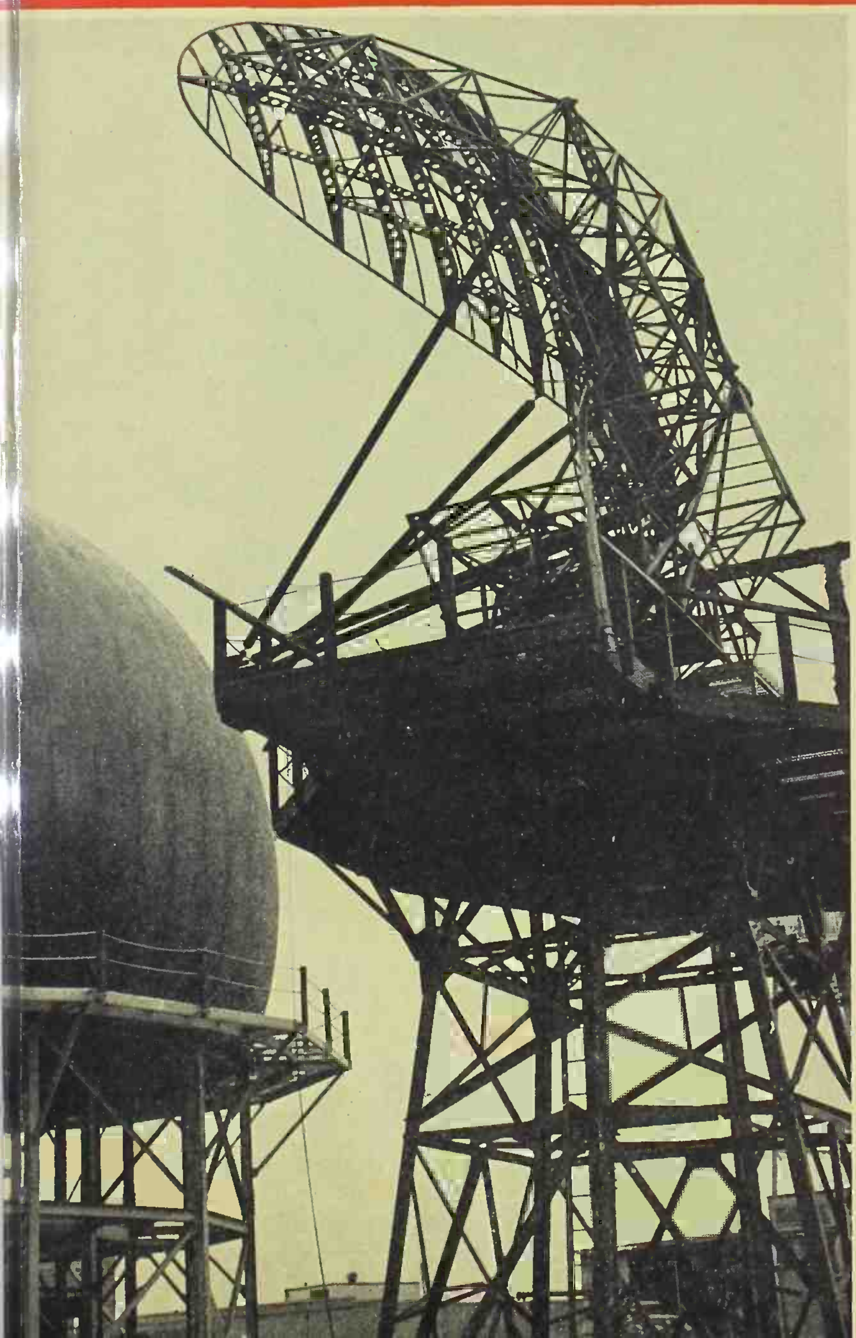
RADIO-ELECTRONIC Engineering SECTION

RADIO & TELEVISION NEWS

Reg. U.S. Pat.Off.

TELEVISION • RADAR • ELECTRONICS • RESEARCH • COMMUNICATIONS • MICROWAVES



DECEMBER, 1951

MULTI-STABLE MAGNETIC MEMORY TECHNIQUES
3

MULTIVIBRATOR FREQUENCY DIVIDER
6

AMPLITUDE DISTRIBUTION ANALYZER
8

RECENT ADVANCES IN MEDICAL ELECTRONICS
11

SQUARE WAVE STIMULATOR FOR CARDIAC RESEARCH
14

NEW MINIATURE I.F. AMPLIFIER
16

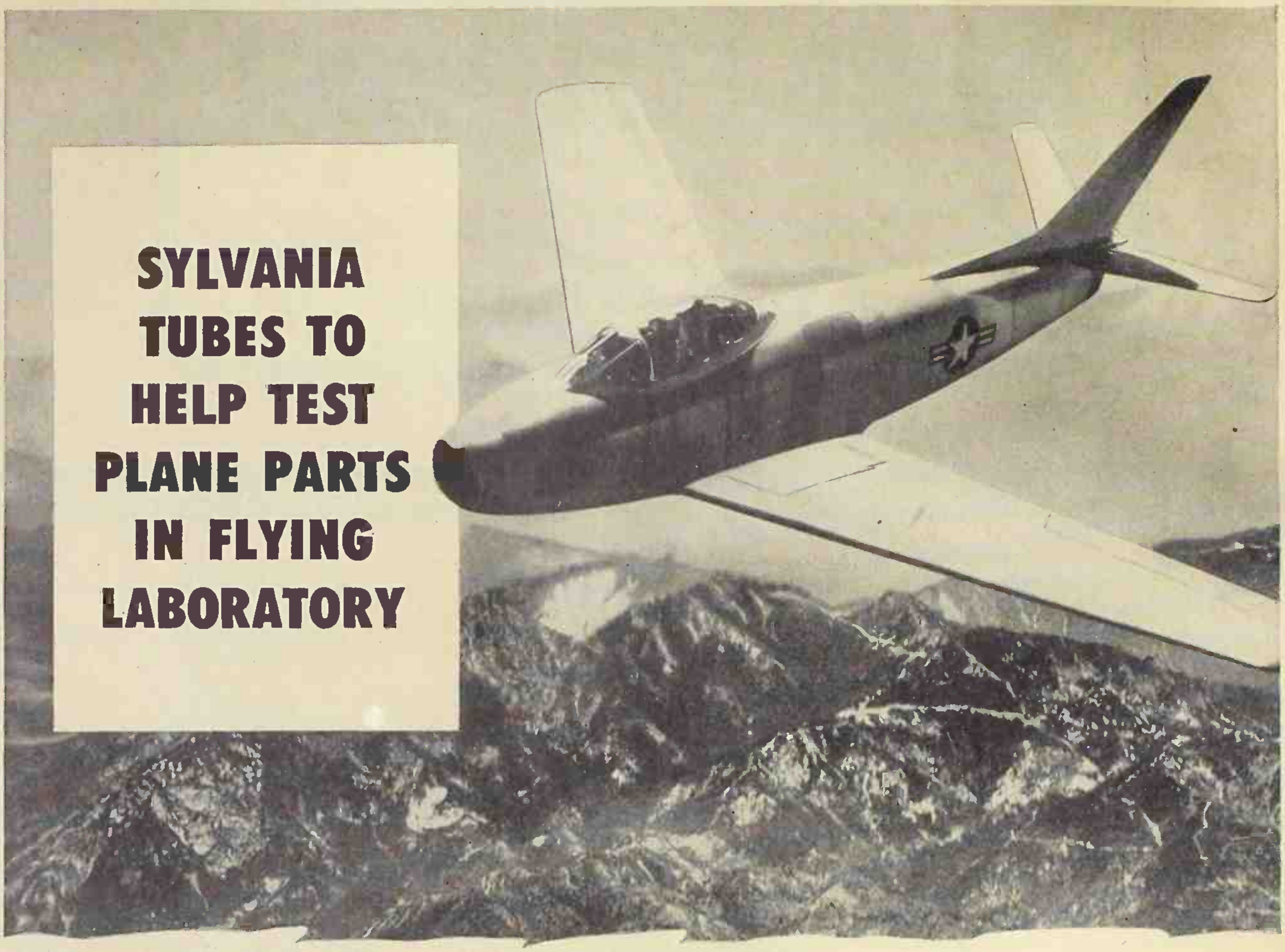
SQUARE WAVE GUIDE ATTENUATION
32

DEPARTMENTS

NEWS BRIEFS 18
NEW PRODUCTS 20
PERSONALS 22
PATENT REVIEW 24
TECHNICAL BOOKS 26
CALENDAR 28
1951 INDEX 30

RADIO-ELECTRONIC ENGINEERING is published each month as a special section in a limited number of copies of RADIO & TELEVISION NEWS, by the Ziff-Davis Publishing Company, 366 Madison Avenue, New York 17, N. Y.

← A scene near the radar test site of Bendix Radio Division of Bendix Aviation Corp., Baltimore, Md. The radome (left) is a plastic bubble transparent to microwaves and supported by internal air-pressure. It protects a radar antenna similar to the one shown at the right.



SYLVANIA TUBES TO HELP TEST PLANE PARTS IN FLYING LABORATORY

"ELECTRONIC BRAIN"* *using Sylvania Tubes will check equipment under actual flying conditions for North American Aviation*

Determining the behavior of airplane components for actual conditions of stress, strain, vibration and varying temperatures is reduced to mathematical equations by North American Aviation.

The quick, accurate solution of such problems is accomplished by an improved electronic digital differential analyzer built by The Computer Research Corporation, and known as the CRC-101.

This machine can solve any problem that can be put in the form of ordinary differential equations . . . linear or non-linear.

Remarkably compact!

Matching the speed and efficiency of the CRC-101 is its unusual compactness. Employing only about one hundred Sylvania tubes, the complete computing and power units occupy a space hardly larger than an office desk.

The selection of Sylvania Tubes for this modern computer is a high tribute to their outstanding performance and dependability. That's why today, when tube ratings and characteristics are critical factors, you'll find more and more circuit engineers put Sylvania Tubes *first!* For further information about your tube problems or applications, write to: Sylvania Electric Products Inc., Dept. R-1312, Emporium, Pa.

Complete control panel of CRC-101 occupies no more space than a standard typewriter.

Computation is controlled by approximately 100 Sylvania Tubes operating through a germanium diode "nerve center."

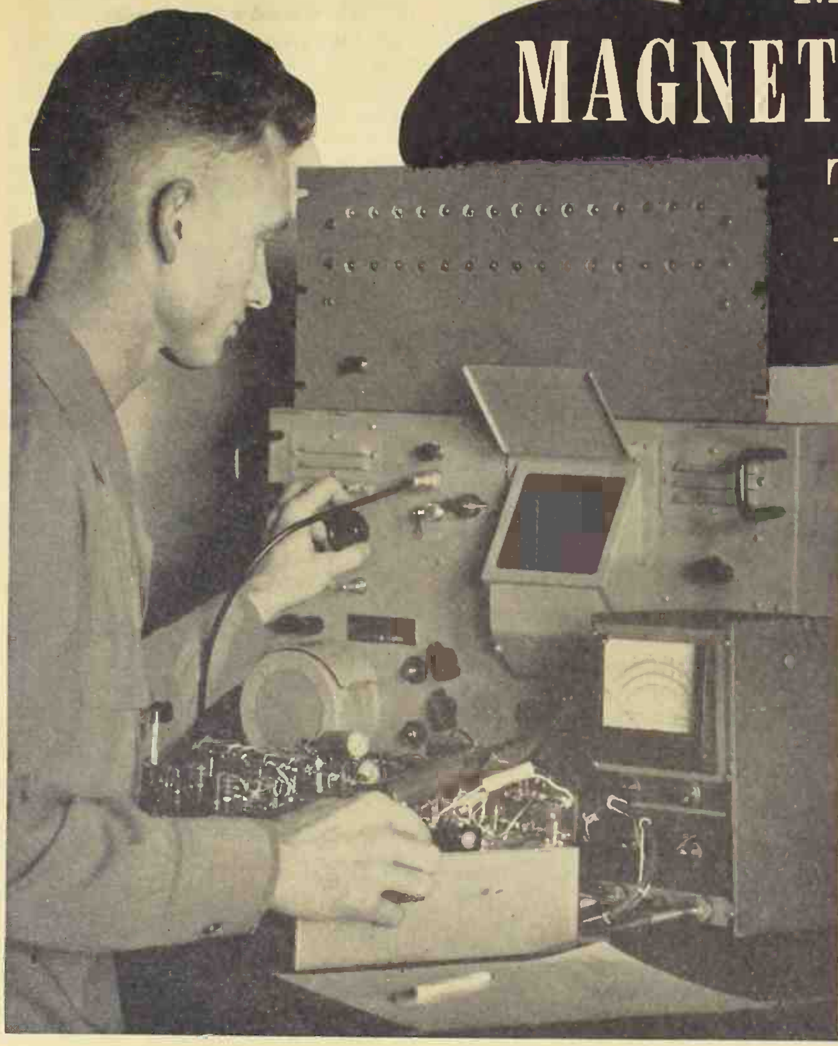
* 50 Integrator Electronic Digital Differential Analyzer made by Computer Research Corp., Hawthorne, Calif.

SYLVANIA ELECTRIC PRODUCTS INC. 1901-1951 — 50th ANNIVERSARY — FIVE DECADES OF PROGRESS

SYLVANIA

RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

Bread-board wiring circuits for investigating multi-stable magnetic elements.



Multi-Stable MAGNETIC MEMORY Techniques

By
JOHN D. GOODELL
President

and

TENNY LODE
Chief Engineer
The Minnesota Electronics Corp.

Fast and accurate storage and access times result from the employment of new materials and techniques.

PRIOR TO the advent of large scale computing machinery, desk type calculators were designed almost exclusively for operation in terms of decimal notation; for rotating mechanical structures this was entirely practical. When high speed computers were first developed it became evident that decimal notation was not practical using the storage and computing elements available. Devices capable of operation with two stable states were dependable and simple to design, while structures capable of multiple stable states were possible only with complex linkages between simpler devices. This is one of the reasons that binary arithmetic has been so widely employed in computing machines. The restriction on the use of radices higher than binary is eliminated by the developments described in this article.

There are other reasons and other advantages for specific applications, but it cannot be stated as a generality that binary systems are superior. Obviously, when a machine must communicate with people, it is necessary to provide translation devices so that input decimal information is converted to binary and binary answers converted to decimal, or the machine must operate in decimal, or a re-education program that is not practical must be instituted. It is necessary to educate not only machine operators but also the general public, since many business machines function to print the answers to computing problems in connection with invoices and similar communications. Binary/decimal translation devices usually turn out to require more intricate circuitry than the actual computing elements in business machinery.

There are other reasons for operating with notations other than binary, and for various special applications, a specific radix such as 8, 12, or any other number, may turn out to be desirable. This problem has not yet been completely investigated in its general form and there is considerable controversy regarding the relative merits of various radices. As is true of so many controversies, neither extreme is correct and each system has its place.

Magnetic Storage Elements—Bi-stable

Among the basic structures that have been used for information storage are magnetic materials. These methods are attractive because power is not required to maintain storage, and for other reasons associated with the fact that the elements are passive.

This article is based on a paper presented at the 1951 National Electronics Conference, Edgewater Beach Hotel, Chicago, Ill.

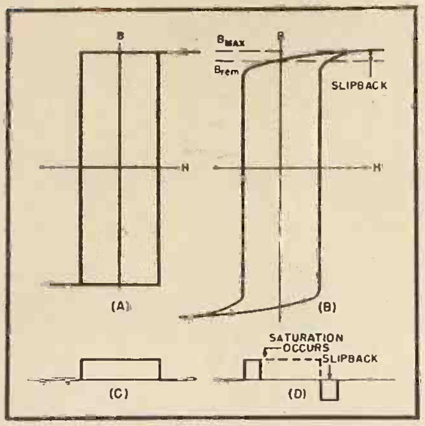


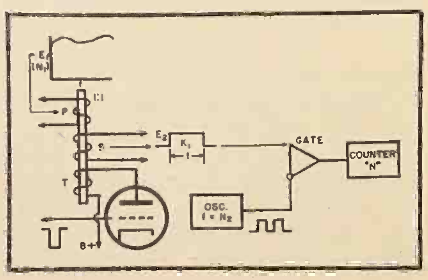
Fig. 1. (A) Idealized rectangular hysteresis loop. (B) Actual rectangular hysteresis loop. (C) Normal pulse. (D) Saturation pulse.

Considerable success has been achieved in work accomplished by others with magnetic materials used as binary elements. For this purpose, an essentially rectangular hysteresis loop is a desirable characteristic. It is also desirable that the coercive force of the materials be low, so that the magnetizing forces required are held to a minimum. These two characteristics are essentially incompatible and the designers of such materials strive to effect a useful compromise.

A rectangular hysteresis loop implies that when a magnetic core is saturated in one sense it will be stable in that state until a magnetizing force is applied in the opposite direction. Using this principle, it is possible to design devices that operate in accordance with binary arithmetic. Information is read into the material by applying a magnetizing force in one direction. Information is read out of the material by applying a magnetizing force in the opposite direction and observing whether a significant flux change is produced. Thus the material may be interrogated to determine whether it is storing one or zero.

Binary magnetic elements have been applied successfully in the design and construction of many computing systems originally developed at the Harvard Computing Laboratory under the direction of Howard Aiken and his associates. At this time, the practical application of magnetic storage elements in binary applications has been limited to moderate pulse repetition rates in an order of thirty to forty kilocycles. It has been indicated that investigators believe this may be increased to very high speeds with the development of new techniques.

Fig. 2. Block diagram of an analogue to digital translation system.



Magnetic Storage Elements—Multi-stable

The steep sides of a rectangular hysteresis loop imply that with the application of a sufficient magnetizing force to overcome the coercive force of the material, the flux will swing all the way to saturation and be passive in that state until a magnetizing force is applied in the opposite direction. This does not mean that the flux is capable of swinging from saturation in one sense to saturation in the opposite sense in zero time.

The rate of flux change in any magnetic material is proportional to the magnitude of the applied voltage across the magnetizing coil. The total flux change is a function of the applied voltage and the time duration of its application. Thus the change in flux is proportional to the volt/second integral of the applied magnetizing force. With materials having a rectangular hysteresis loop, the induced back emf functions to hold the current flow to the minimum required to overcome the coercive force through the entire swing. Thus the most convenient parameters to consider are voltage and time.

Using suitable materials, it is possible to obtain stability not only in the states of saturation but at the intermediate states between these boundaries. This means that by controlling the time duration of applied pulses, it is possible to obtain a multiplicity of stable memory states in a magnetic core. Information is read into the core by saturating the core to a state designated as zero and then applying a series of pulses in the opposite sense. It is necessary to quantize the volt/second integral of such pulses with an accuracy dependent on the maximum number of pulses the system is designed to store in the core. In this way, the flux density is changed in discrete steps and the state of magnetization of the core is directly related to the number of applied pulses.

To read the information out of the core, a train of pulses may be applied to swing the flux back to saturation zero. As the flux swings from the intermediate state representing the stored number, a pulse will appear across a secondary winding for every read-back pulse applied to the primary. When the core reaches saturation zero, there will be no further flux change and the amplitude of any pulses that appear across the secondary will be significantly diminished.

To the extent that rectangularity of the hysteresis loop is not perfect, the performance in accordance with the criteria discussed will be degraded.

A wide variety of techniques is available for reading in and out of multistable magnetic structures of this nature, and the resulting flexibility is useful in many applications. The input information may be applied in the form of discrete quantized pulses, each of which represents a single digit, or it may be applied in the form of a single pulse. In the latter case, the magnitude may be held constant and the time duration made to represent the number to be stored, or the time duration may be held constant and the amplitude varied. The information may be read out in a similar way. Thus information may be dealt with in the system either in digital or analogue form and translated between these forms in accordance with the requirements of the program.

It is also possible to apply an irregular waveform representing information in analogue form, and the storage in the core will be proportional to the volt/second integral. Thus, by reading data out with digitalized pulses, a transformation may be made. For periodic sampling of an analogue quantity, an arrangement such as is shown in Fig. 2 can be useful. The tube conducts current to swing the core to saturation state "q", even with the maximum allowable voltage applied to the primary winding. At selected intervals, a pulse is applied to the grid of this tube so as to cut it off. When the tube is cut off the core is, so to speak, released from "q" and the applied voltage E_1 swings it to saturation in the state "p". The minimum allowable voltage E_1 must be sufficient to overcome the coercive force of the material. If the transfer function is 1:1, the voltage E_2 of the output pulse that appears at the secondary winding will be equal to the voltage applied to the primary. This assumes that the analogue input voltage does not vary appreciably over the time duration involved, and also neglects the resistance of the windings and the constant voltage required to overcome the coercive force. The time duration of the output pulse will be inversely proportional to the instantaneous magnitude of the applied analogue voltage.

The output pulse may then be used to enable a gate to pass a number of pulses from an oscillator of fixed frequency to a suitable counter. The counter may be a magnetic core or some conventional structure. The area K_1 of the output pulse will be a constant determined by the characteristics of the core. If the applied voltage is increased, the time duration of the output pulse will decrease, and vice versa.

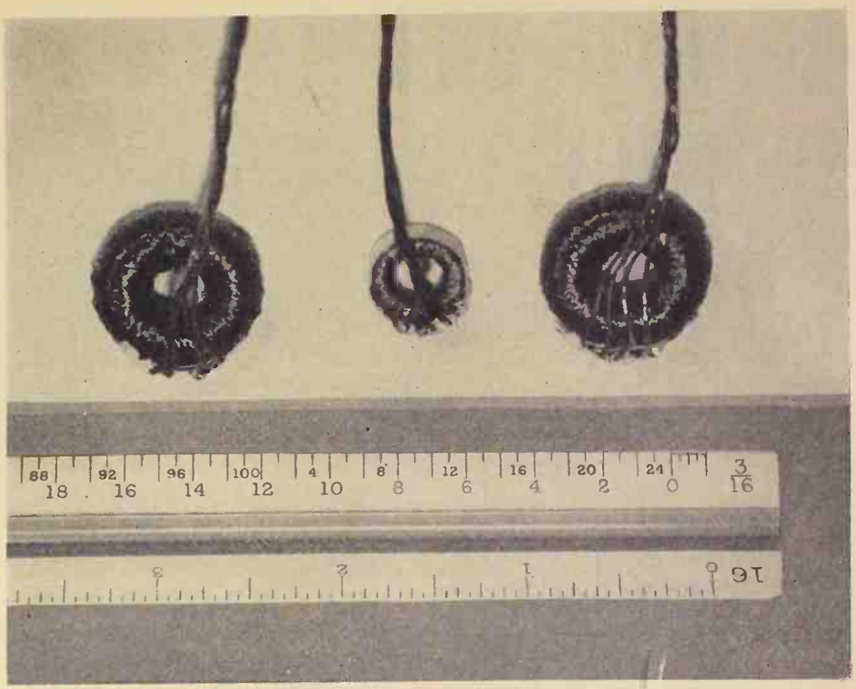
The sampling core in this case is used as a "time" gate and, in one sense, functions as a d.c. transformer. It is of some interest in this arrangement that the number of pulses representing the input voltage is in an exact inverse relationship. Thus, the relative accuracy of the translation increases as the magnitude of the input signal is decreased. This is the opposite of the effect ordinarily obtained in sampling observations of this kind. If the input were, for example, an error signal, such a relationship might be very desirable for it is when the error signal is small that the absolute accuracy is most important. Obviously, the number of counted pulses may be translated into a number directly proportional to the input signal by dividing it into an arbitrary constant.

It is of passing interest that if the magnitude of E_1 is controlled to represent a number N_1, and the frequency of the oscillator is controlled to represent a number N_2, direct division may be accomplished and the output number N appearing in the counter will be equal to N_2 divided by N_1.

There are many methods by which the output transition may be observed. Amplitude discrimination is one of the useful tools, but the negative pulse that results from slip-back to remanence after dynamic saturation is another interesting method. In practical materials, the loop is never precisely rectangular, and consequently when a read-back pulse drives the core material into dynamic saturation it will slip back to B_r from B_{max}. This will produce a negative going pulse at the output that can be observed as an indication that the end of meaningful read-back pulses has been reached.

This same phenomenon is a limiting factor in connection with maximum storage capacity that can be observed with digital accuracy. When the core has been driven into dynamic saturation by a read-back pulse, any additional pulses applied will produce an output pulse of reduced amplitude as well as negative going slip-back indications. The magnitude of the output pulses observed after dynamic saturation of the core will be a result of combined air coupling and the flux change from B_r to B_{max}. Obviously the minimum pulse that is practical for read-out in this manner must be a pulse that differs significantly from the pulses produced by air coupling and slip-back flux changes.

There are various methods of minimizing these effects in order to obtain storage of high numbers. Decimal storage is relatively simple and may be accomplished with a wide variety of pulse volt/second choices, depending on the requirements of the problem. The choice of parameters is limited with respect to short duration pulses by the maximum practical amplitude and, conversely, minimum amplitudes imply longer pulse durations, hence lower repetition rates.



Multi-stable magnetic memory elements for storing large numbers of pulses.

These limitations are not serious in connection with most problems and storage of very large numbers may be accomplished with reasonable pulse parameters. Pulses with a duration corresponding to a fraction of a microsecond may be used without exceeding practical pulse amplitudes. This means that pulse repetition rates corresponding to the limitations of available associated circuitry may be attained.

Multi-stable magnetic techniques may be used for many applications in computing machines. Storage registers may be extremely compact and light in weight with elements that are relatively free from effects of their environment. Magnetic elements with multi-stable characteristics may be used in the arithmetic computing sections of machines and for accumulation of data. Inventory control machines for business and military problems may be constructed with greater memory capacity in a given space than by any other known method. High speed operation with passive elements using almost any convenient radix is made possible and component failure is reduced to a minimum. Access time is very short indeed and associated circuitry is relatively simple.

A considerable amount of experimental work has been carried out in an effort to determine the optimum magnetic structures for these multi-stable applications. In general, ribbon-type toroidal orientations are most desirable, although useful results have been achieved with other types of cores.

The pulses used in this technique must be accurately quantized with respect to their volt/second integral. It is desirable that this be accomplished with passive elements in order to obtain long term stability. Temperature extremes will affect storage capacity to some degree but this does not present a problem of consequence. One of the advantages obtained with magnetic elements is a large degree of freedom from the effects of environmental factors.

Magnetic structures are now being developed for use in so many applications that they make a fair bid toward becoming more important than electron tubes. Magnetic amplifiers, flip-flops, gates, oscillators, counters, accumulators, adders, and almost the complete list of basic circuits appear to be possible of design for an increasingly large number of applications.

Other methods and techniques for applying magnetic principles to the design of computing machinery, control, conversion and sensing structures will be discussed in future articles.

Note: The multi-stable magnetic structures, techniques and systems described in this article are the subject of patent applications assigned to *The Minnesota Electronics Corporation* by the authors.

Multivibrator FREQUENCY DIVIDER

Fig. 1. Front panel view of the M.I.T. multivibrator frequency divider.

By
R. R. RATHBONE
and R. L. BEST

Servomechanisms Laboratory
Massachusetts Institute of Technology

This versatile instrument provides a frequency divider, delay circuit and pulse standardizer.

THE multivibrator frequency divider shown in Fig. 1 is a pulse generator with an output range of from 200 kc. to 60 cycles, and which may be synchronized with any frequency equal to or greater than the output frequency. Two free-running multivibrators are used to cover this range, their individual ranges overlapping between 2.5 and 3 kc. Two output pulses are provided: a "standard" pulse and a high-impedance negative pulse used to trigger a synchroscope. The "standard" pulse is 0.1 microsecond on the base line, and is variable up to 25 volts across a 93-ohm load. The high impedance pulse is variable up to 100 volts negative, and has a leading edge of 0.2 microsecond and a slower trailing edge. It will drive an unterminated 93-ohm line of reasonable length, and occurs at the end of a delay interval of from 5 to 100 microseconds. This delay may be continuously variable, or may be varied by the interval between pulses if synchronizing pulses are fed into the "input for lock-in delay." This latter feature gives the most jitter-free operation, especially desirable when a fast sweep is being used or scope photographs are being taken.

The block diagram, Fig. 2, shows the many different ways in which the sections of this unit may be interconnected. The two most important sections are the "High-Frequency Multivibrator" (HFMV) and the "Low-Frequency Multivibrator" (LFMV). These two free-running multivibrators are permanently connected in series, although power may be removed from one or the other by appropriate switching. When both are operating, the LFMV divides the frequency of the HFMV by some integer.

The third important block, designated "Delay Multivibrator" (Delay MV), is a single-shot multivibrator, triggered by either the HFMV or the LFMV. At the end of the selected delay, the Delay MV initiates a negative output pulse which may be used to trigger a synchroscope.

A fourth block, the "Standard Pulse Generator," may be actuated by either the HFMV or the Delay MV and provides 0.1-μsec, half-sine-wave pulses at a 93-ohm impedance level. These pulses are "standard" for all test equipment at the Digital Computer Laboratory, M.I.T.

The switching shown in the block diagram allows for great flexibility in the interconnecting of these blocks. For convenience, let us assume in the following discussion of the circuit details that 1-mc. pulses are being fed to the "input to dividers", and the input selector, S_1, reads "to HFMV." The HFMV divides the pulse repetition frequency to a submultiple, determined by the HFMV coarse frequency setting, and feeds synchronizing pulses to the LFMV. If the standard pulse selector, S_3, reads "from HFMV," then the "standard" (0.1-μsec) pulses will occur at the rate of the HFMV. If the delay selector, S_2, is set to "from LFMV," as shown, the Delay MV will be triggered at the submultiple frequency of the LFMV and, at the end of the delay, will initiate the "output pulse (negative high impedance)."

Editor's Note: The name of Richard L. Best should have appeared as co-author of the third article of this series, Gate and Delay Generator, which was published in the September, 1951 issue.

This is the fifth of a series of articles on test equipment units sponsored by the Office of Naval Research and developed during the past three years by the M.I.T. Servomechanisms Laboratory. These units were designed as building blocks to test pulsed circuits and to simulate the control, arithmetic, and storage functions of an electronic digital computer.

With the above assumptions in mind, let us examine the schematic, Fig. 3, and the waveforms at various important test points. The 1-mc. input pulses are shown in part (a) of Fig. 7, and the output of the input amplifier (V_{2A}) in part (b). Parts (c) and (d) are waveforms of the plate of one section and the grid of the other section of the HFMV (V_3). These may be recognized as typical free-running multivibrator waveforms, with the exception of the synchronizing feature, which operates as follows. The negative pulses shown in part (b) are coupled to each plate of the HFMV through the small (10-$\mu\mu$fd.) capacitors C_4 and C_7, and from there to the opposite grids through the larger cross-over capacitors C_5 and C_6. Whichever triode is conducting amplifies these negative pips, resulting in the positive pulses seen in the lower half of part (c). These positive pulses are also coupled to the opposite grid through one of the cross-over capacitors (C_5 or C_6), synchronizing the triggering action of the circuit. The dual potentiometer (R_{9A}, R_{9B}) controls the free-running frequency of the HFMV, and thus controls the integer by which the input frequency is divided. The right-hand cathode of the HFMV has a peaker circuit, consisting of an inductance to ground shunted by a crystal diode. The diode is connected in such a way that a single positive pulse is generated when this section starts to conduct, and all other ringing is damped out. Part (e) of Fig. 7 shows this cathode waveform. The pips seen after the main pulse are the result of the synchronizing pulses coupled from the opposite plate to the grid of this section while it conducts.

The "Standard Pulse Generator"

(V_{1B}) utilizes a blocking oscillator, peaker, and pulse amplifier; its waveforms are shown in Fig. 6. Part (a) is the cathode output pulse of the HFMV (also shown in part (e) of Fig. 7 but shown here on a faster sweep). With the switches in the positions indicated, this pulse triggers the blocking oscillator (V_{1B}). The resulting pulse of plate current (see waveform (b)) flows through a peaker composed of L_3 and L_4 in parallel, and damped by the diode CR_3. The end of this current pulse causes the peaker to ring positive once before the diode damps it out, generating the waveform of part (c). This signal is then capacitor-coupled to the output pulse amplifier which puts the pulse shown in (d) out onto a 100-ohm line.

Figure 5 shows the waveform of the LFMV (V_4). Synchronization may be accomplished either by connection to the input amplifier or, as is done in Figs. 2 and 3, to the HFMV. The signal from one plate of the HFMV is differentiated and coupled to both plates of the LFMV through the two 2-$\mu\mu$fd. capacitors. Part (a) shows one plate waveform; part (b), the waveform of the opposite grid. The synchronizing action is the same as in the HFMV. The dual potentiometer (R_{16A} and R_{16B}) varies the free-running rate of the LFMV, and determines the submultiple of the HFMV frequency at which the LFMV runs. The right-hand cathode has a peaker (like that of the HFMV) which generates a single positive pulse when V_4 starts to conduct. The cathode waveform may be seen in part (c) of the figure; the pips occuring after the main pulse, while this section is conducting, are a result of the synchronizing signal fed from the HFMV and gave a great deal of trouble in the Delay MV, preventing a smooth continuous delay. Diode CR_5 is biased off by about 8 volts so that these pips are eliminated (see part (d), Fig. 5). The negative pulse that occurs after the main positive one, is fed back from the Delay MV at the end of the delay interval.

Figure 4 gives the waveforms of the single-shot Delay MV (V_5). Part (a) shows the same cleaned-up pulse as does part (d) of Fig. 5, but at a different sweep rate and delay setting. This pulse is capacitor-coupled to a proper d.c. level, and, through diode CR_6 lifts the normally-off grid of the Delay MV into conduction as waveform (b) shows. The plate waveform (c) is coupled through a capacitor to the opposite grid, (d); the d.c. return path for this grid is a bit unusual and merits closer attention. In the quiescent state, the grid is at a voltage determined by the plate drop of the same triode across R_{42} and the divider R_{45}-R_{46}. The highly degenerative circuit maintains the quiescent grid

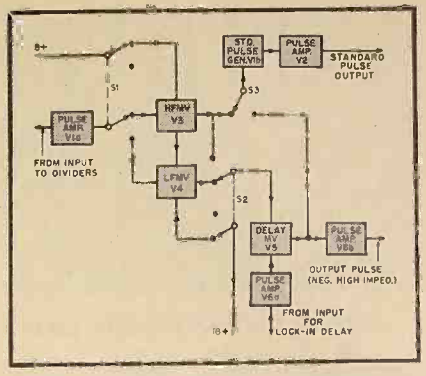


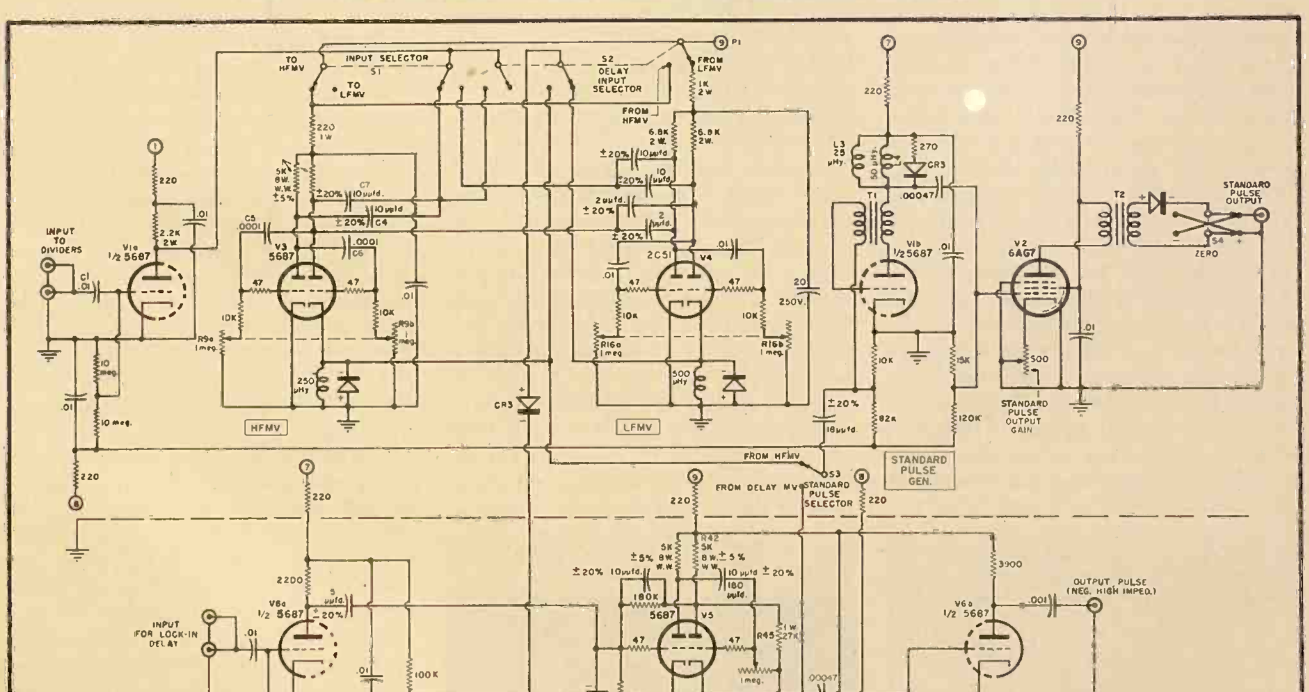
Fig. 2. Block diagram of operation. Numerical notations refer to Fig. 3.

voltage about zero, so that as the Delay MV potentiometer is varied, no great amount of grid current is drawn. During the delay interval, however, the plate of this triode rises as shown in part (e), giving a positive grid return for the now cut-off grid. Thus the benefits of a positive grid return are realized (steep slope of the waveform at the end-of-delay point, and therefore less jitter), with the benefits of zero grid return during standby (prohibitive grid currents are not drawn when adjusted for minimum delay).

Synchronization of this delay could have been accomplished by feeding the

(*Continued on page 29*)

Fig. 3. Circuit schematic and parts values for the multivibrator frequency divider.



AMPLITUDE DISTRIBUTION ANALYZER

By
R. E. NEINBURG and T. F. ROGERS
Mass. Inst. of Technology

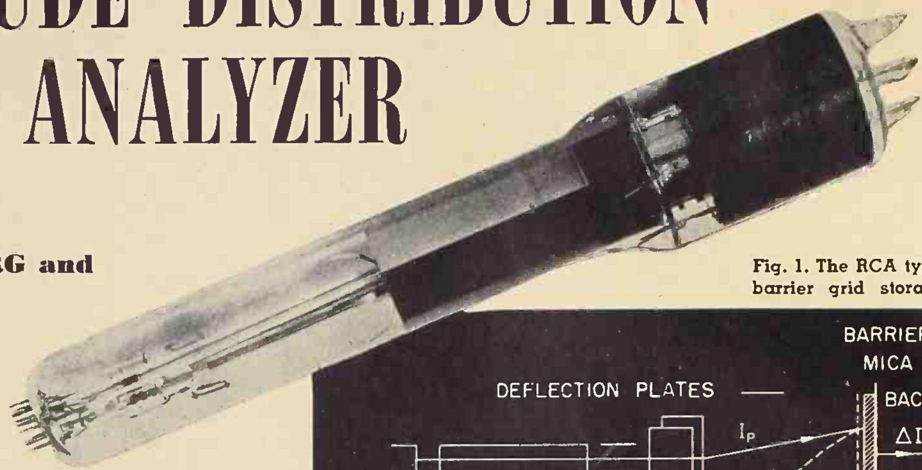


Fig. 1. The RCA type STE-A barrier grid storage tube.

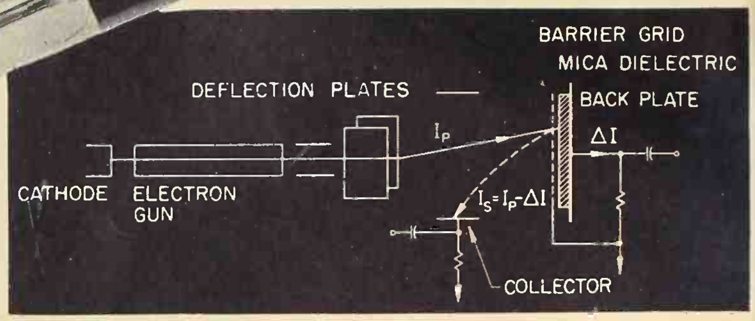


Fig. 2. Simplified drawing of the barrier grid storage tube.

A barrier grid type of storage tube is used in this electronic means for realizing statistical distributions.

THE RELATIVELY recent attention focused upon the statistical means of analyzing various types of signals by the work of Wiener, Shannon, Rice and others has encouraged many investigators to search for an electronic means of realizing statistical distributions. This paper concerns itself with the product of such a search; a device that analyzes signals on the basis of the distribution of amplitude levels which they display. The final results are presented as an oscilloscope trace in the form of the distribution density function, or amplitude distribution, of the signal being analyzed.

At the outset of this study, it was realized that several methods of obtaining amplitude distributions were already available.[1] For example, by the simple process of photographing a signal waveform and determining, by actual count, the number of times the signal enters various incremental amplitude levels, the distribution of amplitude levels can be obtained. However, in this, as in other existing methods, the inherent delay and the expense in man-hours tend to be prohibitive. The object of the investigation then became to design a system that could sample a given signal and present the amplitude distribution of this signal with negligible delay and in a form convenient for dynamic analysis.

The heart of the device is the *RCA* barrier grid type of storage tube, a simplified drawing of which is shown in Fig. 2.[2] This tube is similar to other memory devices of this general type in that the memory is derived from the storage of an electric charge on a dielectric surface, the charge being supplied by a primary electron beam that is formed and focused in an electrostatic deflection system. Enough energy is imparted to the electrons of the primary beam to enable them to dislodge other electrons from the dielectric surface and cause secondary emission. Those secondary electrons emitted with sufficient energy to escape the field at the dielectric surface are focused on a collector ring and thereby escape to the external circuits. The magnitude of the secondary, or collector, current is dependent on the secondary emission ratio of the dielectric surface, which is, in turn, a function of the cathode to dielectric potential. The steady state potential of the dielectric, which results in a value of unity for the secondary emission ratio, may be considered a surface equilibrium potential.

In view of the capacitive coupling that exists between the dielectric and backplate, any positive voltage applied to the backplate will increase the dielectric surface potential by the amount of the applied voltage, and will, therefore, remove the dielectric from equilibrium. As a result, the secondary emission ratio will decrease by an amount proportional to the applied voltage (to a good first approximation for signals $\leq$ 10 volts) as the surface again seeks the equilibrium potential.[3] Thus, by applying a positive step voltage to the backplate, the dielectric surface is given a positive potential and is, therefore, in a condition to store charge on any area element scanned by the primary beam. The process of storing a charge density distribution in this manner will be referred to as the writing operation.

Interrogating the stored charge (called reading) is accomplished by returning the backplate to the voltage it had prior to the writing period, and scanning the line containing the stored signal by the primary beam. As the variations of dielectric potential caused by the stored charge are encountered during the scan, the secondary emission ratio will vary in such a manner as to produce, across a load resistor in the collector circuit, a voltage waveform that is a replica of the distribution of the dielectric charge density. The read operation, in that it removes

Fig. 3. Charge density distribution for a sine wave.

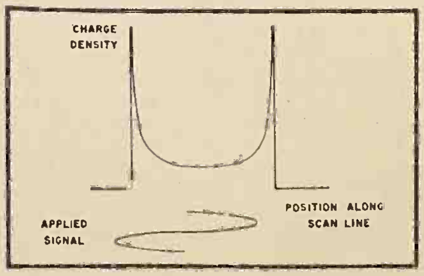
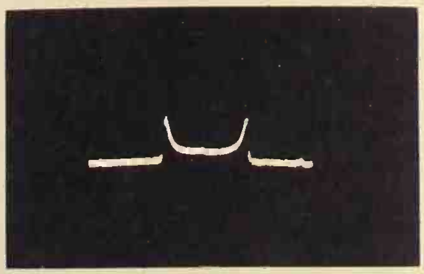


Fig. 4. Amplitude distribution for a sine wave.



the stored charge, is also an erasing operation.

When used as an amplitude distribution analyzer, the storage tube is a summation device, not for amplitude addition as in some applications,[4] but in the following sense. The amplitude distribution of a signal may be determined by dividing the signal into equal amplitude increments and determining, in some manner, the length of time the signal spends within each increment of amplitude. A graph of this time (see Fig. 9) versus the amplitude increments for all amplitudes that the signal displays, is the amplitude distribution of the signal. As the individual increments are chosen so as to approach zero, the distribution approaches the theoretical amplitude distribution. The function of the storage tube in this operation is to determine the relative length of time the amplitude remains within the various incremental levels, with the size of the amplitude increments determined by the diameter of the primary beam.

The summation of time described above is performed by the storage tube in the following manner. A fixed centering voltage is applied to the vertical deflection plates of the storage tube, and the signal to be analyzed is applied to the horizontal deflection plates. Since the position of the primary beam is controlled by the potential developed between opposite plates of the deflection system, it is possible to associate every point along the single horizontal line scanned to a particular amplitude of the signal that is applied to the horizontal deflection plates. The beam will, therefore, scan a horizontal line in a manner determined wholly by the amplitude of the signal.

During the writing period, while the signal is applied to the deflection plates, a positive step voltage is applied to the backplate removing the dielectric from equilibrium and permitting it to store charge. Since, as mentioned previously, the position of the beam at any instant is a linear function of the amplitude of the signal on the horizontal deflection plates, each point along the scan line corresponds to some particular signal level; it follows, therefore, that the charge density on any line segment is proportional to the time the signal spends at the amplitude level corresponding to that segment. Furthermore, since the amplitude distribution is, in effect, a plot of the percentage of time a function remains at each amplitude level versus all amplitude levels, the distribution of the charge density as a function of displacement along the line scanned is the desired amplitude distribution. This, briefly, is the method by which the distribution measurement is made.

To illustrate the basic principles of operation let us assume that a sinusoidal waveform (Fig. 3) is applied to the deflector plates. The velocity of the beam will be maximum at the center of the dielectric (corresponding to the maximum rate of change of the sine wave around the zero level) and, as the peak of the sine wave is approached, the beam velocity will decrease, finally stopping completely and reversing its direction. At the end of one complete sine wave cycle, the beam will have swept to the right a distance dependent on the peak signal amplitude, reversed its direction and traveled to the left extremity, reversed again and returned to the center. If the beam is stopped at this point, the magnitude of charge on any line segment along the scan line will be directly proportional to the time spent by the beam at that segment, or inversely proportional to the velocity of the beam at that segment. It would be expected then, that the magnitude of charge density would be a maximum at the extremities of the dielectric and a minimum at the center, and would closely resemble the calculated amplitude distribution shown above the signal in Fig. 3.

To transform the stored amplitude distribution into a voltage wave, it is merely necessary to read out the stored charge. The backplate writing voltage is returned to the equilibrium value and the signal on the horizontal deflection plates is replaced by a voltage (such as a saw-tooth or triangular waveform) which causes the beam to scan the charged line with a constant velocity.

As discussed previously, in connection with interrogating the distribution of the stored charge, the collector current will vary in accordance with the variations of charge density stored along the scan line. Since the line is scanned with constant velocity during the "read" operation, variations of charge density as a function of distance along the scanned line are transformed into variations of collector current that are a function of time. The variation of collector current will now be proportional to the amplitude distribution of the signal being analyzed. It should be noted that to insure complete erasure, that is, to insure the return of the dielectric surface to the equilibrium potential before the next writing operation, it is necessary to scan the line more than the one time needed to view the distribution.

The basic idea, then, is to allow the beam to travel along the scan line in a manner determined by the amplitude of the signal. Since each segment corresponds to a particular amplitude interval, the charge density at any segment will be proportional to the length of time the signal spends within that interval. The resulting distribution of charge-density is then the desired amplitude distribution, and is read out of storage during the read interval.

The first signals analyzed were those having relatively simple amplitude distributions. In this way, the validity of the early results could more easily be judged.

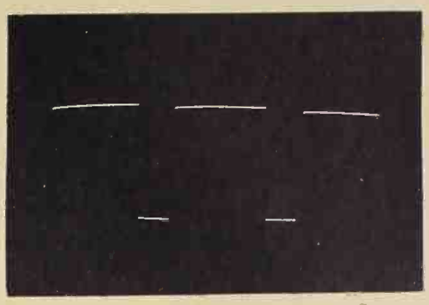


Fig. 5. Rectangular input voltage.

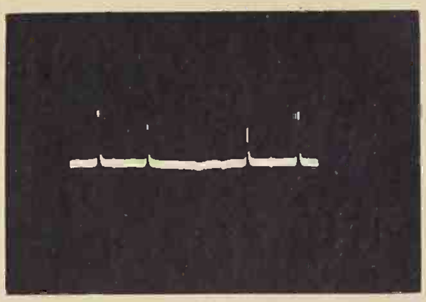


Fig. 6. Amplitude distribution of a rectangular input voltage.

Fig. 7. Output of the second detector of a radar receiver.

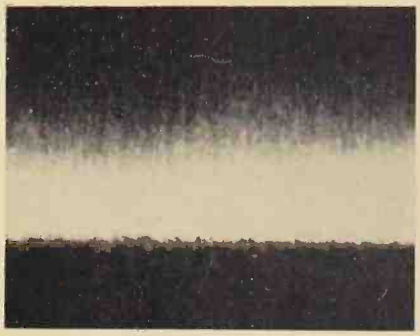
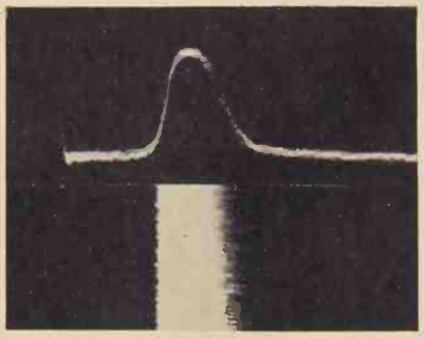


Fig. 8. Experimentally determined amplitude distribution of Fig. 7.



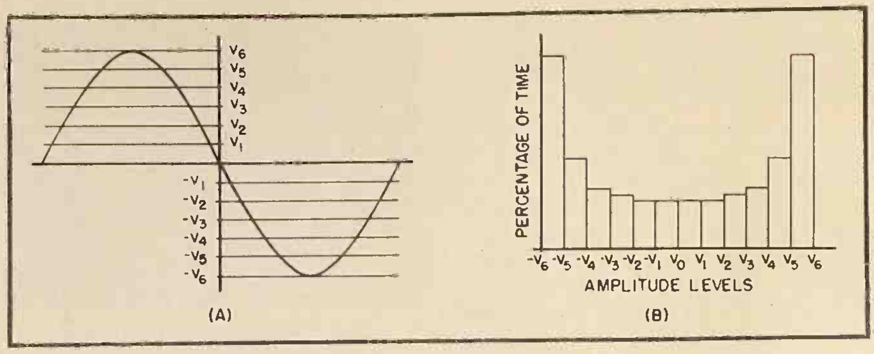


Fig. 9. Diagram of a sine wave and its amplitude distribution.

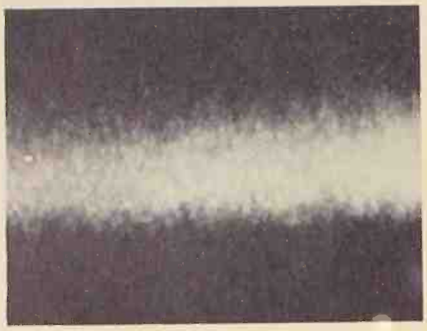


Fig. 10. Signal of Fig. 7 with a carrier introduced.

Fig. 3 shows the calculated amplitude distribution of a sine wave; Fig. 4 shows the experimentally determined amplitude distribution of a sine wave. The two spikes, as before, correspond to the positive and negative sine wave peaks. The fact that the distribution does not go to infinity at the extremities, is due to the quantizing effect of a finite beam current and diameter, and is an indication of measurement limitations. Aside from this obvious discrepancy, the general shape of the experimental and calculated distributions are in close agreement. Although no quantitative comparison was attempted, the results appear to fall within tolerable limits.

Rectangular waves such as those shown in Fig. 5 were also analyzed. The distribution shown in Fig. 6 illustrates the effect of employing a triangular scanning voltage. The image on the left is the result of scanning the charge distribution from left to right. The image on the right, which is the mirror image of the first, is generated as the beam scans from right to left. Many such scans are required to erase the stored pattern. The results realized from the analysis of rectangular waves have special significance in the alignment procedure.

Assuming the rectangular wave to have essentially zero rise time, the primary beam will focus on only two segments of the scan line, one segment corresponding to the raised portion of the pulse, the other to what may be considered the base line. Said another way, we are concerned with a signal displaying only two levels of amplitude, and would, therefore, expect only two areas of high charge density on the scan line. Notice that the ratio of the time spent at one amplitude to the time spent at the other amplitude is approximately 3:1. One would expect, then, that the ratio of the charge density corresponding to each of these amplitudes would also be in the ratio 3:1. In this particular case, the expected results are not verified, the reason being that the primary beam remains focused on one spot of the dielectric for a period sufficient to exceed the linear dynamic range of the storage tube. The charge density stored on that spot is, therefore, not a linear function of time. This phenomenon may be used to good advantage. By applying a rectangular wave of known asymmetry for a given sampling period, the primary beam intensity may be adjusted until the output spikes are in the same ratio as the two amplitude levels of the rectangular wave. The larger of the two spikes is now the largest output possible for the particular intensity setting used, that is, within the limts of tube linearity. Thus a method of system alignment is provided by the use of rectangular waves.

As examples of aperiodic signals, two types of noise were analyzed. The first, shown in Fig. 7, is the output of the second detector of a radar receiver, and consists for the most part of positive peaks, resulting in an output that is substantially unidirectional. The experimentally determined amplitude distribution of this signal, shown in Fig. 8, closely approximates the expected Rayleigh curve, being skewed to the right.[5]

The second type of noise analyzed was produced by introducing a carrier into the radar receiver resulting in the disappearance of the unidirectional character as seen in Fig. 10. The distribution of this signal is shown in Fig. 12, with the previous noise amplitude distribution being shown in Fig. 11. Notice how the second distribution has assumed a symmetrical appearance relative to the first, just as the second signal was the more symmetrical of the two. Also, the increased spread of amplitudes is seen to have extended the limits of the distribution and introduced a flattening effect, as would be expected.[6]

The results that were realized by the analyzer in the experiments performed were very encouraging, and serve primarily as an indication of the possibilities of such a device. Further development of the analyzer should greatly facilitate studies of the distributions of signal amplitudes, thereby bringing statistical methods of analysis closer to acceptance as a general communications tool.

The authors would like to acknowledge the guidance and assistance given throughout the course of this research by J. V. Harrington of the Cambridge Research Laboratories.

REFERENCES

1. *Winter, D. F., "Amplitude Probability Distribution," Quarterly Progress Report (Research Laboratory of Electronics, M.I.T.) April 15, 1948, p. 50.*

   "Probability Distribution of Random Noise," Quarterly Progress Report (Research Laboratory of Electronics, M.I.T.) October 15, 1948, p. 50.

   Knudtzon, Nic, "Filtered Random Noise," Technical Report 115 (M.I.T.) July, 1949.

2. *Jensen, A. S., Smith, J. P., Mesner, M. H., and Flory, L. E., "Barrier Grid Storage and Its Operation," RCA Review, March, 1948. Vol. IX, No. 1, p. 112.*

3. *Harrington, John V., "Storage of Small Signals on a Dielectric Surface," Journal of Applied Physics, October, 1950. Vol. 21, No. 10.*

4. *Harrington, John V. and Rogers, T. F., "S/N Improvement Through Integration In a Storage Tube," Proc. I. R. E., October, 1950.*

5. *Goldman, S., "Frequency Analysis, Modulation and Noise," McGraw-Hill Book Co., N. Y., 1948, p. 245.*

6. *Ibid.*

Fig. 11. Amplitude distribution of second detector output noise.

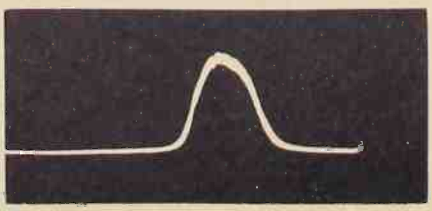
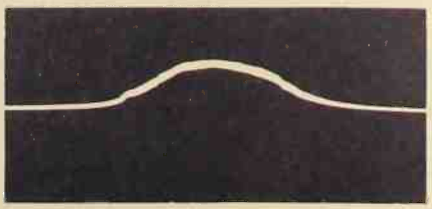
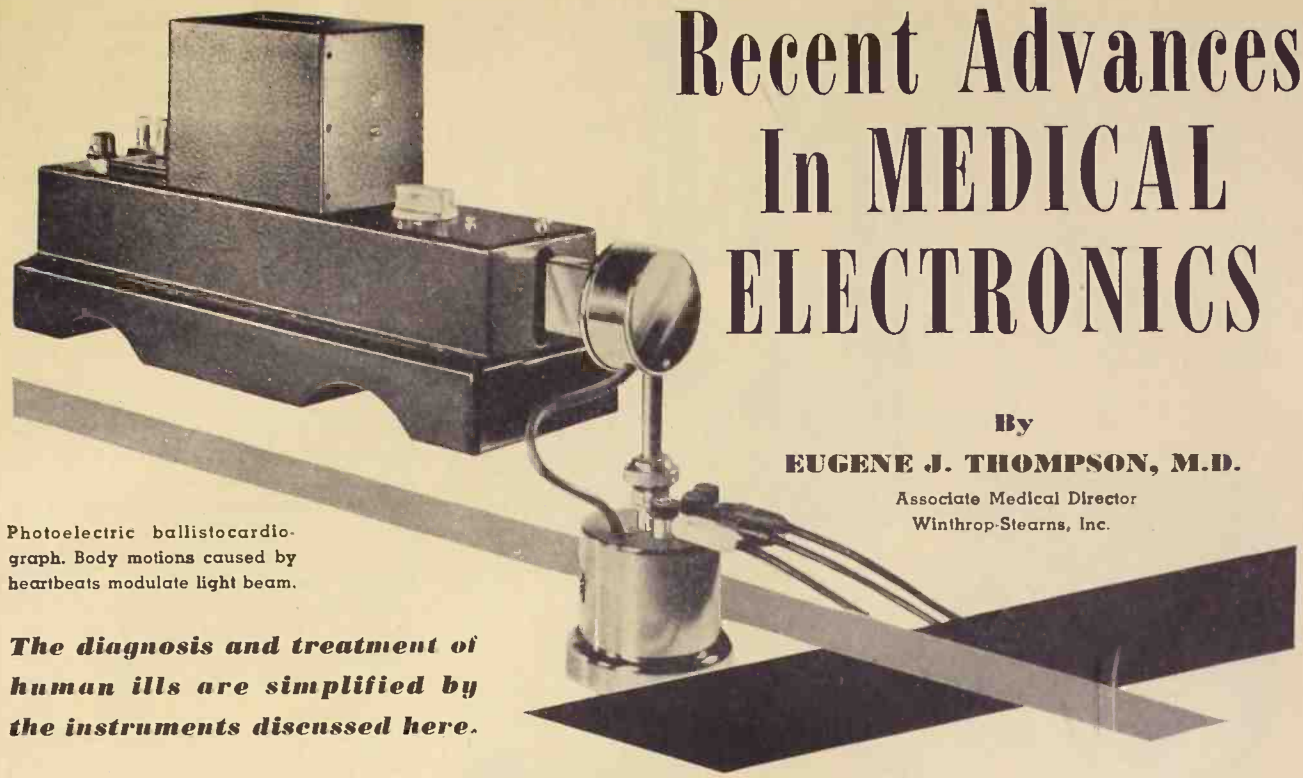


Fig. 12. Amplitude distribution as in Fig. 11 with a carrier present.





Recent Advances In MEDICAL ELECTRONICS

By
EUGENE J. THOMPSON, M.D.
Associate Medical Director
Winthrop-Stearns, Inc.

Photoelectric ballistocardiograph. Body motions caused by heartbeats modulate light beam.

The diagnosis and treatment of human ills are simplified by the instruments discussed here.

WERE IT possible to transport the medical investigator of yesteryear to present times, he would almost certainly gaze in awe and amazement at the incredible achievements which the past three decades have witnessed. For this relatively brief span of time has seen the perfection of the electronic cardiograph, the electroencephalograph, and a score of similar devices which the miracle of electronics has fashioned into instruments of such precision and refinement as to have surpassed even his wildest dreams. Yet, to the modern electronic engineer and research scientist, these marvels seem almost prosaic, when matched against the complexities of the instruments which are now taking their place in the great research laboratories.

Many centuries ago Socrates, the great Greek philosopher, said, "I know nothing except the fact of my ignorance." But, ancient as it is, this statement is even more true today. One of the paradoxes of science is that the more we learn, the more we realize what we do not know. For this reason, much more complex multiple channel measurement apparatus is needed for modern medical research.

Two such multiple channel recording instruments are illustrated in this article. These instruments provide the biophysical or other research or investigative laboratory, hospital or teaching group with the widest available range of multi-channel, simultaneous recording of a great variety of biophysical and other phenomena.

The *Sanborn* Poly-Viso, a block wiring diagram of which is shown in Figure 1, through a selection of input circuits, permits separately or simultaneously, any selection of the following, in up to four recording channels:

Any combination of electrocardiograph leads (including four simultaneous "V" chest positions).

Physiologic pressure recording (blood pressure, spinal fluid pressure, gastrointestinal pressure, etc.). This is accomplished with the aid of the electromanometer, to be described later.

Ballistocardiogram, also described later.

Pulse waveforms.

Recordings of respiration.

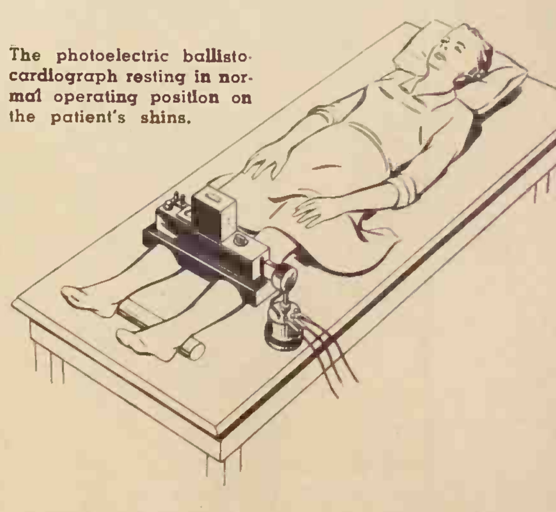
Phonocardiograms, with the aid of a heart sound microphone, to study heart murmurs.

Temperature, volume, and acceleration changes, with the help of a strain gauge amplifier.

Referring to Fig. 1, it can be seen that the instrument contains four preamplifiers. These are especially designed to amplify with a high degree of accuracy and linearity, any signals of a pulsating nature. Because such signals as the heart's electrical field and other biologic impulses have frequencies extending down to around 1 cycle per-second, amplifiers of this type must have relatively long time constants. This is illustrated by the high value of the coupling capacitors used in the amplifier diagrammed in Fig. 2. Note that the circuit makes use of two stages of high-gain pentode amplification, operated in cascade. This provides a voltage gain in the vicinity of 9000—an absolute essential when one is dealing with biologic currents with an emf in the fraction of a millivolt range. As a further precaution, the entire amplifier is operated in push-pull which appreciably attenuates extraneous electrical disturbances.

In order to achieve the high degree of constancy in gain which is required for measurement purposes, amplifiers of this type are customarily battery-powered, or equipped with special, high-stability, voltage-regulated power supplies.

Four direct-coupled amplifiers are also included in the instrument. An example of such an amplifier is shown in Fig. 3. This type of circuit serves two important purposes; it provides a



The photoelectric ballistocardiograph resting in normal operating position on the patient's shins.

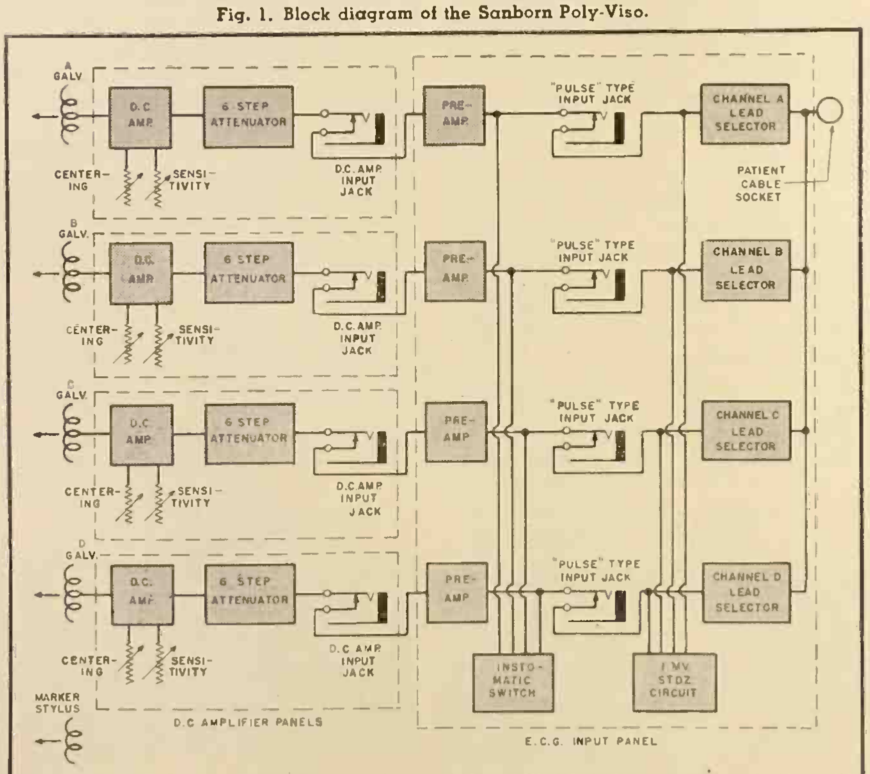
Over-all view of the Sanborn electromanometer.

method for measuring steady-state (d.c.) biologic phenomena, and it also permits quantitative recording of the amplitude of pulsating impulses. It is well-known, of course, that conventional *RC* coupled amplifiers will not amplify direct current.

The important differences between *RC* coupled and direct coupled amplifiers with respect to biologic measurement can best be illustrated by the following example. When one attempts to measure the blood pressure, for example, it is found that it is not constant; instead, the pressure is continually oscillating between about 80 and 120 mm. of mercury, in the normal individual. This difference between the upper and lower extremes of the blood pressure, amounting to 40 mm. of mercury, is referred to as the pulse pressure. If one translates millimeters of pressure into millivolts, by means of a piezoelectric crystal transducer, the emf representing the blood pressure will swing between 80 and 120 millivolts. Under these circumstances, the 40 mm. pulse pressure will be represented by a voltage swing of 40 millivolts. This can be broken down into an a.c. and a d.c. component; the d.c. component will amount to 100 millivolts (the average of 80 and 120), and the a.c. component will be represented by a swing of 20 millivolts above, and 20 millivolts below this d.c. reference level.

If such a signal is fed through an *RC* coupled amplifier, the circuit will not pass the d.c. component. Instead, only the a.c. waveform, representing a periodic change in amplitude of 40 millivolts, will be present at the amplifier output. Unfortunately, this information is of relatively little value, because any range of pressures, separated by 40 mm., will produce the identical waveform, such as 60 and 100 mm., or 160 and 200 mm., etc. There is a world of difference, of course, between the latter abnormal blood pressures, and the normal range of 80 to 120 mm. For this reason, the physician must know the absolute value of the blood pressure. He can obtain this with the aid of a direct-coupled amplifier, because this type of circuit does not discriminate against the d.c. component of blood pressure voltage curve. As a result, the galvanometer or recording arm is deflected to the average voltage level, and remains there instead of decaying as it would with an *RC* coupled circuit. The fluctuations above and below this average are represented by excursions above and below the d.c. setting.

Fig. 1. Block diagram of the Sanborn Poly-Viso.



The 6 step attenuator which is incorporated into the Poly-Viso is similar in principle to the loudness controls used in high-fidelity audio amplifiers. Like the loudness control circuit, it allows variations in amplifier gain without introducing frequency discrimination. It has the additional advantage of providing a selection of gain settings, which are related to each other by an accurately pre-determined ratio (X1, X4, X20, X100, X400, and X1000).

A variety of recording devices is used with multiple channel recorders of this type. In one of the instruments shown in the photographs, optical galvanometers, which throw a moving beam of light on a roll of moving photo-sensitive paper, are employed. Records of this type must be developed photographically for interpretation.

Another recording method makes use of electromagnetically-driven pens. These produce an inked record on ordinary paper. The most modern recorders, however, and the ones which are used with the most recent, direct-writing electrocardiographic recorders, are the direct-writing galvanometers. These consist of a moderately sensitive galvanometer, of the d'Arsonval type. Attached to the meter suspension is a long, but lightweight, extension arm on which is mounted an electrically heated stylus. The meter movements are etched by the heat of the stylus in the surface of special, plastic-coated paper to produce the finished record. As a rule, provision is made in most modern recorders to plug a cathode-ray oscilloscope into the output circuit of the direct-coupled amplifier.

With the addition of certain accessory equipment, multiple channel recording systems of the type just described become exceedingly versatile research instruments.

Two of the most recent accessory devices which are fulfilling roles of great importance in medical research are the electromanometer and the ballistocardiograph. The electromanometer circuit is shown in block diagram in Fig. 4. It would be difficult to over-emphasize the value of this ingenious instrument as a research tool. In one compact unit, this apparatus represents the culmination of a need, the solution of which has challenged the most brilliant scientific minds of more than two centuries—a method for accurately and continuously measuring the blood pressure. In terms of the countless human lives which will some day be saved as a result of the research into heart disease which this instrument has made possible, its value is immeasurable.

The heart of the instrument is the r.f. oscillator (B) and the condenser microphone-bridge circuit (C). The device operates in the following manner. A needle is introduced into a suitable blood vessel, such as the brachial artery (in the arm). The variations in the blood pressure are physically transmitted through a special salt solution from the needle tip, through a length of lead tubing, to the condenser microphone. When the condenser microphone is stimulated by these pressure changes, the change in capacitance of this element, which constitutes one arm of the bridge circuit, unbalances the bridge. The unbalanced voltage from the r.f.-excited bridge is then amplified and rectified. The rectified voltage which is proportional to the blood pressure is then fed through the power unit and into the multiple-channel recorder.

Prior to the development of the electromanometer, the most satisfactory way to measure the blood pressure was

(*Continued on page* 28)

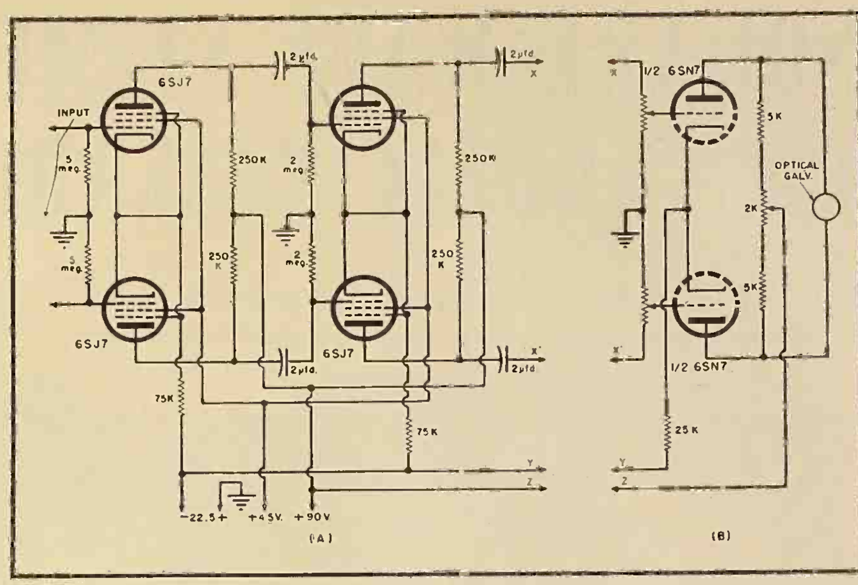
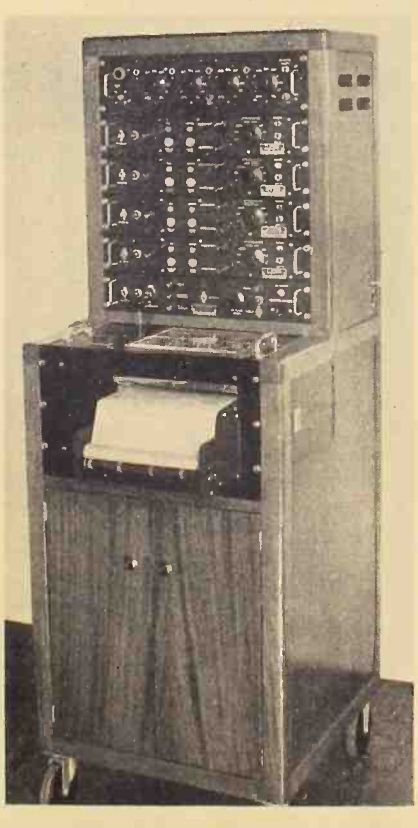
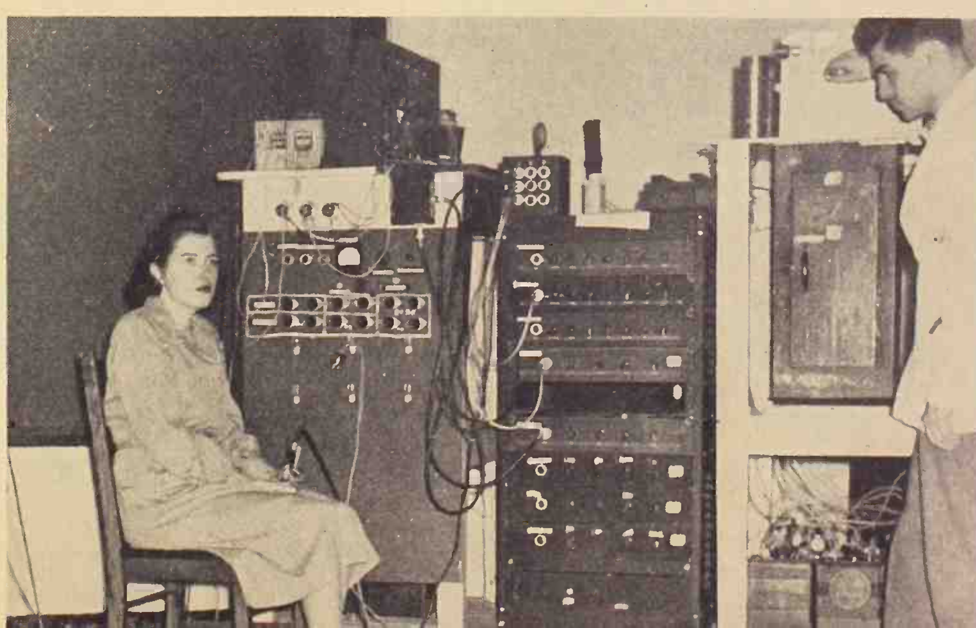


Fig. 2. Circuit of pulse-type, resistance-capacitance coupled amplifier (A), with connections for completely self-contained recorder (B). For a multiple-channel recorder, the terminals X,X' would go to a direct-coupled amplifier.

The Sanborn Poly-Viso recorder.



A ten-channel research recording system in operation.



SQUARE WAVE STIMULATOR for CARDIAC RESEARCH

Details of a dual pulse generator with variable pulse positioning and a repetition rate of 30 to 300 PPM.

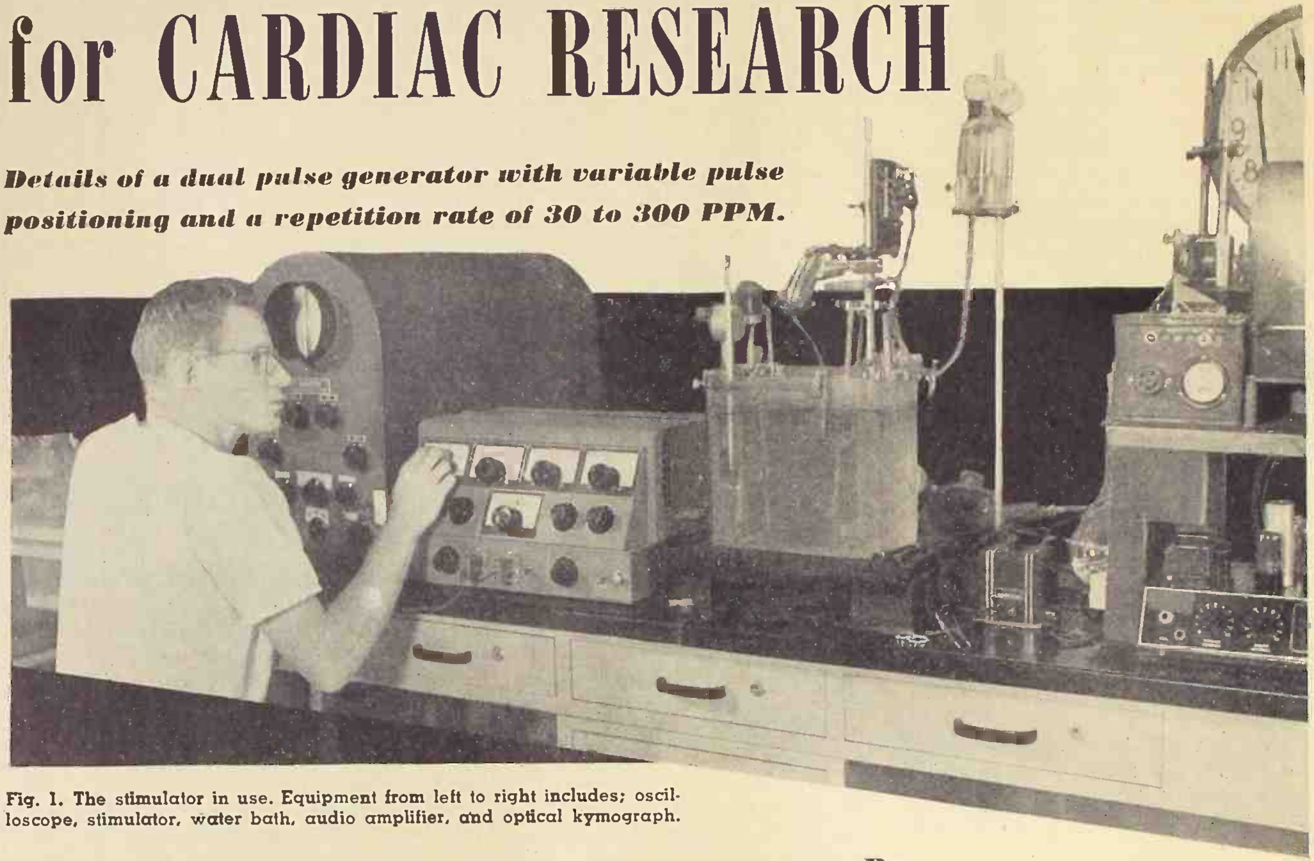


Fig. 1. The stimulator in use. Equipment from left to right includes; oscilloscope, stimulator, water bath, audio amplifier, and optical kymograph.

By

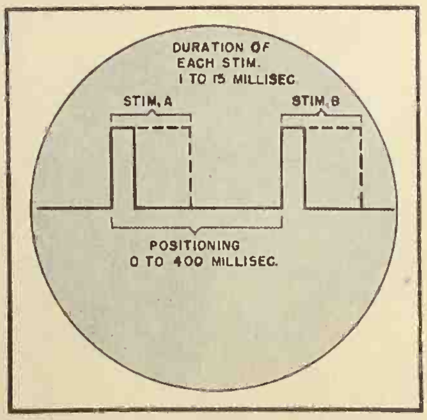
J.R. DiPALMA, M.D.* and E.E. SUCKLING**

DURING THE course of an investigation on the excitability and refractory period of mammalian cardiac tissue, a special stimulator was designed[1]. The requirements were as follows:

1. Rectangular negative pulse in all ranges.
2. Selection at will of a single or a dual stimulus at repetitive rates from 30 to 300 pulses per-minute.
3. Continuously variable dual pulse positioning so that the pulses might be separated from 0 to 400 milliseconds apart.
4. Independent, continuously variable control of the duration of each pulse from 0.1 to 15 milliseconds.
5. Independent output control of each pulse from 0 to 20 milliamperes.
6. Previously calibrated controls so that any of the variables might be quickly selected.
7. Stable operation.

Other investigations on the same problem have, for the most part, used rotary commutators and induction coils[2, 3]. These are difficult to construct mechanically and because of the induction coils and inevitable sparking at the contacts, variations in amplitude and wave shape of the output result. Many types of pulsed electronic stimulators have been designed but none fit the particular requirements set forth above[4, 5]. For this reason, it is felt desirable to present the circuit, certain construction details, and applications of this unit.

Fig. 2. Waveforms obtainable. Amplitude, 0-20 ma.; sweep duration, 300-2000 milliseconds.



V_1 is an ordinary thyratron oscillator (Fig. 4.) The rate of oscillation is set by the potential on its grid. The pulse from V_1 triggers V_2, which in turn empties its plate condenser into the cathode of V_3. The condenser in the cathode V_3, slowly discharges through pentode V_4 in a linear manner. This quick-rise, slow-discharge voltage goes to cathode follower V_6, where it is used to trigger a multivibrator circuit composed of V_7 and V_8. V_5 and the second plate of V_3 limit the charge and discharge of the V_3 cathode condenser. V_6 has a large saw-tooth voltage with a moderately fast rise and a slower discharge each time V_1 fires. V_7 and V_8, the d.c. multivibrator circuit, is triggered off when the grid of V_7 reaches approximately 38 volts. The multivibrator falls back again when the grid of V_7 drops in potential down to 35 volts. The 38 volt charge occurs during the fast rise, and the 35 volt charge during the slow fall. Thus, during the saw-tooth wave, V_7 and V_8 trip and return. The return depends on the setting of the potentiometer in the cathode of V_6, and thus the system gives a delay in relation to the firing of

**Professor of Pharmacology, Hahnemann Medical College.*
***Instructor in Physiology, State University of New York.*

V_1 of any duration up to 0.4 seconds. When V_7, V_8 return to normal conditions, a negative pulse is passed from the plate of V_7 to the grid of V_9 and is amplified to become a positive pulse which can fire off V_{10}. The pulse from the plate of V_{10} is used to trigger the square wave generator V_{11}, V_{12}. This square wave generator on being triggered off by the unvarying pulse from V_9, produces square waves whose duration can be altered by the combination of condensers and the potentiometer in its plate circuit between the limits of 0.1 to 17 milliseconds. The square wave is taken from the plate of V_{12} for the purpose of amplification and improvement in shape to the grid of V_{13}. From the plate of V_{13} it passes to the grid of V_{14}. This is a power tube whose plate is connected to ground through a 5000-ohm resistance. V_{14} is supplied with negative high voltage to the cathode and is normally cut off. Thus the pulse from V_{13} produces in the plate of V_{14} a step of voltage negative to ground which can be connected without blocking condensers or transformers directly to the biological preparation. The negative current pulse from V_{14} can be adjusted in value to give a stimulus of up to 20 milliamperes. The second channel shown at the bottom of Fig. 4 is exactly the same as tubes V_6 to V_{14}, and has the same characteristics. The attenuator system consisting of *T* pads allows the outputs of the two channels to be connected in parallel with little interaction between the two output attenuators. In some types of dual stimulation, the *T* pad attenuator system shown here need not be used but it was found desirable in the experiments which we desired to perform.

The power supply circuits are conventional and are wired in relation to ground so as to supply separate positive and negative voltage. It was found desirable to control the supplies with VR 150 tubes (Fig. 6).

A schematic diagram of the output of the stimulator as it appears on the screen of the cathode-ray oscilloscope is shown in Fig. 2. In this diagram, the two pulses are symmetrical but, as in-

(*Continued on page* 26)

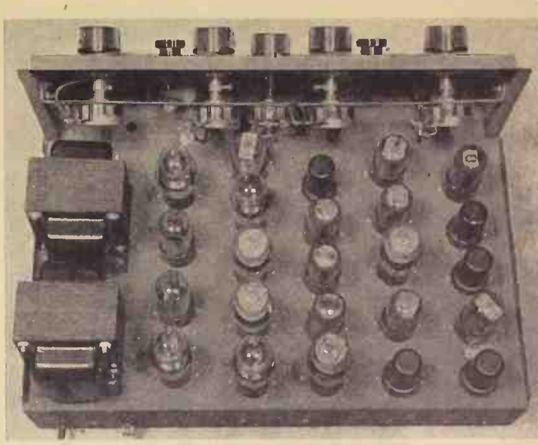
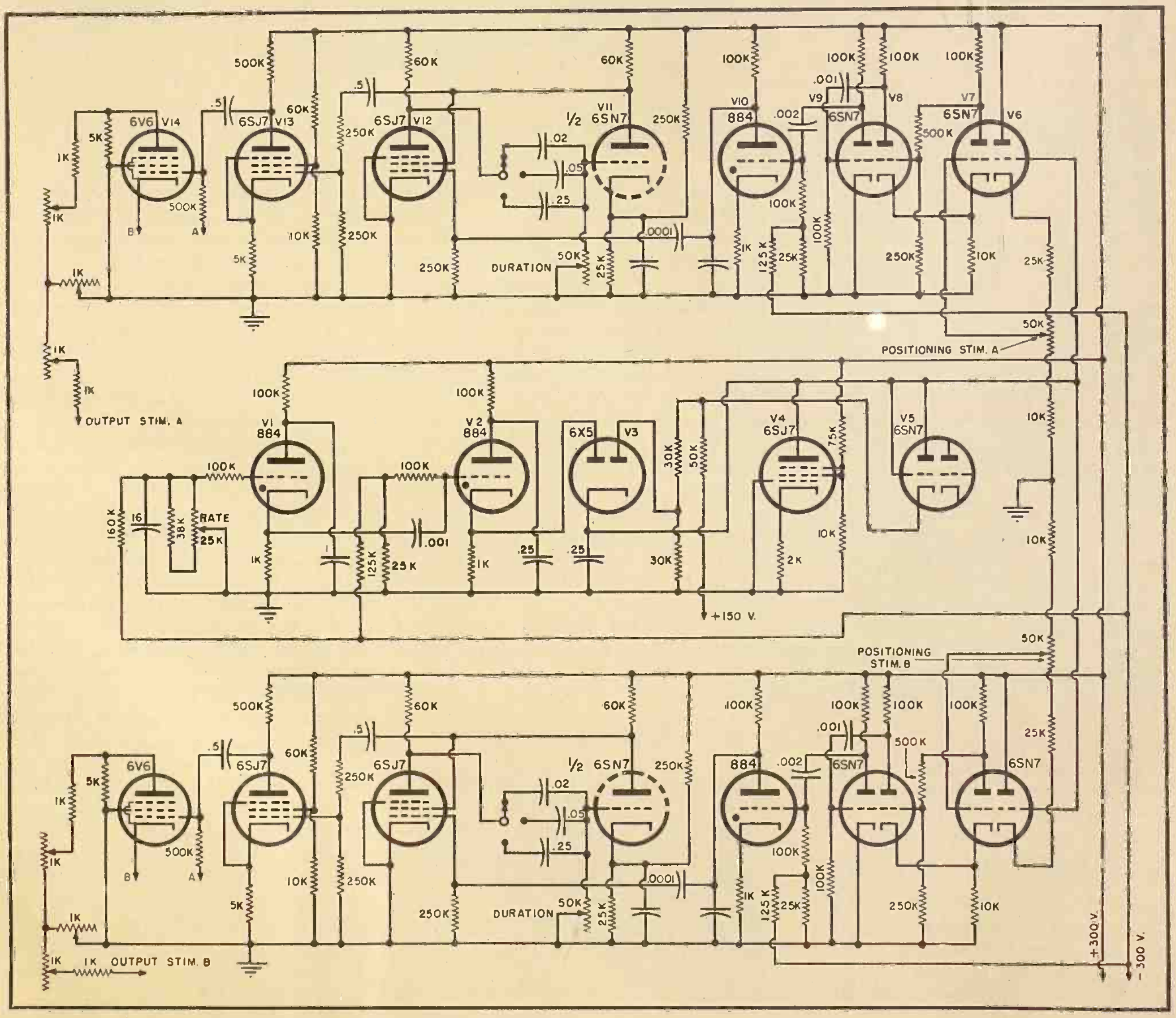


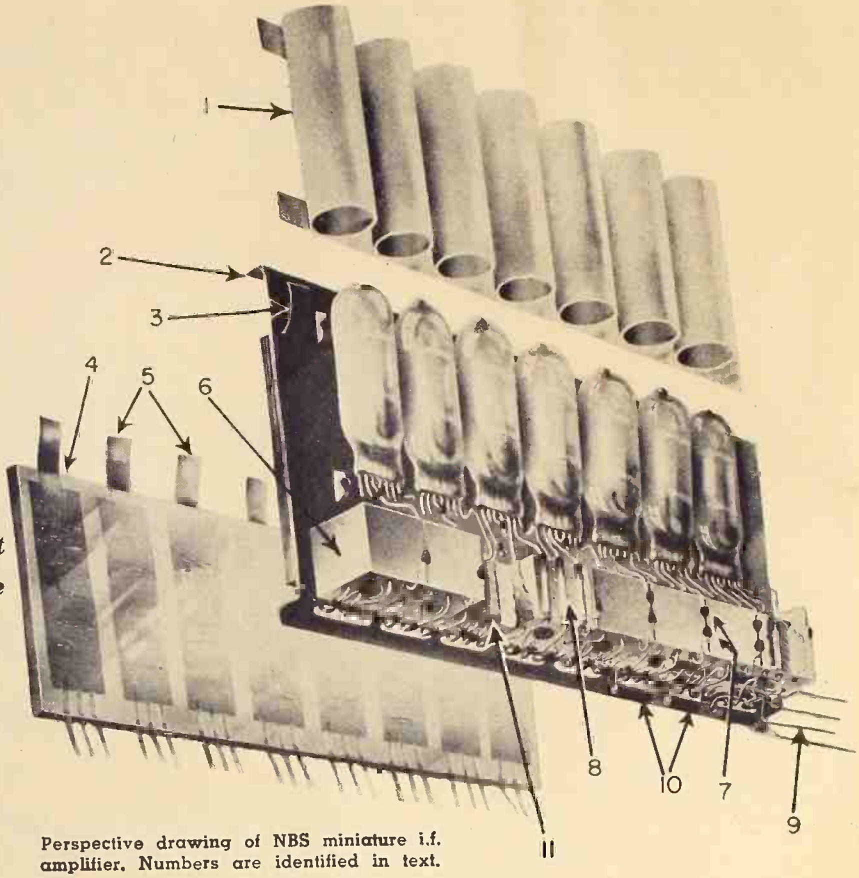
Fig. 3. Top view of the stimulator chassis.

Fig. 4. Complete schematic diagram and parts values for the square wave stimulator.



New MINIATURE I. F. AMPLIFIER

Miniaturization techniques at NBS have resulted in a more compact, lighter-weight unit.



Perspective drawing of NBS miniature i.f. amplifier. Numbers are identified in text.

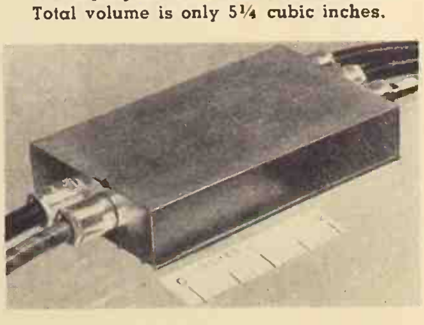
A 7-tube miniature intermediate-frequency amplifier, recently developed at the National Bureau of Standards, embodies several innovations in electronic miniaturization technology. Particular emphasis is placed on the use of preassembled groups of similar circuit elements to simplify production. Developed by Robert K-F Scal and associates of the NBS engineering electronics laboratory, the Model VI i.f. amplifier is a product of a continuing comprehensive program of electronic miniaturization. This program is supported principally by the Navy Bureau of Aeronautics and, for particular equipments, by the Bureau of Ordnance.

Size reduction of electronic equipment is becoming increasingly important for many applications, particularly in military equipment. Electronic miniaturization activities initiated at NBS by the Department of the Navy have already produced a number of advances in printed circuit technology, and techniques for reducing size to what at present seems a practical minimum have been demonstrated. Development of the Model VI amplifier was undertaken, not to effect further substantial size reduction, but rather to work out designs for maximum simplicity, flexibility, and ease of manufacture.

The extent to which the goals of simplicity and ease of fabrication have been attained is indicated by the fact that the Model VI amplifier requires only 40 construction drawings compared to twice that number for its immediate predecessor, the Model V. Attainment of these design goals centered around the use of separate subassemblies, each consisting of a preassembled group of identical or similar circuit elements. Model VI design, suitable for center frequencies ranging from 20 to 100 mc., is flexible also in its adaptability to different types of components; for instance, three resistor types and two capacitor types can be accommodated. Components were not restricted to those hitherto available; when standard components were found wanting, new ones were designed, after consultation with manufacturers to insure that the new units would be adaptable to straightforward fabrication. Designed to be hermetically sealed for protection against contamination and moisture, the new amplifier uses components and materials capable of withstanding the high operating temperatures, up to 200°C, found in compact sealed equipment.

The capacitor, resistor, and tube-shield subassemblies are fastened to the inductor subassembly, which thus serves as the main chassis of the amplifier. The inductor subassembly comprises input and output transformers and six bifilar inductors fitted inside holes in eight ceramic blocks. The outer surfaces of the blocks are metallized by applying silver paint and firing. Besides providing electrical shielding for the inductors, this metallizing permits soldering the eight blocks to the chassis to make up the unitized subassembly.

A non-plug-in case for the i.f. amplifier. Total volume is only 5¼ cubic inches.



The inductors themselves are wound on tubular powdered iron cores having ferrite rods at their centers. Trimming is accomplished by sliding the rods in or out. After the length of insertion has been adjusted, the rod is cemented in place and the protruding end broken off.

The preferred capacitor subassembly is of a new glass dielectric type. Seven groups of three capacitors (heater, plate-supply, and automatic-gain-control bypass) are encased in a single sealed and insulated glass unit. Common ground leads for each group of three are brought out from one edge of the unit, while the other leads extend through the opposite edge. This capacitor subassembly combines compactness with high dielectric strength and ample capacity (about 1500 μμfd. per capacitor). Since the capacity-temperature coefficient and the losses are low, capacitors of this type could be used for tuned circuit as well as bypass applications.[1]

(*Continued on page* 27)

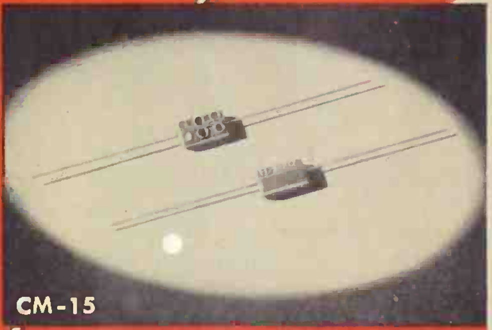
PERFORMANCE...

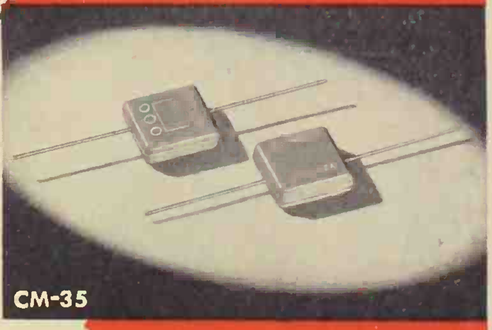
COMES IN...

From the midget champ which spins around a ¼ mile oval in 19 seconds . . . to the Indianapolis winner which clocks 157 m.p.h. on the straightaway . . . performance is the keynote in auto racing. In Electronics El-Menco Silvered-Mica Capacitors set the space. From the tiny CM-15 (2-525 mmf. cap.) to the mighty CM-35 (3300-10000 mmf. cap.) . . . unexcelled performance is paramount.

Precision workmanship, fine materials, careful design . . . these are the qualities which produce peak performance in racing cars and in El-Menco Capacitors. There is an El-Menco Capacitor for every specified military capacity and voltage. Each unit is factory-tested at *double* its working voltage. You are assured of dependability for every application.

For higher capacity values — which require extreme temperature and time stabilization — there are no substitutes for El-Menco Silvered-Mica Capacitors.


CM-15


CM-35

Jobbers, Retailers, Distributors—For information communicate direct with Arco Electronics, Inc., 103 Lafayette St., New York, N. Y.

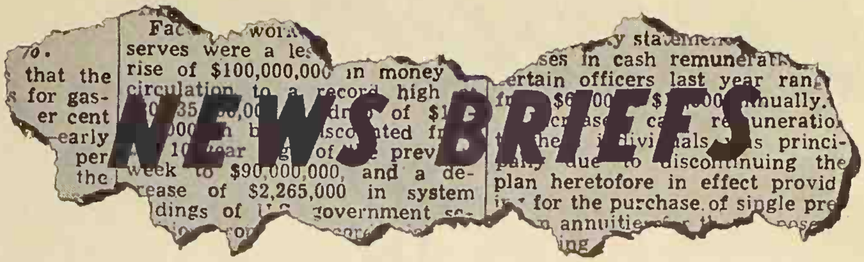
Write on your business letterhead for catalog and samples.

MOLDED MICA **El-Menco** **MICA TRIMMER**

CAPACITORS

Radio and Television Manufacturers, Domestic and Foreign, Communicate Direct With Factory—

THE ELECTRO MOTIVE MFG. CO., INC. **WILLIMANTIC, CONNECTICUT**



WEST COAST SIDELIGHT

IRE President, Ivan S. Coggeshall, General Traffic Manager, *Western Union International Communications*, at right, discusses manufacturing meth-

ods for powdered-iron torodial inductors used in carrier telegraph equipment, with L. B. Rice, San Francisco Regional Manager of *Western Union*, at left, and Philips B. Patton of *Lenkurt Electric Company*, San Carlos, Calif. Occasion was an inspection tour of the *Lenkurt* plant during the recent Western Convention of IRE and Pacific Electronic Exhibit in San Francisco.

FLUORESCENCE ANALYSIS

Incorporating design improvements to facilitate rapid qualitative and quantitative analysis of constituents in metals, alloys, minerals, ores, chemical mix-

tures and compounds, the *Norelco* Fluoresence Analysis Unit is being produced by the *North American Philips Company, Inc.*, Mount Vernon, N. Y.

This unit employs a wide range vertical goniometer with a sweep radius of 170 mm., and utilizes a horizontal, water-cooled diffraction unit. Operating at potentials up to 50 kv. peak and at current values up to 50 ma., the unit is entirely non-destructive and permits analysis of very small specimens.

HOUSTON IRE

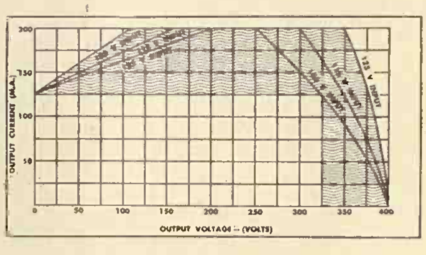
The 4th Southwestern IRE Conference and Radio Engineering Show will be held in Houston, Texas on May 16th and 17th, 1952 at the Rice Hotel.

Comprehensive technical sessions and equipment expositions are being planned for electronic engineers in all fields.

The conference manager is Mr. Gerald L. K. Miller, past chairman of the Houston Section of IRE, 1622 West Alabama, Houston, Texas.

D.C. POWER SUPPLIES

Performance figures on d.c. power supplies, manufactured by *Sorensen &*



Company, Stamford, Conn., indicate minimum current available over the entire specified voltage range, except when voltage approaches zero. The illustration shows the performance of a typical unit, Model 325BB. The unshaded rectangle represents the specified performance, with the rated current output (125 ma.) available at any output voltage above ten volts and with 105 line volts. The shaded area shows the extra current capacity available at any output voltage and at various line voltages.

COMPANY MOVE

The *Technology Instrument Corporation*, formerly of Waltham, has now moved to Acton, Massachusetts, because of the rapidly expanding activities of the company.

All basic manufacturing operations, including winding of potentiometers and transformers, production of basic parts for precision potentiometers such as precision turning, milling, grinding, and boring operations, can be carried on in this new plant. Assembly operations are divided into two sections; one for potentiometers, and the other for precision laboratory instruments. Extensive laboratory facilities for developmental and experimental work are provided for all phases of the company's activities.

WIRING HARNESS

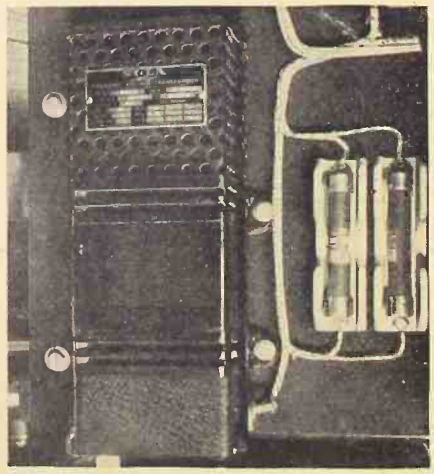
The *Runzel Cord & Wire Co.*, Chicago, Ill., is offering technical advice in

wiring harnessing and is fabricating harnesses completely assembled, finished and terminated, with shielded leads and jacks, terminals and/or plugs properly attached, ready for installation in the various electronic devices and machines.

The illustration shows a typical wire harness in the process of assembly, demonstrating service to manufacturers of electrically operated machinery and devices.

INDUCTION HEATING

Induction heating has proved useful in selective hardening, high temperature brazing, soft soldering, selective annealing, shrink fitting, melting elec-



trolytically deposited tin for tin reflow, and melting small amounts of ferrous and non-ferrous metals.

Constant voltage transformers, such as those made by *Sola Electric Company*, Chicago, Ill., protect the filaments of the rectifier and oscillator tubes against voltage fluctuation, thus insuring optimum performance and tube life. The transformer shown in the photograph is one of two such transformers installed in Lindberg Engineering Company's r.f. heating units.

TUBE OVEN

A new baking and annealing oven, used for experimental work for television picture tubes, is utilized by the

General Electric Company, Syracuse, N. Y. Subject to extreme heat, the oven cools slowly, eliminating brittleness in the tube.

PHYSICS DEPARTMENT EXPANSION

Increasing demand for research in fields of physics, electronics and instrumentation, has caused Southwest Research Institute to broaden its Physics Department staff. Recent appointments, as announced by Dr. Paul Erlandson, include the following: James W. Annis, James C. Axtell, Bascom F. Batts, William W. Bradshaw, Graydon E. Buss, William C. Coombs, Dr. Charles A. Culver, Malon H. Dickerson, George A. Furguson, Felix N. Kusenberger, John P. O'Meara, Richard E. Pabst, and M. John Prucha, Jr.

NEW CORPORATION

The formation of a new corporation, *Magnecord International Ltd.*, Chicago, Ill., has been announced by *Magnecord, Inc.*, manufacturers of professional tape recorders.

The international corporation will handle all *Magnecord* business outside of the Western Hemisphere, having as

(*Continued on page* 25)

NEW PRODUCTS

REJECTION FILTER

Krohn-Hite Instrument Company, 580 Massachusetts Ave., Cambridge, Mass., announces a new variable ultra-low frequency rejection filter.

Featuring low internally generated

noise, single scale logarithmic dials, electronically regulated supplies, and input and output buffer stages, the Model 350-A is especially useful for vibration studies and electromedical research, for geophysical and seismological instrumentation, and in conjunction with any low frequency phenomenon involving selective amplification.

The high and low cut-off frequencies of the rejection band are adjustable over the frequency range from 0.02 to 2000 cps. A sharp null may be obtained at any frequency between 0.1 and 500 cps, with gain within 3 db of unity at one octave above or below the null frequency.

PULSED CARRIER GENERATOR

A new pulsed carrier generator, designed to give rapid and accurate transient response information, is offered by *Kay Electric Company,* Pine Brook, N. J.

Known as Rada-Pulse, it has the following specifications: Carrier frequen-

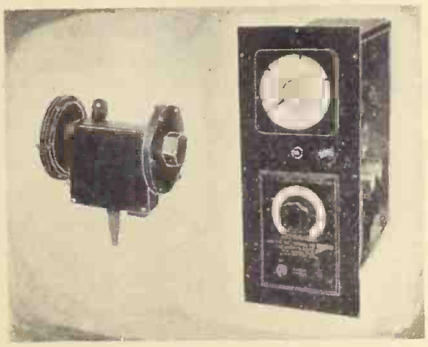
cies: 30 mc and 60 mc. Pulse widths: 0.1 and 0.25 microseconds. Pulse repetition rate: Continuously variable from 500 to 2000 pps. Maximum r.f. output: approx. 1 volt at 70 ohms. Attenuators: 20 db, 20 db, 10 db switched, 10 db continuously variable.

Pulse output is 50 volts at 70 ohms. External modulation: Input terminals provided to permit modulation by other pulse widths from external source. Trigger pulses: Positive and negative furnished ahead of pulsed carrier to trigger oscilloscope sweep circuit. Regulated power supply is built in.

INDICATING CONTROL UNIT

The Cat. 120 Electronic Differential Pressure Indicating Control unit is an electronic control system designed to indicate and control the differential pressure between a volume of corrosive gas and a surrounding gas, manufactured by *The Henry G. Dietz Company,* 12-16 Astoria Boulevard, Long Island City 2, N. Y.

It consists of a sensing element and

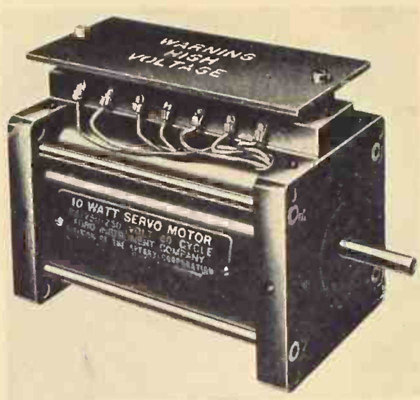


an indicating control unit, the sensing element noting a signal according to the variation in the differential pressure, which will produce a visual indication on the indicating control unit located at a distance of approximately 100 to 250 feet from the sensing element. The indicating control unit, in addition to being a visual indicator, is a two position controller which will close a set of contacts when the differential pressure drops below a predetermined value. A manual control on the indicating control unit is provided so that the pressure differential, necessary to operate the contact points, may be varied. This control system, with modifications of the sensing element, can be adjusted to be used to indicate linear movement and, therefore, may be used to indicate pressures, temperatures, accelerations, and forces, provided the equipment is calibrated in terms of the particular sensing element used.

The sensing element is constructed of special materials, such as teflon and monel, to withstand the action of corrosive gases.

SERVO MOTORS

A complete line of low inertia servo motors with high voltage control windings, which eliminate the need for transformers in servo amplifiers, is now being produced by *Ford Instrument*



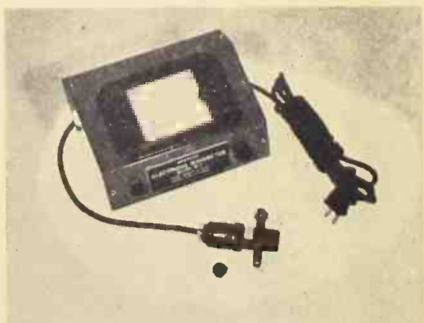
Company, 31-10 Thomson Ave., Long Island City, N. Y.

These motors have close-coupled windings for feedback purposes, and are available in ½, 1-½, 5- and 10-watt sizes. Of particular significance is the space and weight saving resulting from the elimination of the transformer.

ELCTRONIC MANOMETER AND FLOWMETER

An entirely new type, highly sensitive electronic manometer and flowmeter, having no glass or plastic tubes and containing no fluids, is announced by the *Hastings Instrument Company,* Inc., Hampton, Va.

The electronic manometer operates from a noble metal thermopile. The two taps on the gauge tube are connected



to the two points at which the pressure difference is to be measured. To use the instrument as a flowmeter, the tube is directly in the line for low flow rates or connected to pressure taps on two sides of a calibrated orifice for high flow rates.

The electronic manometer measures extremely low pressure differences, having a dual range of 0.001" to 0.1" and 0.1" to 2" of water. The calibration and accuracy of the instrument are not affected when long extension cables are used from the gauge tube to the meter, and may be used for direct indications or attached to a recorder.

Accessories to the instrument include a 5-position switching attachment, permitting monitoring of gauge tubes in 5 locations with one indicating meter. The instrument operates on 110 v., 60 cycle power, with a constant voltage transformer available to eliminate any effects from variation in the line voltage.

SPRING COMPUTER

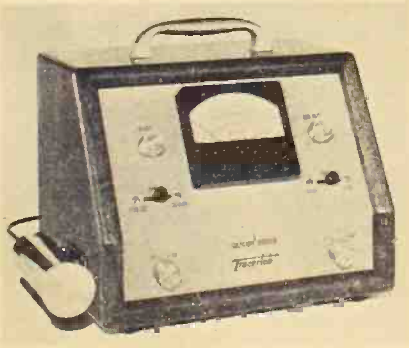
Problems of spring design are solved with the Calculaid Spring Computer, devised by the *American Hydromath Corporation*, 145 W. 57th St., N. Y. 19, N. Y. This computer correlates, in one setting, all the variables in spring design, namely O. D. of spring, wire size in diameter and gauge number, number of active coils, material and its torsional modulus G, maximum sheer stress, load and total deflection.

The computer's stress scale includes the correction for non-linear distribution of torsional stresses in curved wires and is produced from sheets of vinylite plastic, having laminated scale markings.

LABORATORY MONITOR

Featuring greater reliability and a better method of high voltage control, a new laboratory monitor is announced by *Tracerlab, Inc.*, 130 High Street, Boston 10, Mass.

The SU-3B Laboratory Monitor is a.c. operated, and has three full-scale



meter ranges of 200, 2000, and 20,000 counts per minute. It was developed specifically for use as a contamination monitor in radioactivity laboratories. Weighing 17 pounds, it is equipped with a mica end-window Geiger tube, loudspeaker monitor for use as an aural monitor, volume control, and built-in pulse generating circuit synchronized with 60 cycle line frequency, allowing quick calibration check without need of an external pulse generator.

WIDE BAND VIDEO AMPLIFIER

Designed for use as an oscilloscope deflection amplifier for the measure-

ment and viewing of pulses of extremely short duration and rise time, a new improved Wide Band Video Amplifier, Model V-2, has been announced by *Polarad Electronic Corporation*, 100 Metropolitan Ave., Brooklyn 11, N. Y.

The amplifier has a flat amplitude response ± 1.5 db from below 10 cps to 20 mcps. It is a tool for laboratory and industrial use to extend the amplitude range of vacuum tube voltmeters and signal generators. Permitting accurate analysis of television signals by its extended frequencies, sixty cycle square waves are passed with less than 5% tilt.

MINIATURE POWER RESISTORS

The Dalohm resistor, said to pack more resistance per watt per cubic inch than any other resistor on the market today, is now being produced by the *Dale Products, Inc.*, Columbus, Nebraska.

This resistor, made in 2-, 5-, 10-, 25-, and 50-watt sizes, is sealed by a special silicone material, making it completely

impervious to moisture, with completely-welded construction from terminal to

(*Continued on page* 22)

Personals

DR. W. R. G. BAKER was awarded the medal of honor of the Institute of Radio Engineers for his technical contributions to the art of radio transmitting and outstanding service to the Institute. Dr. Baker, Vice President of *General Electric Company*, is also Chairman of the National Television Systems Committee of the Radio-Television Manufacturers Association and is active in many other engineering, management, and civic organizations.

GEORGE R. FAUSTMAN has been named general factory manager of the *Bendix Radio Division of Bendix Aviation Corporation*, according to an announcement by E. W. Foster, Vice President of the corporation. Associated with that company for the past 11 years, Mr. Faustman held successive positions of supervisor of standards, plant superintendent, and chief industrial engineer of the Division, besides being Director of the Society for the Advancement of Management.

JAMES B. FERGUSON has been appointed Chief Engineer of *Link Radio Corporation*, having contributed extensively by designing mobile radio transmitter-receiver units. Among the first 100 men in the country to receive a commercial radio operator's license in 1912, Mr. Ferguson also was a radio engineer in the U.S. NavyDepartment, Vice President of Ship Owners' Radio Service, President of J. B. Ferguson, Inc. and Manager of Press Wireless, Inc.

JAMES E. MYERS has joined the staff of the Research Division of *Burroughs Adding Machine Company*, as Research Engineer. Mr. Myers received the degree of A.B. in Mathematics from the University of Michigan in 1942 and served as an Ensign in the U. S. Navy. From 1946, until joining the *Burroughs* organization, he was a research associate at the Moore School of Electrical Engineering, University of Pennsylvania.

DR. HENRY M. O'BRYAN has been appointed manager of the Physics Laboratories, *Sylvania Electric Products, Inc.* Prior to his work with the Research and Development Board in Washington, he served as Director for the *Baird Associates* of Cambridge, Mass. and was a member of the staff of the Naval Ordnance Laboratory. Dr. O'Bryan received his Ph.D. from Johns Hopkins University in 1930, and was Associate Professor of Physics at Georgetown University.

DR. WENDELL C. PEACOCK has been elected Vice President and technical director of *Tracerlab, Inc.* Responsible for the introduction of many unique pioneer products of that company, his work included synthesized radioactive chemicals and equipment employing radioisotopes. After receiving his doctorate from M.I.T. in 1944, Dr. Peacock participated in advanced procedures for radioisotope standardization at Oak Ridge, Tennessee.

New Products

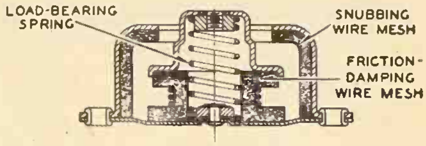
(*Continued from page* 21)

terminal. It has a standard tolerance of one per-cent, with tolerances as high as 0.05 per-cent furnished, plus a resistance shift less than 0.00002 percent per degree centigrade. The temperature coefficient of this resistor is substantially flat.

VIBRATION ISOLATORS

New unit vibration isolators, developed and manufactured by *The Barry Corporation*, 870 Pleasant St., Watertown 72, Mass., cover new load ranges of 8 to 16 lbs., 14 to 25 lbs., and 22 to 35 lbs. The new units are available in the 6600 series, the 6645 series, the 6600R series, and 6645R series.

The 6645 and 6645R series units have center studs 5/32" longer than the corresponding units in the 6600 and 6600R

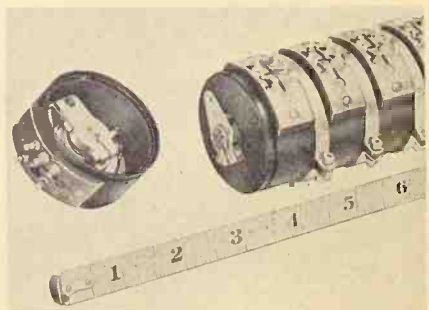


series and may be attached directly to the equipment, instead of requiring dimples at the mounting holes. The 6600R and 6645R units are "Ruggedized" to withstand severe shocks, such as those met in arrested landings in aircraft carrier service and in crash landings. They are tested to meet the shock requirements of Specification AN-E-19 for the equipment sizes listed in JAN-C-172A.

All of these new unit vibration isolators exhibit excellent performance, unaffected by very extreme temperatures.

PHASING POTENTIOMETER

A new C-200 series of potentiometers has been announced by the *DeJur-Amsco Corporation*, 45-01 Northern Boulevard, Long Island City, N. Y., with clamping ring method of gauging that permits accurate external phasing of individual units at any angle when circuit elements are changed.



The taps on this potentiometer, Series C-200, can be furnished at any specified points on the winding within ±½°, and it has a mechanical rotation of 360° continuous, and electrical rotation of 320° ±1°. The resistance range is 10 to 200,000 ohms, up to ±1%, with a linearity accuracy up to ±0.25%. Its operational life is 1,000,000 cycles dependent on rating and has a case of anodized aluminum.

NOISE AND FIELD STRENGTH METER

The incorporation of the "slide-back" technique in the vacuum tube voltmeter circuit of their Model 58 U.H.F. Radio

Noise and Field Strength Meter has been announced by *Measurements Corporation*, Boonton, N. J.

Making possible a greater accuracy of noise measurements of short pulses having a slow repetition rate, or a random variation in magnitude, Model 58's already in use may be modified to include this new facility. Covering the frequency range of 15 to 150 megacycles, Model 58 is used for the measurement of steady carrier voltages or fields; line loss; front-to-back ratios of directional antennas; signal-to-noise ratios of antennas; effectiveness of noise filters and for investigation of ignition and other radio noises.

WIRE HARNESS CLAMP

Built with an interlocking slot and T-shaped tongue, the new Wire Harness Clamp, manufactured by *Tinnerman Products, Inc.*, Cleveland, Ohio, can be opened and closed without the use of tools. The tongue, which slips into a narrow portion of the slot and is held by lateral and outward spring action, may be used singly or in tandem to hold bundles $\frac{3}{16}$" to 1-¼" in diameter. It can be opened without removal from the structure to which it is attached and features pre-assembly to the wire bundle, facilitating installation.

This new type wire harness clamp is also suitable for varying dimensions caused by deviations in wire insulation thickness, and is compatible for mounting to the structure with a screw driver.

TUBING AND SLEEVING SELECTOR

A new and easier way to select the exact size of tubing or sleeving needed to insulate wires is the main feature of a new sample card, the "Dieflex" Selector, distributed by *Insulation Manufacturers' Corporation*, 565 West Washington Blvd., Chicago 6, Illinois.

Leads or wires, slipped into the closest fitting hole on an aluminum gauge, permit determination of the correct size of tubing or sleeving, with seven actual samples of the different types, grades, and colors mounted on rugged pressboard. A description of various tubing or sleeving types is also included on the selector.

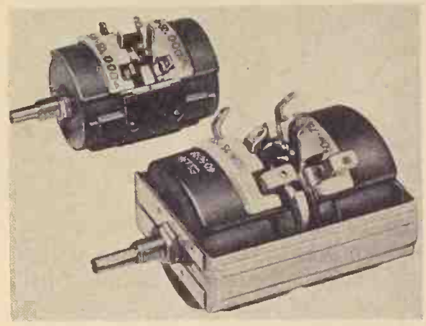
MULTIPLE SPINDLE DRILLING MACHINE

A multiple, 1-½ H.P. axial air gap motor driven Spindle Drilling Machine, ME-25 with three spindles mounted integral to a column, and suited to high volume production, has been introduced by the *Sibley Machine & Foundry Corp.*, South Bend, Indiana.

Featuring a 25" swing, the ME-25 has a wide speed range obtained by a self-locking speed control. A tachometer on the front of the machine provides accurate reading of speeds, with five options of spindle speeds, each with a 4 to 1 ratio, ranging from a low of 206-825 rpm, to a high of 540-2160 rpm, and 3 phase 60 cycle motor. Having a capacity of ¾" in steel and 1" in cast iron, the machine is equipped with a speed chart on the side of the machine showing proper speeds for different drill sizes.

DUAL POWER RHEOSTATS

The DeJur-Amsco Corporation, Long Island City, N. Y., has announced new features to its precision power rheostats. They are available as dual units with single hole mounting of both Models 245 (25-watt each section) and 241 (50-watt each section) for simultaneous



operation of independent circuits by means of one control.

Of all-metal construction, with black anodized aluminum diecast frame, metal winding core, stainless steel insulated shaft, and copper graphite brushes, these rheostats are available in exceptionally high resistance ranges within ±5% up to 50,000 ohms in the 25 watt size, and 75,000 ohms in the 50 watt size. Linear and non-linear windings over this range can be maintained within ±1%.

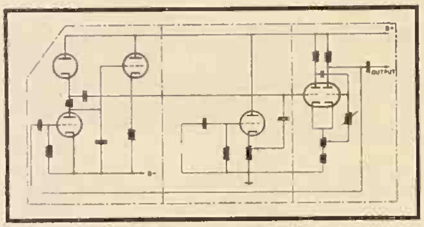
PATENT REVIEW

Printed copies of these or any other patents may be obtained from the U. S. Patent Office for 25c each. Address the Commissioner of Patents, Washington 25, D. C.

FREQUENCY DIVIDER

The object of this invention is to provide a novel, stable frequency divider with a high count-down ratio which depends primarily on the peak-to-peak voltage of an auxiliary wave developed by the circuit.

A linear saw-tooth wave is developed in the left-hand section (see diagram) and fed to a multivibrator or blocking oscillator (right-hand section.) The input pulses developed by the pulse source (center section) are also fed to this right-hand section. Thus, sharp pulses will be superimposed on the saw-tooth wave and, after a certain number of pulses, the voltage at the right-hand section will be sufficient to fire the multi-



vibrator or blocking oscillator. The number of pulses appearing before firing takes place gives the count-down ratio.

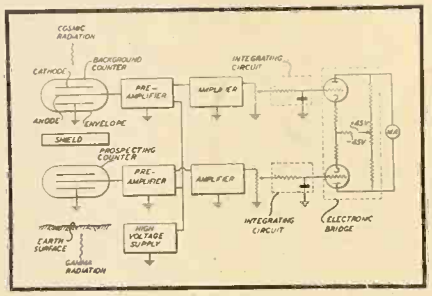
Several variations of this circuit are described, and parts values given for a circuit having a count-down ratio of 14 to 1. Much higher stable count-down ratios are possible with this circuit.

Patent No. 2,562,889 was issued August 7, 1951, in the name of John A. Buckbee.

PROSPECTING

The determination of gamma rays emitted from the earth is a valuable aid in a variety of operations including well logging, geological mapping of contacts, outcrops, etc., and also in locating deeply buried mineral deposits. Because of the weakness of these radiations, they are frequently masked by cosmic rays and the normal background count. This invention presents methods for increasing the accuracy of measuring gamma radiation.

Two detectors are used, both of which have about the same efficiency for the detection of background radiation, such as cosmic rays. One detector is then made more sensitive to gamma rays than the other by any of several methods. The outputs of these two detectors are subtracted electrically and the dif-



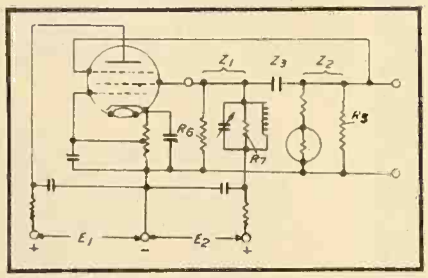
ference is measured. This procedure greatly increases the accuracy of the investigation.

Several variations are described, in addition to the one shown in the diagram.

Patent No. 2,562,968 was issued August 7, 1951, in the name of C. F. Teichmann et al.

STABILIZED ELECTRIC OSCILLATOR

The problem of instability in oscillators, with respect to both frequency and amplitude, has been attacked by engineers from many different angles. This



invention represents one approach to the solution of the problem.

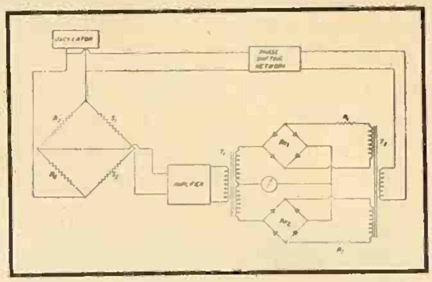
Oscillation circuit arrangements are set up in which the interelectrode impedances of the tube or other device are made to form a part of the oscillation circuit in such a way that variations of their resistive components do not affect the frequency.

The circuit shown incorporates these arrangements, and includes a thermosensitive element (shown circled) which functions in such a manner as to hold the output amplitude constant.

Patent No. 2,562,894 was issued on August 7, 1951 in the name of G. P. De Mengel.

PHASE SENSITIVE DEMODULATOR

In many types of measurements, a carrier wave has superimposed on it a



modulation voltage which varies in direction. In demodulating this carrier, it is many times desirable to distinguish phase or direction as well as amplitude. It is the purpose of this invention to describe such a system.

The circuit, as shown, performs as indicated. A pair of balanced demodulators is connected between two transformers, one fed direct from the bridge output through an amplifier, and the other from the oscillator supply through a phase shifting network. When the circuit is adjusted properly, the indicating meter will denote a 180° phase reversal in the bridge output.

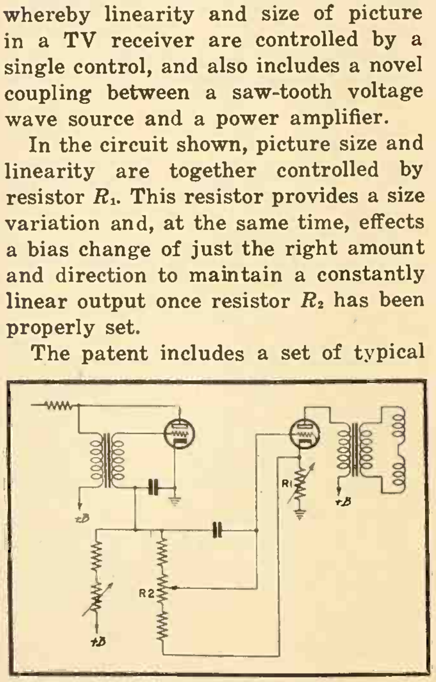
Patent No. 2,562,912 was issued August 7, 1951, in the name of Paul F. Hawley.

BEAM DEFLECTION SYSTEM

This invention presents a system whereby linearity and size of picture in a TV receiver are controlled by a single control, and also includes a novel coupling between a saw-tooth voltage wave source and a power amplifier.

In the circuit shown, picture size and linearity are together controlled by resistor R_1. This resistor provides a size variation and, at the same time, effects a bias change of just the right amount and direction to maintain a constantly linear output once resistor R_2 has been properly set.

The patent includes a set of typical



component values for the proper functioning of this circuit.

Patent No. 2,562,985 was issued August 7, 1951, in the name of Marvin H. Kronenberg.

News Briefs

(*Continued from page* 19)

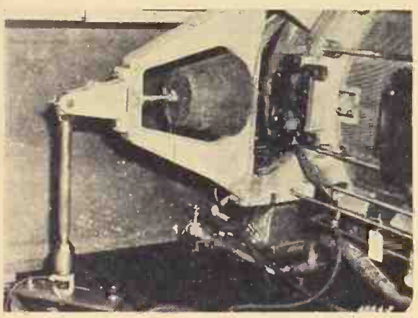
its special aim, the creation of new markets for U. S. goods and the goal of distributing manufacturing "know-how" to the countries unable to manufacture for themselves.

The manager of the new corporation is Mr. Ad. Auriema, who has been widely recognized as one of the leading experts on the export of electronic merchandise.

LOAD CELLS

SR-4 Load Cells, supplied by *Baldwin-Lima-Hamilton Corporation*, Philadelphia, Pa., are being used to weigh dynamometer loads for full scale tests of aircraft reciprocating engines.

Composed of steel columns or rods, the load cells are bonded by SR-4 re-



sistance wire strain gauges. Strains in the column affect the electrical resistance of the strain gauges, with electronic circuits of an indicator changing automatically into units of torque or thrust.

IBM INFORMATION MACHINE

The development of an electronic information searching machine by the *International Business Machines Corporation*, brings to light the use of photoelectric eyes to read scientific information from IBM cards at the rate of 1000 cards a minute.

Coupling electronic principles with a new machine "language" of 792 characters, information contained in a book or article is thus condensed and transferred into IBM cards. When information is desired, the machine matches the question and information cards, selecting those which give the answers. Successfully demonstrated before a group of scientists, the machine has been found to be important in its application to the field of searching for similar chemical compounds.

IRE AWARDS

The Institute of Radio Engineers named 45 leading radio engineers and scientists for its annual Fellow Award, at a meeting held on September 12, 1951 in New York City. Presentation of the awards with citations will be made by the President of the Institute at the Annual Banquet on March 5, 1952 at the Waldorf-Astoria Hotel during the 1952 IRE National Convention.

Among the 45 recipients, was Dr. Newbern Smith, Chief of the Central Radio Propagation Laboratory of the National Bureau of Standards in Washington, D. C., who is well known for his outstanding contributions on the propagation of radio waves. Mr. Smith was also named the recipient of the 1952 Harry Diamond Memorial Award, bestowed annually upon a person in Government service who has made outstanding contributions to the field of radio or electronics.

ELECTRICAL INSULATION

An asbestos-base, silicone-treated Class H high temperature electrical insulation is being offered by *Johns-Manville*, 22 East 40th St., New York 16, N .Y., combining greater safety and opportunity for more compact design.

Identified as "Quinterra Type 3," it is used for both inter-layer and wire wrapping insulation, and is adaptable to a wide range of electrical devices, including air-cooled, inert gas, and silicone-filled transformers.

"Quinterra Type 3" maintains a dielectric strength of at least 350 vpm under continuous exposure to Class H maximum temperature of 180°C, this dielectric strength remaining practically constant even under continuously high humidity. When silicone treated, its uniformity in texture and thickness is aided by the base sheet of purified asbestos, which is completely inorganic and of closed structure with no holes, making winding dimensions easily calculable.

This new electrical insulation is supplied in the form of sheets, rolls and tapes in widths varying from ¼" to 36" with thicknesses from 3 to 9 mils and may be used alone, or combined with other dielectric materials such as mica or glass cloth.

MINIATURIZED COUNTER DECADES

A compact redesign of a four-tube electronic counter decade, approximately one-third smaller than the standard decade, has been announced by the *Potter Instrument Company*, Inc., 115 Cutter Mill Road, Great Neck, N. Y.

Differing only in the maximum counting capabilities, Model 12 is designed for counting at rates up to 130,000 counts per-second, and Model 13, for counting at rates up to 30,000 counts per-second.

Four large quarter-watt neon glow lamps, arranged in a 1-2-4-8 decimal coding, facilitate accuracy of counter

(*Continued on page* 31)

TECHNICAL BOOKS

"ELECTRIC TRANSMISSION LINES" by Hugh H. Skilling. Published by *McGraw-Hill Book Co., Inc.*, 330 W. 42nd St., New York 18, N. Y. 438 pages, $6.50.

The author developed this book during ten years of teaching, which would indicate that the material contained in it has met all tests for accuracy and lucidity. The background necessary for studying the text includes a rather intimate acquaintance with ordinary circuit theory involving lumped constants, and some knowledge of integration and differentiation.

The book is a presentation of the theory of circuits with distributed constants, which is valid at all frequencies, followed by chapters on the application of this theory to radio-frequency lines, power lines, telephone lines, filters, and wave guides. It is written primarily for the more general type of course that treats lines at all frequencies, although specialized material is included on certain applications.

There are numerous problems at the end of each chapter, and numerous footnotes, as well as an appendix, supplement the material found in the main body of the text.

"NOMOGRAPHIC CHARTS" by C. Albert Kulman. Published by *McGraw-Hill Book Co., Inc.*, 330 W. 42nd St., New York 18, N. Y. 224 pages, $6.50.

This book presents a collection of nomographs which have been found to be time-saving devices in engineering and mathematical computations in such fields as hydraulics, mechanics, thermodynamics, and electrical engineering. Each chart occupies a full page, and a brief explanation of its use is included. Accuracy exceeds normal slide rule calculations.

Typical charts in the chapter on Function Scales include 5th, 4th, and 3rd powers and roots; 5/2, 2/5, 1.9, 3/2, 2/3, 1-7/16, 4/3, 3/4, 5/4, 4/5, 1.16, and 1.1 powers; reciprocals; and circle circumference and area. Under General Charts appear charts dealing with compound interest, sinking funds, annuities, and properties of triangles. The group of Hydraulics Charts covers various flow calculations and other hydraulic problems. Groups of charts on mechanics and thermodynamics cover these fields rather thoroughly. The 17 charts under the Electrical group are of value to electronic, as well as electrical, engineers.

A total of 92 nomographs is included in this useful collection.

Square Wave Stimulator

(*Continued from page* 15)

dicated, each might be varied independently to form any rectangular shape with the given limits of duration and amplitude. Also, each pulse can be positioned on the sweep so as to be at any desired distance from the other pulse. Moreover, the pulses can be made to superimpose or even pass each other if desired.

Construction and Calibration

The chassis measures 14 x 17 x 3 inches with a sloping front panel. Positioning of the various components is not critical, and both negative and positive power supplies are built on the same chassis. Five vernier type dials with calibration scales (*National* MCN dial) are mounted on the sloping front. These provide for the selection of the repetitive rate and the duration and positioning of the two stimuli. The duration and output range switches are also on this panel. On the lower chassis panel are the variable output controls, on-off switches and output jacks.

The duration of each pulse was separately determined by synchronization with the sweep of a suitable oscilloscope and timed with a 1000 cycle sine wave. Each duration dial was calibrated in 3 ranges, 0.1 to 3, 1 to 5, and 3 to 15 milliseconds. Each positioning dial was calibrated separately with the dial of the other stimulator set at zero position, *i.e.*, the beginning of the saw-tooth timing pulse in the stimulator. For our purposes it was found satisfactory to use an ordinary ECG string galvanometer recording on the customary optical kymograph to time the distances between the pulses at each setting of the dials. For greater accuracy an oscilloscope with a slow linear sweep synchronized with the beginning of the saw-tooth pulse in the stimulator should be used. The rate dial was most conveniently calibrated with the string galvanometer.

Applications

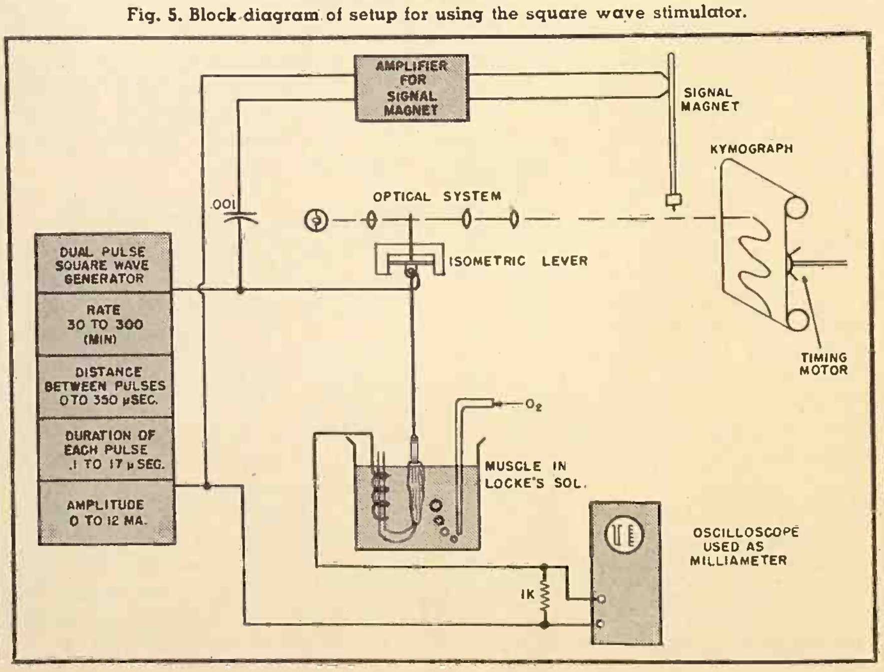
The stimulator has been found to be most satisfactory for the determination of the refractory period of isolated heart muscle. The variation with temperature, rate, and effect of drugs is easily demonstrable. Strength-duration curves are easily obtained for the determination of excitability. In this instance the amplitude of the stimulator output is measured by utilizing an oscilloscope as a milliammeter. Moreover, the excitability of the heart muscle can be measured during any particular instant of the cardiac cycle by using one of the pulses to drive the muscle and the second pulse to measure the response at any set interval.

Obviously, the stimulator could be used in the intact animal with chest opened and electrodes attached to either auricle or ventricle. Here, as in the isolated preparation, refractory period and excitability may be conveniently studied. Preliminary experiments in our laboratory have shown the stimulator to be entirely satisfactory for this purpose. Other uses might be the study of excitability and refractory period of skeletal muscle and even certain types of nerve and smooth muscle responses.

REFERENCES

1. *DiPalma, J. R., and Mascatello, A. V., "The Resting Excitability and Refractory Period of the Isolated Auricle and Papillary Muscle of the Cat's Heart; With a Note on Summation of the Papillary Muscle."* *(In Press)*.
2. *Lewis, T., Drury, A. N. and Bulger, H. A.*

Fig. 5. Block diagram of setup for using the square wave stimulator.



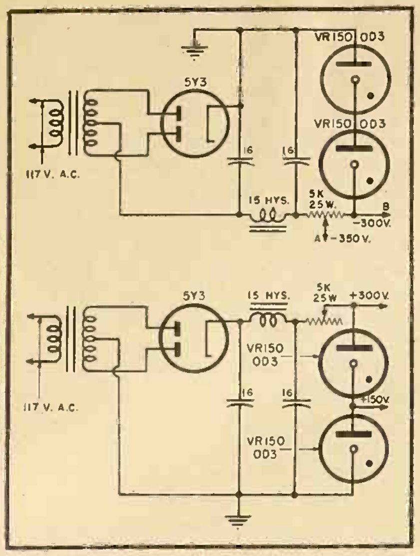


Fig. 6. Circuit diagrams of power supplies for use with stimulator.

Observations on Flutter and Fibrillation. Part IV. The Refractory Period and the Rate of Propagation in the Auricle; Their Relation to Block in the Auricular Walls and to Flutter, etc. Heart, 8, 83, 1921.

3. Andrus, E. C. and Carter, E. P. *Refractory Period of the Normally Beating Dog's Auricle with a Note on the Occurrence of Auricular Fibrillation Following a Single Stimulus. J. Exp. Med.,* 51, 357, 1930.
4. Woodbury, L. A., Nickerson, M. and Woodbury, J. W. *Pulsed Stimulator Aids Medical Research. Electronics,* 22, 84, 1849.
5. Newman, H. W. *A Constant Current Square Wave Stimulator. Proc. Soc. Exp. Biol. and Med.* 63, 201, 1946.

Miniature I. F. Amplifier

(*Continued from page* 16)

Because the multiple glass-dielectric capacitor subassembly was developed specially for Model VI and is not yet in production, an alternative capacitor subassembly was designed. This unit uses capacitors consisting of high-K ceramic tubes of 0.100-inch outer diameter silvered inside and outside. The outside plates are grounded directly by soldering the tubes to the subassembly chassis sheet, while metal inserts soldered inside the tubes provide the inner plate connections.

Three types of resistors may be used with the amplifier. The NBS tape or printed type seems most promising, since all resistors may be applied and fired on a single ceramic subassembly plate. Because all the required tape resistance values are not yet available, however, variations of the Model VI constructed so far have used separate resistors rather than a single subassembly. These have been either conventional ¼-watt carbon composition resistors or the cracked-carbon-on-ceramic type.

The remaining subassembly comprises the tube shields. Thin brass tubes, 1⅜ inches long and 0.400 inch in diameter, are placed side by side and joined in a single soldering operation. Spring fingers on the main chassis hold the resulting shield subassembly in place over the tubes.

Final assembly of the Model VI is a rather simple matter. After the subassemblies have been combined, only the tubes and r.f. chokes remain to be added, and also the resistors if a unitized resistor subassembly has not been used. The seven tubes are of a single type, the 5702,[2] although other types might have been used. The chokes, used in chains in the plate, heater, and agc voltage supply lines, are wound directly on ferrite cores ⅜ inch long and ⅟16 inch in diameter. To withstand high temperatures, "Ceroc-200" insulated wire[3] is used for the chokes as well as for the inductors.

Wiring is simple and accessible. Since the layout makes possible extremely short connections, component leads are used exclusively. A high melting point solder of 95 per-cent tin and 5 per-cent silver was used throughout except for the case assembly; for this, a silver solder was used to give greater mechanical strength.

The various subassemblies shown in the perspective drawing (page 16) are identified as follows: (1) tube shield assembly; (2) amplifier chassis; (3) clips for tube shield subassembly; (4) capacitor subassembly; (5) common ground leads for triple capacitor sections; (6) steatite inductor mounts; (7) solder points connecting ground leads to metallized surface of inductor mounts; (8) resistors, cracked carbon on steatite, high temperature miniature type; (9) power, control, and signal leads; (10) chokes; and (11) inductor, bifilar-wound on powdered iron core.

Many types of circuits could of course be adapted to some or all of the design features of the Model VI amplifier, and the circuitry used in the developmental model is not particularly significant. In the developmental model the first two tubes, comprising a low-noise input circuit, were triode connected and were followed by five tuned pentode stages. Over-all bandwidth was about 3.5 mc. with a center frequency of 30 mc., while gain was about 120 db. Input and output of the amplifier were transformer-coupled to coaxial cables.

The NBS Model VI miniature i.f. amplifier thus combines easier producibility, principally through the use of subassemblies, with the great compactness of previous NBS electronic miniaturization developments. The techniques and components embodied in the Model VI amplifier are, of course, adaptable to other electronic equipment.

[1] *These capacitors were developed and manufactured by Corning Glass Works in accordance with specifications submitted by NBS.*

[2] *Product of the Raytheon Manufacturing Company.*

[3] *Product of Sprague Electric Company.*

Medical Electronics

(*Continued from page* 13)

with the combination of a piezoelectric crystal transducer, or some similar device for transforming pressure into an electrical impulse, and a direct-coupled amplifier. Although this method was fairly satisfactory, it suffered from one major deficiency—drift in the direct-coupled amplifier. This created the serious problem of a shifting baseline with its unavoidable error in measurement. That is, if the resting state of the amplifier (representing 0 mm. of pressure) drifts to a new balance point, the recording pen will shift accordingly, and the blood pressure reading will be in error by an equal amount. In experiments in which it is necessary to operate the amplifier over moderately long periods of time (five or six hours), this error can be considerable.

This problem is avoided in the electromanometer by the r.f. bridge circuit which converts the variations in blood pressure to radio frequency instead of direct current. This makes it possible to use the more stable, resistance-capacitance coupled amplifier in which the drift effect is of negligible proportions. By the time the signal reaches the final stage of direct-coupled amplification in the multiple channel recorder, the amplitude of the signals which represent the blood pressure level are amplified to such an extent that the drift effect is almost undetectable.

The diagnosis and evaluation of the severity of heart disease constitutes one of the most difficult problems in medicine. However, with the aid of a new device, the ballistocardiograph, this question is greatly simplified. Ballistocardiography is based on the principle that when an individual lies on a flat solid surface, his body moves back and forth with each respiration and heart beat. Thus, on inspiration the body moves footward, and on expiration the body travels headward; at the time the heart contracts to pump the blood through the body, the body is pushed footward.

It is possible to record these movements of the body in several ways. The changes in pressure of the body against a device for converting pressure changes into electrical impulses, such as a piezoelectric crystal, can be measured. A second method to obtain ballistocardiograms is a magnetic method. This instrument was described by Dr. William Dock of the Department of Medicine, State University of New York, College of Medicine in a recent issue of the Journal of the American Medical Association. The electromagnetic ballistocardiograph, as it is called, is quite simple, consisting of a stationary alnico magnet and a pickup coil mounted on a board which is laid across the patient's shins. As the patient's body moves headward and footward, the pickup coil sweeps across the magnetic field of the alnico magnet. The induced current which flows through the coil as the latter cuts the lines of force from the magnet, is fed into a resistance-capacitance coupled amplifier of the type shown in Fig. 2. The purpose of the 50 μfd. condenser is to filter out the electrical impulses which are produced by the respiratory component of the body's motion.

In the photoelectric ballistocardiograph (illustrated on p. 11) the box-like frame rests on the patient's shins and, as it also rides with each axial ballistic movement of the body, a sharply defined light beam of standard intensity, from a light source within the unit, swings rhythmically across the window of a photoelectric device placed in proper proximity on the testing table. The moving field of light modulates the stationary photoelectric cell proportionately to the ballistic thrusts, and the resulting electrical impulses are amplified and recorded by the same type of amplifier as shown in Fig. 2. The ballistocardiogram is then analyzed to obtain the desired information.

These instruments represent only a few of the refinements which have resulted from the combined efforts of the electronic engineer and the research scientist. Certainly the future will see even greater achievements in the ceaseless war against disease.

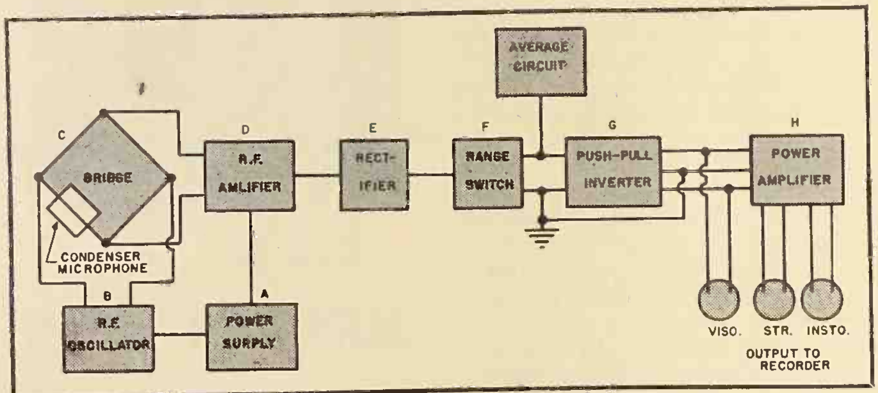
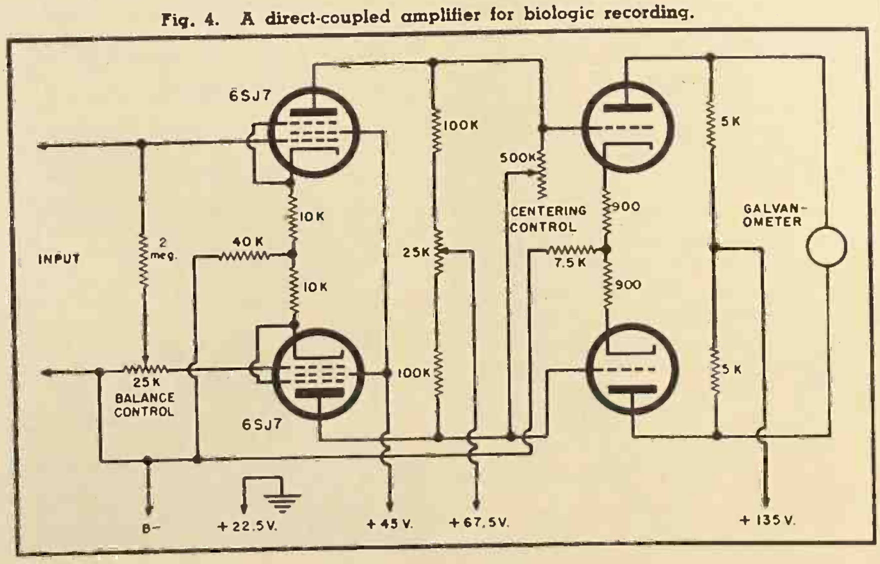


Fig. 3. Block diagram of a typical electromanometer.

Fig. 4. A direct-coupled amplifier for biologic recording.



CALENDAR
of Coming Events

NOV. 29-DEC. 1—First JETEC General Conference, Absecon, N.J.

DEC. 6-7—AIEE Conference on Feedback Control Systems, Haddon Hall Hotel, Atlantic City, N.J.

DEC. 10-12—Joint AIEE-IRE Computer Conference, Benjamin Franklin Hotel, Philadelphia, Pa.

JAN. 21-25, 1952—AIEE Winter General Meeting, Hotel Statler, New York.

JAN. 30, 1952—IAS-ION-IRE-RTCA Conference on Air Traffic Control, Astor Hotel, New York.

MAR. 3-6, 1952—IRE National Convention, Waldorf-Astoria Hotel and Grand Central Palace, New York, N.Y.

MAY 16-17, 1952—Fourth Southwestern IRE Conference and Radio Engineering Show, Rice Hotel, Houston, Texas.

Freq. Divider

(Continued from page 7)

same 1-mc. input pulses to the "input for lock-in delay." The pulses would then have been inverted by V_{6A}, coupled through a 5-$\mu\mu$fd. capacitor to the normally-off grid of the Delay MV, and would have put positive synchronizing pips on the rising grid waveform, (d) of Figure 4. For taking photographs at fast speeds, this procedure is very useful.

To obtain smooth continuous delay when no synchronizing signals are fed in, it was necessary to place the circuits for the Delay MV in a separate shielded compartment, besides cleaning up the pulses which trigger the circuit, as previously described. As in both the HFMV and the LFMV, a peaker is used in the right-hand cathode of the Delay MV and produces a waveform (f) of Fig. 4. This pulse is capacitor-coupled to a normally-off tube, resulting in the negative pulse (g). This pulse is suitable for triggering a synchroscope and when so used, varying the delay varies the time of the start of the sweep up to 100 μsec. with respect to the synchronizing signals, so that all portions of a waveform may be examined on a fast sweep.

The service records of this model and its predecessor have been exceptionally good. Of the twenty four or so units in use at the Digital Computer Laboratory during the past three years, none have needed major repair work.

Fig. 4. Waveforms of Delay MV. (a) input, (b) normally-off grid, (c) normally-off plate, (d) normally-on grid, (e) normally-on plate, (f) cathode, (g) output pulse. Sweep length, 20 microsec. Fig. 5. Waveforms of LFMV. (a) plate, (b) grid, (c) cathode, (d) after CR5. Sweep of (c) and (d) has been expanded. Fig. 6. Waveforms of Standard Pulse Generator. (a) input, (b) plate, (c) peaker output, (d) standard pulse. Sweep length, 5 microsec. Fig. 7. Waveforms of HFMV. (a) input, (b) output of input amplifier, (c) plate, (d) grid, (e) cathode. Sweep length, 20 microsec.

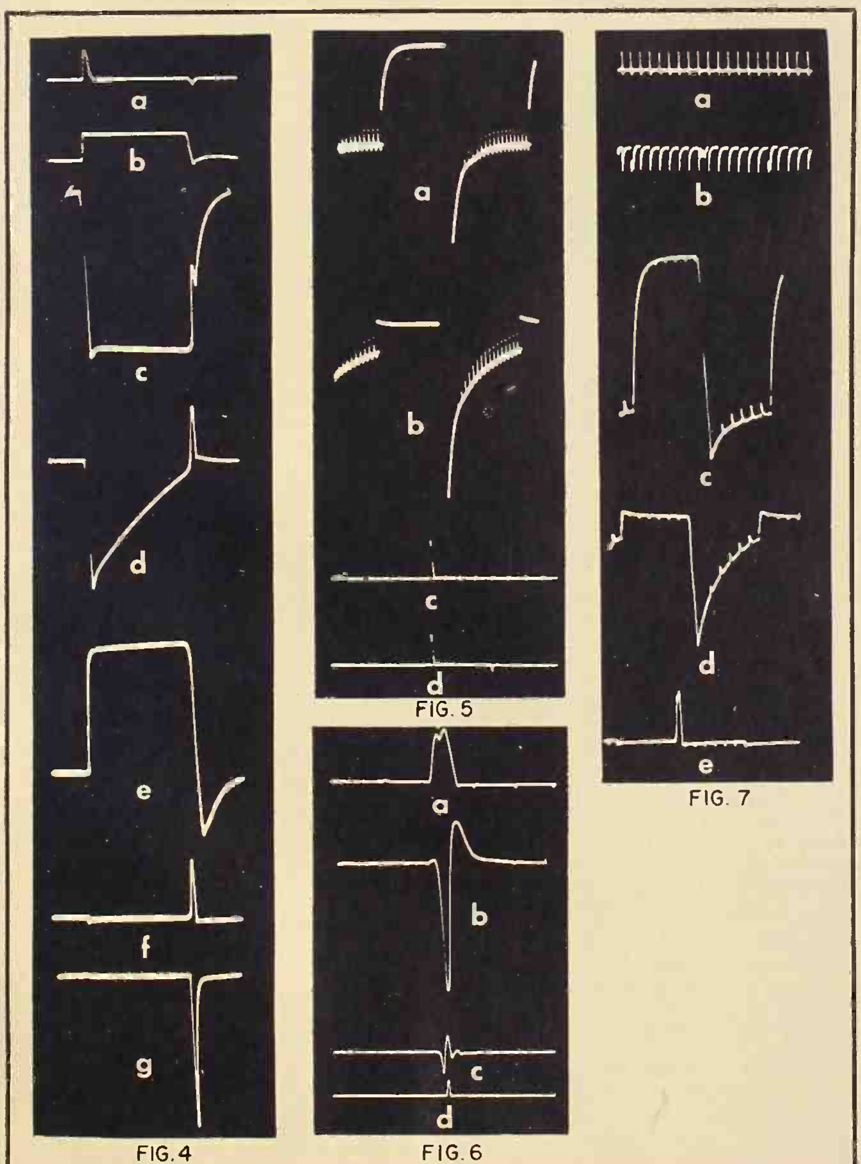


FIG. 4 FIG. 5 FIG. 6 FIG. 7

Radio-Electronic Engineering·1951

Index to Volumes 16 & 17

ANTENNAS

Antenna Systems Design (Devey). 10A Mar.
Ferromagnetic Loop Antennas (Polydoroff) ... 11 Nov.
Recording Antenna Radiation Patterns (Brasse, Jr.) ... 8A May
Slot Antenna Developments (Rhodes) ... 3A May
Slot Antenna Developments (Rhodes) ... 7 June

AUDIO

Constant-Amplitude Pickup Compensation (John, Jr.) ... 10A Apr.
Electronic Tone Generator Developments (Krauss and Tennes) .. 8A Jan.
Improvements in Audio Amplifiers (Childs and Dorf) ... 10 June
Impulse Noise Limiters (Moses) ... 16 June
Past, Present and Future Recording Systems (Goodell) ... 11A May
Tube Applications in Amplifier Design (Sterling) ... 14A May

COMMUNICATIONS

A Subminiature I.F. Receiver ... 13 July
Microwave Communication Links (Racker) ... 13A April
Pulse Code Modulation (Diven and Moskowitz) ... 12A Mar.

COMPUTERS

An Introduction to Computer Concepts (Goodell) ... 3 Aug.
An Introduction to Computer Concepts (Goodell) ... 7 Sept.
An Introduction to Computer Concepts (Goodell) ... 14 Oct.
Multi-Stable Magnetic Memory Techniques (Goodell and Lode) 3 Dec.
NBS Computation Laboratory (Alt) 7A May
The "Maddida" Electronic Computer ... 12A Mar.
The Versatile Binary Scaler (Schmidt) ... 15 Aug.

MEASUREMENTS

Electron Tube Curve Tracer (Kuykendall) ... 9 Aug.
Electronic Micromanometer ... 7A Feb.
High Frequency Crystal Calibrator (Minter) ... 6A Apr.
Impedance Measurements in the 50 to 2000 mc. Range (Soderman) ... 3 July
Improved Ramberg Accelerometer 24A Feb.
Meter A.V.C. (Kaufman) ... 6A May
Microwave Measurements (Part 2) (Racker) ... 15A Jan.
Miniature Piezoelectric Accelerometer ... 16 Nov.
Pulsed Waveform for Bridge Measurements (Monroe and Kaufman) 10A Feb.
Recording Antenna Radiation Patterns (Brasse, Jr.) ... 8A May
R.F. Dielectric Standards ... 15 Sept.
R.F. Micropotentiometers ... 20A May
Spark Chronograph and Chronoscope ... 6 June
Standards for Electrical Measurement (Silsbee) ... 6A Mar.

MICROWAVES

Microwave Communication Links (Racker) ... 13A Apr.
Microwave Measurements (Part 2) (Racker) ... 15A Jan.
Microwave Printed Circuits (Barrett and Barnes) ... 16 Sept.
Microwave Television Links (Racker) ... 14A Apr.
Microwave Systems Design (Racker) ... 12A Feb.
New Techniques in Microwave Spectroscopy (Good) ... 10A Jan.

MISCELLANEOUS

Amplitude Distribution Analyzer (Neinberg and Rogers) ... 8 Dec.
Analysis of Non-Recurrent Pulse Groups (Schwartz and Salz) ... 8 Nov.
A New Miniature I.F. Amplifier .. 16 Dec.
Carrier Strain Gauge Systems (Kaufman) ... 7 July
Carrier-Type Regulated Power Supply (Houle) ... 14 Nov.
Closed Loop Servosystems (Goodell) ... 3A Mar.
ILS Field Test Set (Ellis) ... 3 Nov.
Nuclear Pulse Amplifiers (Kaufman) ... 7 Oct.
Phase Sensitive Strain Gauge System (Kaufman) ... 3A Jan.
Recent Advances in Medical Electronics (Thompson) ... 11 Dec.
Self-Balancing Strain Gauge Equipment (Kaufman) ... 12 Aug.
Sensing Systems (Goodell) ... 3A Apr.
The Stamped Circuit Process (Chase) ... 13 June
Ultrasonic Wave Analyzer (Benham) ... 12 Sept.

NOMOGRAPHS

Bridged T and H Attenuators ... 32A Apr.
Constant K Type High-Pass Filter Design (Yamasita) ... 32A Feb.
Constant K Type High-Pass Filter Design (Yamasita) ... 32A Mar.
Cylindrical Wave Guides ... 32 July
Matching-Stub Calculations (Yamasita) ... 32 Aug.
Minimum Loss Pads ... 32 June
Multi-Layer Coil Calculator Nomograph (Yamasita) ... 32A Jan.
Per-Cent Ripple Nomographs (Halm) ... 32 Oct.
Square Wave Guide Attenuation 32 Nov.
Square Wave Guide Attenuation 32 Dec.
Symmetrical T and H Attenuators 32A May
$TM_{1,1}$ Waves in Rectangular Wave Guides ... 32 Sept.

SPECIAL CIRCUITS

A Pulse Mixing Unit (Rathbone) .. 10 Sept.
Bridged-Tee Phase Modulators ... 8 Aug.
Electronic Tone Generator Developments (Krauss and Tennes) .. 8A Jan.
Gate and Delay Generator (Rathbone) ... 10 Oct.
Improved Techniques for Tube Circuit Design (Pullen, Jr.) ... 10 July
Multivibrator Frequency Divider (Rathbone and Best) ... 6 Dec.
Photomultiplier Circuitry (Kaufman) ... 18 Nov.
RC Filter Circuits (Fidelman) ... 3 Oct.
Square Wave Stimulator for Cardiac Research (DiPalma and Suckling) ... 14 Dec.
Test Generator for Pulse Coded Systems (Pickens and Gerlach). 14 July
The Pulse Standardizer (Rathbone) 6 Nov.
The Series Amplifier (Crosby, Jr.). 12 Oct.
Variable-Frequency Clock-Pulse Generator (Rathbone) ... 19 Aug.
Wide Range Logarithmic Amplifier (Child) ... 6 Aug.

TECHNICAL BOOKS

Advances in Electronics (Marton). 30 Aug.
Alternating Current Circuits (Kerchner and Corcoran) ... 26A Apr.
Applied Electronics Annual 1951 (Blaise) ... 23A May
A.S.T.M. Standards on Electrical Insulating Material ... 31A Mar.
Basic Electron Tubes (Geppert) ... 29 Nov.
Design of Electrical Apparatus (Kuhlmann and Tsang) ... 30A Feb.
Electronic Fundamentals and Applications (Ryder) ... 26A Apr.
Elements of Television Systems (Anner) ... 29 Oct.
Elements of Television Systems (Anner) ... 29 Nov.
Electric Transmission Lines (Skilling) ... 30 Dec.
Fundamentals of Acoustics (Kinsler and Frey) ... 30A Feb.
Fundamentals of Atomic Physics (Dushman) ... 29 Oct.
High-Frequency Measurements (Hund) ... 29 July
Introduction to Industrial Electronics (Benedict) ... 23A May
Nomographic Charts (Kulman) ... 30 Dec.
Pulse Techniques (Moskowitz and Racker) ... 28 June
Radio Communication at Ultra High Frequency (Thompson) ... 28A Jan.
Radio Laboratory Handbook (Scroggie) ... 31A Mar.
Short Wave Wireless Communication (Ladner and Stoner) ... 29 July
Theory and Application of Industrial Electronics (Cage) ... 28 June
Theory and Design of Television Receivers (Deutsch) ... 28 Sept.
Time Bases (O. S. Puckle) ... 30 Aug.
Transmission Lines and Networks (Johnson) ... 28A Jan.
Ultrasonics (Vigoureux) ... 28 Sept.

TV

Contrast Measurement in TV Images (Vogel and Harjes) ... 3 June
High Definition Monochrome TV (Dome) ... 8A Feb.
Microwave Television Links (Racker) ... 14A Apr.
New Miniature I.F. Amplifier ... 16 Dec.
Rack-Mounted Flying-Spot Scanner (Kuehn and Seigle) ... 7A Apr.
Television Relay Link (Silver, Stashover and French) ... 3A Feb.
The Problem of Recording TV Frequencies (Goodell) ... 16 July
Wide Angle Deflection Yokes (Thomas) ... 3 Sept.

TRANSMISSION LINE AND WAVE GUIDES

Attenuation & SWR for Transmission Lines (Pinkerton) ... 7A Jan.
Impedance Circle Diagrams (Bryan) ... 15A Feb.
Magnetic Attenuator ... 18 Oct.

TUBES

Improved Techniques for Tube Circuit Design (Pullen, Jr.) ... 10 July
The Balitron Tube (Part 1) (Ballantyne) ... 16A Mar.
The Balitron Tube (Part 2) (Ballantyne) ... 16A Apr.
Tube Applications in Amplifier Design (Sterling) ... 14A May

News Briefs

(*Continued from page 25*)

reading under high ambient light conditions, wide angles, and distance.

Being available with either a remote panel-mouted, four-lamp readout, or with a small plug-in neon cluster on the decade frame for applications, the size of the new unit is 6-⅛" long, 6-½" high, and 1-⅛" wide, including tubes. The decade is equipped with a special silver-plated connector, a binary decimal coding system (1-2-4-8) and is available as a separate component or incorporated in standard and custom-designed counting, timing and computing equipments.

NEW IIT APPOINTMENT

Mr. D. Ward Pease, research engineer for the *A. B. Dick Company* for eighteen years, has been appointed assistant to the chairman of the electrical engineering department at Armour Research Foundation of Illinois Institute of Technology.

Mr. Pease graduated from the University of Illinois in 1920 with a degree in mechanical engineering, and has specialized in the development of technical specialty papers and stencil base tissue.

A native of Chicago, Mr. Pease is the author of a monthly column appearing in POPULAR PHOTOGRAPHY magazine, and is a fellow of the Photographic Society of America.

AMPLIFYING SYSTEM

A design for an amplifying system for use in generating plants was described by S. C. Bartlett, of the *American Gas and Electric Service Corporation*, during a power session of the Fall General Meeting of the AIEE in Cleveland, Ohio.

Explaining the fact that modern plants, with the multiplicity of devices provided to obtain high efficiency, introduce problems of coordination of all personnel, their observations, the readings of instruments and the orders regarding control and adjustment. He further stated that present-day trends in plant design are in the direction of unit construction, in which case a separate P.A. system should be provided for each unit, readily consolidated at one or more points for simultaneous control in the event of any emergency. He concluded with the statement that by adhering to practical considerations, a device may be produced using commercially available components in circuits, obtaining high performance characteristics at low cost.

PHOTO CREDITS

Page	Credit
3, 5	Minnesota Electronics Corp.
6	Massachusetts Institute of Technology
11, 12, 13	Sanborn Co.
16	National Bureau of Standards

NEW LITERATURE

Recording Oscillograph

A highly compact and versatile 5-114 Recording Oscillograph, multi-channeled for the analysis and measurement of strain, vibration, pressure and acceleration, is the subject of a fully illustrated technical bulletin published by *Consolidated Engineering Corporation* of Pasadena, California.

This instrument records photographically up to 18 separate, static or high-frequency phenomena simultaneously at speeds of ½" to 115" per-second, recording timing lines at 1/1000th per-second intervals so that each phenomenon can be interpreted in relation to others, and in relation to time.

Copies of this publication may be obtained by writing for the CEC Bulletin 1500B, *Consolidated Engineering Corporation*, 300 N. Sierra Madre Villa, Pasadena 8, California.

Electrical Insulation

Complete descriptive information and technical data on tubings and sleevings are contained in an 8-page bulletin issued by *Insulation Manufacturers Corporation*, Chicago, Illinois. Their "Dieflex" products are used to insulate leads and wires in all types of electrical equipment, having cotton, rayon, or glass base braids with oleoresinous varnish, vinyl resin, or silicone varnish treatments.

Free copies of this Bulletin, No. 250A, are furnished by Publications Department, *Insulation Manufacturers Corporation*, 565 West Washington Boulevard, Chicago 6, Illinois.

Potentiometer Manufacture

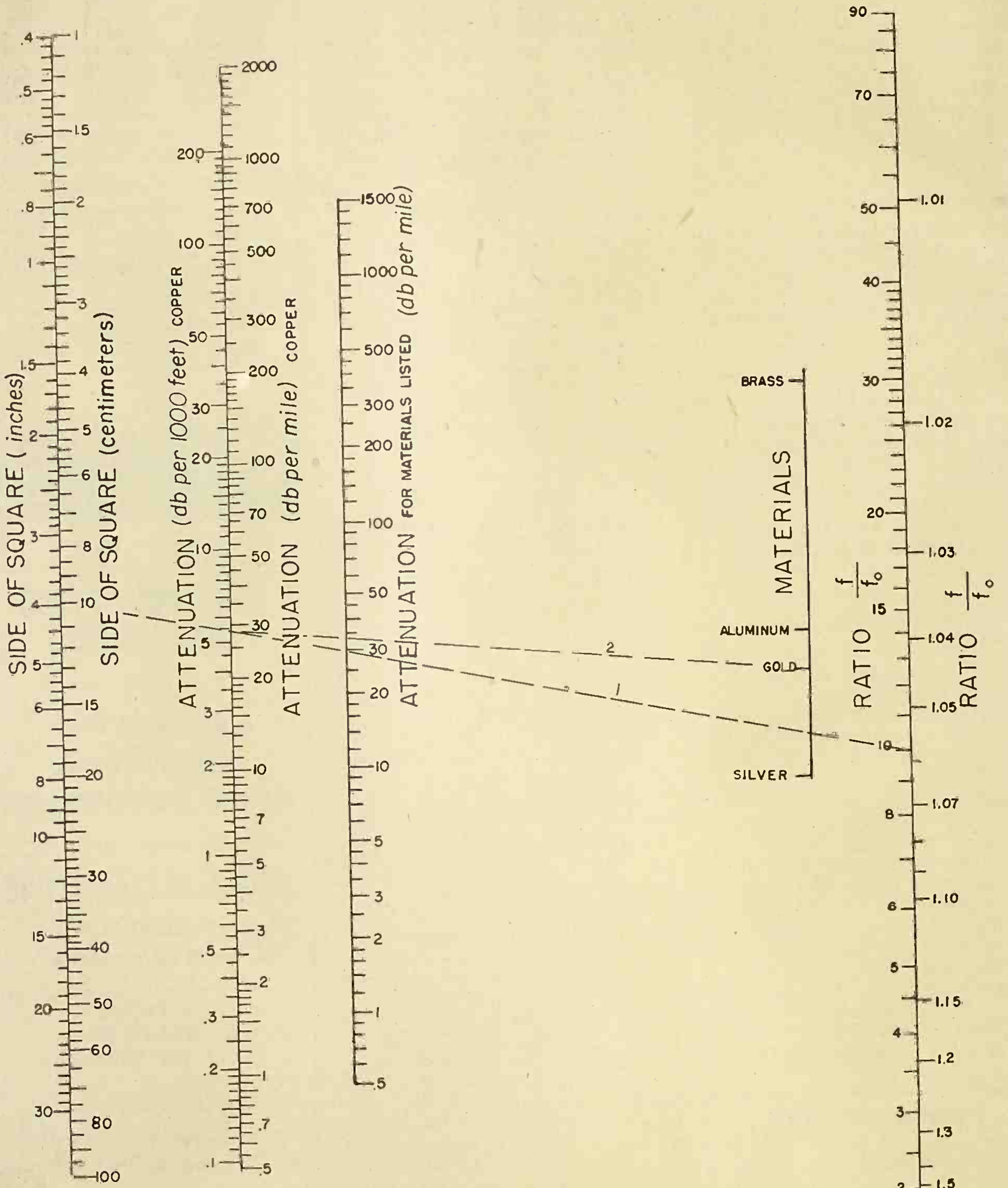
A 38-page, tri-colored catalogue, complete with illustrations, has just been released by the *Helipot Corporation*, South Pasadena, California, containing data tables, comprehensive index, and general specifications on wire-wound potentiometers and associated products.

The catalogue describes standard potentiometers, suggests some of the modifications to accommodate special applications, theoretical and actual characteristics of all types of precision linear wire-wound pots, and the facilities of the *Helipot* factories in their manufacture of these instruments.

This catalogue is obtainable by writing to *Helipot Corporation*, 916 Meridian Avenue, South Pasadena, California.

SQUARE WAVE GUIDE ATTENUATION

A nomograph for determining the attenuation of the $TM_{1,1}$ mode in a square air-dielectric wave guide.



Courtesy of Federal Telephone and Radio Corporation