easily removed for repair or replace-

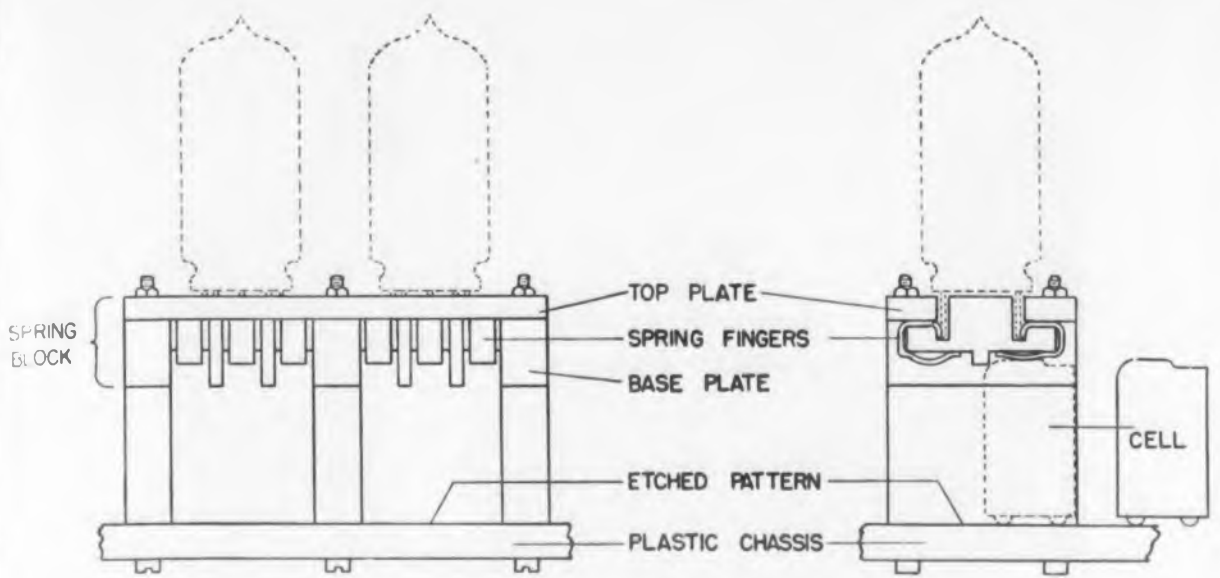


Fig. 2. Drawing showing details of the cellular assembly method.

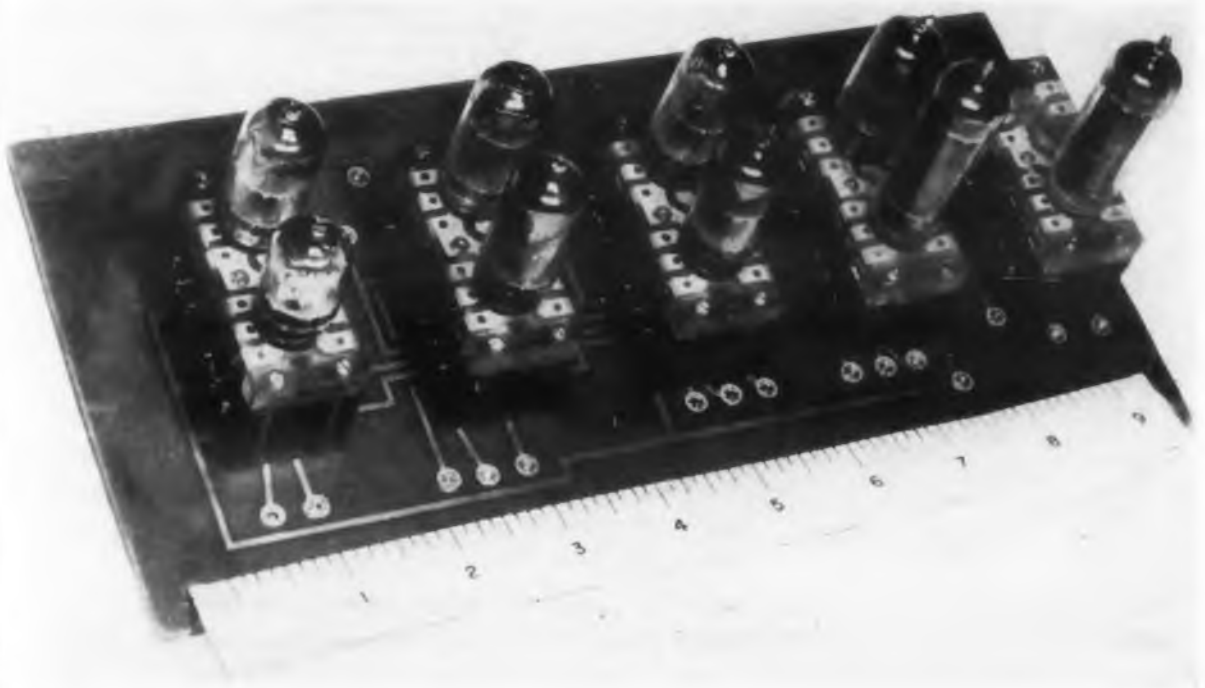
ment, simply by loosening the screws that hold it to the base plate. Either on the spot or after return to the factory or service laboratory, defective blocks can be repaired by replacing faulty cells. Each cell is identified by suitable markings.

An important aspect of the use of three-terminal cells is the fact that positive pressure can be maintained at three points, and only three points, by a single spring. Fortunately, in the great majority of electronic circuits no more than two circuit elements need be connected electrically to a single tube electrode. A three-terminal cell, therefore, besides being easy to hold under firm spring pressure, will in general provide enough electrical contacts for the elements associated with any tube pin. Ex-

ceptional cases can be taken care of in the NBS system by providing for a spare cell not connected to the tube pins. It is also possible to provide for three-terminal cells of double or triple the standard thickness to accommodate oversized elements.

An experimental 9-tube cellular circuit shown in Fig. 3 appears to confirm the practical possibilities of this type of construction. For convenience, the limited number of cells needed were formed at room temperature using a casting resin, although this is not the best material. For quantity production, cells could be molded in phenolic by the process now in wide use for making resistors and capacitors. The components would be spotwelded together and to the terminal tabs before molding.

Fig. 3. A nine-tube working unit made by the cellular construction method.



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Miniaturization Engineers

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AND APPLICATION
OF
SUBMINIATURIZATION
TECHNIQUES**

Significant advancements in the fields of guided missiles, airborne electronic systems and commercial electronic computers are requiring further applications of miniaturization techniques in the Hughes Advanced Electronics Laboratory. Positions are open for engineers qualified in this work.

THE COMPANY

Hughes Research and Development Laboratories, located in Southern California, form one of the nation's leading electronics organizations. The personnel are presently engaged in the development and production of advanced electronic systems and devices.

AREAS OF WORK

Techniques involved are those dealing with printed and etched circuits, encapsulation, plastics, metallurgy, dip-soldering, spot-welding, electrochemistry and materials. Development activities are concerned with plug-in units, auto-assembly techniques, potted units, new wiring methods, electromechanical de-

vices, hardware and production techniques. These techniques are used to achieve compactness, reliability, ease of manufacture, serviceability and interchangeability.

THE FUTURE

Engineers who enjoy a variety of developmental problems find outlets for their abilities and imaginations in these activity areas. New semiconductor components are opening new avenues of miniaturization and are certain to have widespread application commercially in the next few years. Hughes engineers will have full benefit of working experience in this fundamental development.

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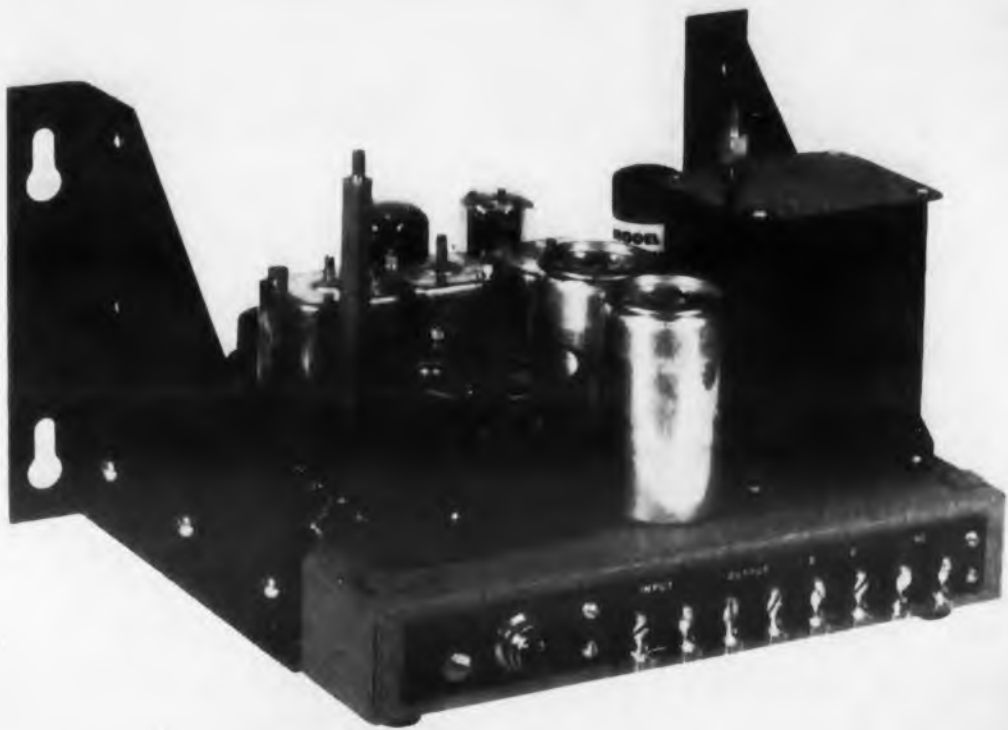
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D-C Instrument Amplifier

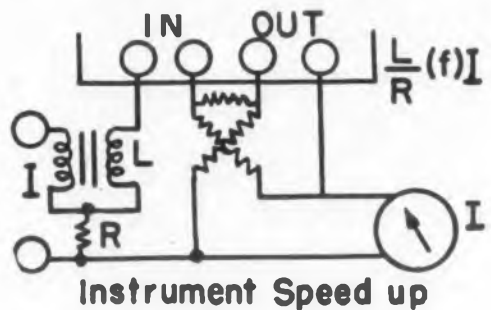
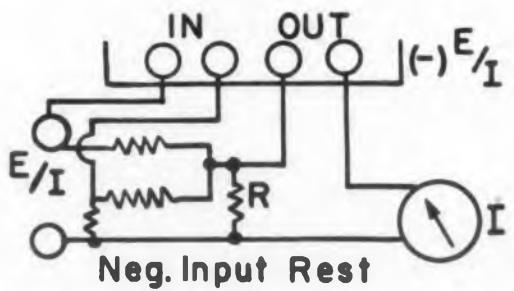
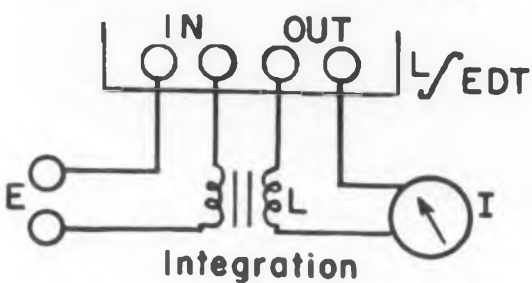
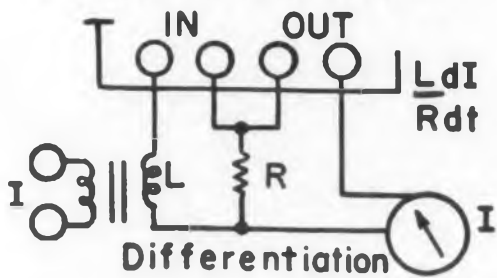
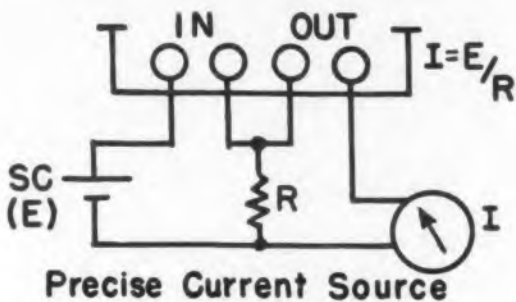
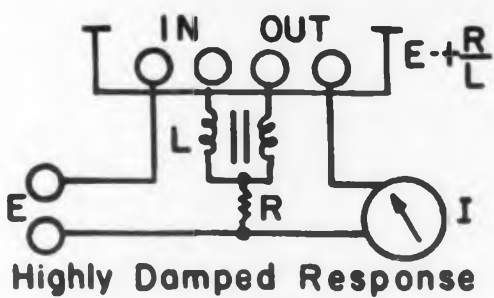


Fig. 1. At the top is the "Inductronic" d-c amplifier which employs no chopper for converting low level d-c to a-c for amplification. The circuits shown below indicate the wide range of applications possible with this versatile amplifier.

ELECTRONIC designers dealing with low-level d-c potentials in measurement or control equipment applications will appreciate the versatility, stability, sensitivity, and accuracy of the Model 1411 "Inductronic" D-C Amplifier. A development of Weston Electrical Instrument Corp. (Newark 5, N. J.), it operates in conjunction with various types of transducers (thermocouples, bolometers, resistance thermometers, photocells, etc.), and employs no "chopper" for converting the low level d-c to a-c for amplification. The unit is shown in Fig. 1 (top).

Essentially, the device is an automatic potentiometer type, wherein an output current is maintained in balance against the input potential or current through a network of precision resistors. Heart of the instrument is a special converter which consists of a standard "Alnico" magnet assembly, with the pivoted movable coil structure having torqueless conducting filaments in place of the normally heavy restoring springs used in d-c instruments.

The movable coil is suspended in the magnetic field produced by the permanent magnet. This field also has a 200kc component furnished by an electronic oscillator. A d-c input causes the coil to deflect and couple to the 200kc flux, the degree of couple being proportional to the d-c input to the coil. The output of the coil is picked up and amplified by an oscillator-amplifier-discriminator circuit, and the d-c output current is fed back to the input through a range determining network of resistors to complete the potentiometer circuit.

Several ways in which the amplifier can be used are shown in Fig. 1. When required, the d-c feedback loop can include reactance for integration, differentiation, and damping functions. Many combinations of L, C, RL, RC, and RLC feedback networks are practical because of the high speed and high resolution sensitivity of the amplifier system. For example, the system operating with the usual resistive range standard may have a response time constant of a small fraction of a second, but by the addition of reactance can be slowed down to a response time constant of several minutes.

The amplifier range determining network can be designed to present negative resistance to the source. In such instances, the amplifier is actually delivering energy to the input source. By applying a standard cell to the amplifier input it is possible to produce a precision standard reference current or potential equal to the accuracy of the standard cell. Another application shows a network designed to increase the response of a d-c instrument beyond the response period of the instrument itself.

Range of the amplifier is determined by interchangeable plug-in range standards. Normal minimum ranges for industrial applications are 1mv and 20 μ amp; and for laboratory service, are 100 μ v and 2 μ amp. Output of the unit is bidirectional, normally 0 — 1ma or 500 — 0 — 500 μ amp into a maximum output burden of 5000 ohms (5v).

Why Hughes Diodes have set

A NEW STANDARD OF RELIABILITY

Reliability in a germanium diode is determined principally by permanent freedom from the two major causes of diode failure—moisture penetration of the diode envelope, and electrical instability under extreme operating conditions.

HUGHES GERMANIUM DIODES are designed to prevent such failures through two exclusive features:

- 1. Fusion Sealing**—The glass-to-metal seal, proved in billions of vacuum tubes, is incorporated to full advantage in diode manufacture by the Hughes-developed process of fusion sealing at high temperature. The result is a rigid one-piece glass envelope making moisture penetration impossible.
- 2. 100% Testing**—One hundred per cent testing insures the satisfactory operation of **HUGHES DIODES** under adverse conditions of moisture, temperature, vibra-

tion and severe shock. Hughes testing procedures invite instabilities to occur prior to shipment and assure rejection of every defective diode. Each **HUGHES DIODE** is humidity-cycled, temperature-cycled, JAN shock-tested, and electrically tested under vibration.

Reliability of **HUGHES DIODES** has been proved in airborne military electronic equipment for navigation, fire control and guided missiles. The same high standard required for these uses is your insurance against costly shutdowns, high maintenance expense and time losses.

Specify **HUGHES DIODES** wherever reliability is essential.

HUGHES GERMANIUM DIODE ELECTRICAL SPECIFICATIONS AT 25° C.

Description	RTMA Type	Test Peak Inverse Voltage* (volts)	Maximum Inverse Working Voltage (volts)	Minimum Forward Current @ +1 v (ma)	Maximum Inverse Current (ma)
High Peak	1N55B	190	150	5.0	0.500 @ -150 v
	1N68A	130	100	3.0	0.625 @ -100 v
High Back Resistance	1N67A	100	80	4.0	0.005 @ -5 v; 0.050 @ -50 v
	1N99	100	80	10.0	0.005 @ -5 v; 0.050 @ -50 v
	1N100	100	80	20.0	0.005 @ -5 v; 0.050 @ -50 v
High Back Resistance	1N89	100	80	3.5	0.008 @ -5 v; 0.100 @ -50 v
	1N97	100	80	10.0	0.008 @ -5 v; 0.100 @ -50 v
	1N98	100	80	20.0	0.008 @ -5 v; 0.100 @ -50 v
High Back Resistance	1N116	75	60	5.0	0.100 @ -50 v
	1N117	75	60	10.0	0.100 @ -50 v
	1N118	75	60	20.0	0.100 @ -50 v
General Purpose	1N90	75	60	5.0	0.800 @ -50 v
	1N95	75	60	10.0	0.800 @ -50 v
	1N96	75	60	20.0	0.800 @ -50 v
JAN Types	1N126**	75	60	5.0	0.050 @ -10 v; 0.850 @ -50 v
	1N127†	125	100	3.0	0.025 @ -10 v; 0.300 @ -50 v
	1N128‡	50	40	3.0	0.010 @ -10 v

*That voltage at which dynamic resistance is zero under specified conditions. Each Hughes Diode is subjected to a voltage rising linearly at 90 volts per second.

**Formerly 1N69A.

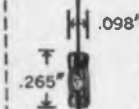
†Formerly 1N70A.

‡Formerly 1N81A.

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Fusion sealed in glass for electrical stability



actual size

Hughes

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Microwave Secondary Frequency Standard

ELECTRONIC designers having need for an instrument that is capable of generating accurate test signals over a range of 50Mc to about 11,000Mc will be interested in the Model 100 Microwave Secondary Frequency Standard which employs no frequency tuning. (See Fig. 1). This relatively inexpensive instrument delivers to the 50 ohm input of a typical microwave receiver an uninterrupted, simultaneous series of c-w signals spaced every 100Mc and 200Mc over its complete frequency range, and a 50Mc marker output useful to about 9000Mc.

These signals are all delivered simultaneously without any frequency tuning. The only variable adjustment is an output level control on the front panel. Identification of signals in any 200Mc sector is accomplished by comparing their relative amplitudes (the 200Mc amplitude is

greater than the 100Mc amplitude which in turn is greater than the 50Mc amplitude).

The instrument is provided with a ruggedized, hermetically sealed meter, and is designed to insure high stability and trouble-free service over a wide range of environmental conditions. Input requirements are 115v \pm 10%, 50/1750cy, 60w; and output c-w power ranges from -10dbm at 1000Mc to about -60dbm at 10,000Mc (0dbm = 1mw).

Used in conjunction with a suitable microwave receiver and an auxiliary signal generator, the Model 100 permits rapid easy frequency measurements over its range with an accuracy of \pm 0.005%. It can perform the function of expensive primary standards and establish standard frequencies. Other typical applications include the calibration of standard signal generators, the calibration and alignment of receivers, and for providing markers for panoramic displays. The unit also can be used to test radar or microwave installations by radiating signals in conjunction with standard microwave antennas.



Fig. 1. The Model 100 Microwave Secondary Frequency Standard, which uses no frequency tuning.

"Minicube" Subminiature Blower

SPOT cooling of compactly constructed electronic equipment always is a difficult problem because there rarely is space enough to accommodate the usual sized cooling devices. Electronic designers therefore will welcome news of the "Minicube" Subminiature Blower (Fig. 1), a centrifugal type unit whose entire assembly including the motor is housed in a 1" cube weighing less than 1 oz. It is manufactured by Sanders Associates, Inc., Nashua, N. H.

Despite its small size, the unit delivers 3cu ft/min at a velocity of 50ft/sec. Heart of the blower is a tiny hysteresis 22,000rpm motor which normally is 2-phase, but can be operated on 3-phase, or single phase with a phase shifting capacitor. Standard motors are furnished with a 6.3v, 400cy, 3w motor or a 26v, 400cy, 4w motor. Motors also are available for other voltages and frequencies. Absence of brushes eliminates electrical noise.

The unit has provisions for universal mounting. Standard models have three tapped mounting holes in the base, and for other requirements, holes can be drilled and tapped in the top, back or sides of the blower. The "Minicube" can be used in hermetically sealed equipment for heat transfer to or from the case. Mounted on the inside it affords efficient heat transfer to the case. Mounted on the outside, it can be used to remove heat from the case. Cooling tubes such as klystrons is another typical application as shown in Fig. 1. Note the small size of the unit compared with the tube.

Standard models operate over a temperature range of -55°C to $+85^{\circ}\text{C}$ and have an expected life of 1000hr.

The miniature size, light weight, and versatile mounting capabilities of the unit make it widely adaptable for solving many difficult cooling problems.



Fig. 1. A typical application of the "Minicube" Subminiature Blower (above) is for cooling klystrons (left).

STANCOR

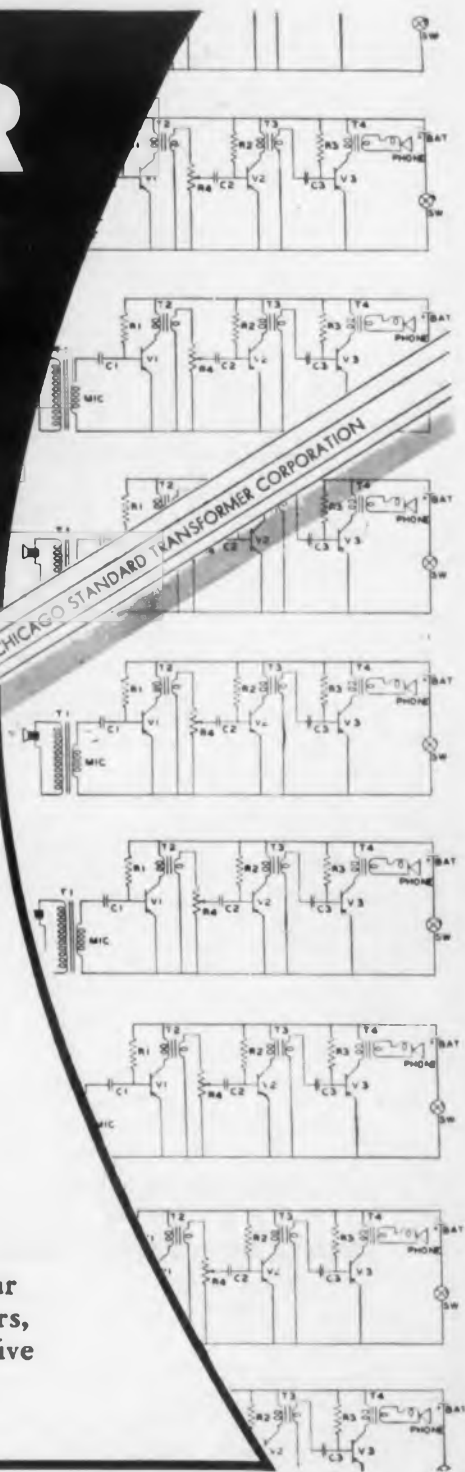
ULTRA-MINIATURE TRANSFORMERS for TRANSISTOR CIRCUITS . . .



If you are having space problems with your transistor circuitry, consider these Stancor transformers as a means of solving your difficulties.

In addition to the units shown below, special transistor transformers, designed and built to your specifications by Stancor engineers, can be supplied in quantities of five or more.

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These five Stancor ultra-miniature transformers, designed especially for transistor applications, are available through your local Stancor distributor. The smallest weighs 0.07 ounce and measures $\frac{1}{4}$ " x $\frac{3}{8}$ " x $\frac{3}{8}$ ". The largest weighs only 0.10 ounce and measures $\frac{3}{8}$ " x $\frac{3}{8}$ " x $\frac{3}{8}$ ".

Part No.	Application	Pri. Imp.	Sec. Imp.	Pri. DC Res.	Sec. DC Res.
UM-110	Interstage	20,000	1,000	1675	285
UM-111	Output or matching	1,000	50/60	120	9.0
UM-112	High imp. mic. input	200,000	1,000	4000	195
UM-113	Interstage	20,000	1,000	1350	205
UM-114	Output or matching	500	50/60	70	9.0

Write for Stancor Bulletin 462R listing complete data and performance curves on these units.

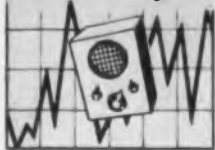


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MOST ECONOMICAL
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Provide delays ranging from 2 to 120 seconds.

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- Hermetically sealed. Not affected by altitude, moisture, or other climate changes.
- Circuits: SPST only—normally open or normally closed.

Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from -55° to $+70^{\circ}$ C. Heaters consume approximately 2 W. and may be operated continuously. The units are most compact, rugged, explosion-proof, long-lived, and—very inexpensive!

TYPES: Standard Radio Octal, and 9-Pin Miniature.

PROBLEM? Send for Bulletin No. TR-81



STANDARD

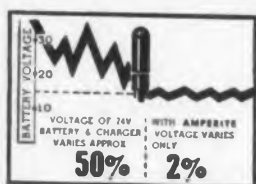


MINIATURE

BALLAST-REGULATORS

Amperite Regulators are designed to keep the current in a circuit *automatically regulated* at a definite value (for example, 0.5 amp).

- For currents of 60 ma. to 5 amps. Operates on A.C., D.C., or Pulsating Current.
- Hermetically sealed, light, compact, and most inexpensive.



Maximum Wattage Dissipation:
T6½L—5W. T9—10W.

Amperite Regulators are the simplest, most effective method for obtaining *automatic regulation* of current or voltage. Hermetically sealed, they are not affected by changes in altitude, ambient temperature (-55° to $+90^{\circ}$ C), or humidity. Rugged; no moving parts; changed as easily as a radio tube.

Write for 4-page Technical Bulletin No. AB-51



T9 BULB

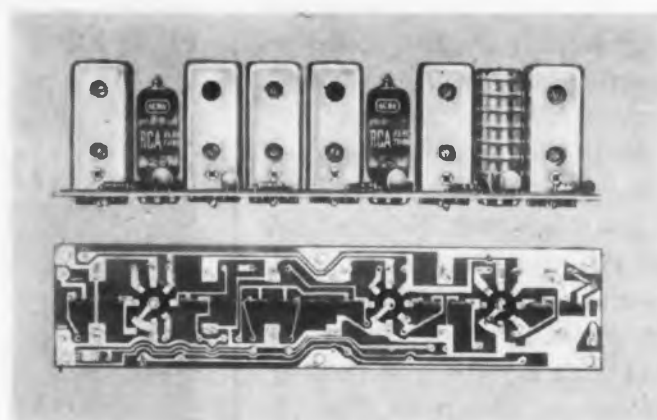


AMPERITE CO., Inc. 561 Broadway, New York 12, N. Y.

In Canada: Atlas Radio Corp., Ltd., 560 King St., W., Toronto 2B

CIRCLE ED-10 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products . . .



Prealigned I-F Amplifier Has Printed Circuit Components

Shown here (and on the front cover) is the Type 207E1 prealigned, tandem 40Mc I-F Amplifier which comes complete with electron tubes and printed circuit components. It is intended to help TV set designers save design time, reduce production time by eliminating complex assembly and alignment operations, and to provide high efficiency i-f amplifier operation.

The unit employs printed circuit transformers, coils, and traps arranged in tandem, with three Type 6CB6 tubes and a Type 1N64 crystal on a panel 8-25/32" long x 1-15/16" wide. All wiring on the panel is printed to provide a high degree of uniformity and to minimize stray capacitances and their variations.

Designed to operate with a diode load resistance of 5600 ohms, the amplifier is intended for TV sets which utilize intercarrier-sound systems having picture i-f and sound carriers of 45.75Mc and 41.75Mc respectively. When used with a cascade type tuner, a voltage of only $6.5\mu\text{v}$ at midband is required at the input of the tuner to provide a d-c voltage increase of 1v at the output of the amplifier. Radio Corp. of America, RCA Victor Div., Dept. ED, Harrison, N. J.

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

Miniature Hook-Up Wire Shielded, High Temperature Type

The Type SRPF (SN) Shielded Hook-Up Wire has been developed for electronic and low-current electrical applications. Of miniature size, it has a high-

temperature thermoplastic insulation with shield and nylon braid covering.

The wire has a high degree of workability and durability. The insulation is readily stripped and will not creep back during soldering. It is free from wrinkles after bending. Features include resistance to abrasion, flame, fungus, and solvent.

Insulation resistance is 10,000 megohms per 1000' at room temperature. The relatively low capacity of the wire is stable over the entire temperature rating, which is -55° C to $+150^{\circ}$ C. Additional features include a continuous ambient rating of 125° C, and a voltage rating of 1000v a-c or d-c. Boston Insulated Wire and Cable Co., Dept. ED, 65 Bay St., Boston, Mass.

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

Volt-Ohm-Microammeter With 100,000 ohms/v Sensitivity



Featuring 33 ranges and a 100,000 ohms/v sensitivity, the Model 269 Volt-Ohm-Microammeter can be used in place of vacuum tube voltmeters for many voltage and resistance measurements. It is ruggedly constructed

for hard usage and is provided with a 7" dial for reading ease.

The d-c voltage ranges (100,000 ohms/v) include 0-1.6v, 8v, 40v, 160v, 400v, 1600v, and 4000v. The a-c voltage ranges (5000 ohms/v) include 0-3v, 8v, 40v, 160v, and 800v.

Also provided are six resistance ranges from 0 — 2000 ohms (18 ohm center) to 0 — 200 megohms (1.8 megohm center); four a-f output voltage ranges; four volume level (db) ranges; and seven current ranges from 0 — $16\mu\text{amp}$ to 0 — 16amp. Measurement accuracy is 3% (d-c) and 5% (a-c) of full scale deflection. Simpson Electric Co., Dept. ED, 5200 W. Kinzie St., Chicago 44, Ill.

CIRCLE ED-13 ON READER-SERVICE CARD FOR MORE INFORMATION

Insulated Couplings

Withstand More Than 15kv



Capable of withstanding more than 15kv, these High Voltage Insulated Couplings have been designed for use in high quality civilian, army, navy, and air force electronic equip-

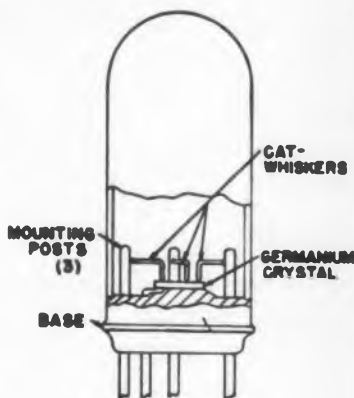
ment. These units effect major economies by eliminating milling operations and are applicable to any standard potentiometer with slotted shafts. Dimensions and mechanical arrangement of the devices are shown above. Jan Hardware Mfg. Co., Inc., Dept. ED, 25-30 163rd St., Flushing 58, N. Y.

CIRCLE ED-14 ON READER-SERVICE CARD FOR MORE INFORMATION

Tetrode and Pentode Transistors

Permit Simplified Circuitry

Two new point contact transistors, a "tetrode" and "pentode", have been added to the company's line. Because these units have more elements than conventional types, they can serve as replacements for the conventional triode transistors on a one-for-two or one-for-three basis in some circuit applications.



Basically, the units are regular transistors with provisions for extra inputs, the tetrode having two inputs and the pentode three inputs. This permits controlling the switching action of the transistor from either two or three sources, as well as allowing mixing of two or three signals with the use of only one transistor. In this way circuit simplifications can be effected and more compact equipment can be built.

The tetrode unit (Type 3N21) is designed primarily for switching and also finds use in mixer or modulator applications. Maximum ratings include -60v collector voltage, 100mw collector dissipation, -50v emitter voltage on either emitter, 30mw emitter dissipation (either emitter), and an ambient temperature of 50°C. For switching applications, the unit has a rise time of 0.2μsec and a turn-off time of 0.5μsec. Ratings for the pentode unit are the same except that one more input is provided. Sylvania Electric Products, Inc., Dept. ED, 1740 Broadway, New York 19, N. Y.

CIRCLE ED-15 ON READER-SERVICE CARD FOR MORE INFORMATION
ELECTRONIC DESIGN • August 1953



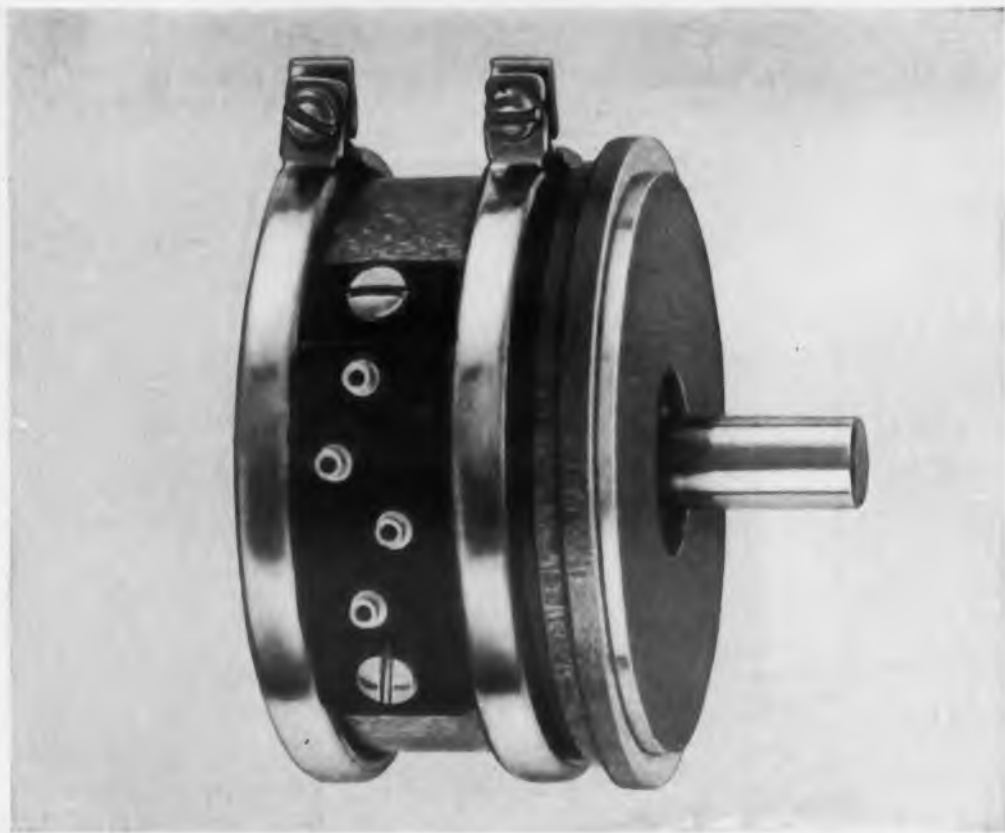


ELECTRONS, INCORPORATED

127 SUSSEX AVENUE

NEWARK 3, N. J.

*Electrons tubes--always in the lead! This time in the
"701" IBM Electronic Data Processing Machines.*



TYPE 756— Fairchild's latest single-turn PRECISION POTENTIOMETER

Gives you all these advantages...

- 1** Extremely low noise level and longer life with sustained high accuracy result from improved windings and wiper design. These improvements also permit higher rotational speeds with minimum of wear.
- 2** Higher resolution (0.05% at 2,000 turns) and close functional tolerances (linear $\pm 0.25\%$; non-linear 0.35% with 3:1 slope ratio in high resistance ranges) give higher point-to-point tracking qualities.
- 3** Standard electrical functional angle is 320 deg. nominal with ORV tolerance of $\pm 5\%$ in resistance range from 800 to 40,000 ohms. Electrical functional angle of 350 deg. nominal with ORV tolerance of $\pm 3\%$ in resistance ranges of 50 to 45,000 ohms can be supplied on special order.
- 4** Greater flexibility—For non-linear functions as many as 13 taps can be provided by adding extra terminal boards.
- 5** All the desirable qualities of the well-known Type 746 unit, including easy and more accurate phasing, ganging up to 20 units on a single shaft, all-metal precision-machined housing and shaft, low torque, etc., are included in the Type 756.

Full information about the entire line of Fairchild Precision Potentiometers, including specifications of the Type 756 unit and how we can help solve your potentiometer problems, is available for the asking. Write to *Potentiometer Division, Fairchild Camera and Instrument Corporation, Park Avenue, Hicksville, Long Island, New York, Department 140-39N.*

FAIRCHILD

PRECISION POTENTIOMETERS

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

New Products...

Hollow Shaft Differential For Adding and Subtracting



This Hollow Shaft Differential has been designed for high accuracy in additive and subtractive analog computer operations. It has special applications in angular or angular velocity sums and differences, and sequence operations. Features include low inertia (0.0745 oz-in²), minimum backlash (0.10' max), and low weight (1-1/4 oz).

The versatility of the hollow shaft design permits the axial positioning of the differential on the shaft. It also facilitates easy installation or removal of the unit from the shaft without differential or instrument disassembly. Librascope, Inc., Dept. ED, 1607 Flower St., Glendale, Calif.

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

Laboratory Radiation Monitor Provides Visual and/or Aural Indication



instrument may be obtained with a G-M tube and probe.

Specifications include an accuracy of about $\pm 5\%$, power requirements of 117v $\pm 10\%$ and 35w, dimensions of 6-1/2" x 6-1/2" x 10-1/4", and a net weight of about 8 lb. Berkeley Scientific Div., Beckman Instruments, Inc., Dept. ED, 2200 Wright Ave., Richmond, Calif.

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

Important
SAVINGS
to VOLUME users
of small parts

..like these



thanks to
MULTI-SWAGE

If you need small tubular metal parts like these in large VOLUME, Bead Chain's MULTI-SWAGE Process can mean important savings to you.

Much Cheaper Than Solid Pins

Many prominent users of solid pins for electronic and mechanical purposes have cut costs by switching to Multi-Swaged tubular pins... without sacrificing strength or accuracy.

Typical Applications—

As terminals, contacts, bearing pins, stop pins, male-female connections, etc., in a wide variety of products such as Business Machines, Ventilator Louvres, Toys, Radio and Television Apparatus, Terminal-boards, Electric Shavers, Phonograph Pickups, etc.

Send part (up to 1/4" dia. and to 1 1/2" length) and your specs for a quotation or write for DATA BULLETIN.

B[®]

THE BEAD CHAIN[®] MFG. CO.

58 Mountain Grove St., Bridgeport 5, Conn.

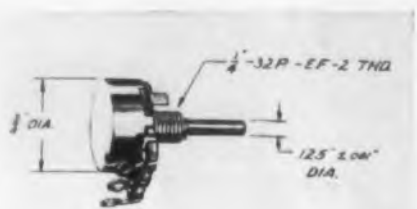
Manufacturers of BEAD CHAIN—the kinkless chain of a thousand uses, for pull and retaining chains and other industrial uses; plumbing, electrical, jewelry, fishing tackle and novelty products.

CIRCLE ED-22 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 1953

Miniaturized Variable Resistor

With Resistance Range From 100 ohms
to 5 Megohms



Type 65 Miniaturized Variable Resistor has been designed for use in jet and other planes, guided missiles, tanks, ships, portable or mobile

equipment, and all other military communications under conditions ranging from extreme cold or extreme altitudes to extreme heat.

A feature of the unit is its ability to remain stable during severe temperature and humidity changes. Characteristics include a temperature range of -55°C to $+150^{\circ}\text{C}$ (aridity to saturation ranges), a $3/4$ " diam, a wattage and voltage rating of $1/2\text{w}$ at 70°C derated to zero load at 150°C with maximum safe operating voltage across end terminals of 350v, and a resistance range of 100 ohms to 5 megohms. Chicago Telephone Supply Corp., Dept. ED, Elkhart, Ind.

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

Position Indicator

Accurate Basic Sensing Element



This "Microsyn" Position Indicator is a small electro-mechanical signal generator which transforms angular displacement accurately into an electrical signal for measurement of any mechanical variable. Tested

and perfected as a standard military component for use in gyro instruments and computers, the instrument is now finding wide application in the industrial fields of process control, data transmission, measurement of mechanical variables, and analog computation.

Features of the instrument include true linear output, extreme resolution, low operating torque, exceptional sensitivity (up to 7v/degree at 400cy), reliability, and versatility. Characteristics include a linearity of $\pm 1/2\%$ to 7° , $\pm 1\%$ to 10° ; a residual null not exceeding signal equivalent to 0.01° rotation; a static friction of 0.03 oz-in nominal; a temperature range of -67°F to $+200^{\circ}\text{F}$; and a rotor moment of inertia of 0.04 oz-in sq. Doelcam Corp. Dept. ED, Soldiers Field Rd., Boston 35, Mass.

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

Microwave TEST COMPONENTS

PRD offers a complete line of test equipment for precise measurements in the Microwave region.

This equipment, the finest obtainable anywhere, includes Frequency Measuring Devices, Signal Sources and Receivers, Attenuators and Terminations, Impedance Measurement and Transformation Devices, Detection and Power Measurement Equipment, Bolometers and Accessories.


When you test,
use the best—

PRD


QUALITY

DEPENDABILITY


ACCURACY



TYPE 250-A BROADBAND PROBE — Frequency range of 1 to 12.4 Kmc/s; two tuning knobs permit precise adjustment for maximum power transfer from the probe tip to the crystal or bolometer detector; third knob controls depth of probe tip insertion.



SLOTTED SECTIONS—The mechanical and electrical design of PRD slotted sections emphasizes these important features: Instrument accuracy assured indefinitely by virtue of three bearing carriage suspension to minimize wear; waveguide section machined from solid aluminum alloy stock, to avoid warpage no castings are used.



TYPE 275 VSWR AMPLIFIER — Featuring high gain; A.G.C. to maintain output constant for slow variation in r-f power source; low input noise level of 0.03 microvolts; wide VSWR ranges of 1:1.3, 1:3, 3:10, 10:30, and 30:100; greater accuracy because VSWR scale on meter is linear.

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D-7 — no obli-
gation.



Polytechnic RESEARCH & DEVELOPMENT COMPANY, Inc



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WESTERN SALES OFFICE:
741 1/2 NO. SEWARD ST., HOLLYWOOD 38, CALIF.

CIRCLE ED-25 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products...

Magnetic Material

Has High Coercive Force

"Cromag", a ceramic Permanent Magnet Material, features magnetic and physical potentials applicable in numerous fields. It requires no critical raw materials and is therefore not limited in quantity.

Lightweight and magnetically hard, the material has very high coercive force and at the same time has a suitable residual induction to cover a wide variety of applications. Its stability makes it useful in high demagnetizing fields. In high frequency applications it shows a very low and minimum proximity effect on associated circuitry.

This powdered material is fabricated by powder metallurgy methods adaptable to pressing in a wide variety of intricate shapes with no machining necessary. In addition, it can be supplied in long rods, tubes, square, rectangular, or other shapes. Henry L. Crowley & Co., Inc., Dept. ED, West Orange, N. J.

CIRCLE ED-26 ON READER-SERVICE CARD

Rosin Flux

Insulates as it Bonds

Insulation characteristics comparable to polyethylene have been combined with fast "take" in the "Lonco" Insulating Rosin Flux. This flux is devoid of any free acid and is completely noncorrosive. These features make the material especially useful in the dip tinning of printed circuits and in the elimination of breakdown due to corrosion in the soldering of delicate u-h-f components.

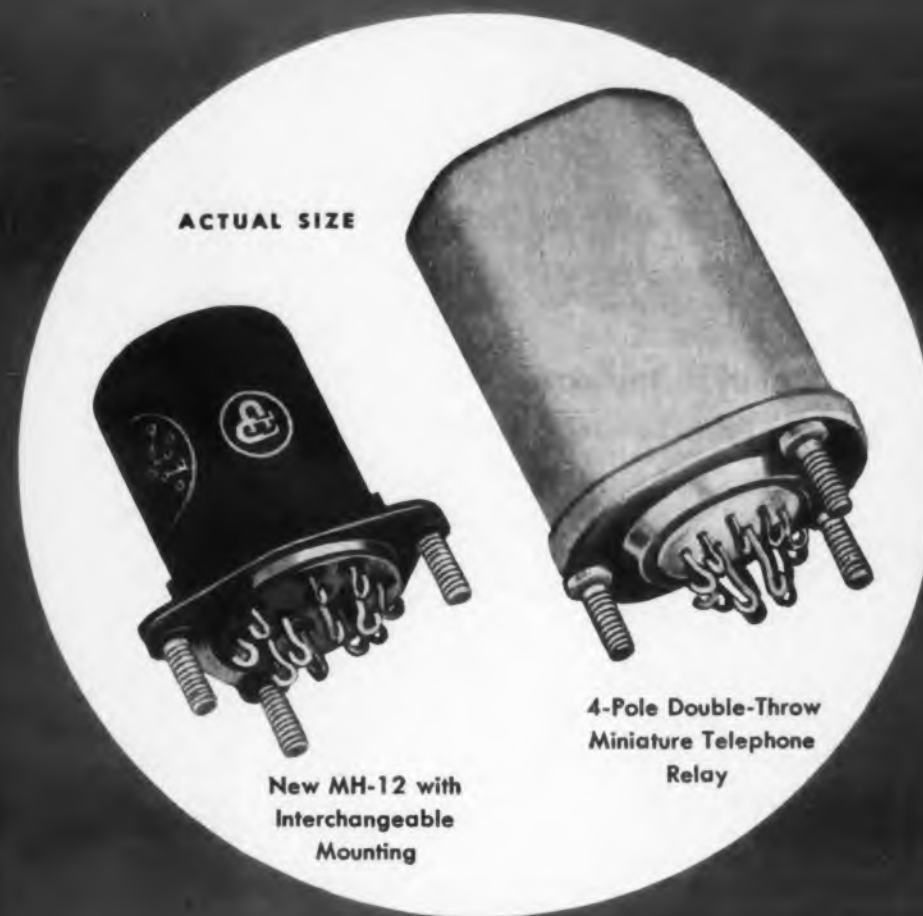
Another feature is the material's resistance to high temperatures, which enables it to withstand prolonged application of heat in soldering through badly oxidized copper surfaces and hard-to-bond metals and alloys, such as cadmium, nickel, and nichrome steel. London Chemical Co., Inc., Dept. E12, 325 W. 32nd St., Chicago 16, Ill.

CIRCLE ED-27 ON READER-SERVICE CARD

ALLIED CONTROL'S

NEW

- ✓ SIZE CUT 66%
- ✓ WEIGHT CUT 48%
- ✓ RELIABILITY DOUBLED
- ✓ WRIGHT FIELD APPROVED



Designed to withstand a shock of 50G, these new Allied Control double-throw miniature relays were developed to meet the rigid requirements of U.S.A.F. Specifications MIL-R-5757A.

Known as the Allied MH series, this new line of relays consists of the 6-pole MH-18, the 4-pole MH-12, and the 2-pole MH-6. Contacts are rated at 2 amps resistive or 1 amp inductive at 28 volts D. C.

The high performance of these relays has been achieved

in an extremely compact, unitized construction and parallels the most recent advances in airborne equipment design. The "actual size" photographs shown above highlight the 66% savings in overall size, the 48% savings in weight and the 30% reduction in chassis area.

For detailed specifications and drawings of these new relays, contact your local Allied Control Representative or write us for Bulletin 1002.

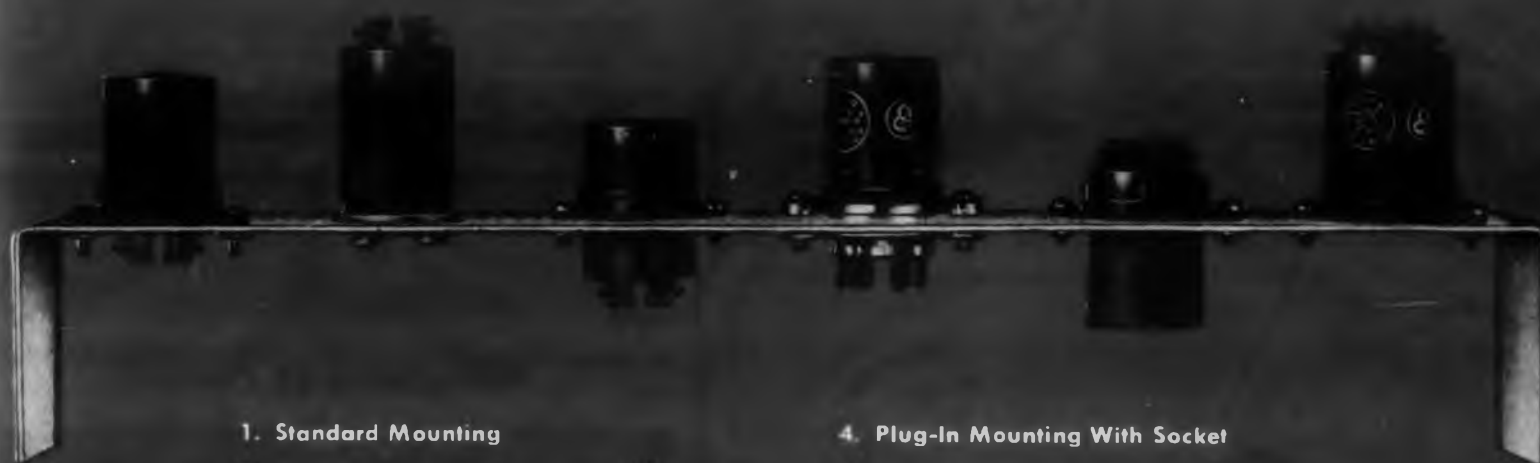
CIRCLE ED-28 ON READER-SERVICE CARD

W

50 G MINIATURE RELAY

APPROVED MIL-R-5757A

SIX DIFFERENT MOUNTINGS



1. Standard Mounting
2. Flush Mounting—2 Studs at $\frac{5}{8}$ " Centers
3. Thru-Chassis Mounting—Terminals Down
4. Plug-In Mounting With Socket
5. Thru-Chassis Mounting—Terminal Up
6. Flush Ring Mounting



FEATURES

Wide Ambient Temperature Range: 55°C to 85°C standard—65°C to 125°C MHB-type

Vibration Resistant: 15G's vibration to 500 cycles • **Operating Shock:** no contact chatter to over 50G's

High Altitude: seal-tested to 70,000 feet

Dependable Operation: life expectancy of over 1 million operations at rated load

High Speed: operate-to-make time under 8 ms.

release-to-make time under 4 ms.

release-to-break time under 2 ms.

ALLIED CONTROL COMPANY, INC.

2 EAST END AVENUE, NEW YORK 21, N. Y.



Gasket Material

Radio and TV Shield

A highly conductive Gasketing Material has been developed for shielding radio and TV equipment. It is said to be effective even under difficult conditions of high receiver sensitivity and low signal strength.

The material consists of aluminum wire screening whose interstices are filled with neoprene. Both surfaces of the material are buffed to insure uniform gage and smoothness, and to expose the aluminum wire so that it will make good electrical contact with the flanges.

The gasketing is intended primarily for mounting electrical equipment in automobiles and aircraft, and for general use in radio, TV, and other electronic equipment. The good electrical conductivity of the aluminum wire permits static electricity to drain through the gasket.

Additional features of the material include dimensional stability and resistance to deterioration. It can be supplied either in the form of cut gaskets or as uncut sheets 19" long x 15" wide, and 0.02" thick. Vulcanized Rubber & Plastics Co., Dept. ED, Morrisville, Pa.

CIRCLE ED-29 ON READER-SERVICE CARD

Plastic Tubing

For Low Temperatures

"Airflex" No. 6904 is a clear Plastic Tubing developed for use in military and commercial aircraft, guided missiles, and airborne electronic equipment insulation applications.

Approved under the new specification MIL-I-7444A (USAF), this material is especially adaptable for use on equipment operating at extremely low temperatures and can be widely applied as both primary and secondary insulation.

In addition, the material is fungus resistant. It can be used as wire harness sheathing, as a wiring conduit where abrasion resistance is needed, and as a fluid drain or transfer medium. Irvington Varnish and Insulator Co., Fibron Div., Dept. ED, Irvington, N. J.

CIRCLE ED-30 ON READER-SERVICE CARD

ON READER-SERVICE CARD FOR MORE INFORMATION

MAGNETIC AMPLIFIERS

"MotoMag"
A Division of Keystone Products Co.

Keystone has an answer for your servomechanism problems with their line of "Moto-Mags". With our packaged Magnetic Amplifiers you will find that "Moto-Mags" are capable of saving valuable design time and costs.

The units being manufactured at this time are for 400 cycle power. Why not investigate the possibility of using "Moto-Mags" in your systems today. Full literature will be sent upon request.



KEYSTONE PRODUCTS COMPANY

904-6 TWENTY-THIRD ST. • UNION CITY 9, NEW JERSEY • UNion 6-5400

New Products...

Variable Inductors For Video Peaking in Amplifiers



This series of variable, slug-tuned Inductors, both solenoid and pi wound, are especially suited for use as video peaking inductors in amplifiers where electrical performance, miniaturization, and reliability are essential.

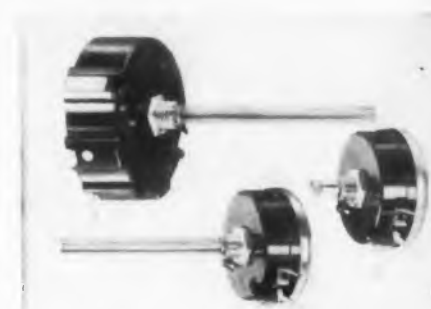
They can be furnished in many standard values.

Designated as the Series IT-123CS (solenoid) and the Series IT-123CP (pi), these units are wound on forms of Series FM-3001 black nylon with slugs of "Pyroferrie" P-4399. Design center induction range for solenoid types is 1 to 100 μ h and for pi windings 100 to 20,000 μ h. Industrial Television Inc., Dept. ED, 359 Lexington Ave., Clifton, N. J.

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

Potentiometer Controls Designed for TV Applications

Three TV Controls, Types 4WK, 4WS, and HV, have been added to the company's line. Type 4WK, a universal, 4w, wire wound control especially designed for TV service, comes



equipped with a knurled, flatted, and grooved master shaft to fit most knob requirements without modification, except for cutting to required length. Specifications include a 1-3/4" diam, 11/16" depth behind panel, a 1/4" bushing, and a shaft length of 3".

Type 4WS is identical to Type 4WK except that it comes equipped with a short, knurled, slotted shaft 5/8" long. Type IIV is a 2w carbon-element, high-voltage unit for use in TV receivers using picture tubes requiring electrostatic focus. It also comes equipped with a knob master shaft, and its specifications include a 2-11/64" diam, a depth behind panel of 25/32", a bushing of 1/4", and a shaft length of 3". International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

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



Germanium Transistors and Diodes

POINT CONTACT TRANSISTORS

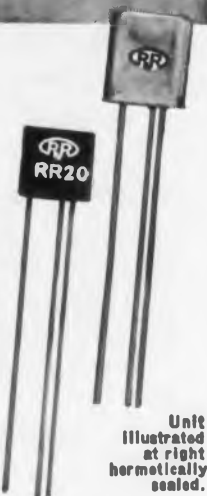
Available in a variety of stable controlled types suitable for both fast and medium speed switching circuits and high frequency amplifiers.

JUNCTION POWER DIODES

Useful in power supplies, magnetic amplifiers and telephone systems, etc., they have the characteristics of large plate-type power rectifiers and size and weight of a small circuit component.

PNP JUNCTION TRANSISTORS

Tiny, stable high gain units, most economical of power, may be soldered in place or socketed in a recommended RTMA transistor socket. Suitable for audio amplifiers, servo amplifiers and transformer coupled carrier amplifiers. In plastic or hermetically sealed in metal and glass.



Unit illustrated at right hermetically sealed.

Coming Soon...

JUNCTION POWER TRANSISTORS
PHOTO TRANSISTORS

Our engineers will be glad to offer suggestions regarding your Germanium Transistor and Diode applications without obligation... Write to Section ED-1.

Seletron and Germanium Division

RADIO RECEPTOR CO., INC.

Since 1922 in Radio and Electronics
Sales Dept.: 251 W. 19th St., New York 11, N. Y.
Factory: 84 North 9th St., Brooklyn 11, N. Y.

CIRCLE ED-35 ON READER-SERVICE CARD FOR MORE INFORMATION

"IMPROVED" INTERLOCK SWITCH

The newly improved MODEL 2A airflow interlock switch now replaces the model 2 switch. Simultaneously Rotron releases this new "DETERMINATOR KIT", which allows quick determination of appropriate actuator vane size as well as evaluation of turbulence and other peculiarities of airstream.

NEW!

"DETERMINATOR KIT"



WRITE FOR LITERATURE AND PRICES

(If you already subscribe to our catalog service this material being mailed to you without further request.)

ROTRON MANUFACTURING CO.

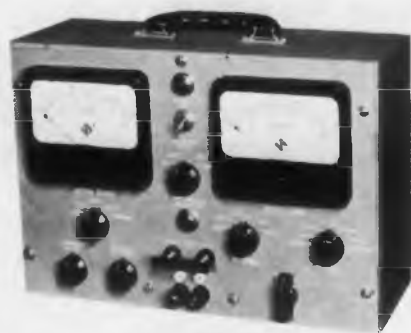
WOODSTOCK, N. Y. SCHOONMAKER LANE

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

ELECTRONIC DESIGN • August 1953

Diode Tester

With Minimum of Operations



The Model DT-100 Diode Tester is designed for measuring the static characteristics of germanium and low-power selenium diodes, including the power type germanium diodes. Separate

forward and reverse power supplies having continuously variable outputs or pre-set regulated reverse potentials permit complete measurements or checks at selected operating points. This arrangement provides accurate results with a minimum of operations.

Features include a forward voltage supply continuously variable from 0.05v to 2.0v d-c at a maximum current of 500ma d-c; a reverse voltage supply continuously variable from 0 to 150v d-c, with three pre-set potentials of 10v, 50v, and 100v d-c provided; a 3-position, spring-return switch allowing rapid transfer from forward to reverse test positions and returning to neutral; an automatic overload circuit for detecting shorted or reversed diodes and limiting current to a safe value; and an oven to permit testing diodes at elevated temperatures. Teletronics Laboratory, Inc., Dept. ED, 54 Kinkel St., Westbury, L. I., N. Y.

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

Meter Shunt Box

Converts Voltmeter to Ammeter



The Type MV-121 Shunt Box converts the company's Model MV-12A voltmeter, into a very sensitive a-c ammeter covering a wide frequency range. This instrument is particularly useful if an

oscilloscope is plugged into the output terminal of the a-c voltmeter for the observation of wave-shapes of the current, and is generally useful in a-c instrumentation.

Specifications for the device include a frequency response of 1μamp to 3 amp within 0.2db, a range of 20cy to 250ke for the lamp range, and 20cy to 100ke for the 3amp range. Millivac Instrument Corp., Dept. ED, 444 Second St., Schenectady 6, N. Y.

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

Another FLASH-O-LENS at work ...checking soundness of welds at INTERNATIONAL HARVESTER



By lighting and magnifying welded parts with FLASH-O-LENS, International Harvester Company's Memphis Plant guards against the most minute cracks in the welds.

FLASH-O-LENS offers a quick, simple way of detecting defects—of maintaining product quality. Built-in bulb brightly illuminates the inspection area—accurately ground lenses give sharp, detailed enlargement.

Battery and plug-in models from \$10.65. Write for free literature on applications, types, prices.

E. W. PIKE & COMPANY

NORTH AVENUE

ELIZABETH 3, N. J.

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

'DIAMOND H' RELAYS

pack more performance into less space ...



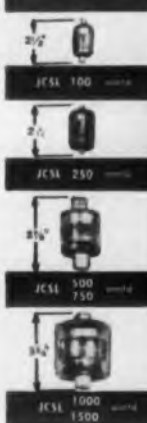
Rating for rating, "Diamond H" Series R hermetically sealed, miniature aircraft type 4PDT relays are smallest (1.6 cubic inches), lightest (3.76 ounces), have widest temperature range (-65° to +200°C.), greatest operating shock resistance (to 50 "G" and higher) and excel all others in their field in ability to break high currents and high voltages.

Ideal for high frequency switching, their inter-electrode capacitance is less than 5 micro-microfarads contacts to case, less than 2½ mmf between contacts, even with plug-in type relay and socket. Vibration range is from 0 to 500 cycles per second and upward at 15 "G" without chatter. Coil resistances up to 50,000 ohms are available, with contact loading through 10 A. resistive for 100,000 cycles (30 A. resistive for 100 cycles) at 30 V., D.C., or 115 V., A.C. Sensitivity approaches 100 milliwatts at 30 "G" operational shock resistance. They meet all requirements of USAF Spec. MIL-R-5757 . . . and far surpass many. Various standard mounting arrangements available. Write for Bulletin R-150 or ask for "Diamond H" technical assistance.

THE HART MANUFACTURING COMPANY
210 Bartholomew Avenue, Hartford, Connecticut

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

FIXED TYPE



INTRODUCING

**A FULL LINE OF
CLOSE SPACED
MINIATURE
FIXED AND
VARIABLE
VACUUM
CAPACITORS**

Rated at 3 KV and 5 KV

All copper construction
for
High amperage loads

Small physical size

Negligible power factor

Extremely wide capacity range

We invite your inquiries re-
garding specific applications.

LITERATURE MAILED ON REQUEST



JENNINGS RADIO MANUFACTURING CORP. 970 McLAUGHLIN AVE. P. O. BOX 1278 - SAN JOSE 8, CALIF.

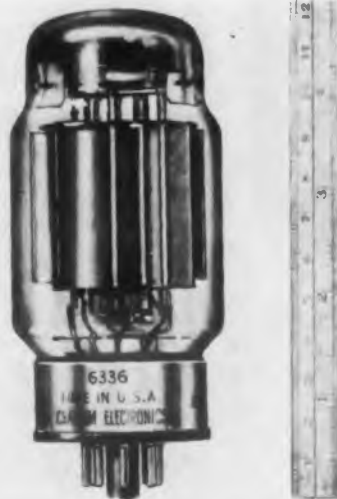
CIRCLE ED-41 ON READER-SERVICE CARD FOR MORE INFORMATION

VARIABLE TYPE



New Products...

Twin Power Triode For Voltage Regulation



grid bias of $-60v$.

Features include a hard glass envelope and an 8-pin butt stem. Characteristics of the device include a μ of 2.7, a G_m of $11,000\mu\text{mhos}$, a plate resistance of 250 ohms, and a life of 1000 hours minimum. Forced ventilation is not necessary at ambient room temperature. Chatham Electronics Corp., Dept. ED, Livingston, N. J.

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

Test Adapters

Permit Above Chassis Testing



In addition to its 7-pin "Test Adapter," a 9-pin Miniature Test Adapter and an 8-pin Octal Test Adapter have been added to the company's line. Tubes are plugged into these units, which then are inserted into tube sockets on the chassis to permit rapid and convenient above chassis testing of tube circuits.

These units find ready use for circuit designers, especially where it is inconvenient to get to the underside of equipment chassis. The low-resistance, silver-plated base pins and test points assure positive contact, and the units are easily inserted into tube sockets. CBS-Hytron, Dept. ED, Danvers, Mass.

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



IF it's a problem in
Precision Potentiometers

**...Helipot
HAS THE ANSWER!**

World's largest manufacturer of precision potentiometers

HELIPOT offers a unique combination of unequalled "know-how", advanced manufacturing facilities and experienced personnel for solving your particular problems in the application of precision potentiometers to modern electronic circuits.

Suppliers to both Government and industry, HELIPOT has developed high speed winding, assembling and testing equipment that combine custom-built precision with mass-production economies. Multiple and single-turn designs... single and double shaft extensions... ganged assemblies... custom-spaced taps... multi-turn dials... these and many other special features are part of the daily output at HELIPOT!

If you have a problem requiring precision potentiometers, bring it to HELIPOT Corporation—world leader in its field. A call or letter outlining your problem will receive immediate attention!

Write for Data File 824

Helipot
division

BECKMAN INSTRUMENTS, INC.
SOUTH PASADENA, CALIFORNIA

PLANTS IN SO. PASADENA, CALIF. AND MOUNTAINVIEW, N. J. REPRESENTATIVES IN PRINCIPAL CITIES

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



First in the field with ball bearing shaft supports as a standard production feature is the Model J Helipot. The single-turn "J" offers 1 oz. starting torque, continuous rotation, 3-way servo mounting, custom taps, 5 watts power rating, 50 to 50K ohms resistance, $\pm 0.5\%$ linearity. As many as 6 units can be mounted on one shaft and independently phased after installation. Send for complete data.

Radio-noise Filter for Bulkhead Mounting

Filterette No. 1613 1000 volts DC 5 amperes



This wide-band radio-noise filter is designed for connection in series with any single line that may be carrying radio interference. Hermetically sealed in a metal case, it is built to make use of the shielding afforded by metal bulkheads or firewalls. Installed in a $1\frac{1}{2}/32$ " hole in the bulkhead, Filterette 1613 has a mounting flange that completes the filter circuit to ground. External-tooth lockwashers are recommended between the mounting flange and the metal bulkhead to maintain low-resistance contact. This unit conforms to applicable military specifications, and is suitable for use at high altitudes.

TOBE DEUTSCHMANN CORPORATION
NORWOOD, MASSACHUSETTS

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

ELECTRONIC DESIGN • August 1953

PRECISION THREAD PROTECTORS

Custom Made
FOR SPECIFIC NEEDS...

- safeguard external and internal threaded surfaces.
- protect finely finished or lapped rods, tubing, etc.
- effectively seal out dust, dirt, moisture, grit, rust.
- re-usable for storage or intra-plant protection.
- serve as lubricant retainers... protect cable leads.
- spirally wound to within tolerances of .003 inch.
- compressed under heat of fibre, kraft paper or acetate.
- formed, crimped or perforated for irregular shapes.
- transparent where visibility is necessary or desired.
- can be imprinted with mfr's. name or part number.
- economical to use because of their low unit cost.



Add up all these advantages inherent in Precision Thread Protectors. Consider their practical value in offering definite protection, shipping and handling convenience, ready identification. It will pay you to investigate the many functional applications Precision Protectors have for your products.

Write today for full details.

PRECISION PAPER TUBE CO.

2055 W. Charleston St. Chicago 47, Illinois
Plant No. 2 — 79 Chapel Street; Hartford, Connecticut
Also Mfrs. of PRECISION Coil Bobbins and Paper Tubes.

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

Subminiature Tube Clamp Reduces Bulb Temperatures



These "Kool Klamps" Subminiature Tube Clamps have been developed for use under conditions of extreme heat, vibration, and shock. They reduce bulb temperatures, when used in miniaturized electronic

equipment, by as much as 40°C.

Constructed from a specially developed heat treatable alloy that is 99-1/2% pure silver, and with a thermal conductivity almost 70% of pure copper, the units provide maximum heat flow.

For wider application the units are available in 2 types: the "Clip Holder," designed to permit insertion of the tube from top or end; and the "Sleeve Holder," designed for end insertion only and preferred where overall height is critical. Birtcher Corp., Dept. ED, Valley Blvd., Los Angeles, Calif.

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

Low-Torque Speed Changer For Computers and Servo Systems



This ball and disk type "Integrator," essentially a high-precision, comparatively Low-Torque Speed Changer for generating variable reversible speeds in a smooth and stepless fashion, incor-

porates moving parts of hardened alloy steel. The device may be used for analog computers, servo mechanisms, and similar devices which require precise and smooth speed control with high accuracy and reproducibility.

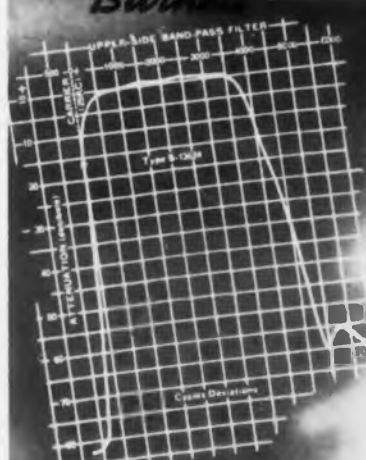
Of light weight, long life, and reasonable accuracy, the instrument is housed in a die cast case of anodized aluminum alloy. Hardened alloy precision steel disk and balls assure smooth operation with maximum accuracy and minimum wear.

The unit is very compact and weighs only 17 oz. At 750rpm input speed to the disk, the maximum output speed is 1500rpm. Output torque rating at this speed is 5 oz-in. Reflectone Corp., Dept. ED, Stamford, Conn.

CIRCLE ED-48 ON READER-SERVICE CARD FOR MORE INFORMATION

A New Approach in Economical Side-Band Filters

TOMORROW'S FILTERS TODAY IN COMMUNICATION NETWORK COMPONENTS

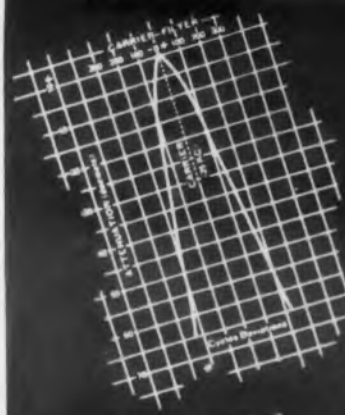


The elimination of space carrier and the improvement in reception attributable to its use, is still considered to be in its embryonic stage. Elimination of the duality of the modulation products, and the attainment of mono-band reception of the intelligence transmitted, has always been the apotheosis of communication engineers. Probably the greatest single factor that has precluded the rapid advancement of single side band systems, has been the excessive cost of the carrier and side band filters. Filters presently produced consist of a complex array of crystals and L. C. networks, which represents not only an expensive design but one not readily obtainable.

BURNELL & COMPANY'S new approach to this problem, not employing crystals, is based on the use of a system having a 25KC carrier and the exclusive combination of toroidal coils in a highly engineered assembly of temperature stabilized and temperature compensated components to produce the sharp-sided curve required in this system.

Burnell & Company
YONKERS 2, NEW YORK

A STEP FORWARD IN COMMUNICATION NETWORK COMPONENTS

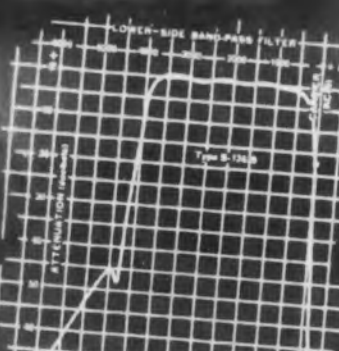


The use of the 25KC carrier is a major factor in the design of side band filters. It establishes a better ratio between carrier frequency and the cut off frequency of the filter with the aid of the 25KC carrier and miniaturized multi-layer toroidal cores, obviates the need for quartz crystals. The end result is a tremendous saving in size and weight. Burnell filters which are a fraction of the size of the former crystal filters. Typical dimensions are 1 1/2" x 6" x 2 1/2" and weight 1 1/2 lbs.

In offering these advantages BURNELL & COMPANY has taken not one but five steps forward by offering single side band filters which are: 1) LESS EXPENSIVE 2) MUCH SMALLER 3) MUCH LIGHTER 4) MORE RUGGED 5) MOST AVAILABLE

Burnell & Company
YONKERS 2, NEW YORK

OPENS NEW DOORS IN COMMUNICATION NETWORK COMPONENTS

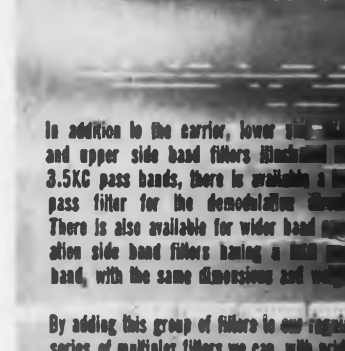


The potential demand for single side band equipment has up to now been restricted behind the "locked doors of frustration", so to speak, but we feel that we are helping to unlock these doors and release an even greater demand for side band equipment than we can now supply. The BURNELL system now eliminates all the objectionable features.

both civilian and military applications. In the latter field single side band systems were virtually prohibitive because of the inadequateness of crystal filters for field use. The BURNELL system now eliminates all the objectionable features.

Burnell & Company
YONKERS 2, NEW YORK

HIGH SPEED COMMUNICATIONS IN COMMUNICATION NETWORK COMPONENTS



In addition to the carrier, lower side and upper side band filters, Burnell filters which are a fraction of the size of the former crystal filters. Typical dimensions are 1 1/2" x 6" x 2 1/2" and weight 1 1/2 lbs.

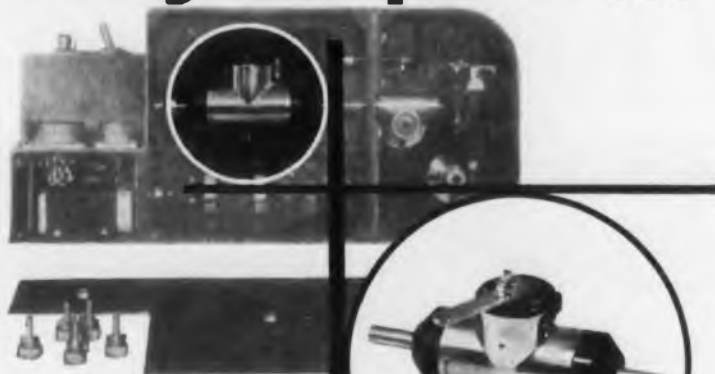
By adding this group of filters to our regular series of multiplex filters we can, with pride, state that BURNELL & COMPANY has gone a long way toward assisting the communication industry to develop high speed communication resulting from more efficient operation and greater freedom from interference.

If you are an engineer in 'communications', you will be interested in our brochure describing the BURNELL single side band filters in greater detail.

Burnell & Company
YONKERS 2, NEW YORK

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

Design Simplified...



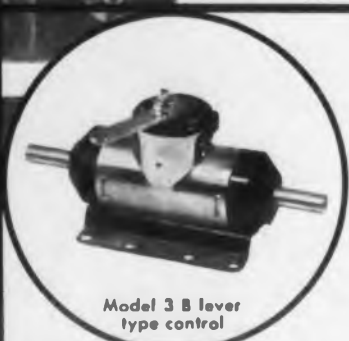
with the **Metron** VARIABLE SPEED DRIVE

- Permanently lubricated
- Your choice of 6 controls
- Speeds up to 10,000 RPM
- Nominal output .025 HP

• For further information about how Metron units can simplify your costly speed changing problems, write for Bulletin 99.



Metron



Model 3 B lever
type control

Design engineers at Century Geophysical Corporation make use of the Metron Variable Speed Drive to give them continuously adjustable chart speeds in their miniature oscillograph. Century engineers find that it is simpler and more economical to use Metron Miniature units as components than to design and build their own. Metron Variable Speed Drives are designed into countless products that call for changes in speed. The units are small—only 4 3/16" long—to fit minimum space. They are smooth and accurate in operation and cover infinitely variable output speeds from 5:1 step down thru 1:1 to 1:5 step up.

INSTRUMENT COMPANY
450 LINCOLN ST., DENVER 9, COLO.

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

Ceramic Coil Forms

A wide variety of ceramic coil forms is available from C.T.C. Made of grade L-5 silicone impregnated ceramic, they meet strict government specifications, come in the following sizes:

CERAMIC COIL FORM SPECIFICATIONS

Coil Form	Mounting Stud Thread Size	Form O. D.	Mounted O. A. Height
*LS1	8-32	.205"	1 1/32"
*LS6	10-32	1/4"	2 1/32"
*LS5	1/4-28	3/8"	1 1/16"
LS8	1/4-28	25/64"	2 1/32"
*LS7	1/4-28	1/2"	1 1/16"

*ALSO AVAILABLE as Type C with silicone fibreglas terminal retaining collars permitting 2 to 4 terminals. Type C forms excellent for bifilar windings, and for single pie windings, permit terminals to be located above or below winding thus shortening wiring to circuit elements. Type C also have twice as many soldering spaces.

Kit (X1897) containing three each of forms listed above is also available.

Wind these forms to your specifications, then let C.T.C. make them up for you in quantity.

For prototypes and pilot models, designers will also find the new C.T.C. (Type X2060) ceramic coil kit a handy aid. Contains 10 slug-tuned LS6 Type C coils with silicone fibreglas collars. Range: from 2 Microhenries to 800 Microhenries. Kit includes color-coded chart listing data of interest to designers. For details and prices, write Cambridge Thermionic Corporation, 457 Concord Avenue, Cambridge 38, Massachusetts.

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



Shown actual size. Type C on right.

New Products...

Plug-In Amplifier With Replaceable Tube Feature



This ERA Type 416D2 single-stage Plug-In Amplifier has been developed for a high voltage gain and independence of power supply voltage fluctuation. Its special feature is its ability to accept an unusually large amount of negative feedback without showing instability. The unit, which uses two replaceable tubes, yields a voltage gain of 8000 with the phase-shift of a single stage.

These features make it useful for analog computing systems and for a-c servo mechanisms, as well as for applications involving low-level, low frequency inputs such as obtained from thermocouples, strain gauges, and crystal and magnetic detecting devices.

Characteristics include an input impedance of 5 megohms; a voltage gain of 8000; an equivalent input hum of 20 μ v, (a-c filament, grounded grid); a maximum output of 28v rms; and a frequency response flat within ± 2 db over 2 to 1000cy without external feedback. Power supply requirements are 600ma, 6.3v filament supply and 0.5ma, 250v plate supply; and output impedance is 2500 ohms. Remington Rand Inc., Dept. ED, 315 Fourth Ave., New York 10, N. Y.

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

Insulating Material Resists Great Pressures

A flexible electronic Insulating Material, produced from polystyrene and designated "Styroflex", has many applications for the electronic designer, including use in low loss capacitors. The film does not have any of the brittle characteristics of other forms of polystyrene, but it does have the same basic electrical properties that have made polystyrene a widely accepted high frequency insulating material.

At temperatures below the softening point of 95°C the film resists great pressures without yielding and shows almost no plastic flow. Features include a compressive strength of 14,000psi and a high tensile strength of 10,000psi. The material is unaffected by moisture and adverse humidity conditions and is available in tapes of any length, from 1/4" to 10" in width, and in thicknesses of 0.0004" to 0.005." Natvar Corp., Dept. ED, Woodbridge, N. J.

CIRCLE ED-53 ON READER-SERVICE CARD FOR MORE INFORMATION

The Green Engraver

ENGRAVES
ROUTES
PROFILES
and MODELS

Used and endorsed by tool and die, electronic, machine, plastics, radio, electrical and instrument manufacturers. A real money saver.



Specify the Green Engraver for precision engraving on metal, plastics, wood, glass, hard rubber etc. . . . engraves panels, name plates, scales, dials, molds, lenses, instruments, instruction plates, directional signs . . . by simple tracing from master. Routing, profiling and three dimensional modeling indicate its versatility. Electric etching attachment available.

Special attachments and engineering service available for production work.

FREE: Brochure—yours upon request.



Green Instrument Co.
INCORPORATED

361 PUTNAM AVENUE · CAMBRIDGE · MASS.

CIRCLE ED-54 ON READER-SERVICE CARD FOR MORE INFORMATION

NYLON CABLE HANGER . . . high-strength clip resists temperature extremes, chemicals



Eleven standard diameter sizes accommodate single cables or bundles from 3/16" to 2". Several sizes have two or three-hole tongues, to permit diameter adjustment in installation.

Combining the best features of metal clips with the advantages of nylon, Burndy molded nylon cable hangers weigh 70% less than metal cable clips of comparable size, yet have sustained loads of more than 300 lbs.,

in the larger sizes. Extremely flexible, these nylon cable hangers are preformed, for ease of installation, requiring no shaping or forming on the job and retaining their shape permanently. Resistant to sustained temperatures from -60°F to 250°F, these cable hangers are also unaffected by oils, gasoline, alcohol, or hydraulic fluid. An insulator itself, this type of cable hanger cannot cause grounds or short circuits and is free from hysteresis losses. Smooth, rounded-edge, non-abrasive surfaces facilitate installation and prevent injury to insulation.

For information on Burndy nylon cable hangers, write Department D, BURNDY, Norwalk, Connecticut.

52-7

CIRCLE ED-55 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature Connectors

Precision, Light Weight Units



These compact, light weight, multiple contact Precision Miniature Connectors have been designed for such applications as aircraft, electronic instruments, telemetering, computers, audio and similar applications, as well as for portable airborne rack to panel and cable to

panel applications. The precision machined contacts are gold plated over silver for maximum conductivity and corrosion resistance. Their "floating" contact design facilitates "ease" in engaging and disengaging, and the guides provide positive polarization.

The connector bodies are of a highly precision molded melamine with raised barriers, which provide high resistance to arcing and heat, as well as longer creepage paths with excellent mechanical strength and high dielectric properties. The units are adaptable for use where higher voltages are required and wherever space is limited, and compactness and light-weight are essential. They are available with 14, 18, 20, 21, 34, 41, and 50 contacts. Gorn Electronics, Div. of Gorn Electric Co., Dept. ED, 883 Main St., Stamford, Conn.

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

Selenium Rectifiers

Rated to 130v a-c, 12ma d-c

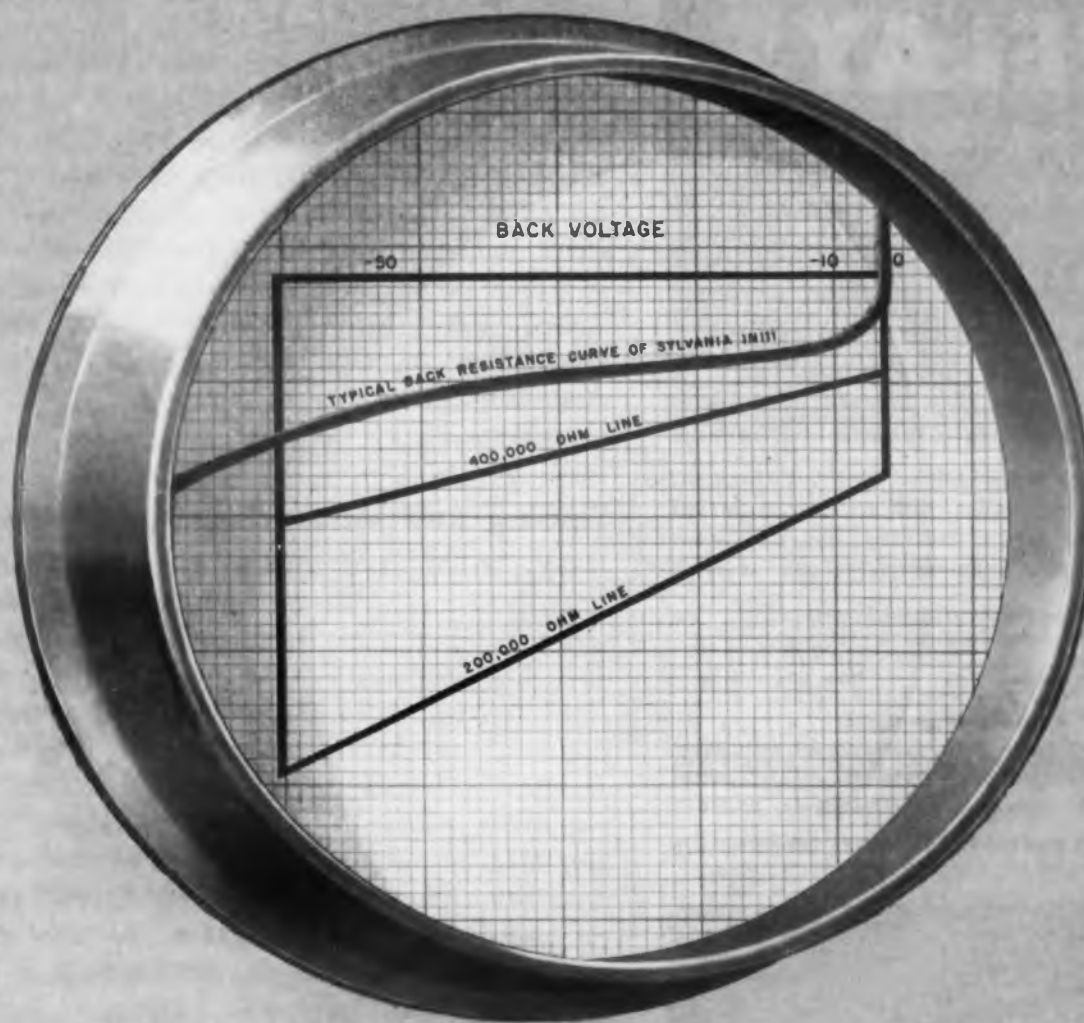


The Series SE3P hermetically sealed Selenium Rectifiers has been designed for use in d-c relays, bias supply, and surge suppressors. These units offer greater efficiency and much better heat dissipation than previous similar hermetically sealed units.

Rated up to 130v a-c, 12ma continuous d-c, the devices meet JAN and MIL specifications for high temperature, vibration, shock, and salt spray. Dimensions are 9/16" diam. x 7/8" long. Bradley Labs., Inc., Dept. ED, 82 Meadow St., New Haven 10, Conn.

CIRCLE ED-57 ON READER-SERVICE CARD FOR MORE INFORMATION

Sylvania Computer Crystal Diodes



1N111
1N112
1N113
1N114
1N115

All Dynamically Tested at 55° C. For High Back Resistance and Stability

Sylvania Types 1N111, 1N112, 1N113, 1N114 and 1N115 were designed specifically for computer use. All Sylvania's Computer Diodes are tested at raised temperatures simulating actual operating conditions. To insure maximum stability and life, all units are tested for

evidence of drift and hysteresis. Each diode is hermetically sealed in glass and is designed so that it may conveniently be soldered or clipped into a circuit.

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In Canada: Sylvania Electric (Canada) Ltd., University Tower Building
St. Catherine Street, Montreal, P. Q.

Sylvania Electric Products Inc.
Dept. 3E-4008, 1740 Broadway, New York 19, N.Y.
Please send me data sheets on Sylvania Computer Crystal Diodes.

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CIRCLE ED-58 ON READER-SERVICE CARD FOR MORE INFORMATION



MOTOR & CONTROL



ROTARY



MIDGET



Write for New
36 Page Catalog

ONE MILLION RELAYS

Over 1000 Types

24 HOUR DELIVERY FROM OUR STOCK!

- Standard, Respected Brands
- Brand New, Boxed
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- Priced to Your Advantage

Our relay stock, which is the world's largest, has been carefully built up over a period of several years. Nothing but first run, professionally selected items are carried.

Send us your relay requirements.
You will receive immediate quotations.

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SEley 8-4146

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DEPT. 14

CHICAGO 44, ILLINOIS

CIRCLE ED-59 ON READER-SERVICE CARD FOR MORE INFORMATION



NEW IDEAS IN MEASUREMENT

• Facts on stress, strain, vibration and other characteristics can help you improve the design and performance of your products. Brush instruments help you get design and operating data easily and quickly. The applications of these instruments and many new ideas that may help solve your particular measurement problems, are presented in this new booklet "Instruments for Modern Measurements". For your copy of this booklet write Brush Electronics Company, Dept. J-8, 3405 Perkins Avenue, Cleveland 14, Ohio.

BRUSH ELECTRONICS COMPANY

formerly
The Brush Development Company.
Brush Electronics Company
is an operating unit of
Clevite Corporation.



CIRCLE ED-60 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature . . .

Rosin Core Solder 61

A 4-page, 3-color brochure (No. 158), describes the company's RTS-200 rosin core solder, which is available in a wide variety of wire sizes, compositions, and quantities. The bulletin indicates five ways in which the solder exceeds ordinary solders: greater spread, faster oxide penetration, non-corrosiveness, non-toxicity, and stable flux. Federated Metals Div., American Smelting and Refining Co., 120 Broadway, New York, N. Y.

Testing and Measuring Equipment 62

GEC-1016A is a 64-page revised edition of the company's measuring equipment catalog, containing information on more than 115 testing and measuring devices for laboratory and production line use. This fully illustrated brochure contains information on products ranging from simple current indicators to completely automatic oscillographs; from surface roughness scales to mass spectrometers; from d-c amplifiers to radiation monitors. Included are a brief description of each item, its field of application, and condensed tables of important characteristics and prices. General Electric Co., Schenectady 5, N. Y.

Electroplated Gold 63

Scientific gold plating is described in a 4-page, 2-color technical data sheet. This thorough compilation of electrical, thermal, and chemical information on gold indicates the physical properties, as well as electroplating specifications, diffusion coefficients, optical properties, and applications of electroplated gold. Charts illustrate optical properties and the effect of gold concentration on current efficiency. Technic Inc., 39 Snow St., Providence 1, R. I.

X-Ray Analysis 64

An 8-page booklet, entitled "Twenty Questions and Answers on X-Ray Analysis", has been prepared specifically to clear up some of the prevalent misunderstandings concerning the difference in X-ray powder camera, spectrometer, and spectrograph equipment and techniques. Also explained are specimen preparation, application fields for each of the three X-ray diffraction methods, and calibration and selection of analyzing crystals for use with the spectrograph in analysis of specimens to determine what elements are present. Research & Control Instruments Div., North American Philips Co., Inc., 750 South Fulton Ave., Mt. Vernon, N. Y.

(Advertisement)

SHOCK AND VIBRATION NEWS



COMPLETE ENGINEERING DATA ON ALL-METL BARRYMOUNTS

The first really comprehensive bulletin on knitted-wire vibration isolators, Barry Product Bulletin, 534, is now available for distribution.

Full experimental data, taken under stated test conditions, and much of it in graph form, is presented: transmissibility curves for all directions of motion, at extremely high and extremely low temperatures, and after severe shock; isolation curves for acceleration and displacement; curves showing the effect of changed loading on performance; curves for selecting isolators to carry unsymmetrical loads; plus dimensions and construction data, weights, load ratings, and catalog numbers.

Here, for the first time, is the complete story on JAN knitted-wire vibration isolators. For your FREE copy, write for Barry Product Bulletin 534, to The Barry Corporation, 775 Pleasant St., Watertown 72, Mass.

CIRCLE ED-65 ON READER-SERVICE CARD FOR MORE INFORMATION

(Advertisement)

SOLA CONSTANT VOLTAGE TRANSFORMER — regulates $\pm 1\%$ with less than 3% harmonic distortion



Type CVH Sola Constant Voltage Transformers are designed for use with equipment that requires a source of constant, undistorted voltage. Regulation is $\pm 1\%$, distortion less than 3%.

They may be used for the most exacting applications such as general laboratory work, instrument calibration, precision VHF and micro-

wave testing, or other operations involving elements which are sensitive to power frequencies harmonically related to the fundamental.

Regulation is automatic, recovery is 1.5 cycles or less. There are no moving parts, no manual adjustments and every unit is self-protecting against short circuit.

These harmonic filtered SOLA Constant Voltage Transformers are available from your electronic distributor in the following capacities: 30va, 60va, 120va, 250va, 500va, 1000va, and 2000va.

Write for Bulletin P-CV-142 which describes the complete electrical and mechanical characteristics of SOLA Type CVH and other Constant Voltage Transformers.

SOLA ELECTRIC CO.

4633 West 16th Street, Chicago 50, Illinois

CIRCLE ED-66 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature ELASTIC STOP[®] nuts down to 0.109" across flats



NOW, miniature ELASTIC STOP nuts are available in sizes #0 through #4 in both SAE fine thread and USS coarse series—for special applications, such as electronics equipment and instruments. Smaller than any other self-locking nut they maintain a precise adjustment whether tightened against a seating surface or positioned at any point on a threaded member.

Nylon inserts make them self-locking, vibration-proof and re-usable, like all ELASTIC STOP nuts. They are simpler and less expensive to assemble than double nuts or soldered units.

WRITE FOR design information on Miniature Nuts and other special and standard ESNA fasteners. Address Dept. N38-857.



ELASTIC STOP NUT CORPORATION OF AMERICA

2330 Vauxhall Road, Union, N. J.

DESIGN HEADQUARTERS FOR SELF-LOCKING FASTENERS

CIRCLE ED-67 ON READER-SERVICE CARD FOR MORE INFORMATION

Top-liner
for Top Designers

PUSH BUTTON CASTELL
LOCKTITE HOLDER AND
CASTELL IMPORTED LEAD

- One-hand clutch operation avoids touching lead, smearing fingers or drawing.
- Exclusive collet holds lead in bulldog grip, prevents it slipping back into holder.
- Clean, balanced, efficient for every type of drawing, sketching, rendering, coloring.

CASTELL Imported Lead

18 degrees, 7B to 9H—gives more prints — cleaner and sharper prints — than any other drawing lead. Lasts 25% to 33 1/2% longer. Black or colored. Your Drawing and Art Supply Dealer has them.

the drawing pencil with the Master Degrees

AW FABER-CASTELL
PENCIL COMPANY, INC. NEWARK, N. J.

CIRCLE ED-68 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • August 1953

Thread Inserts

69

Bulletin No. 661 (2-page, 2-color) contains information on the company's wire thread inserts. The bulletin explains how the inserts of stainless steel or phosphor bronze protect tapped threads in aluminum, magnesium, die-cast metals, plastics, iron, steel, brass, bronze and wood. Photographs indicate the wide range of standard sizes, and also included is a description of the use of these inserts in design. Illustrated case histories present their design advantages in products such as terminal boards. Heli-Coil Corp., 1321 Shelter Rock Lane, Danbury, Conn.

Specialty Transformers

70

Booklet B-5806 is an 18-page, 2-color brochure describing the company's specialty transformers. Part I describes the standard line of units available "off the shelf". Complete details of transformer characteristics and construction are included for general purpose, machine tool, signaling, control, low-power pulse, and aircraft power types. Part II discusses units that can be built from basic components to fit specific requirements. The booklet closes with a section on testing techniques and a discussion of specialty transformer core developments. Westinghouse Electric Corp., 401 Liberty Ave., Box 2278, Pittsburgh 30, Pa.

Paper Capacitors

71

Bulletin AB-18 is a 4-page, 2-color brochure containing complete performance characteristics and test specifications on the company's "Meteor" high temperature, subminiature paper capacitors. Performance characteristics include information on operating characteristics, voltage rating, voltage derating, capacitance stability, and test conditions. Various types of units are described and illustrated. Astron Corp., 255 Grant Ave., East Newark, N. J.

Radio, TV Knobs

72

A 16-page catalog, No. 55, describes the company's stock knobs for radio and TV. Each type is illustrated, and specification data are included. Also described are items such as antenna mounts, extension jack and connector, a jumbo fuse holder, antenna plug, rotary switches, and heavy duty power switch. A price list is included. Gee-Lar Mfg. Co., 1330 10th Ave., Rockford, Ill.

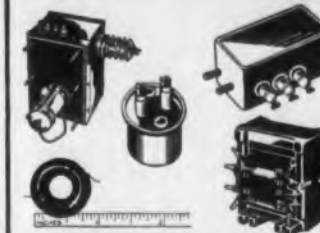
Coil Winding Tubes

73

A paper-bound catalog, consisting of data sheets, describes the company's coil winding tubes for Class A, B, and H applications in various combinations. Applications, physical and electrical qualities, and properties are indicated and illustrated by photographs and tables. Accurate Paper Tube Co., 809 N. Peoria St., Chicago 22, Ill.

FREED

TRANSFORMERS INSTRUMENTS



MILITARY COMPONENTS TO
SPECIFICATIONS MIL-T-27 & ANE-19
AND COMMERCIAL TYPES

Pulse Transformers
Filter Reactors
Charging Reactors
Saturable Reactors
Toroid Inductors
Low Pass Filters
High Pass Filters
Band Pass Filters
Discriminators
Plate Transformers
Power Transformers
Filament Transformers
Vibrator Transformers
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Interstage Transformers
Driver Transformers
Output Transformers
Modulation Transformers
Blocking Oscillator Transformers
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MEG OHMMETER
DIRECT READING

Self-contained and A.C. operated with electronically regulated supply. 1 megohm to 2 million megohms.



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New Literature...

Microwave Equipment 77

The company's line of microwave instruments and components is described in a 4-page, 2-color bulletin. Listings include frequency meters, mixers, impedance meters, attenuators, and other microwave items. Specification data for the various models are indicated, and photographs provide illustration. Nassau Research & Development Associates, Inc., 66 Main St., Mineola, N. Y.

Manufacturing Services 78

A 16-page booklet describes the company's facilities for precision manufacturing services, including melting and casting 3 to 25 pound ingots of special alloys, forging to bar and rod forms, hot and cold precision rolling of strip, slitting, processing and straightening special alloy wire, and heat treating of small parts. These services are illustrated by numerous photographs. Precision Mfg. Services, Hamilton Watch Co., Lancaster, Pa.

Feed-Through Bushings 79

Bulletin No. 153 (2-page, 2-color) describes the company's line of standard steatite miniature feed-through bushings for efficient low and high frequency equipment. Complete with some engineering data, specifications, and dimensional drawings, the bulletin describes those items which have been designed for government and commercial specifications. Thor Ceramics, Inc., 225 Belleville Ave., Bloomfield, N. J.

Power Supplies 80

An 8-page, 2-color foldover bulletin, No. L453, describes the company's line of magnetic amplifier regulated power supplies for laboratory testing applications. Information is provided on high voltage and low voltage instruments with regulations down to 0.15%. Specifications and special feature data are included, along with photographs and charts. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

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Radio and TV Tools 81

A wide assortment of tools for the repair and maintenance of radio, TV, and electronic equipment is contained in a 36-page reference guide. Reprinted from the large 1220-page catalog (Radio's Master), the guide contains detailed specifications, illustrations, technical and price data on tools made by 17 manufacturers. Included are TV alignment tools, chassis punches, pliers, screw and nut drivers, soldering irons and guns, tool kits, and wire strippers. United Catalog Publishers, Inc., 110 Lafayette St., New York 13, N. Y.

"Teflon" Components 82

The company's line of "Teflon" components is described in an 8-page, 2-color catalog. Included are high tensile molded rods, tubes, and sheets; extruded rods; extruded tubing; electronized rods; and custom moldings, machined parts, and shaved tape. Applications and properties for the material are listed with charts and diagrams. Ethylene Chemical Corp., Summit, N. J.

Test Chambers 83

A 4-page, 2-color bulletin describes the company's L-series of temperature, altitude, and relative humidity test chambers. The units described combine a temperature range from $+185^{\circ}\text{F}$ to -100°F , with relative humidity simulation from 20% to 95%, and altitude simulation from atmospheric pressure to 80,000'. Performance data are indicated, along with specifications, and an altitude-pressure-temperature curve. Bowser Technical Refrigeration, Div. Bowser Inc., Terryville, Conn.

Diodes 84

A 4-page, 2-color folder provides complete specifications for six of the company's temperature-limited diodes, whose special feature is their stable emission characteristic. Three of the tubes incorporate a safety feature by which filament failure closes an external high impedance circuit. All of the units are illustrated, and data include electrical and mechanical specifications, basing diagrams, etc. Thermosen, Inc., 361 W. Main St., Stamford, Conn.

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TYPE 32, (JAN-R-19, Type 8A28)
2 watt, 1 17/64" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19 including concentric shaft tandem construction. Attached switch can be supplied.



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(May also be used as Type 8A25)
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TYPE 62, (JAN-R-94)
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- DIELECTRIC STRENGTH equals 1,000 volts DC at sea level pressure and 500 volts at 3.4 inches of mercury.
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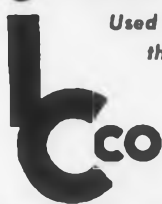
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10 VOLTS

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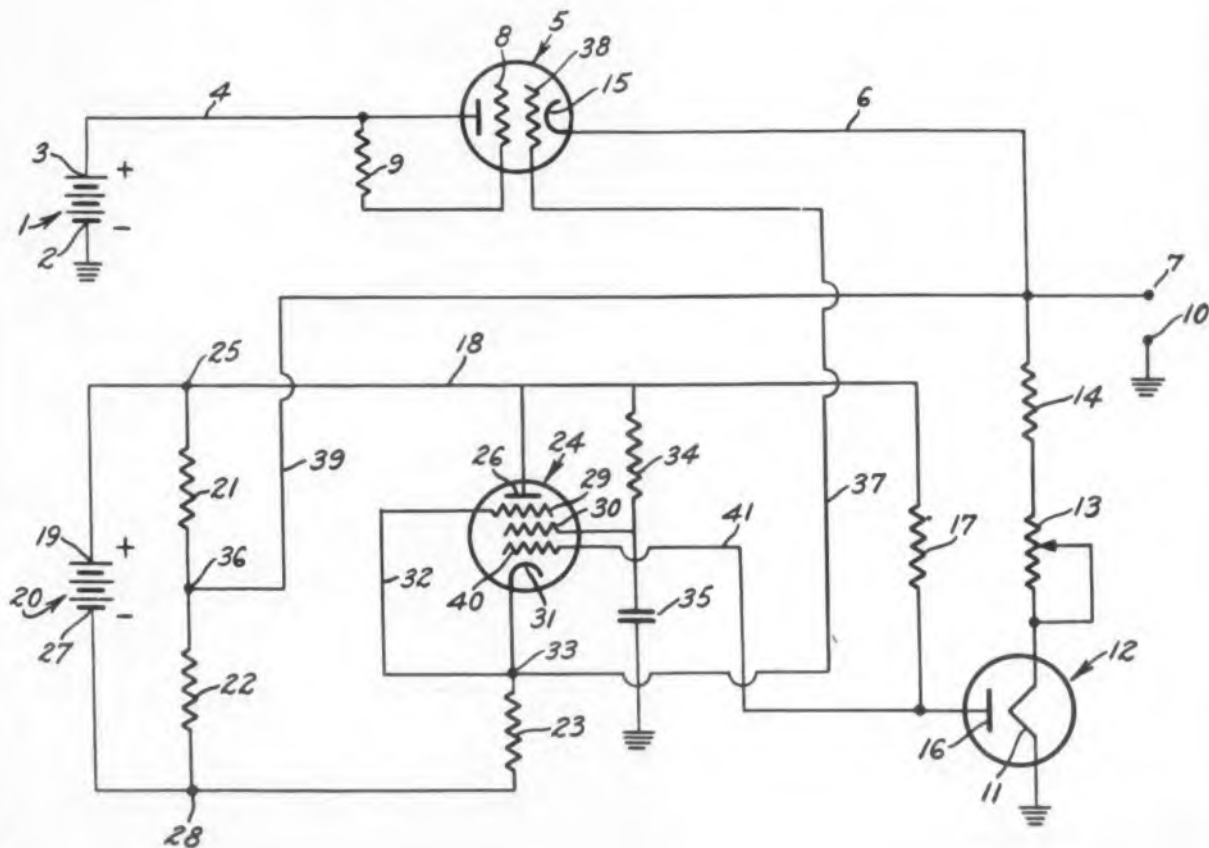
Patents . . . by John Montstream

Voltage Regulator . . . Patent No. 2,629,078. L. L. Helterline, Jr., South Norwalk, Conn. (Assigned to Sorenson & Co., Inc.).

A d-c voltage regulator which accurately controls the output voltage to the load at a substantially constant value over a predetermined voltage range is the subject of this patent. The voltage regulation is secured by a variable non-linear impedance between the power source and the output terminals.

The regulator controls the voltage at the output terminals (7, 10) which is fed from any d-c source (1) by varying the impedance of a tube (5) between the d-c source and the output. The tube (5) is controlled by the current flow through the filament (11) of a tube (12) which is connected across the output terminals. Should the voltage at the output increase, the current flow through the filament increases and its temperature is raised which in turn increases current flow through the tube and

Fig. 1. Circuit diagram of the voltage regulator mentioned above.



results in an increased voltage drop across the load resistor (17). This lowers the voltage on the control grid (40) of the tube (24) which is connected in one leg of a bridge with resistances (21, 22 and 23) forming the other legs.

With a lower voltage on the control grid of the tube (24), the current flow through this tube and the resistance (23) is reduced, and the voltage drop across the resistor is lowered unbalancing the bridge. Since the control grid (38) of tube (5) is connected at the junction (38), the voltage on this grid is lowered and current flow through the tube is reduced. This reduces the voltage at the output terminals. Should the voltage at the output decrease a reverse sequence of operation results to increase the voltage on the grid of tube (5) which results in an increase in the voltage at the terminals (7, 10).

Semiconductor Signal Translating Device . . . Patent No. 2,629,800. G. L. Pearson, Millington, N. J. (Assigned to Bell Telephone Laboratories, Inc.).

The purpose of this invention is to improve the performance of semiconductor signal translating devices, to simplify the structure thereof and to facilitate the making of such devices. The improvement is directed more particularly to rectifiers so as to increase their current carrying capacity and to photosensitive elements.

In making the crystal, an *N* type body is cut and subjected to a temperature of 900°C in a helium atmosphere for 24 hr after which it is cooled rapidly to room temperature. This produces a *P*-type body with an *N*-type film on all surfaces. The film is removed on one major surface by lapping. The major faces are then plated as with rhodium and an annular groove is provided in the face having the film, which groove extends through the plating and film into the crystal body to produce an *N*-type island. The groove may be etched to improve the reverse resistance of the *N*-*P* junction. The crystal may be mounted upon a brass block by soldering to the plating to form one terminal and a conductor is soldered to the plating of the island to form another terminal. The crystal constructed in this fashion gives high current capacity in the forward direction at relatively low voltage levels. The crystal rectifier is oper-

able also in the reverse direction up to about 45 volts.

For use as a photocell the crystal is constructed in the same manner except that the ohmic metallic coating on the island surface is omitted and electrical contact is made with the island by a point contact. The photosensitive response curve is sharply peaked with maximum response at a wave length of about 1.5 microns.

Contact for Semiconductor Devices . . . Patent No. 2,634,322. H. B. Law, Princeton, N. J. (Assigned to Radio Corp. of America).

Improvements in transistors are receiving considerable attention as shown by this patent. One of the problems with this new device is the considerable difficulty of securing the collector and emitter electrodes in close contact with the semiconductor which spacing is of the order of two mils. Another problem is the variation in pressure of the electrodes upon the semiconductor which variation introduces noise. In solving these problems it was found that point contact of the collector and emitter electrodes with the semiconductor was not essential so long as the contact resistance of these electrodes was high as compared to that of the base electrode.

In making the transistor, the surface of the semiconductor or crystal is etched as known to the art. The crystal is then heated in a vacuum to a temperature of less than 200° centigrade, the preferred temperature being about 100°, in order to outgas the crystal. It is then cooled and metallic electrodes are evaporated upon the surface of the crystal. The collector and emitter electrodes may be uniformly spaced from each other by using a masking technique, the spacing being from 1 to 5 mils. Electrical contact with the evaporated electrodes may be made in various ways.

A single evaporated electrode may be used provided one of the contact elements has a sharp tip so as to penetrate the evaporated layer and contact the crystal. It is believed that during operation a small portion of the metallic layer is removed so that the element is insulated from the layer although it has not been possible to observe this condition under a microscope. The patent covers the semiconductor in various forms as well as the method of preparing the crystal with its evaporated electrodes.

NOISE

in RESISTOR APPLICATIONS

NOISE in resistors may be caused by many factors, but most often arises in the incomplete or tangential contact which exists among the carbon granules that make up a molded resistor. Noise also originates where the connector leads meet the body of the resistor.

Because WELWYN High Stability Resistors are formed by depositing a pure, homogeneous carbon film, and because the end-caps are machine-turned and bond-fitted to the body, and the terminal leads clenched into the end-caps, the conducting path presented to any current flow is as continuous as if through a solid conductor. The noise factor of WELWYN Deposited Carbon Resistors is only slightly above that predicted by the Johnson formula.

For further information and Test Data concerning ...



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New Books . . .

Simplified Drafting Practice . . .
By William L. Healy and Arthur H. Rau. 156 pages. John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. \$5.00.

This is not a textbook on engineering drafting, but rather is intended to show how engineering and drafting organizations can save time and money by adopting and extending simplified drafting practices. The authors point out that although there has been much progress in design, engineering, and production, drafting has remained relatively unchanged. It still involves the same time consuming elaboration of detail that it did at the time of its inception.

The authors present a strong case, and after seeing some of the simplifications they suggest one can readily appreciate the great amount of simplification that is possible. The drawings are clear, and the simplification examples are numerous. The design engineer will find this book worth while reading, and will probably have a hard time keeping the drafting department from "borrowing" it.

Audio Amplifiers and Associated Equipment — Vol. 4 . . . Paper bound, 352 pages. Howard W. Sams & Co., Inc., 2201 East 46th Street, Indianapolis 5, Ind. \$3.95.

This is a continuation of the publisher's series of audio amplifier manuals which gives detailed servicing data, parts lists, and specific information on some 60 chassis (75 models) of audio amplifiers and associated equipment produced during 1951 and 1952.

From the electronic designer's point of view this compilation of data presents a valuable collection of examples of commercial audio amplifier designs, including circuit diagrams, underside views of chassis views, etc. The electronic designer who happens to be an audio enthusiast will certainly find the book interesting although he probably would prefer to have brief discussions on the unusual features of each amplifier which unfortunately are not included.

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DC to 5 MC
5 cycles to 10 MC

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Model OA-16 . . . an extremely versatile instrument having d.c. amplification with extended high-frequency response and sweeps ranging from seconds to microseconds.

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- Bandwidth—from d.c. to 5 megacycles
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Each instrument is contained in a blower-cooled steel case 13 $\frac{1}{4}$ " wide, 15 $\frac{3}{4}$ " high, and 22" deep. Case and panel are finished in green, with knobs and markings in frosted aluminum. Prices, complete with tubes:

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Model OL-23\$890.00

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Model OL-23 . . . combines the functions of an oscilloscope and a synchroscope for observing repetitive phenomena or single transients. Broadband amplification, fast sweeps, and high beam-accelerating potential make this 'scope particularly desirable in observing and measuring steep wavefronts and fast pulses.

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ELECTRONIC DESIGN • August 1953

Readers Comment . . .

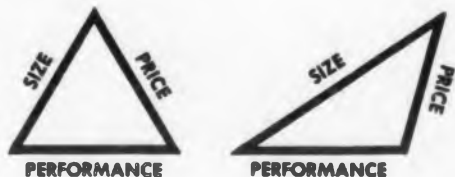
Dear Sir:

Your editorial in the June issue stirs up a fundamental question which has plagued designers through all history of our productive resources. I for one have lived with the problem well over 20 years. No magic formula has come my way. However, there are a few thumb rules, which, if applied judiciously, avoid heartaches and save money.

When a design project is organized, the "top brass" must set up some boundary limitations within which the designers are given reasonable freedom. This provides professional stimulus to bring out the designer's talents.

The boundary limitations are obtained from the answers to three basic questions: (1) What price? (2) How good? and (3) How big?

When arranged graphically these take the form of an equilateral triangle.



Any changes which disturb the proportionality of this triangle should receive rigorous examination before adoption. For example, a change to the original specification may seem attractive for a price reduction. If adopted, the boundary triangle changes from equilateral to scalene.

However, the dream of something for nothing is only for fools to seek. The physical laws of Nature have an uncompromising exigency. Every change must be compensated for.

The scalene triangle clearly indicates an ugly disproportion between size and performance. Whether or not this is wise depends on the ultimate use of the equipment. It would be acceptable on appliances, or certain automatic tools, replacement of which can be made at leisure, without endangering human life. On the other hand, it would be irresponsible dishonesty to accept such a change on aircraft equipment, or any automatic electronic controls used for supervisory application on expensive machinery.

When shall design be frozen? At the very beginning a decision must be made. It is either an equilateral triangle, or a scalene one. After the proportionality-price, size, and performance is decided upon, the first prototype is made. As soon as the prototype passes all performance tests, the design is released "as is"; but only for a pilot run. This brings out the overlooked production considerations.

Meantime designers have become acquainted with the patched up adjustments that were necessary to

PORTABLE OSCILLATOR



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**SOUTHWESTERN INDUSTRIAL
ELECTRONICS COMPANY**

Readers Comment ...

meet performance test requirements. A variety of suggestions for design changes on final model will have to be carefully appraised. It is at this point that the courage, vision, and ingenuity of the designer get the supreme test.

The changes to be adopted must be classified according to a preconceived method of appraisal. For example—

First priority—Changes necessary to meet performance test requirements.

Second priority—Changes desirable to improve appearance, but which do not affect performance or procurement of raw material.

Third priority—Changes desirable to improve appearance and performance above test requirements, but affecting procurement of raw material.

Fourth priority—Changes desirable only on future production.

The items to be included in the pre-

conceived method of appraisal depend, of course, on the size of the plant, facilities for tooling, distance from suppliers, and kinds of products handled.

These ideas are too broad to offer a magic solution to the pressing problem of when to stop designing. Coupled to experience, they may provide useful orientation to steer away from impractical goals and frustration.

John J. Rivera

Federal Telephone & Radio Corp.
Clifton, N. J.

Dear Sir:

Your June 1953 issue editorial was of great interest to me. My professional activities have had an unusually wide range in many fields and with wide personal acquaintanceships.

Generally, whenever a condition such as stated exists, the major fault is on the executive level; and usually

because the designer, assuming his competency, is forced to make too many compromises because of time, economic, and in some cases executive bull-headedness pressures.

A design is ready for production whenever the executive wants it to be so and is willing to take the chances on its performance in the field. What really happens is that the executive does not wish to take chances although economic pressure forces him to do so to some extent. The designer well knows that future trouble will be assigned to something on his part, even if it resulted from executive judgment error.

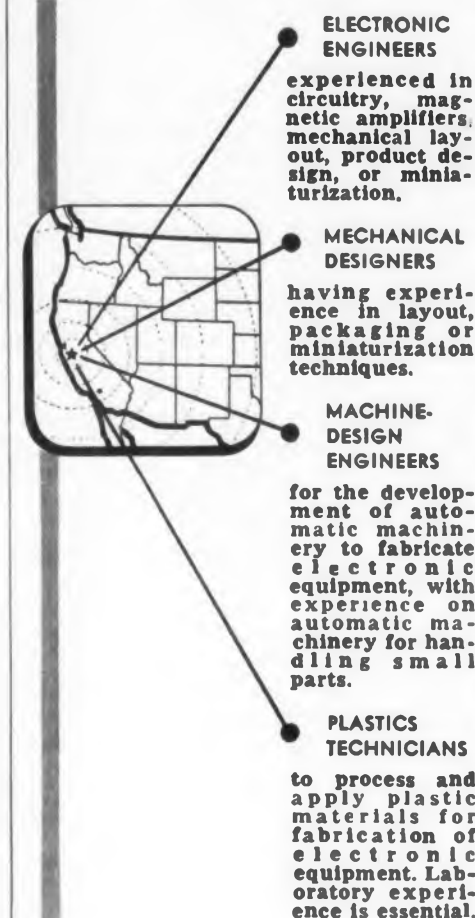
Apparently the electronic field is plagued with the same problem as in the mechanical field where the saying originated: "There comes a time to shoot the engineers and start production."

A. F. Hoesel

Blue Electric Co., Chicago 21, Ill.

YOUR Professional Plans and SRI

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10 amp. 125 volts
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AC—5 amp. 125 volts (at 0.75 PF)
3 amp. 125 volts (lamp load)
DC—5 amp. 30 volts (non-inductive load)
1 amp. 125 volts

Overload
50 cycles—30 amp.
125 volts (non-inductive load)

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CIRCLE ED-95 ON READER-SERVICE CARD FOR MORE INFORMATION

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