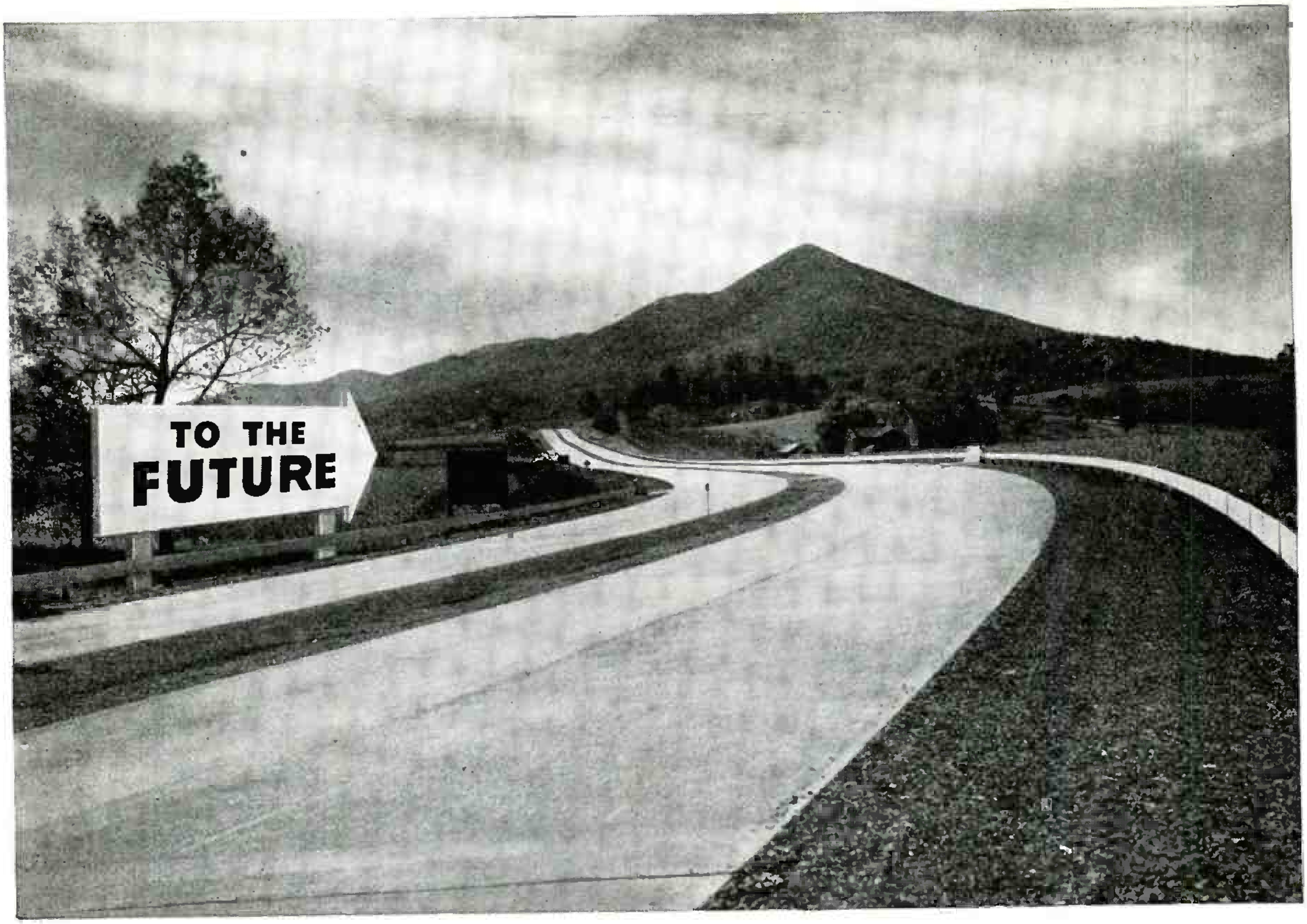
COMMUNICATIONS

- ★ RADIO ENGINEERING
- ★ AIRCRAFT COMPASS CALIBRATION
- ★ SUPER-REGENERATION ANALYSIS
- ★ QUARTZ CRYSTAL PRODUCTION
- ★ OSCILLOSCOPE SWEEP CIRCUITS
- ★ TRANSMISSION LINE FUNCTIONS
- ★ EMERGENCY RADIOTELEPHONE LINE SYSTEMS

MARCH

1943



Paved with Good INVENTIONS

Application of fundamental discoveries in science, the *development of inventions* into practical devices, presents challenging problems to the Electronic Industries.

Inspired theoretical analyses of men like Henry, Faraday and Maxwell; inventions of others like Marconi, de Forest and Armstrong—these are the fundamental ideas of modern communications and electronics.

Working with these ideas, electronic engineers have progressed brilliantly over a part of the long, winding road from scientific discovery to a fast-growing industry serving millions of people.

In this great task IRC is proud to have played a notable part in its special province: investigation in the field of Electronics directed toward the design and construction of fixed and variable Resistors and the use of Resistors as components in the circuits of electronic devices.

Though we may not be able right now to supply you with the Resistors you need for other than war uses, our engineers and executives are at your service for counsel, without obligation, to help you in the solution of Resistor problems. Please feel free to consult them in your search for the best obtainable resistance devices under existing conditions.

PREFERRED FOR PERFORMANCE * FIXED & VARIABLE RESISTORS *
IRC

INTERNATIONAL RESISTANCE COMPANY

415 N. BROAD ST., PHILADELPHIA

LEWIS WINNER, Editor
F. WALEN, Associate Editor

We See . . .

THERE'LL BE NO INDEFINITE SUSPENSIONS of broadcasting for the duration by any station, the FCC has just declared. Operators, who are forced to suspend temporarily, because of materiel and manpower problems, will be given the usual consideration. But the FCC emphasizes that every effort must be made to correct such conditions, so that the suspension of service will be brief. And the operator of that station will have to present a feasible plan for the alleviation of his difficulties, indicating too, when he can return to the air.

In announcing this non-suspension decision, Chairman Fly pointed out that two major factors prompted this ruling. First, an indefinite suspension of broadcast operations might jeopardize this country's interest in the frequency channels provided in the North American Regional Broadcasting agreement. And second, the suspension would also probably result in the elimination of broadcasting in many areas where the need for public service is the greatest.

That the FCC means business was quite evident from their very first ruling, when the applications of two stations to suspend, were promptly denied.

It appears as if Americans will not be deprived of any broadcasts!

IT'LL BE A WAR CONFERENCE this year at the annual NAB meeting, scheduled for April 27, 28 and 29. The meetings will be held at the Palmer House in Chicago, and it will be all business. If your calendar will permit it, you should attend!

CONGRATULATIONS TO FRANK MCINTOSH on his appointment as assistant to the director of the radio division of the War Production Board. In the nine months he has been in Washington, he has been a true friend of the industry. And in his new post as director of foreign and domestic broadcasting, the industry will continue to profit by his outstanding ability.

WATCH THAT NEW WHITE-WHEELER bill amending the Communications Act of 1934. Recently introduced before the Interstate Commerce Committee, it may become a law soon. And it sure does drive teeth into the Communications Act!—L. W.

COMMUNICATIONS

Including Television Engineering, Radio Engineering, Communication & Broadcast Engineering, The Broadcast Engineer. Registered U.S. Patent Office.
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MARCH, 1943

VOLUME 23 NUMBER 3

COVER ILLUSTRATION

A unique semi-automatic tube production unit that provides sealing of a ceramic bar to mica to stem. Not only has this device increased production, but it has improved tube efficiency and reduced materiel loss to a minimum.
(Courtesy Westinghouse)

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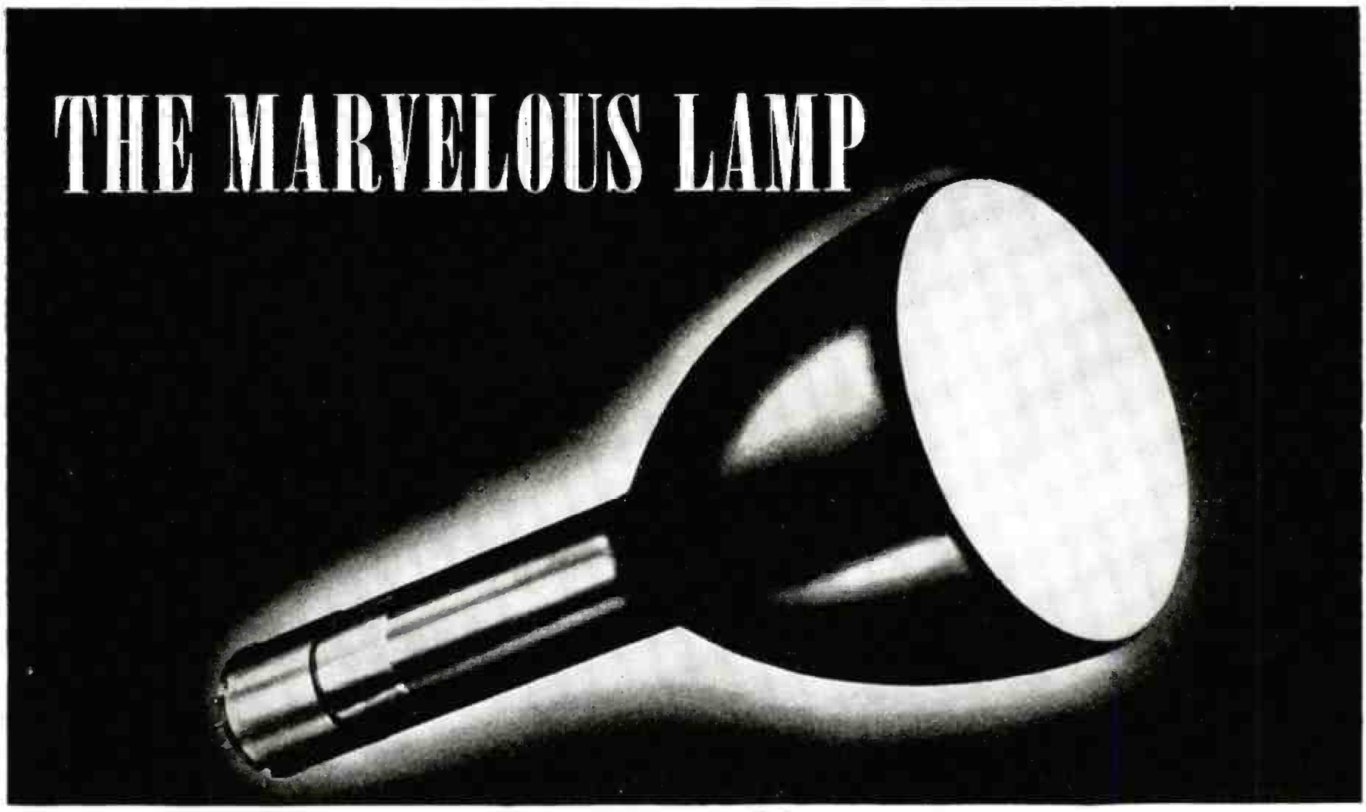

from Genie to Electron

• The fantasy of Aladdin's marvelous genie-commanding lamp – first conceived by the unknown author of "The Arabian Nights' Entertainments" – comes true in the cathode ray tube of today. And there are practical advantages in electrons over genii in modern life and work – in television, for example.

We go back to Aladdin's lamp, because Sylvania has specialized as a maker of marvelous lamps – and electronic tubes.

First it was the incandescent lamp.

Then, in the early days of radio, we put the incandescent "Edison Effect" to work in electronic tubes.

Having attained an electronic reputation in radio research and tube manufacture, Sylvania applied this experience to the making of better artificial light as a fluorescent lamp pioneer.

In our forty years of experience, it has been a far cry from the original incandescent lamp to today's many electronic devices, which have far more possibilities than ever after a year of global war.

Today Sylvania aspires to serve the radio and electronic industries, whose wider destiny is being written in American laboratories, as a supplier of electronic tubes with hundreds of envisioned uses. Ours will be in the role of maker of these marvelous tubes – yours, their application to new products for better life and work in the peace to come.

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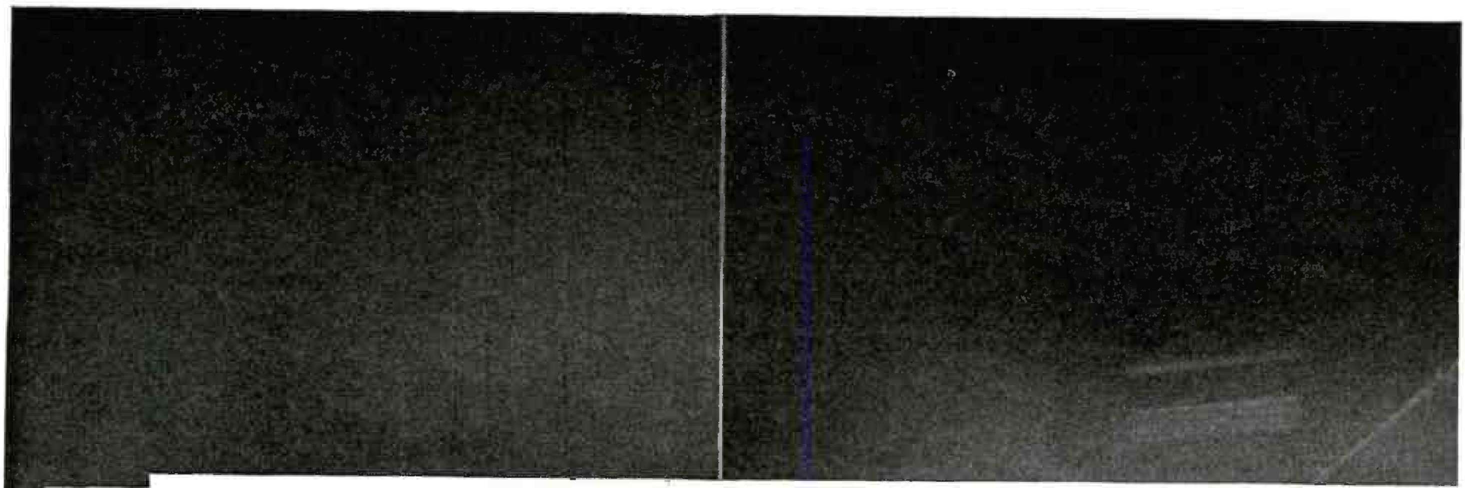
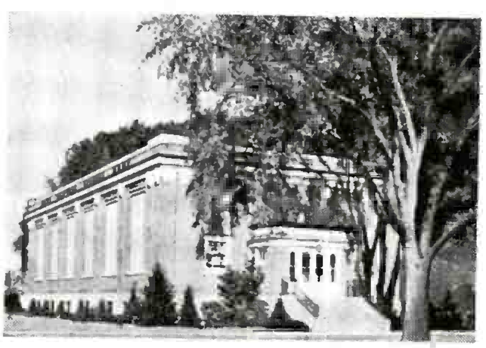
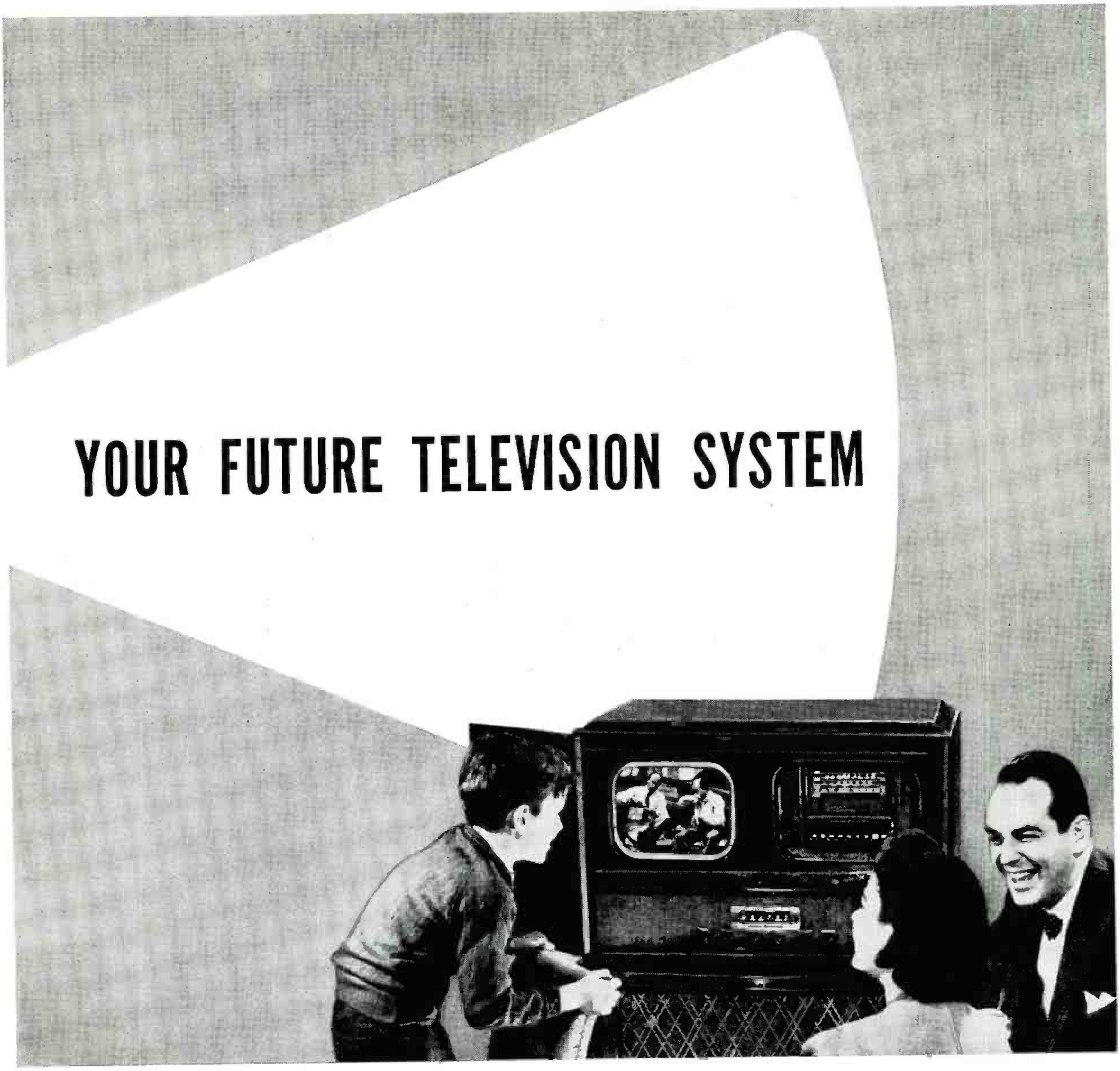
Incandescent Lamps, Fluorescent Lamps and Fixtures, Radio Tubes, Electronic Devices







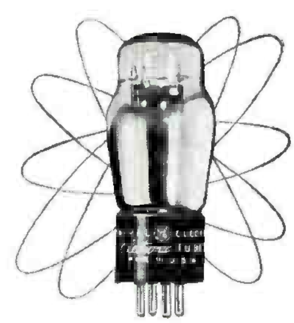
YOUR FUTURE TELEVISION SYSTEM

Techniques in staging, lighting, and make-up are being tried. Carefully checked results provide a vast fund of practical experience for you to draw upon when television is again available. Development of television at WRGB is greatly helped by a co-operative home television audience organized to criticize the programs.

And the G-E post-war television receiver for the home will come out of the same vast fund of television experience. It will be a receiver that will get the most out of the most recent discoveries and developments in television broadcasting.

G-E television broadcast equipment, program experience and receivers are working together for your future television success. We are experimenting so you won't have to.

General Electric cordially invites you when in Schenectady to visit Station WRGB for a preview of your future television system. . . . Radio, Television, and Electronics Department, General Electric Company, Schenectady, New York.



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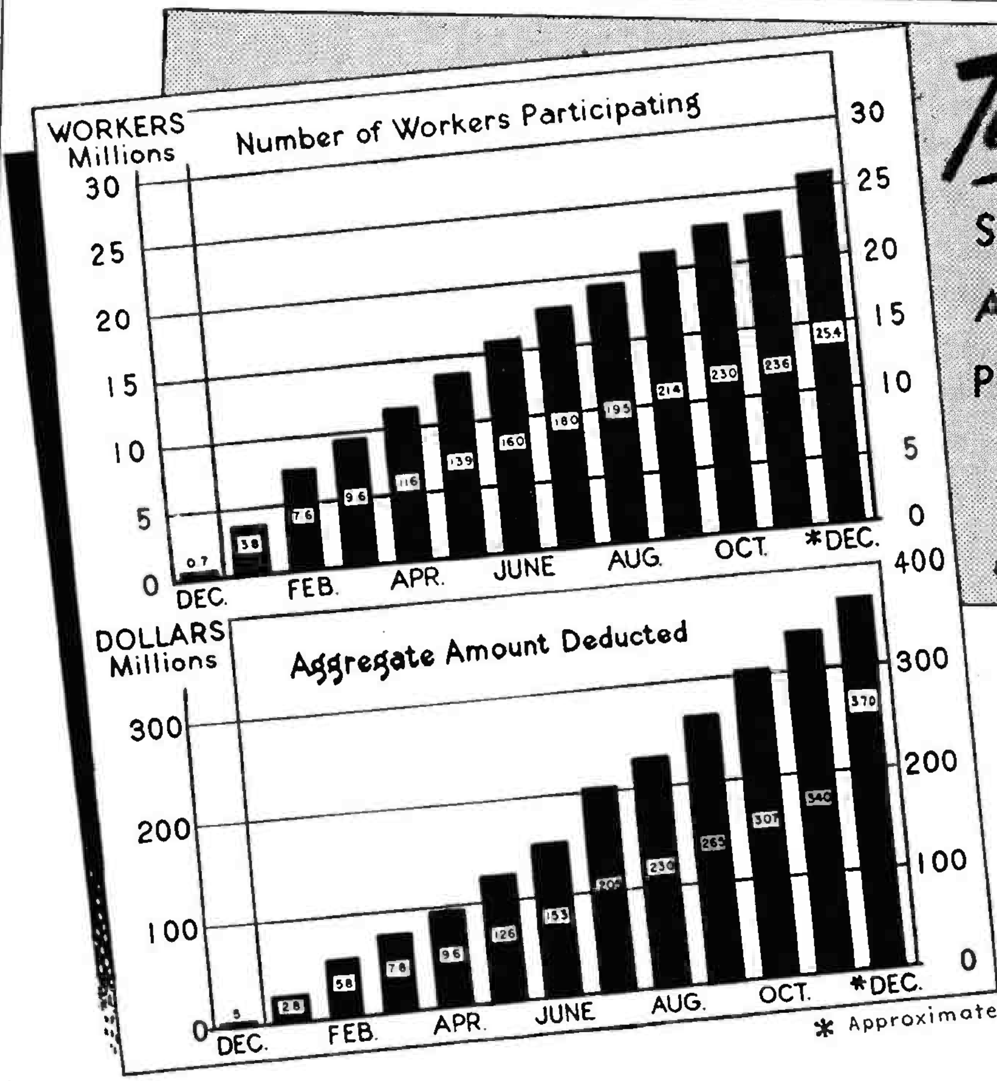


Tomorrow's SALES CURVES ARE BEING PLOTTED . . . *Today*

THESE CHARTS SHOW ESTIMATED PARTICIPATION IN PAYROLL SAVINGS PLANS FOR WAR SAVINGS BONDS (*Members of Armed Forces Included Starting August 1942*)

STUDY THEM WITH AN EYE TO THE FUTURE!

There is more to these charts than meets the eye. Not seen, but clearly projected into the future, is the sales curve of tomorrow. Here is the thrilling story of over 25,000,000 American workers who are today voluntarily saving close to FOUR AND A HALF BILLION DOLLARS per year in War Bonds through the Payroll Savings Plan.

Think what this money will buy in the way of guns and tanks and planes for Victory today—*and mountains of brand new consumer goods tomorrow.* Remember, too, that War Bond money grows in value every year it is saved, until at maturity it returns $4 for every $3 invested!

Here indeed is a solid foundation for the peace-time business that will follow victory. At the same time, it is a real tribute to the voluntary American way of meeting emergencies that has seen us through every crisis in our history.

But there is still more to be done. As our armed forces continue to press the attack in all quarters of the globe, as war costs mount, so must the record of our savings keep pace.

Clearly, on charts like these, tomorrow's Victory—*and tomorrow's sales curves*—are being plotted today by 50,000,000 Americans who now hold WAR BONDS.

EVERYBODY EVERY PAYDAY AT LEAST 10%

Save with War Savings Bonds

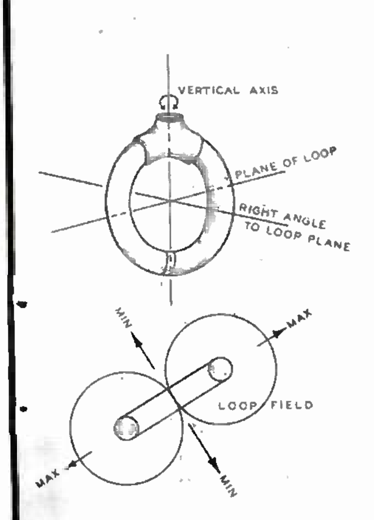
This space is a contribution to America's all-out war effort by

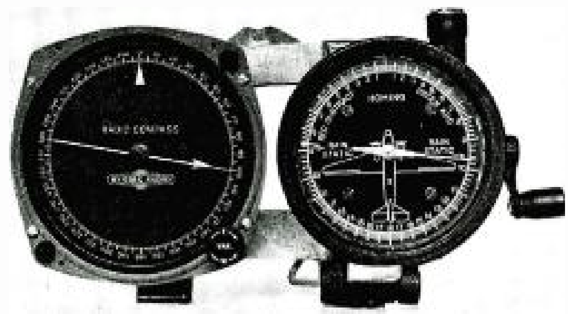
COMMUNICATIONS

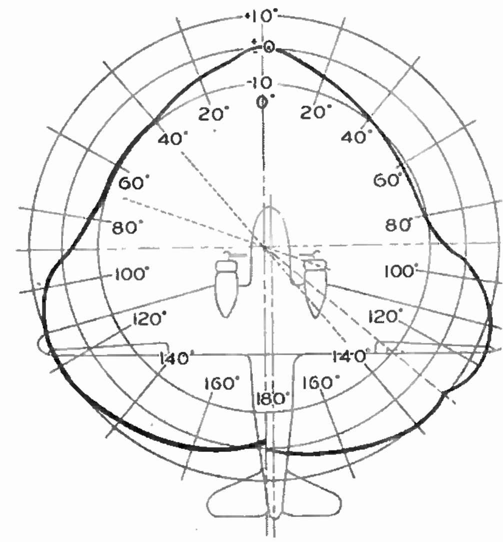
COMMUNICATIONS

LEWIS WINNER, Editor

* * MARCH, 1943 * *







Figures 1 (left), 2 (right) and 3 (center)

In Figure 1, diagram of loop antenna showing its directive characteristics in relation to the plane of the loop. Figure 2 illustrates a polar graph, showing the relation of the deviations to the structure of the aircraft for one type of installation. In Figure 3 (left) is shown a bearing indicator with a dial in true degrees that is used in conjunction with a corrector unit, so that deviations are fully compensated. The dial may be rotated by the knob marked "E-W-Var". With this adjustment the dial may be set at the index to give bearings relative to the aircraft's heading or from true north. At right, a representative calibrated type dial upon which the corrections are applied for reading directly corrected radio bearings.

AIRCRAFT COMPASS CALIBRATION

by CHARLES W. McKEE

Supervisor of Aircraft Radio, Eastern Air Lines, Inc.

In this paper, Mr. McKee discusses the causes for deviations found in the radio compass loop antenna field pattern, and the general deviation characteristics encountered in aircraft installations. The procedure for determining the value of these deviations is provided, with a description of the mechanical means required to apply compensating correction factors. Data on generally-used radio compass calibration methods are also presented.

ONE of the prime factors in radio compass design is the loop antenna. When well balanced and mounted in space free from obstruction that would disturb the r-f field pattern, the loop antenna will present a true *figure-of-eight* pattern, in a definite relation to the planes of the loop.

In Figure 1 we note that the direction *in line* with the plane of the loop antenna is maximum, while at right angles of the plane of the loop, a minimum or null exists. A distortion of the radio frequency field in the vicinity of the aircraft does exist. It is this distortion of the field that results in a displacement of the null loop angle from the normal angle, that would exist, if interference was not present. Various factors contribute to this condition. Probably the one with the most pronounced effect is the *fuselage-coupling* to the loop antenna. In this respect the cross section of the fuselage represents an interference loop. Other factors are loops formed by the structure of the aircraft and grounded wires in the vicinity of the radio loop antenna.

In general these effects are small compared to the fuselage loop effect. It is obvious, that in some cases, these effects are additive while in others they cancel, at least to some extent. It is not necessary that these interference loops be resonated to the frequency to

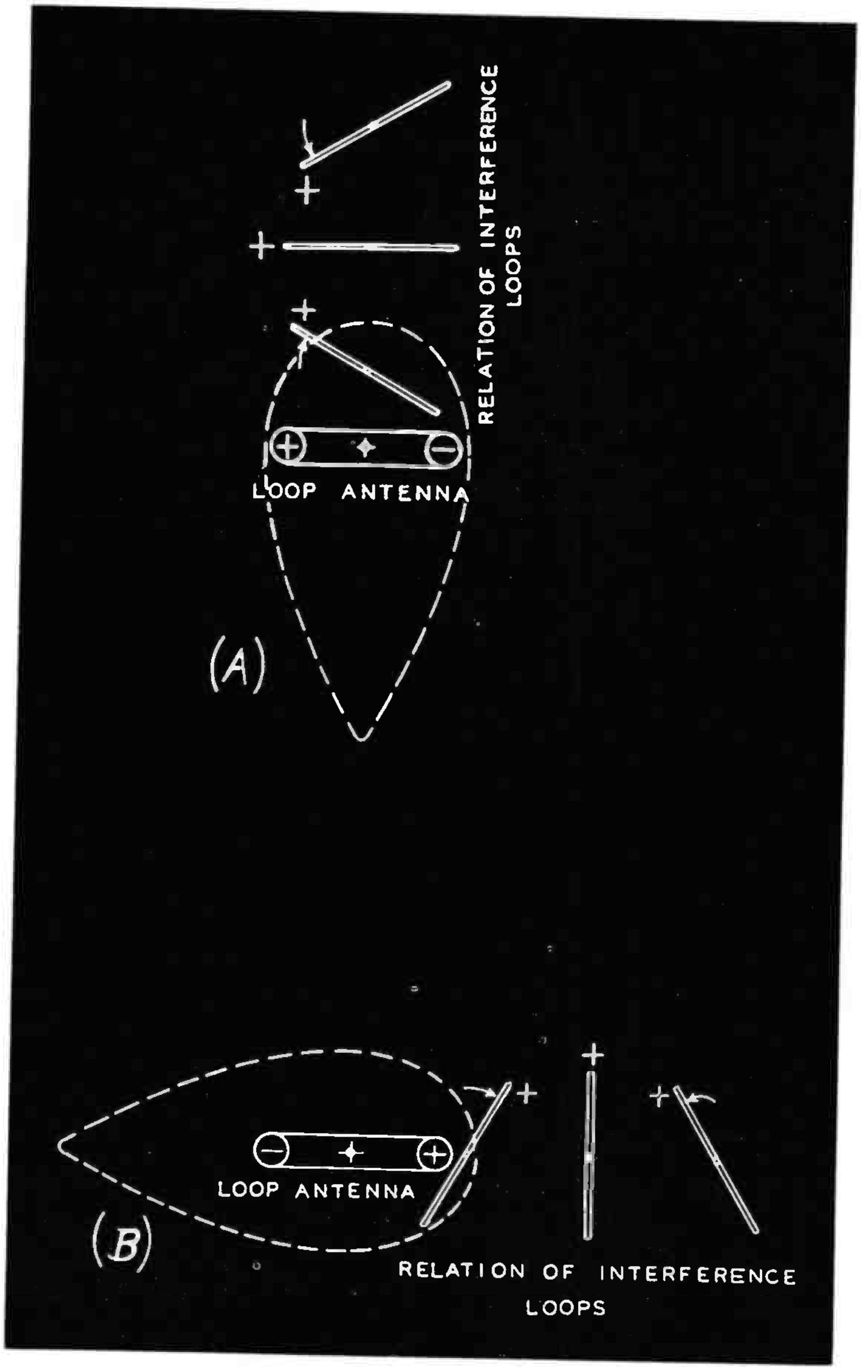


Figure 4
The effects of interference loops are (a) the null is displaced in the direction that the interference loop is rotated. In the relation shown at (b) the loop antenna null is displaced in the direction opposite to the rotation of the interference loop.

which the radio loop antenna is tuned to cause distortion of the radio frequency field. In radio direction finder work, the effect of this distortion of the r-f field by aircraft structure insofar as causing a difference in the loop antenna pattern, is referred to as *Quadrantal Deviation.* These deviations present no problem to radio direction finding work if they are known and the necessary compensating factors are correctly applied.

Other Disturbing Factors

There are other disturbing factors that must be avoided, too. These effects include ungrounded antenna wires mounted near the loop antenna assembly. While this will not give rise to quadrantal deviation, it will, due to the reradiation at 90 degrees out of phase with the original signal, mask the null and cause erratic operation. An antenna near the loop antenna and tuned to the same frequency will also be likely to cause erratic operation. Resonated loops will produce erratic results at that particular frequency to which the equipment is tuned. No appreciable effect will be encountered if antennae and other wires are separated from the loop assembly by a distance of about 35 to 40 inches. On *all-metal* aircraft, the wires within the fuselage do not affect the loop antenna due to the shielding effect of the metal skin. At certain locations on a *fabric covered* aircraft, the metal structure of the fuselage will provide sufficient shielding to these disturbances. From this it is evident that, in certain cases, the shielding is equivalent to that of an *all metal* aircraft.

Effect of Interference Loop

It is relatively simple to demonstrate the effect of an interference loop to the loop antenna. This is accomplished by using a few turns of wire placed near the loop antenna. With the loop antenna in the proper angular position for a normal null, it is possible to displace this null when the interference loop circuit is closed.

From this it is easily recognized that the location of the loop antenna on the aircraft is such that at certain points of the azimuth, it is in the induction field of an object in which a current has been set up by the signal that is being used for direction finding purposes. With these conditions, the position of the loop adjusted for a null, will differ in direction to the wave front by a number of degrees. This deviation can be either plus or minus. It is assumed that the original wave is in place and has not necessarily been distorted. However, the plotted induction field on the wave front presents an irregularity. A deviation is the result of an induction field combining with the wave front, resulting in distortion of the r-f field.

Loop Antenna Deviation

In Figure 2 appears the deviation for a loop antenna located on the bottom of a Douglas DC-3 aircraft, 108 inches from the nose and 11.5 inches to the left of the center line.. This calibration is used with the corrected azimuth dial of the type bearing indicator that is shown in Figure 3b. The dial consists of two 180° sections, left being designated *Red Sector,* and the right *Green Sector.*

The plotting of these deviations on a polar graph that includes the outline of the aircraft and the center of the graph corresponding to the rotating axis of the loop antenna, and the relation between the structure of the aircraft and the deviations, are clearly shown. We note that the 45° to 70° sections are on the opposite side of the loop antenna from the engine nacelles in relation to

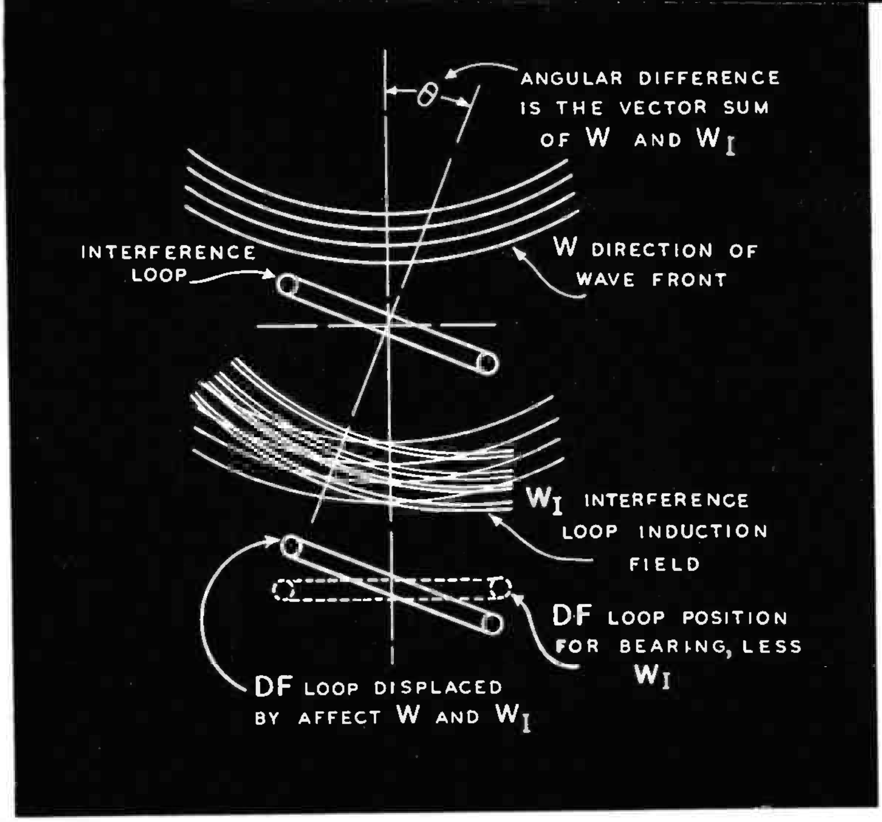


Figure 5
An analogy of the effects produced where the combined induction field and the wave front results in a displacement of the null position of the loop antenna.

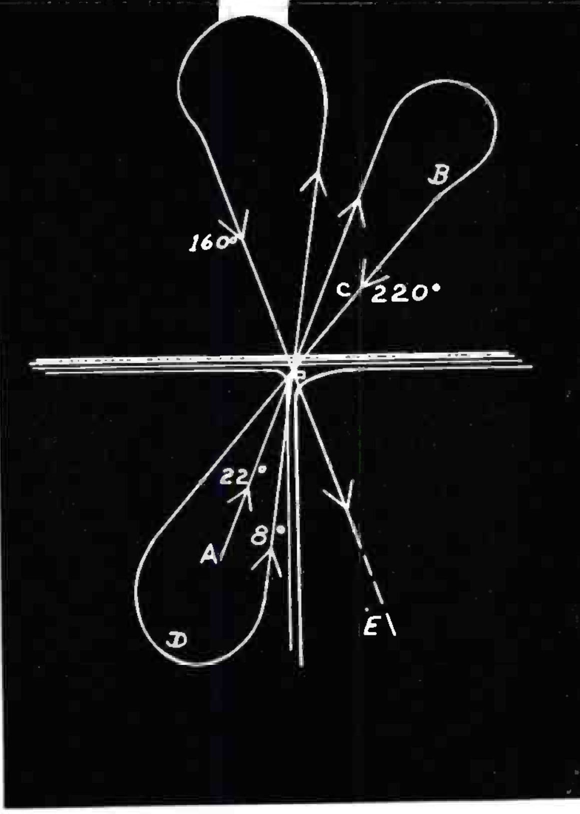


Figure 6
The ground-checking method procedure followed in the **point flight** method. Here the track of the aircraft does not, within a small degree of the heading, affect the accuracy of the gyro and radio compass readings.

the wave front. *The deviation is minus.* The 90° to 180° sections, to a large extent, consist of the wing and engine nacelle that is between the loop and the wave front. Here *the deviation is plus.* It is interesting to note that the sharp indentation at 130° (at right) is in line with the right aileron *Tab.*

Interference Loop Test Results

Let us now correlate this observation with the characteristics of the aforementioned interference loop test. As we see in Figure 4 an interference loop when placed near the loop antenna and with both loops in the same plane or at an angle of 90° to each other, the r-f field is not distorted, that is, no displacement of the null will occur. It is interesting to note that when an interference loop is placed in the former mentioned position, the null of the *sensed* loop antenna is displaced in the direction that the interferenced loop is rotated. With an interference loop in the latter position, the null is displaced in the opposite direction to which the interference loop is rotated.

Currents in Shorted-Turns

It is generally known that the currents set up in *shorted-turns* of the aircraft's structure result in deviations in the loop azimuth dial when the induction field of the disturbing mass is in such position to produce maximum or near maximum loop voltages, while the loop antenna is in a null position of the wave front of the signal, upon which a bearing is being taken. For example, the loop position is 90° displaced with reference to the fuselage *shorted-turn* current field, when the plane of the loop is in the fore and aft position of the aircraft. It is possible that this fact, at least in part, is responsible for certain noise reductions which are experienced in actual operation. And it can be that the loop signal voltage (from the station in line with the aircraft heading) is, to a great extent, independent of the fuselage currents.

A simple means of illustrating this condition appears in Figure 5. This shows the wave front, with the resultant field produced by the previously mentioned mass (shorted-turn represented by an interference loop). Incidentally, it is this phenomena, to a considerable extent, that determines the required distance of physical separation (to avoid inter-action) of the two loop antennae, comprising the dual automatic compass installation. According to this analysis, the location of the two loops, if in the same angular position (null), can be fairly close. It is the angular difference that results in this inter-action that produces the deviation. Without the benefit of an investigation to substantiate this fact, it appears possible, however, that two loops could be mounted fairly close to each other if corrector disc or compensating loops were used for the purpose of making a correction for this inter-action. This appears plausible where only one variable factor is involved. Tests have been made which show that it is not practical, by any present known method, to correct for all involved combinations of loop errors caused by various parts of the aircraft's structure at all points of the azimuth. An example of this type is the installation of a loop antenna within the nose section of the aircraft.

It was previously stated that it is not practical, electrically, by purposely producing induction fields, to compensate for various dissymmetrical interference fields for all angles of the loop antenna. However, it was found, by the writer, from experimentation, that a loop can be located in a symmetrical net-work of interference loops in which the loop compensation is reduced to an almost negligible amount. The type plane involved is a Stinson Reliant which has a steel tube constructed fuselage with fabric covering. The loop antenna was located within the fuselage at a point aft of the cabin. Surrounding the loop antenna, in effect, are six interference loops formed by the steel tubes of the fuselage. Within this cube of loops, one position was found in which the loop antenna presented a normal field. One-half inch displacement of the loop antenna from that position on a horizontal line, longitudinally, will result in producing a null at athwart-ship regardless of the direction to the station to which the direction finder was tuned. Also found was another loop location that gave maximum signal for all points of the azimuth. In addition we found that other possible positions gave erroneous

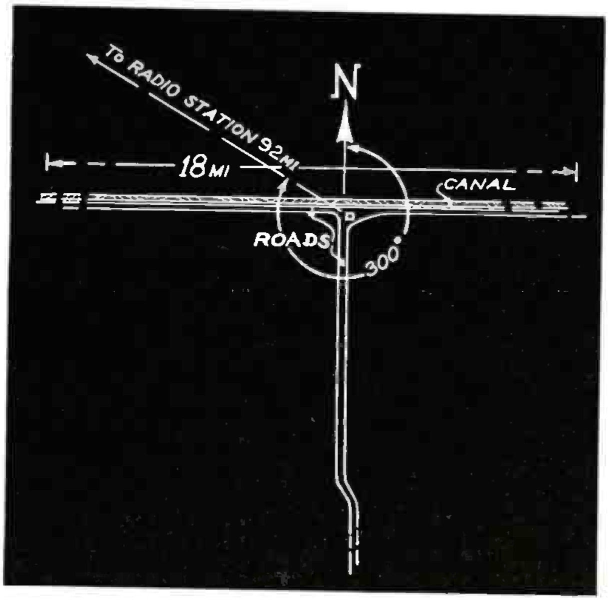


Figure 7
The selection of a ground reference point is vital in compass calibration. Here we have an illustration of a very satisfactory reference point with reference lines, that is used by Mr. McKee. This method, by the way, served as the basis of the examples on flight calibration checks, presented in this paper.

bearings. The loop antenna position for this type of installation is determined, by experimentation, when the aircraft is in the clear, several hundred feet away from buildings, trucks, etc.

Relative TRB and Relative ORB

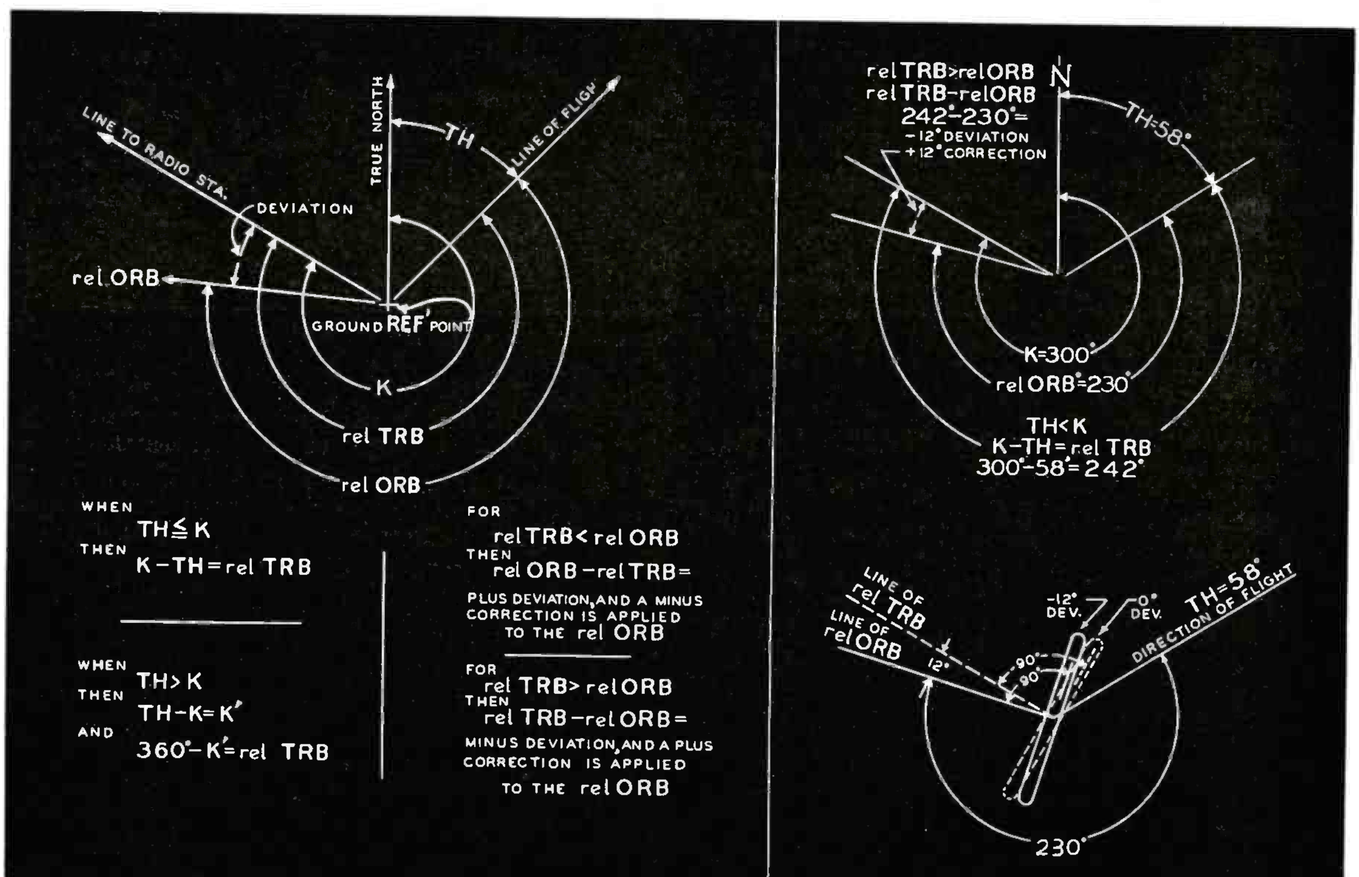
The difference between *true radio bearing* (*TRB*) and the *observed radio bearings* (*ORB*) are plotted for reference purposes. In rectangular coordinates this curve approaches the appearance of a two cycle sine wave of amplitude equal to maximum deviation. For a loop antenna symmetrically located on the longitudinal center-line of the aircraft, it will usually be found that maximum error occurs at *odd forty-five* degree intervals. At zero and one-hundred-eighty degree points the error is nil, while in the vicinity of two-hundred seventy degrees and ninety degrees the error is nil. It is at these points that the sign changes from plus to minus. The general effect is that signals from stations forward of the wings are displaced toward the nose of the plane, while signals from stations aft of the wings are displaced toward the tail of the plane. A summation of these facts are:

Azimuth Dial Reading	***Bearing Indicator Correction***
0°/360°	0
45°	Leading
90°	0
135°	Lagging
180°	0
225°	Leading
270°	0
315°	Lagging

By the term *leading* we refer to a condition whereby the *TRB* is greater than the *ORB* which represents a minus error. A positive correction is applied to the *ORB*. Therefore, the correction

(*Continued on page* 54)

Figure 8
This formula was devised to show the relation between TH, rel TRB, and K, in which true angles are with reference to the geographical north, while relative angles are with references to the aircraft heading. As shown by the drawings, the definitions of the symbols are . . . TH is the true heading of the aircraft and is the angle between a true north line and a fore-aft line through the aircraft. Rel TRB (or relative aircraft heading) is the angle between the aircraft fore-aft line and the line to the radio station. Rel ORB is the angle of the indicated radio bearing from the aircraft heading, with no correction applied to the corrector unit. K is a constant for one particular ground reference point. It is equal to the angle of the line to the station from true north.



THE SAWROOM IN CRYSTAL PRODUCTION

And The Vital Role It Plays

by L. A. ELBL

Engineering Department, Crystal Products Company

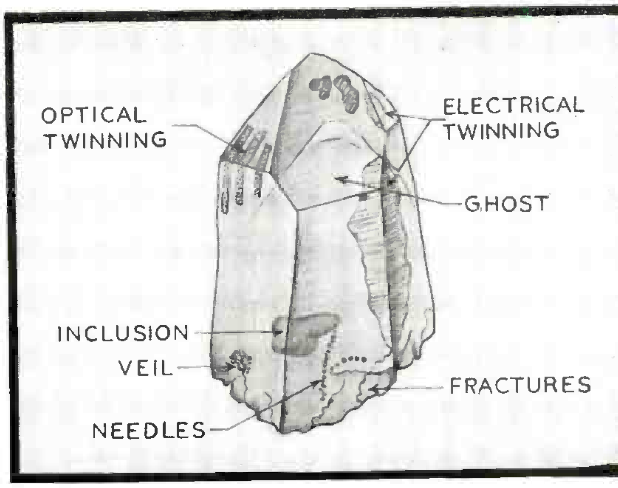
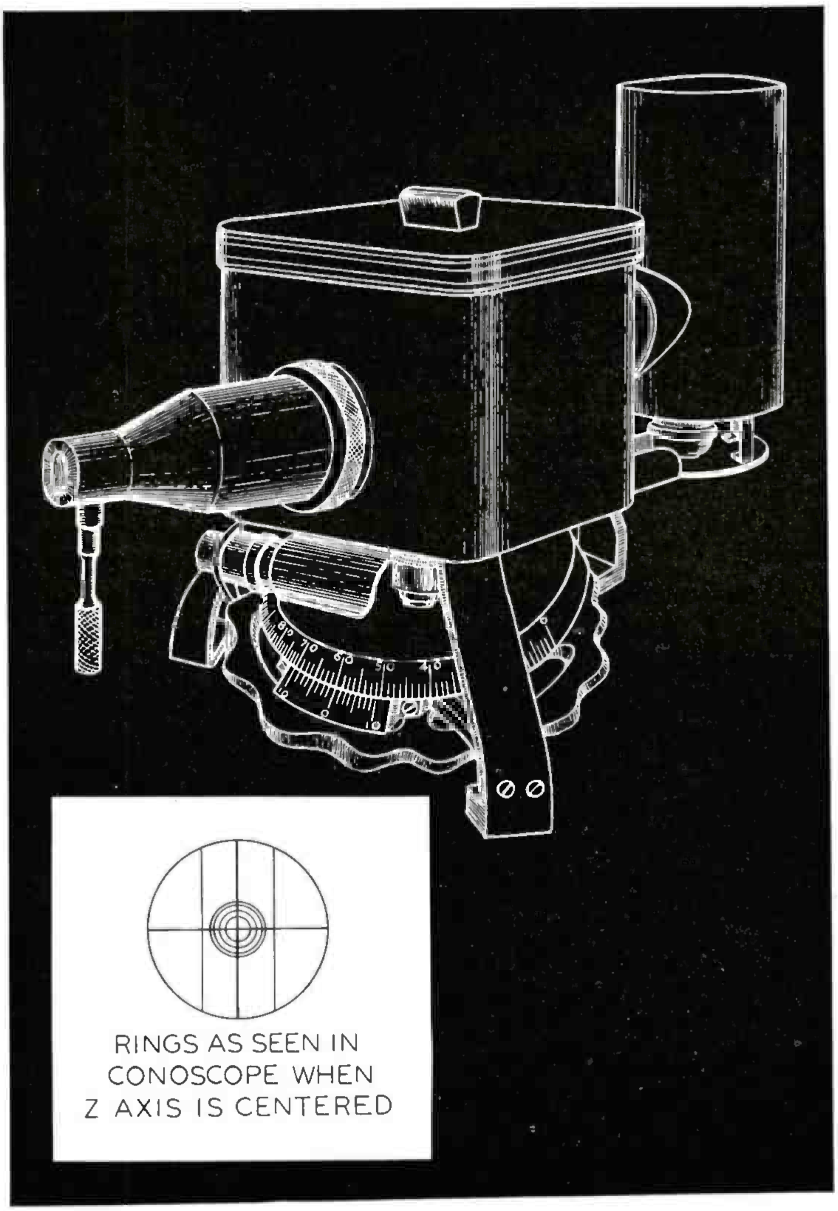


Figure 1
Common impurities as seen in the mother or natural crystal.

TO the average person the word "sawroom" is a very insignificant term and yet in the crystal business it is a most important one. It is here that a great deal of technical knowledge and precision equipment is put to work. It is the sawroom to which most of the "headaches" in the business are eventually traced, and here that these difficulties have to be "ironed out." It is here that people have to be trained to do precision jobs in the capacity of experts, each week adjusting their techniques to include new discoveries which are constantly being made. This is due to the fact that the field of piezo-electricity is still in its infancy and new and better methods are always being developed.

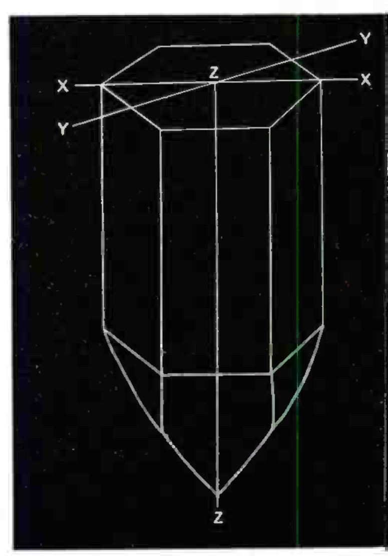


Operations Preceding Sawing

Many vital allied operations precede the actual sawing. Let us, therefore, observe these steps first. Quartz with the best piezo-electric properties comes from Brazil. It is shipped in wooden boxes containing from one to two hundred pounds. The mineral is usually classified according to size, with pieces

Figure 2 (right) and 3 (left)

In Figure 2 we see the crystallographic axes of the mother quartz crystal. In Figure 3 appears a conoscope. The rings that are seen in this conoscope when the optic axis is centered, is shown on the lower left of the illustration.



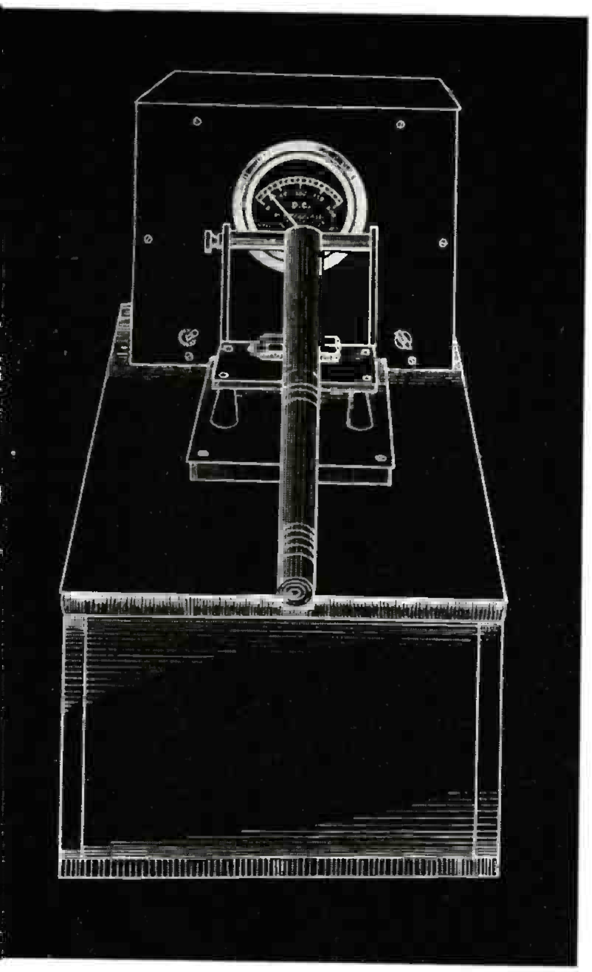
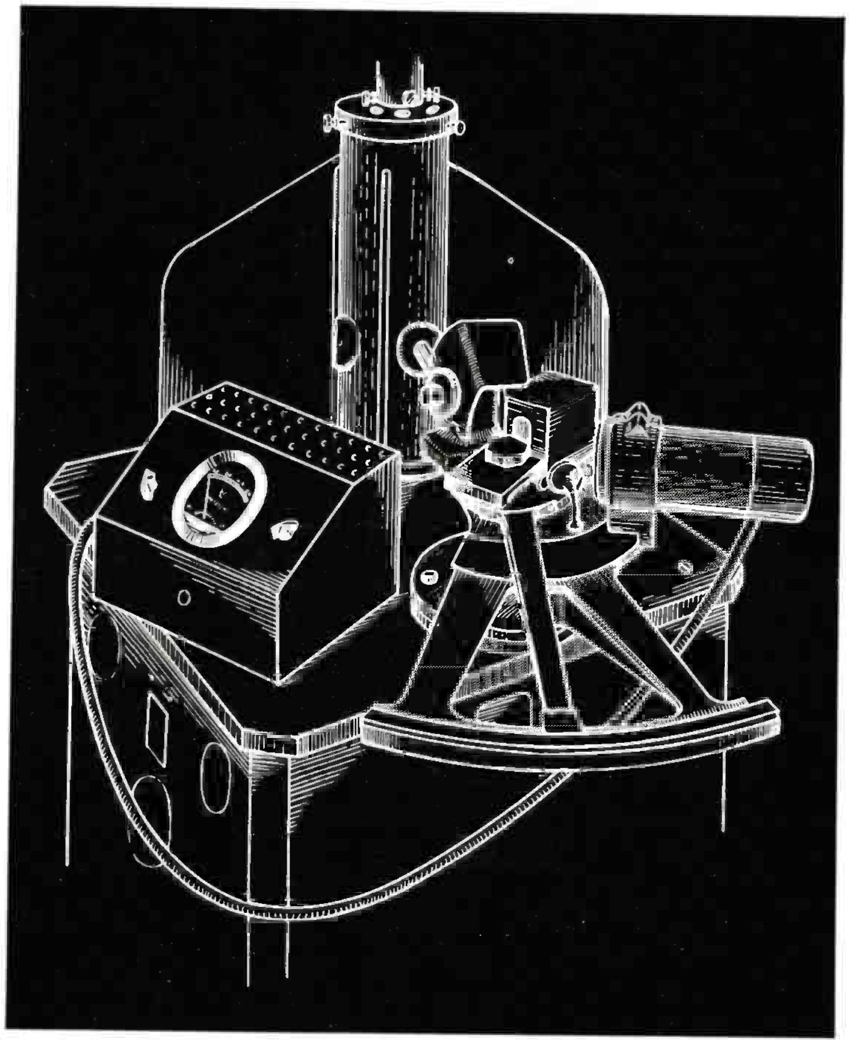


Figure 4 (left) and 5 (below)

In Figure 4 appears an electrometer which determines the polarity of the X-axis of a crystal. In Figure 5, below, appears the X-ray apparatus which is used to check on the exactness of the angles of the slice or wafer of the crystal.



ranging, for instance, from 100 to 150 grams, 150 to 200 grams, 200 to 300 grams, etc. A shipment of quartz nearly always represents a cross section of the quartz supply; that is, some crystals will have good faces and apexes, others only few faces and no apexes, and still others no faces or apexes at all. As the quartz is opened, it is therefore necessary to sort them. This is done by an expert who sorts these into three groups. And each of the crystals in these groups is treated in a slightly different method of mounting for cutting.

Studying the Impurities

The next step concerns a study of the impurities of the different kinds of crystals. The impurities can be seen with the naked eye by simply using a bright source of light such as an arc lamp. A beam of light is passed through the crystal. This shows up such impurities as fractures or cracks, foreign particles included within the crystal, bubbles, needles, veils, color, and ghosts or phantoms. The latter are cases where the crystal contains internal colored bands or planes parallel to the faces of the crystal. These really represent stages of growth of the crystal and it appears to the eye as if one crystal has grown within another. Crystals with excessive amounts of impurities are rejected.

Determining Direction of Cut

The next operation (in order) before mounting is determining the direction of cut. This, of course, refers to the direction of cutting across the optical axis of the crystal. Before going further it should be stated that a quartz crystal has three crystallographic axes and a crystal oscillator must be cut with respect to these axes to be usable. These are the optic or Z-axis running lengthwise through the crystal, the electric axis or X-axis running parallel to the natural faces and at 90° to the Z-axis, and the mechanical or Y-axis which is perpendicular to the crystal faces. In all cases, the axes merely represent directions.

Handedness and Polarity

In order to tell in which direction to cut a mother crystal, we must know (*1*) the handedness and (*2*) the po-

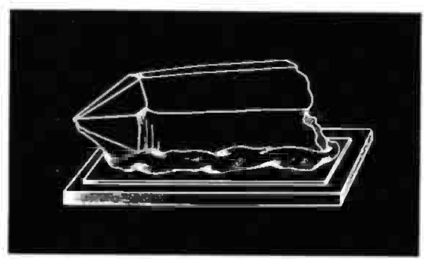


Figure 6

A mounted mother crystal.

larity of the X-axis. By handedness we mean whether the mother is left-handed or right-handed. Mothers are so called because some rotate polarized light to the left and others to the right, the molecular structure of the former being the mirror image of the latter. The easiest way to tell the handedness of quartz mothers is with a conoscope. This instrument is a type of polariscope with a convergent beam of monochromatic light passed through the mother while it is immersed in a tank of oil with approximately the same refractive index as quartz. When the optic axis is parallel with the beam of light and centered, concentric circles are seen. By rotating the aperture on the analyzer, the front polaroid, the rings are seen to contract or expand, telling us the handedness of the quartz.

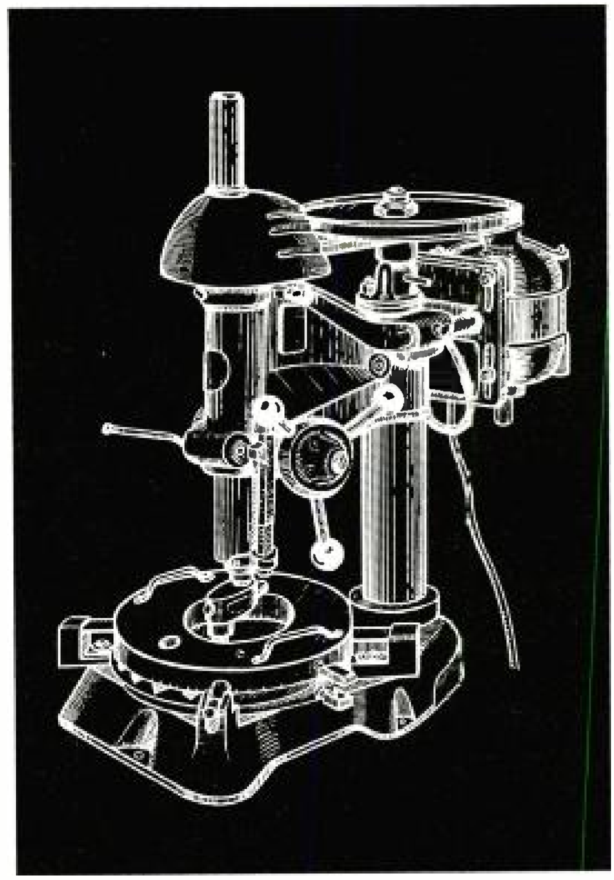


Figure 7

A lapping machine. This device plays a very important role in the production of precision crystals. If the lappers do not lap the crystals to the desired flatness, the activity of the crystal is decreased. Lappers must also be careful to avoid any scratches on the crystal surface, or broken corners. Such apparent minor deficiencies prevent the crystals from oscillating.

The Electrometer

For determining the polarity of the X-axis, an electrometer is used. Due to the piezo-electrical property of quartz, it develops a charge at certain points when compressed along the X-axis. Upon compression, one end of the X-axis becomes positively charged and the other negatively charged. This is read directly on the electrometer. Knowing the handedness of the mother and the polarity of the X-axis, one knows the direction at which to cut the mother with respect to the optic axis for a particular type cut. The next procedure is mounting the crystal for sawing. This is done on a mounting plate or ruled angle iron. For precision crystals, the mother is mounted with the optic axis running parallel to the plate and the electric axis perpendicular to it. If the crystal has faces and an apex, this is a rather simple operation, but becomes increasingly difficult with a lack of an apex and well defined faces. Where neither faces nor apex are present the axes must be located by some other method before mounting. After the mother is set in place it must be securely fastened with some type of glue or wax so that it can be sawed.

Diamond Saw

Quartz is sawed or cut with a diamond saw. This has a round saw blade with diamonds in the periphery. Since quartz is so hard, it is necessary to have this hard substance to cut it.

Cut of the Crystal

As we have previously stated, sawing is a very precise job. To provide a precision crystal the slices have to be cut at just the right angle with respect to the axes.

A precision crystal is one in which the frequency changes *very* little over a wide temperature range. This is determined almost entirely by the angle of cut. The mother is clamped to the saw, the adjustments set for the proper angles, and a trial slice is taken. The exactness of the angles of the slice or wafer is checked on an x-ray machine. By means of deflection of the x-rays from the internal atomic planes, one can read the angle of cut directly on the x-ray machine. The sawman has to hold his angles within 15 minutes on precision crystals. If need be, he continues making corrections on the saw until he gets a cut within the limits. Then he slices the entire mother in thin *baloney* slices, or wafers. The sawman must be careful not to force the saw because his slices must be parallel to within .005 of an inch to avoid changing the angle in further operations.

Optical Twinning

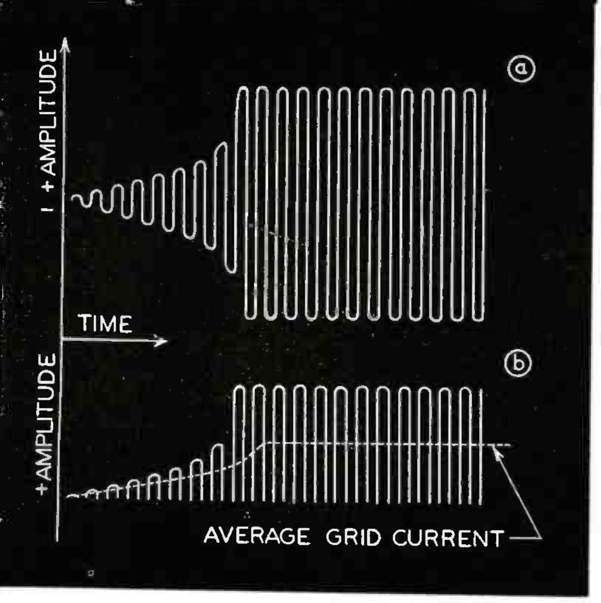
After the quartz is cut, it is ready for the inspection department. In this department, wafers are first checked for cracks and fractures and these are marked. Next, another impurity called *optical twinning* is checked. In optical twinning, we have alternate right- and left-handed quartz in the same wafer. The wafer is first immersed in cedar oil and then placed at an angle between crossed polaroids. When held at the proper angle, optical twinning appears as colored patterns. These are marked with a pencil and then painted with colored wax. A good crystal can be taken from the optical twinning, as long as it is taken in its entirety, but a crystal with only a portion of optical twinning is no good.

Electrical Twinning

The slices are next etched in hydrofluoric acid to bring out another type of impurity called *electrical twinning*. This can be visualized by taking part of the mother and rotating it 180° about the Z-axis. Electrical twinning cannot be utilized in wafers. It is detected by transmitted light after etching and marked out. The wafer now is ready to be diced or cut into blanks. First of all, the X-axis is marked on the slice using crossed polaroids. Then the blanks are drawn on the slice placing the X-axis exactly on one side. A special type of high speed saw with a small diamond blade is used for roughly cutting out blanks. This is called a *cut-up saw*.

Two adjacent sides of the blank are next ground perfectly square. Then

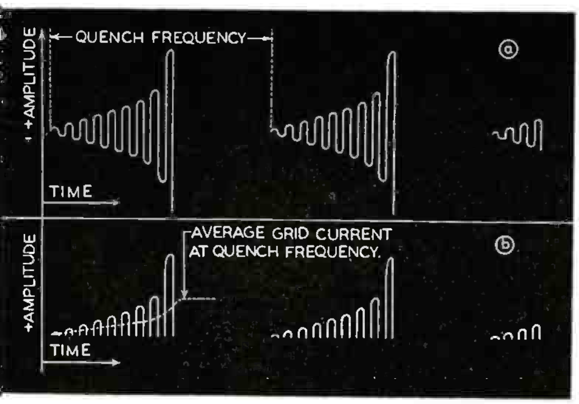
(*Continued on page* 62)



SUPER-REGENERATIVE DETECTORS IN U-H-F

by ART H. MEYERSON

New York Fire Department Radio Laboratory



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Figures 1 (left top), 2 (left center) and 3 (below)

In Figure 1 (a) appears the wave form of the voltage in grid circuit from start to steady state in a feedback oscillator. At (b) appears the grid current in grid circuit due to positive peaks of driving voltage. In Figure 2 (a), we have the wave form of voltage in grid circuit of a quenched oscillator, with no signal. At (b) is shown the grid current in grid circuit induced by positive peaks of driving voltage. In Figure 3, we see what happens when a signal at resonant frequency, of greater intensity than the transient voltage, is introduced in the grid circuit.

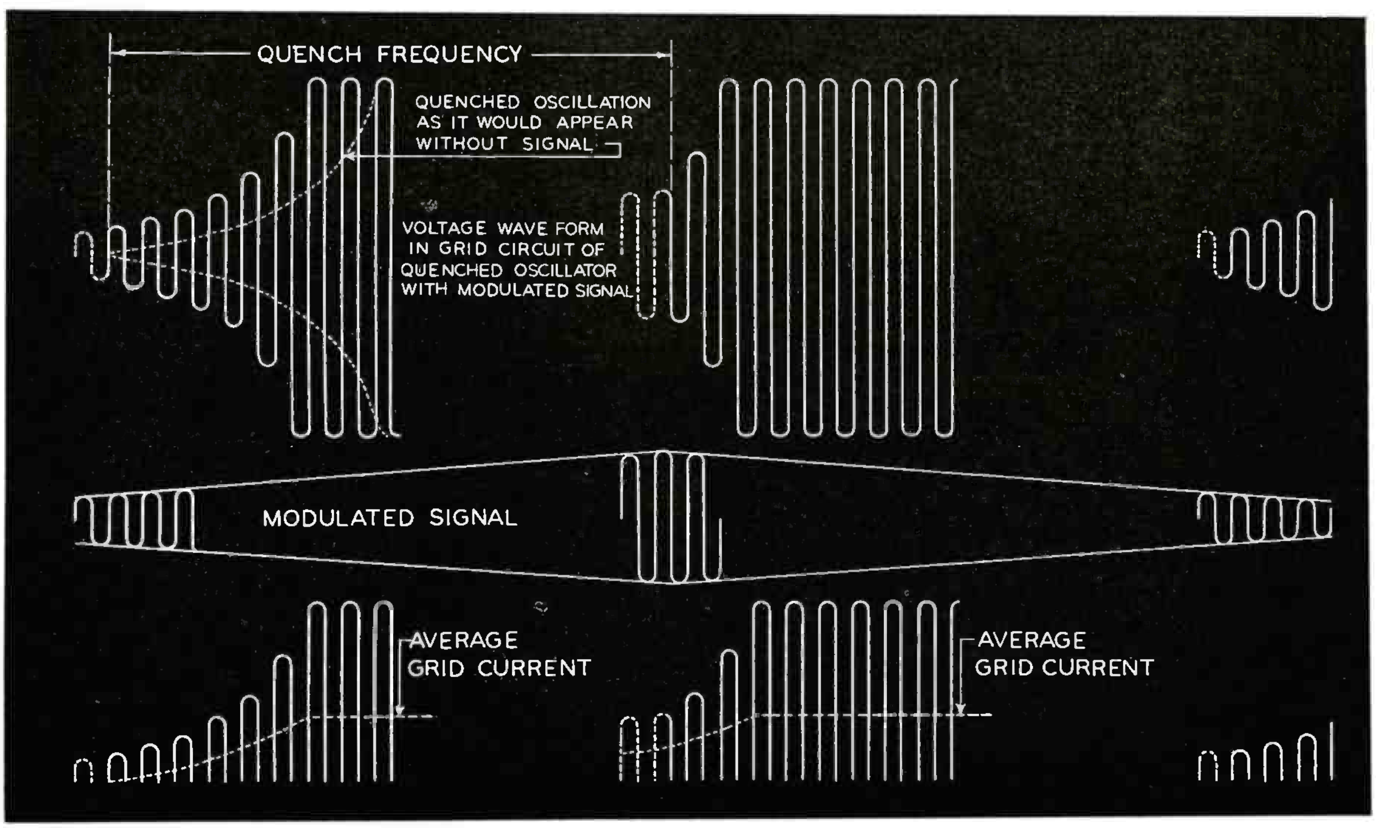
•

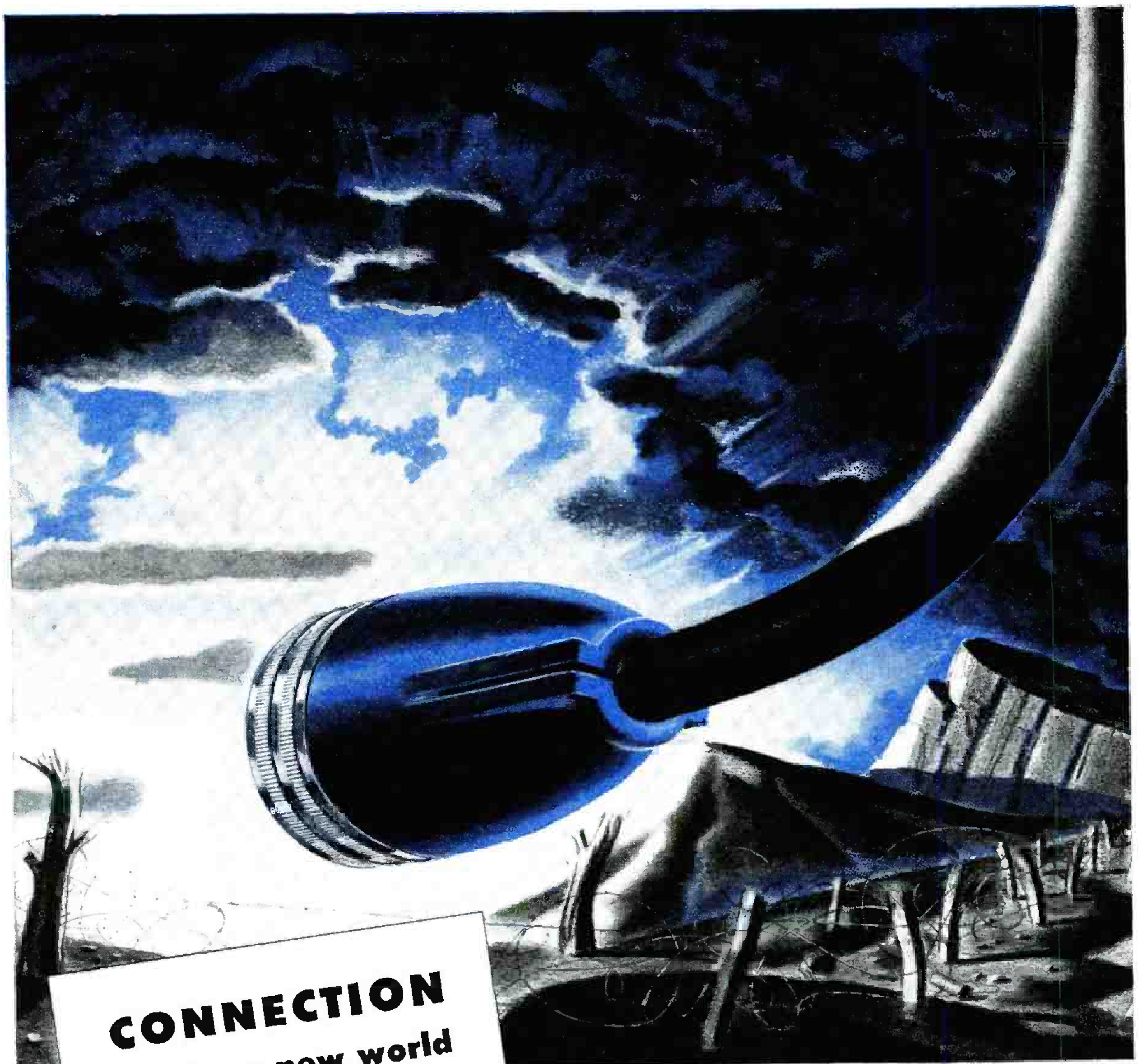
THE super-regenerative detector has recently been revived because of its ability to detect weak signals at ultra-high frequenies with a minimum of equipment. The factors for optimum design can be followed on paper and closely approximated in construction. The purpose of this discussion is to seek out those factors and determine electrical means for ascertaining their optimum values.

A brief review of detectors in general will help to clarify the position of the s-r detector in this field.

Detectors are usually classified as either power or weak signal devices in the broad sense. Under either of these headings can be listed linear, square law, and logarithmic detectors. For a given percentage of modulation, the

(*Continued on page 18*)





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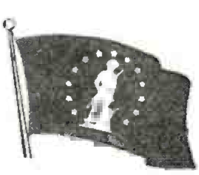

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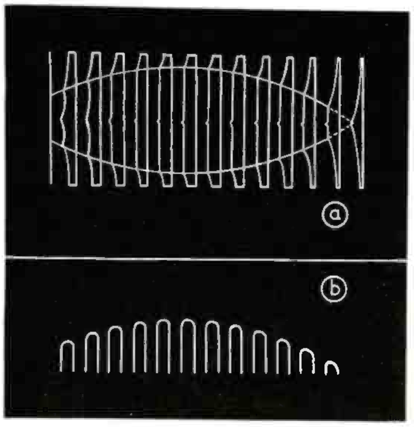
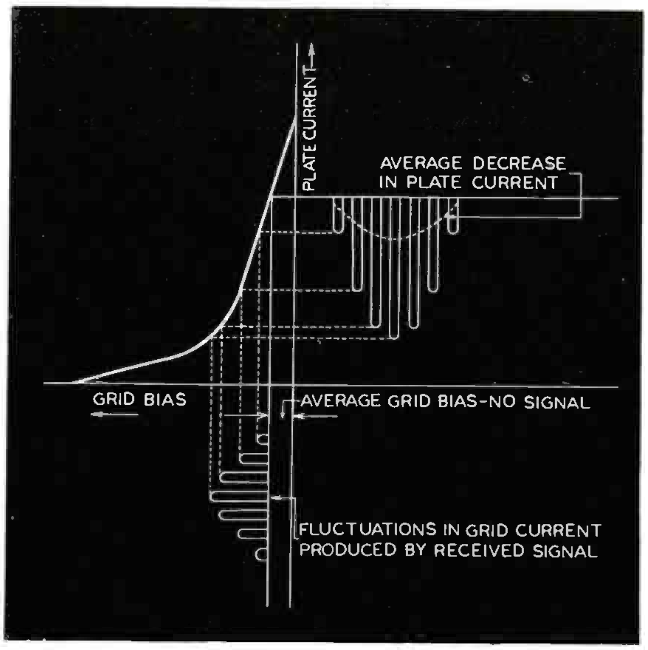
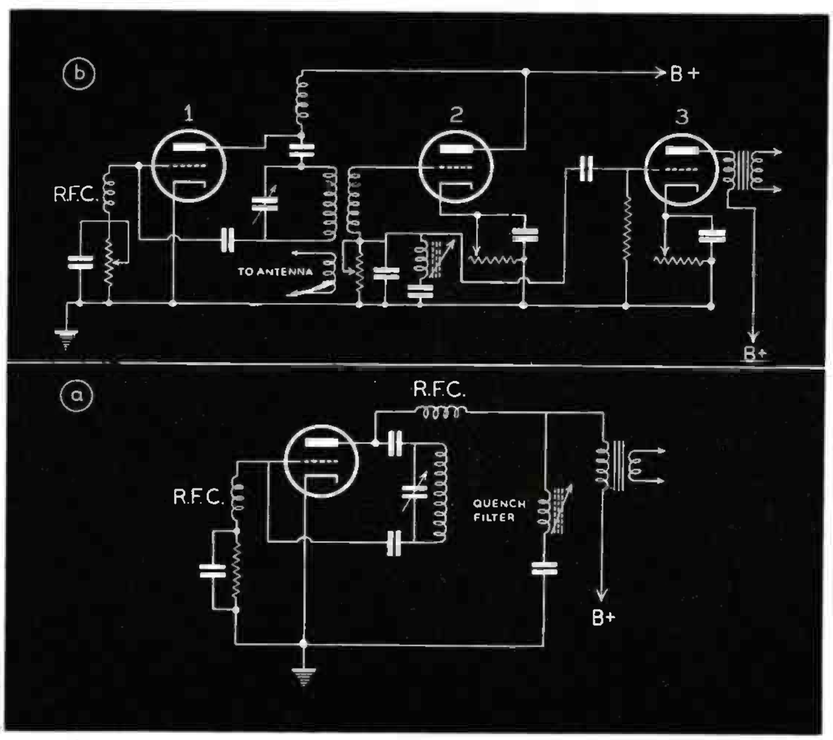






Figures 4 (top), 5 (right) and 6 (below)

At (a) in Figure 4, an envelope pattern for received modulated signal. At (b) grid current form for received modulated signal at quench frequency. In Figure 5, we have the action of s-r detector as a detector amplifier. In Figure 6 is a circuit of a quenched detector (a) and its equivalent (b), showing how it may be broken up into a quenched oscillator (1), detector (2), and audio amplifier (3).

The s-r detector may be so designed, as to be either a weak or signal device, with a linear, square law or logarithmic characteristic, or even a multiple characteristic.

The Feedback Oscillator

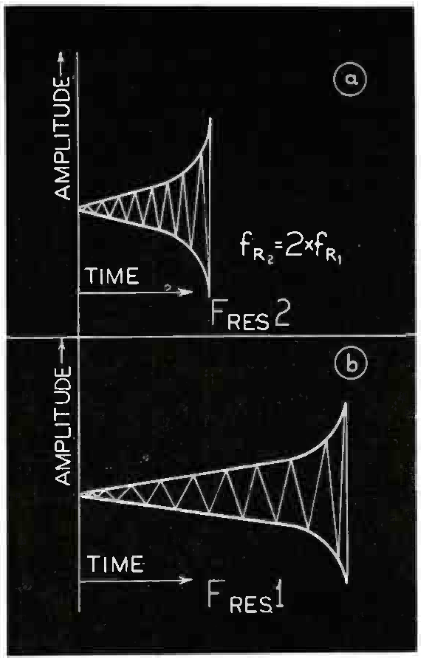
Let us consider first, the action of a feedback oscillator, particularly during the building-up period. When plate voltage is first applied, the plate current will be high, as well as the amplification, since the grid bias is zero. Any transient voltage present in the electron stream at resonant frequency will therefore be amplified. This amplication will decrease with the increase in grid drive voltage because of feedback, since a bias voltage will develop across the grid resistor due to those portions of the cycle when the grid is driven positive and draws current. The tube will reach a steady state of oscillations when the amplification is unity; that is, when the amplitude of oscillation in the plate circuit is just able to sustain the amplitude of oscillation in the grid circuit necessary to create that plate amplitude. This is illustrated in Figure 1.

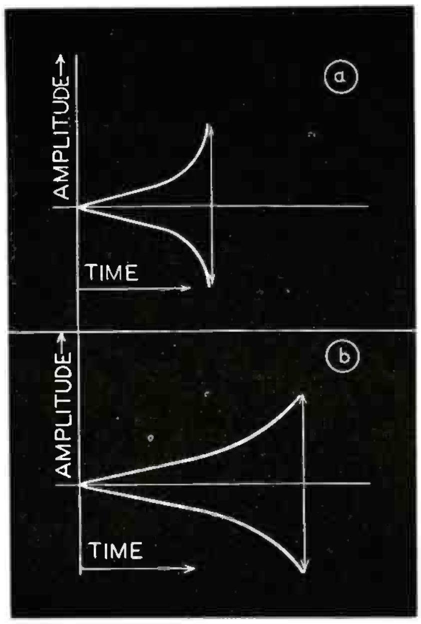
The S-R Detector

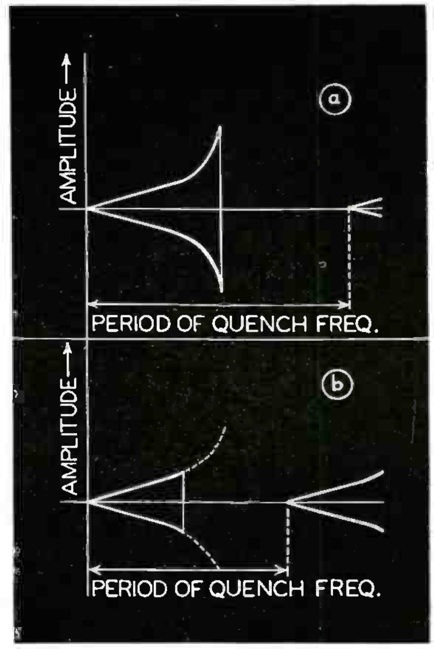
In the s-r detector, these oscillations are quenched just about the time they reach their maximum amplitude, and are periodically permitted to start from minimum amplitude and reach maximum amplitude. This is the quench frequency shown in Figure 2. If a signal of resonant frequency is introduced in the grid circuit, of greater intensity than the transient voltage, oscillations will start at a higher amplitude and reach maximum amplitude sooner for a given quench frequency. Since the voltage drop acaross the grid resistor will reflect the duration time of grid current flow, the longer oscillations are maintained, the larger will be the bias voltage developed, and the bias will reflect the amplitude of the received signal (See Figure 3.) Variations in signal amplitude or modulation will vary the bias from its steady state to a maximum deviation dependent on the percentage of modulation, as we can see in Figure 4. This variation in bias voltage will, in turn, affect the plate current, and thus reproduce the modulation in the plate circuit, as illustrated in Figure 5.

Oscillator Action of Detector

It can be seen from the foregoing that a s-r detector acts as an oscillator varying from a class A to class C state, with the overall characteristic of a radio frequency amplifier creating a detector action in the grid circuit, and







Figures 7 (center), 8 (left) and 9 (right)

In Figure 7, we see how the quench frequency is determined by the time necessary to reach max. amplitude. Figure 8 (a) shows how increasing the resonant frequency to twice that in (b), decreases the quenching time. Figure 9 (a) shows a wave train quenched at max. amplitude; (b) shows the same wave train for a higher quench frequency.

amplifying this action in the plate circuit. (See Figure 6.)

Time Requirements

Let us next consider the time necessary for the amplitude of oscillation to reach maximum. If the oscillation is to be quenched at maximum, the frequency of quench will be determined by two factors. They are . . . (*1*)—the resonant rise in amplitude as shown in Figure 7; and (*2*)—the resonant frequency as illustrated in Figure 8.

The first factor will be determined by the Q of the circuit, the percentage of feed-back, the Mu of the tube, and the value of the grid leak-condenser.

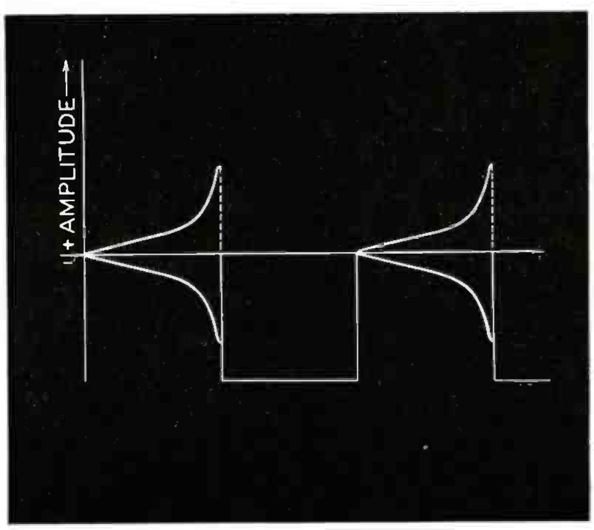
The second factor is self-evident. Inversely, if the amplitude of oscillation were cut off before maximum, the frequency of quench would determine the maximum amplitude, Figure 9.

Quenching Oscillations Methods

Let us now consider methods for quenching the oscillations. The ideal quench action would be one that stopped oscillations just when they reached maximum amplitude. Several methods are popularly used with varying efficiencies. If a square wave voltage were available we could use it to supply the plate voltage with the result pictured in Figure 10. A similar effect could be produced by applying a square wave voltage to the grid as shown in Figure 11, or by applying a trigger voltage to the grid as in Figure 12. The effect here is to drive the grid bias beyond the steady state, or unity amplification so as to cause oscillations to cease. In practice sinusoidal quench frequencies are used, applied to either the plate or grid circuits. The time constant of *r-c* in the grid circuit is adjusted to a critical point, so that any decrease in plate voltage or increase in grid voltage causes the oscillations to die out. As we can see in Figure 13 the quench frequency may be applied from an external source, (a), or by having the tube oscillate at resonant and quench frequency (b), or by making the time constant of *r-c* in the grid circuit so large as to cause intermittent oscillation (c). Figure 14 shows some tube circuits for super-regenerative detectors. The methods are almost infinite in their variety.

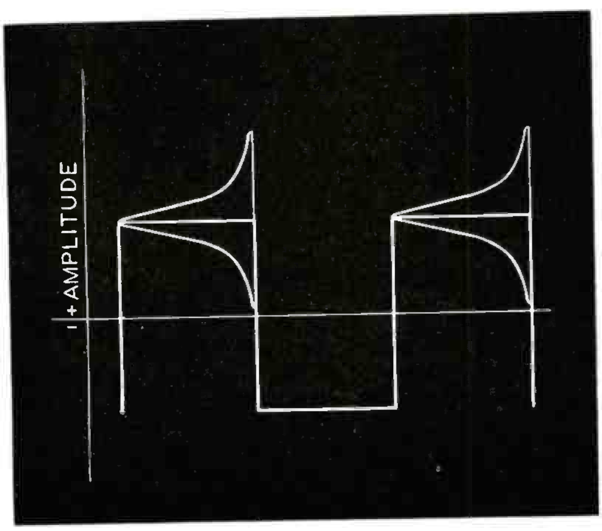
Resonant Rise of Voltage Amplitude

Let us now consider the effect of a received signal on the resonant rise of voltage amplitude, Figure 15. If the quench frequency is of such frequency as to quench oscillations at maximum amplitude, the effect of a signal would



Figures 10 (right) and 11 (left)

Methods for quenching oscillations are illustrated here. In Figure 10, the result if a square wave voltage were used to supply plate voltage. In Figure 11 appears the effect, if the square wave voltage is applied to the grid.



be to increase the time of maximum oscillation amplitude (a). If the quench frequency quenches the local oscillation before it can reach maximum amplitude, the received signal will cause the amplitude of oscillation to approach maximum depending on the amplitude of the received signal (b). The quench frequency may be so adjusted as to cause both effects to be present (c). The shaded areas are representative of the increase in grid bias due to the received signal.

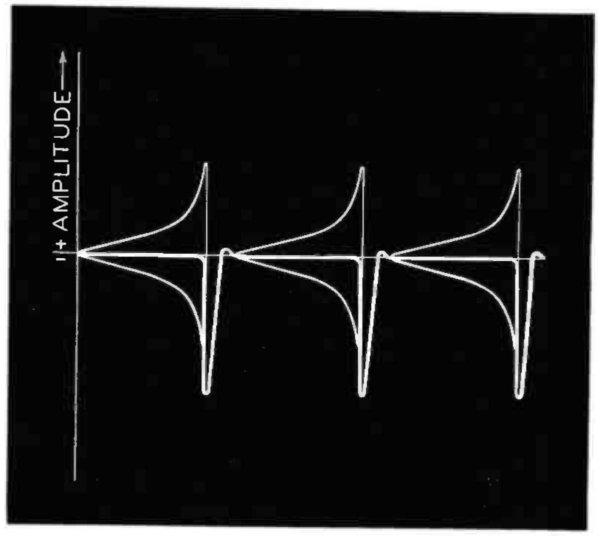


Figure 12
Here we see the result of applying trigger voltage to the grid. The effect here is to drive the grid bias beyond the steady state or unity amplification, so as to cause oscillations to cease. In practice, sinusoidal quench frequencies are used, applied to either the plate or grid circuits. The time constant of r-c in the grid circuit is adjusted to a critical point so that any decrease in plate voltage or increase in grid voltage causes the oscillator to die out.

Design of S-R Detector

Up to this point, we have only treated on the action of a s-r detector and various methods of accomplishing this action. Now let us consider the design of a s-r detector and what qualities are desired.

A s-r detector represents a complete receiving system in that it has the characteristics of an r-f amplifier, a detector and an audio amplifier. If the s-r detector were used as such, design factors would involve all three characteristics. In practice, however, the audio amplifier characteristic is minimized. The reason is that the desired audio output can be easily attained by the addition of an audio amplifier.

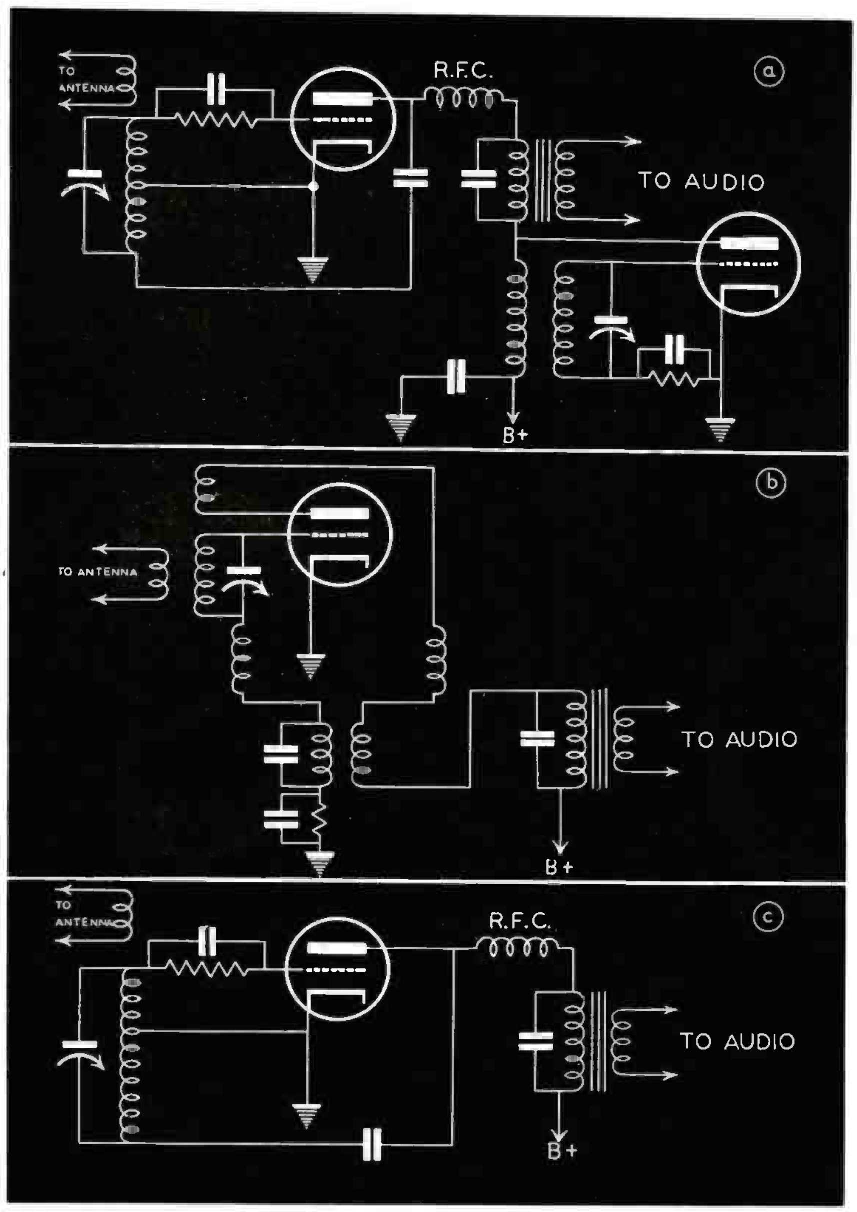


Figure 13
How the quench frequency may be applied. At (a) a separately quenched circuit. In (b) we have an oscillator operating at quench and resonant frequencies, and in (c) we have a self-quenched circuit.

Receiver Characteristics

The most important characteristics of a receiver are fidelity, noise-to-signal ratio, sensitivity and selectivity. Sensitivity may be defined as a product of noise-to-signal ratio for a minimum signal. Selectivity may also be considered as a relative value depending on frequency of operation and service for which it is intended. Fidelity is a characteristic also dependent on type of service. These characteristics are here discussed because they bear an important relationship to the design of the s-r detector.

Requirements for Standards

Before we can proceed with the design, we must therefore set up standards. Usually s-r detectors are used for voice communication systems involving an audio frequency range of from 250 to 4000 cycles and modulation percentages approaching 100%. These characteristics are involved in the design since the value of r-c in the grid circuit will determine the demodulation efficiency at the detector. Terman has shown that

$$\frac{X_c}{R} \geq \frac{m}{\sqrt{1 - m^2}}$$ where

(*Continued on page* 22)

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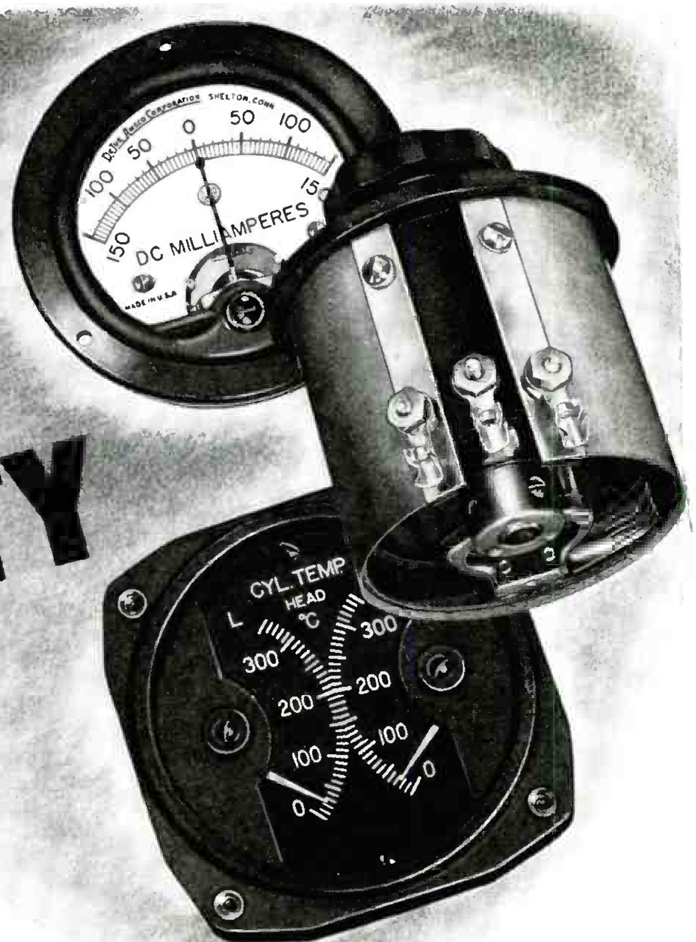

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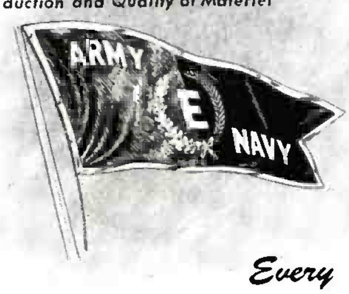

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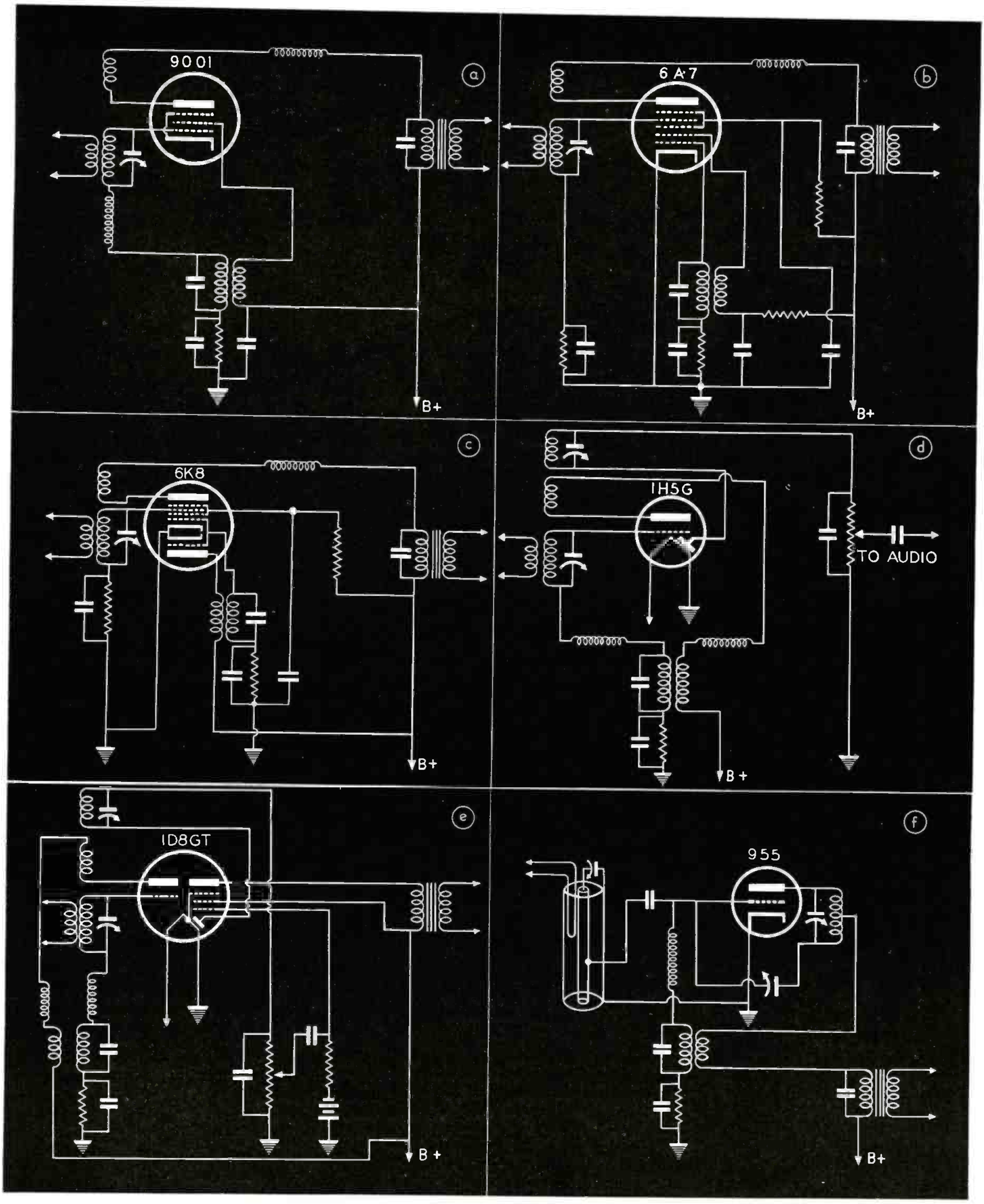


Figure 14

Various methods of s-r detection at u-h-f. At (a) a circuit employing the method similar to an electron coupled oscillator. At (b) the anode and grid act as a quench oscillator, and the pentode acts as a resonant oscillator. At (c) we have the same as at (b), except that the tube has a separate triode section. At (d), a triode with a diode, wherein the triode acts as a conventional detector, oscillating at quench and resonant frequencies. At (e) we have the same as (d), except that the pentode is used as an audio amplifier. At (f), a typical u-h-f s-r detector.

(*Continued from page* 20)

x_c = reactance of G_r at highest frequency desired in ohms

R = Resistance of G_R in ohms

M = percentage of modulation capable of being rectified without distortion.

(*Continued on page* 71)

The Synchronization Of

OSCILLOSCOPE SWEEP CIRCUITS

A Lucid Graphical Analysis

by W. R. MACLEAN

Research Associate, Polytechnic Institute of Brooklyn

THE gaseous discharge sweep circuit, although perhaps waning in importance as an object of research, is still growing with the number of oscilloscopes in use, as an instrument of research. Since the oscilloscope is coming more and more into new hands, it may be well to popularize and possibly simplify the synchronization theory. so that the user may be able to interpret better some of the more important patterns that are observed.

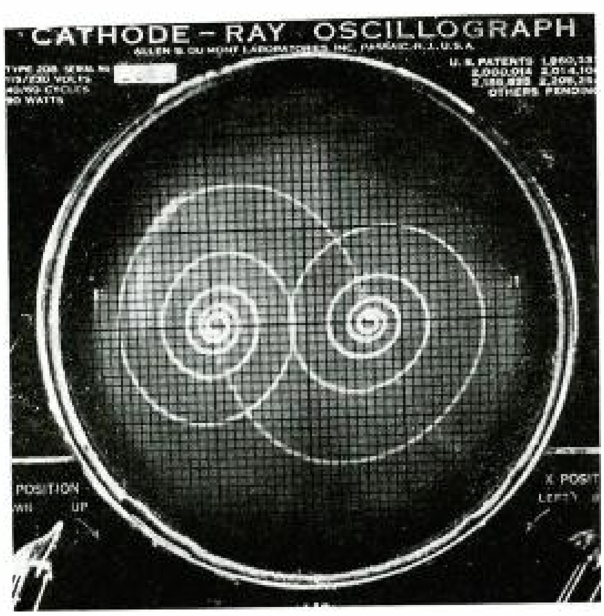
Those who have used the instrument know that there is no power on earth that could give a quick and satisfactory explanation of *all* of the maze of weird designs that appear under random adjustments. (See, for instance, Figure 1.) If, however, the user has a theory of the simpler phenomena in mind, he can proceed through a sequence of adjustments and bring out the desired picture with a minimum of "hash,"—this being a generic term for all patterns that are not understood. The analysis of synchronization presented here is one, which has been given in part, in a series of ESMWT courses at the Polytechnic Institute of Brooklyn.

Gas Triodes

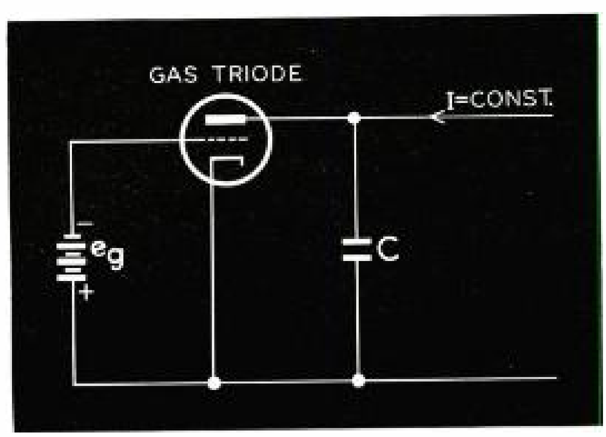
In analyzing the action of the gas-filled triode (sometimes called thyratron) used in most sweep circuits, one distinguishes carefully between the quantities e_p and $\bar{e}_p$. As usual e_p is the plate voltage, while $\bar{e}_p$ is the ignition voltage, that is, that voltage needed to "fire" the tube. In this instance $\bar{e}_p$ is a function (nearly linear) of the grid bias, e_g. A high (negative) bias results in a high ignition voltage; but once fired, the tube cannot be extinguished by raising the negative bias (within operating limits of the tubes usually employed in oscilloscopes). It can be extinguished if . . . (*a*) the voltage is lowered below the so-called ionization voltage. or (*b*) the current is reduced below a certain minimum value.

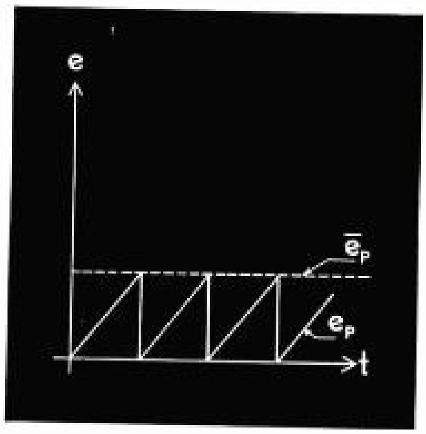
Suppose that in Figure 2 the constant current. I, were less than that needed to keep the tube ionized. In that case one might say the tube would stay de-ionized. But then the voltage across the condenser would increase linearly with time and soon exceed the ignition value, $\bar{e}_p$. The circuit solves this contradiction by oscillating, that is, alterately charging and discharging the condenser. whereby e_p is a sawtooth wave as shown in Figure 3.

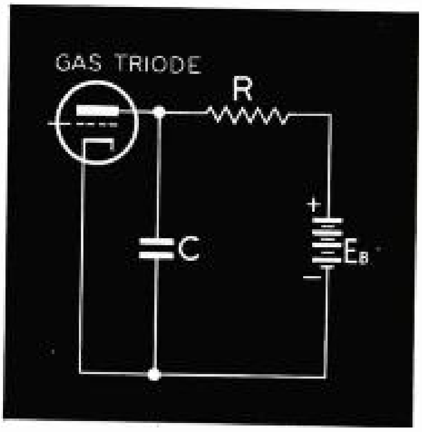
A question one asks at this point is . . . does the voltage across the condenser drop to zero, or merely to the "ionization voltage," E_i, in the neighborhood of 15 volts? Obviously when e_p drops below the true ionization potential of the gas used, no new ions can be formed. However, those already present can continue to conduct and to discharge the condenser. With a very large condenser (low frequency) this effect is slight (due partly to recombination of ions) and e_p drops to about E_i. With a very small condenser (high frequency) the space charge discharges it completely and then continues to pass the charging current, I, for an appreciable part of a cycle thereafter. But. although the situation is not as



Figures 1 (left) and 2 (below)
A wierd oscilloscope pattern is shown in Figure 1. In Figure 2, we have the simplest sweep circuit.

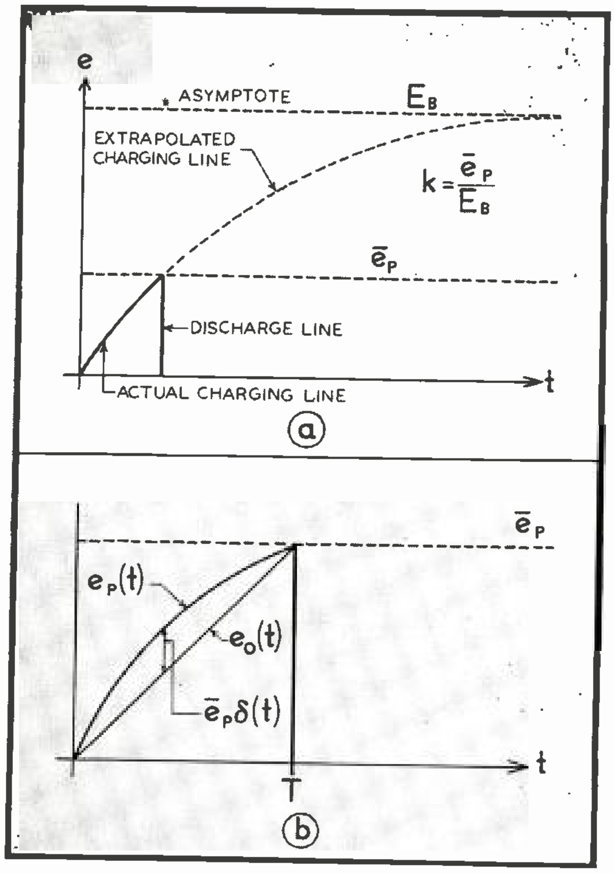






Figures 3 (top, left), 4 (bottom, left) and 5 (right)

In Figure 3 is the simplest sawtooth wave. Fig. 4, shows a conventional charging circuit. In Figure 5, at (a), appears the diagram showing actual wave shape to be a truncated exponential curve. At (b), the first part of (a) is magnified, with the curvature exaggerated for comparsion with a straight line.



simple as shown in Figure 3, the assumption that the voltage falls to zero and rises immediately therefrom is a sort of average condition that will be used to simplify synchronization problems.

Linearity

The constant current of Figure 2 is attained in practice only approximately; one uses a high voltage, E_B, supply and a high series resistor, *R*, to charge *C* as shown in Figure 4. Were it not for the ignition of the tube, the condenser would charge exponentially and asymptotically up to the full battery voltage, E_B. This process terminates at $\bar{e}_p$, however, and if the latter is low enough compared to the former, the line will be almost straight. One would expect the curvature of the "charging line" to depend upon the ratio . . .

(1) $$k = \frac{\bar{e}_p}{E_B},$$

and it can be shown to do so in a simple relationship if the curvature is properly characterized.

Referring to Figure 5, one notes that the actual plate voltage is the time function, $e_p(t)$. Then one defines a perfect or desired curve, $e_o(t)$, which is the straight line having such a slope as to have the same period; that is, to be the chord of $e_p(t)$. One then defines the function. $\delta(t)$ by . . .

(2) $$\delta(t) = \frac{e_p(t) - e_o(t)}{\bar{e}_p}$$

This is the spread between $e_p(t)$ and $e_o(t)$ as a fraction of the amplitude and function of the time. The maximum value of this function is then taken as a measure of the curvature. One finds simply . . .

(3) $$\delta_m = \frac{k}{8}$$

for the threshold effect; that is, for $k << 1$. This is a formla that one can use "in the shop."

Simple Synchronization

To get an approximate theory of synchronization, we can forget the curvature of the charging line and assume it to be straight. One returns, therefore, to Figure 3. In this figure, $\bar{e}_p$ is a constant. But now suppose that in the circuit of Figure 2 a sinusoidal voltage had been impressed in series with the grid bias battery. By referring to the slope of the characteristic of the tube (called the control ratio) we can translate the fluctuating e_g into fluctuations in $\bar{e}_p$. As a result, $\bar{e}_p$ becomes a function of time, $\bar{e}_p(t)$. This is presumed to be a sinusoid biased off zero.

Let us now imagine that the horizontal straight line, $\bar{e}_p$, of Figure 3 is deformed with small sinusoidal wiggles. It then appears that successive periods of the sweep would have different values, and often this is the case. If this were now used as the linear time base of an oscilloscope to observe the same wave which is being used for synchronization, no stable pattern would be seen under such conditions. It so happens, though, that within a range of conditions, the sinusoidal deformation of the line $\bar{e}_p(t)$ will serve to synchronize the sweep so that every period is the same, and so that its frequency bears such a relation to the synchronizing frequency, that a stable pattern is obtained.

To attempt an analysis of this phenomenon with Figure 3, one would have to draw many sinusoids and then follow the saw tooth through them until (if at all) a repetitive cycle was found. Then if a change in synchronizing amplitude and/or frequency were made, still more would need be drawn. In such a form a graphical analysis is hardly practical, but by a slight modification of approach it becomes a satisfactory method. The central idea is to draw *once*, several waves of a sinusoid

(*Continued on page 26*)

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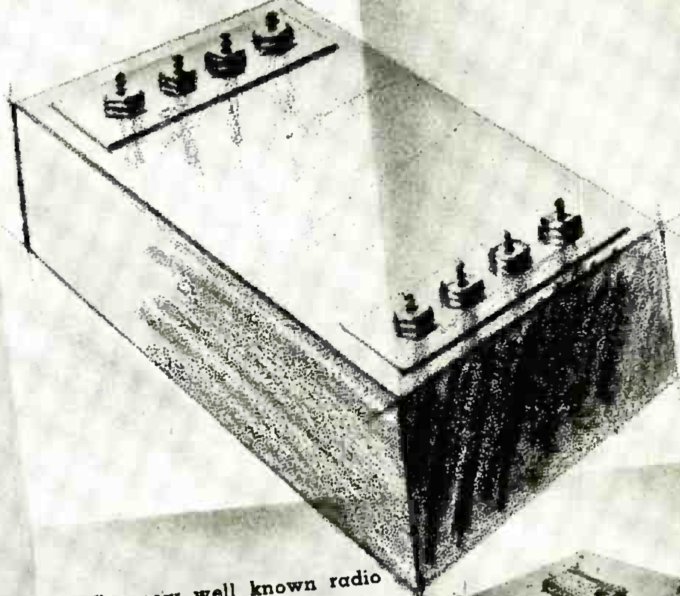

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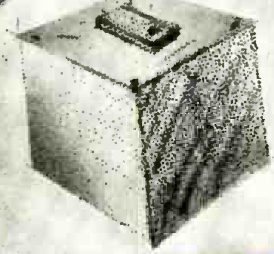
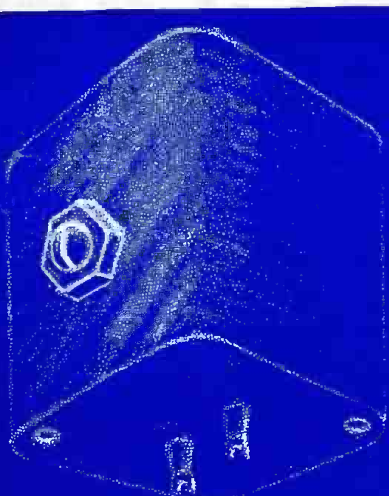
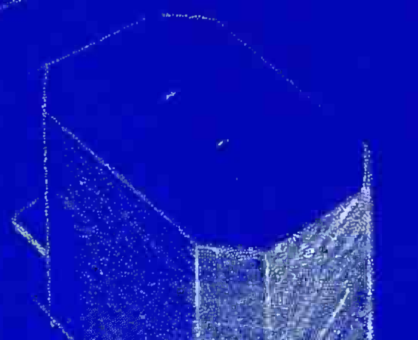


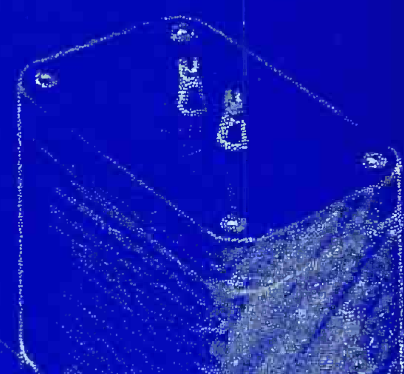


This UTC development is a tunable inductance, adjusted in the same manner as an I.F. trimmer.

Designed for high frequencies, the Q of this coil is 300 at 20,000 cycles.



. . . For medium frequencies, the Q of this coil is 210 at 1,000 cycles.



. . . For low frequencies, the Q of this coil is 80 at 100 cycles.

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(Continued from page 24)

and make this suffice by . . . (*a*)—changing the time scale rather than the geometrical wavelength to obtain frequency changes, (*b*)—changing the vertical scale, that is, the location of the horizontal axis to represent changes in amplitude of the synchronizing voltage, and (*c*)—superimposing a whole series of cycles of the saw tooth one on top of the other. On can make a large drawing of the sinusoid in ink and then draw the straight lines in pencil, which can later be erased.

Suppose, now, that a sinusoidal signal on the grid is translated into an $\bar{e}_p(t)$, given by the equation . . .

$$\bar{e}_p = \bar{E}_0 + \bar{E}_s \cos \omega_s t \quad (4)$$

To represent this graphically we draw the sinusoidal curve of Figure 6, where for the moment the location of the horizontal axis is undetermined. It is found subsequently by scaling down from the center line a distance $\bar{E}_0 \div \bar{E}_s$ times the height of the sinusoid. The frequency of the sinusoid is called f_s. If we remove the synchronization, the curve $\bar{e}_p$ reduces to the center line of the sinusoid. Without synchronization, the saw tooth generator oscillates at a frequency, f_n called the "natural" or "free-running" frequency.

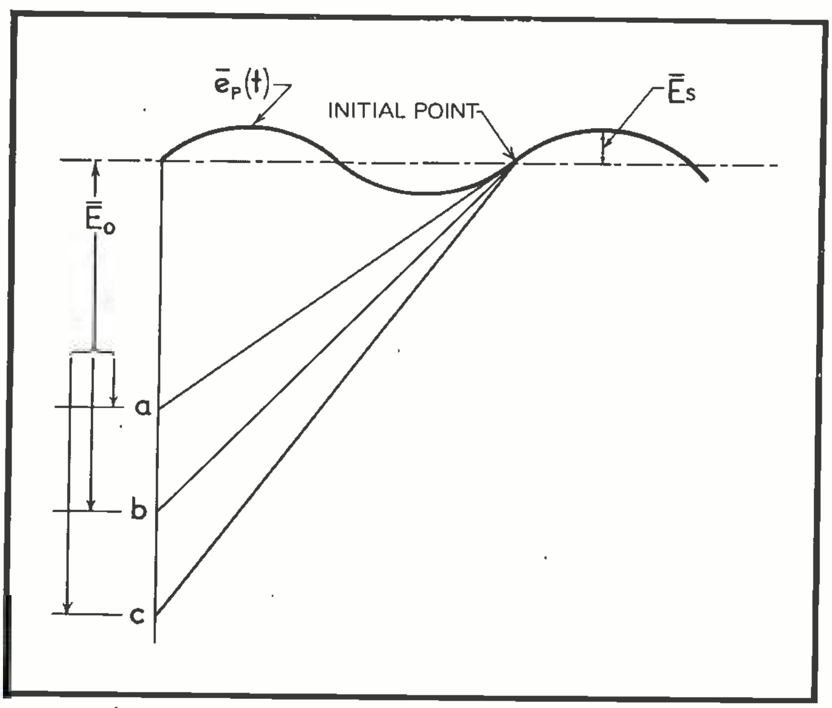
As a first problem, it is desired to determine the phase position of synchronization in the case where $f_n = f_s$. Let us suppose a charging line is initially fated to intersect the sinusoid at the node marked *initial point* in Figure 6. From Figure 3, one sees that the slope of this charging line in volts per second is related to $\bar{E}_0$ and the frequency. Both of these quantities are now fixed. In Figure 6, however, the geometrical slope is not determined until the vertical scale is fixed, that is, until the horizontal axis is located. Its geometrical location depends on $\bar{E}_s$ since the geometrical size of the sinusoid is to remain fixed. We see then that a weakening of the synchronizing signal is represented by a lowering of the horizontal axis and vice versa. Since $f_s = f_n$, the saw tooth requires precisely one cycle of f_s to rise from the axis to the center line. The former is hence located at the intersection of the vertical and sloped lines of Figure 6. One may choose any geometrical slope for the charging line; a steep slope meaning a weak synchronizing signal. In Figure 6, the points a, b, c, represent various locations of the horizontal axis corresponding to progressively smaller values of $\bar{E}_s$.

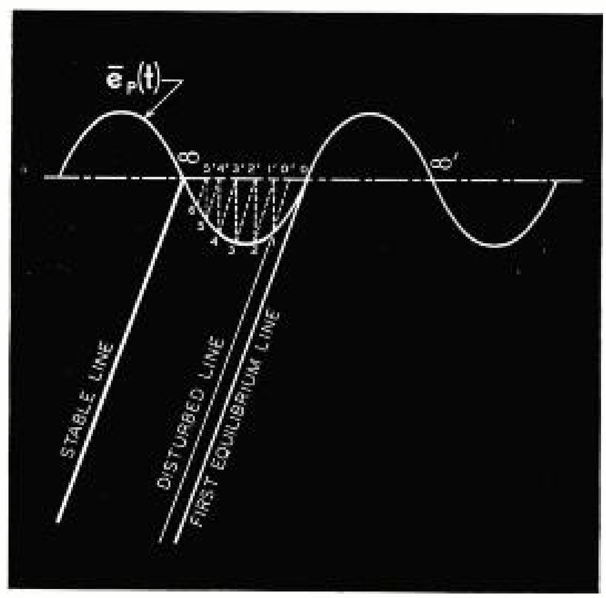
From Figure 6, one sees that if $\bar{E}_s$ is large enough (the slope of e_p small enough) that e_p will intersect the sinusoid prematurely. That is so, but for the moment imagine that $\bar{E}_s$ is not that strong. Since $f_s = f_n$ one would expect the pattern represented by Figure 6 to repeat itself indefinitely. This, however, is not the case. This condition is an equilibrium condition, but an unstable one. To demonstrate this, we use the customary method of considering the effect of a small virtual displacement out of equilibrium.

Suppose the sweep circuit were running under the questionable condition just described. A charging line would be represented by the line marked *first equilibrium line* in Figure 7. But now suppose that this line were accidentally displaced into the position marked *disturbed line*. It would head for the point *o'*, on the center line, rather than the point *o*. In this case, however, it would not reach *o'*, but would be intercepted by the sinusoid at point 1. Since this is an intersection of e_p and $\bar{e}_p$, ignition would occur and the condenser would discharge. The next saw tooth cycle would be such that the following charging line would head for a point on the center line precisely one cycle of f_s later, or 2π radians beyond the point 1'. Instead of chasing this down the drawing, one merely superimposes it on the same wave and sees the new charging line heading for *1'*. It cannot reach *1'*, however, since it is intercepted at *2*. It next directs itself towards *2'* and is intercepted at *3*. This continues until it reaches the point ∞.

The reader can readily confirm by the same process the fact that if the disturbance shifts the line to the right instead of to the left, the ignition point would scurry rightward and arrive at

Figures 6 (left) and 7 (below)
Figure 6 shows how the geometrical slope of the charging line is varied to represent changing strength of synchronization. Figure 7 shows how, for the case $f_s = f_n$, the phase position seeks a stable equilibrium.





the point ∞'. Similarly, one confirms that the ignition point returns to point ∞ if displaced therefrom by gremlins. Hence this is the point of *stable* equilibrium.

What now is the essential difference between the points o and ∞? The difference is that the slope of $\bar{e}_p$ is positive at o and negative at ∞. The question of slope is the deciding one. The sinusoidal shape of $\bar{e}_p$ is not vital—for a triangular or semi-circular wave would have had the same effect. One can conclude then that the ignition point can be stable only where the slope of $\bar{e}_p$ is negative.

Phase Shift

In the construction of Figure 7, the center line of the sinusoid played a role. The reason was that this line becomes $\bar{e}_p$ when the sync is removed, and hence since $f_s = f_n$, the time required for the charging line to rise to the center line. was precisely $1 \div f_s$.

Suppose now that merely $f_s \cong f_n$. Then the charging line would not rise to the c-l in a time $1 \div f_s$, *but* it would tend to rise to *some other* line in that time. As an example, suppose $f_s < f_n$; then the free running *period* is shorter than the sync period, which means that the charging line, although rising to the c-l in a time less than $1 \div f_s$ would rise to an appropriately chosen *higher* line, in precisely that time.

In Figure 8 is shown such a construction for a free running frequency somewhat higher than f_s. The auxiliary line is drawn Δ volts above the c-l. The Δ value is so chosen that the charging line rises to it, in just one sync period. One could now perform an analysis identical to that used in Figure 7 to show that the ignition is stable on the point ∞ and unstable on the point o. Here, however, the auxiliary line would assume the role in the construction played by the c-l in Figure 7.

From Figure 8, we can readily compute the phase angle, ψ, as a function of the frequency error. We relate ψ to Δ and then Δ to the frequency error and then eliminate Δ. We then have first . . .

$$\text{(5)} \qquad \sin \psi = \frac{\Delta}{\bar{E}_s}$$

and then, since the frequency of a saw tooth with given slope is inversely proportional to its amplitude . . .

$$\text{(6)} \qquad \frac{f_n}{f_s} = \frac{\bar{E}_0 + \Delta}{\bar{E}_0}$$

Solving to eliminate Δ . . .

$$\text{(7)} \qquad \psi = \sin^{-1} \frac{\bar{E}_0}{\bar{E}_s} \frac{\delta f_n}{f_s}$$

where δf_n is the deviation of f_n from f_s. For small phase angles, one may omit the $\sin^{-1}$.

For the alternate case of $f_n < f_s$, one obtains the same formula (5); only this time the auxiliary line has to be drawn *under* the center line.

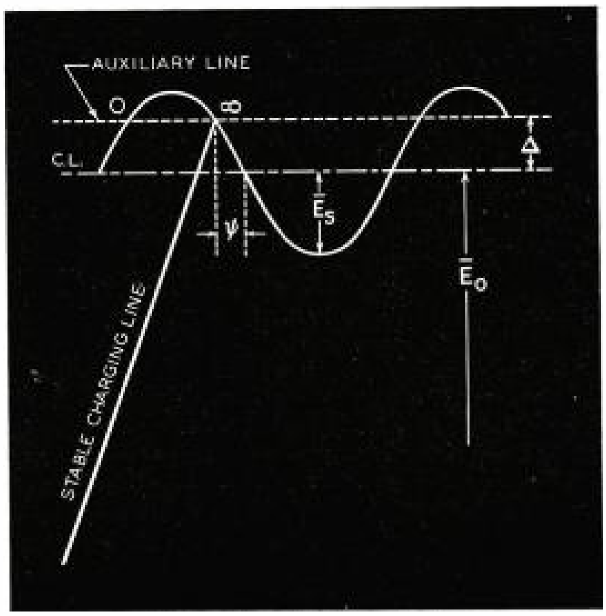
Finally, from Figure 8 and from (7) one can see that synchronization can be maintained only up to phase quadrature, or only so long as the auxiliary line actually cuts the sinusoid. We then see that . . .

$$\text{(8)} \qquad \left| \frac{\delta f_n}{f_s} \right|_{max} \leq \frac{\bar{E}_s}{\bar{E}_0}$$

This presumes a value of E_s so weak that a premature ignition does not occur.

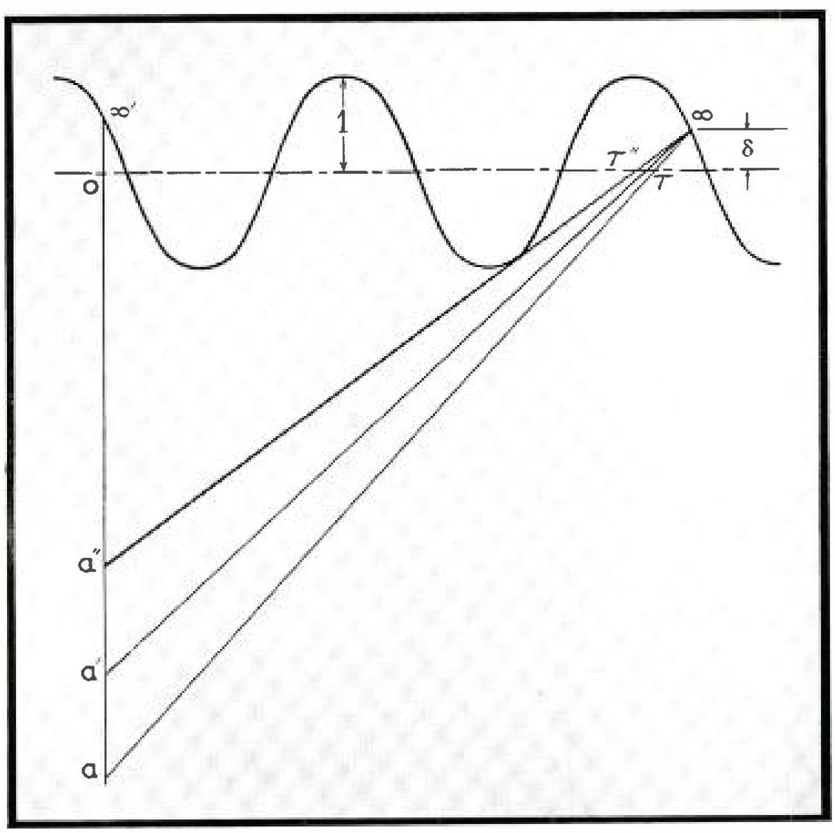
Multiple Synchronization

Returning again to Figure 7, the question arises as to whether it was sential for the construction that $f_n = f_s$. Supposes . . .



Figures 8 (left) and 9 (below)

In Figure 8 appears the construction to determine the phase position for the case $f_s \pm f_n$. In Figure 9, we have the onset of oversynchronization.



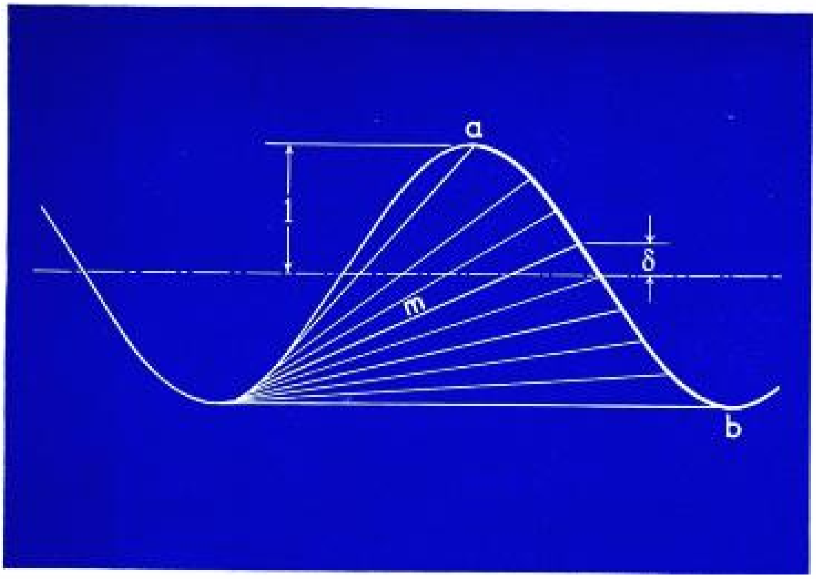


Figure 10
Determination of the limit function, M (δ).

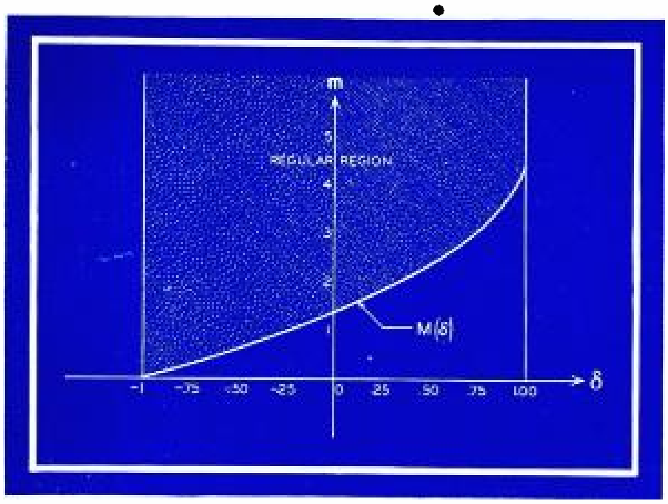
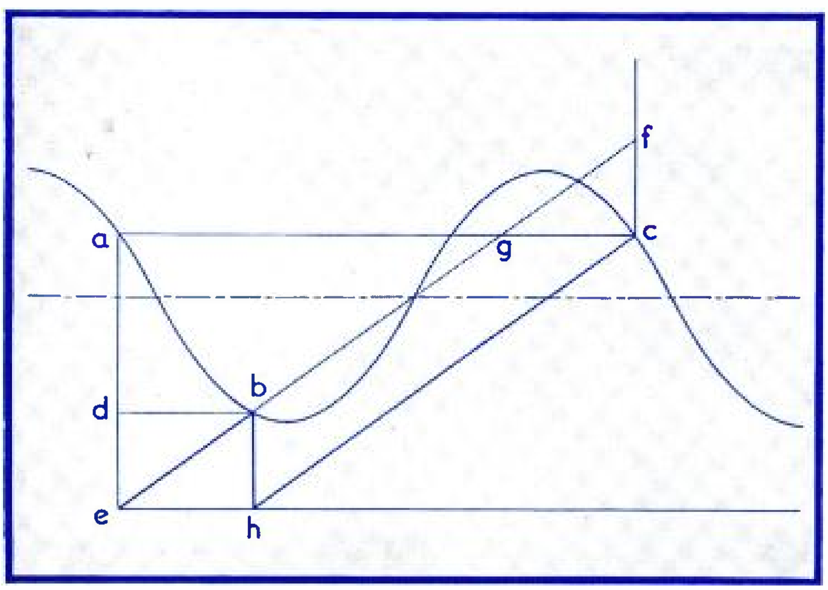


Figure 11
Plot of the limit function, showing the regular region in terms of m and δ. This holds for all multiplicities of synchronization.

Figure 12
Construction of a "long-short" sweep.



$$f_s = N f_n \tag{9}$$

where N is an integer. Then the *"first equilibrium line"* would return to the center line not *one,* but *several* cycles later. This makes no essential difference, and one still shows that the point ∞ is the stable point. If, however, f_n were a multiple of f_s rather than the reverse, then there would be more than one saw tooth to each synchronizing wave and the circumstances would be more complicated. The first case given by (9) is the one of principal importance in oscillography, for that is the circumstance under which several waves are seen on the screen.

The problem of phase can also be solved almost as before. We find that (5) is precisely the same, but in place of (6), we have . . .

$$\frac{f_n}{1/N\, f_s} = \frac{\bar{E}_o + \Delta}{\bar{E}_o} \tag{10}$$

which leads to:

$$\psi = \sin^{-1}\frac{\bar{E}_o}{\bar{E}_s}\,\frac{\delta f_n}{1/N\, f_s} \tag{11}$$

This equation is the same as (*7*) if one interprets the last fraction as the deviation of natural frequency, as a fraction of "what it ought to be" for the multiplicity of synchronization involved.

Regular Sync Zones

Suppose now the sweep circuit were running in any kind of synchronism. The problem of the smallest number of parameters needed to characterize the pattern obtained in the plate voltage-time diagram, then arises. If one does not consider the absolute size of the diagram in seconds and volts as relevant, it would suffice, for instance to give . . . (*1*)—the multiplicity of synchronization; (*2*)—the phase position, and (*3*)—the amplitude of the sinusoid as a fraction of the height of the center line. It would also be permissible to draw the sinusoid of unit height and unit wavelength. Thereupon one could draw the diagram immediately. (*1*) has been called *N*. Instead of (*2*), we could give

$$\delta = \frac{\Delta}{\bar{E}_s} \tag{12}$$

and instead of (*3*), we could write:

$$s = \frac{\bar{E}_s}{\bar{E}_o} \tag{13}$$

The meaning of these is clear from Figure 8, where δ is the height of the ignition point above the center line in the new units, while $1 + s$ is the height of the c-l. In Figure 9 there is shown how for the case $N = 2$, one could choose first δ; then find the points ∞

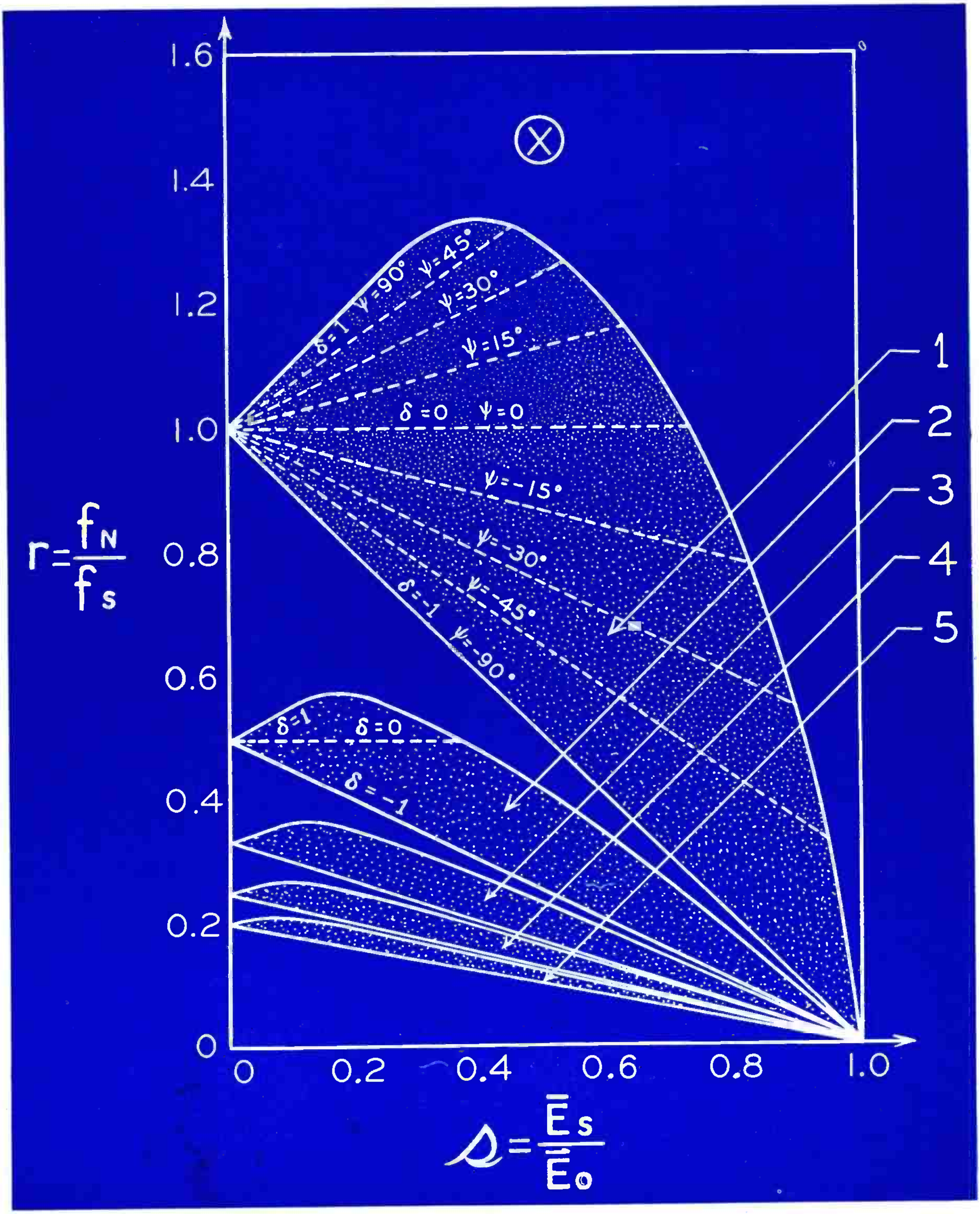
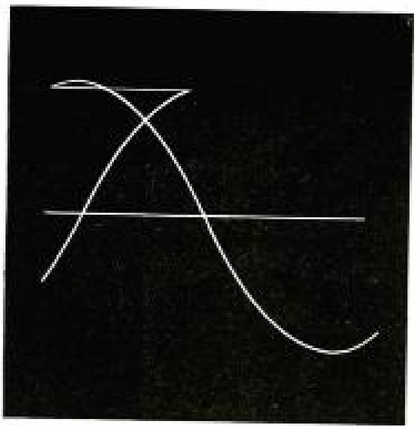


Figure 13

"Regular" zones of synchronization in the (*s-r*) plane. The multiplicity is shown in each zone. There is an infinity of such zones.



and ∞′ two waves apart, and finally spot the point *a* from the value of *s*, and draw the charging line. If, unfortunately, *a* were higher up than *a″*, there could be no such pattern due to a premature ignition.

This poses the problem as to just what are the conditions under which a regular[1] pattern exists. The conditions for it must be expressable by relations among the three parameters . . . *N*, δ, *s*. If these relations were found in these terms they would not be too useful since δ is not a primary quantity. One would rather replace δ by, say, the ratio of f_n to f_s. So let us say . . .

$$r = \frac{f_n}{f_s} \qquad (14)$$

Given *N*, δ, *s*, or given the diagram, we can find *r*; it is related to the distances $\overline{o\tau}$ in Figure 9.

We want the conditions in terms of *N, s, r*, but they are not easy to deduce directly. It would be easier, perhaps, to find them in terms of the slope of the charging line. Let *m* be this slope in

Figure 14
Showing the results of a "long-short" time base sweep.

the new units, that is, in amplitudes per wavelength.

Let us now seek the conditions for a regular pattern in terms of *N*, δ, *m* and later change them into conditions on *N*, *s*, *r*. That will be possible if one can relate the two sets of quantities. By studying Figure 9, we are able to find two equations connecting (δ, *m*) with (*s*, *r*). By inspection we can then say . . .

$$\begin{cases} \frac{1}{s} + \delta = Nm \\ \overline{o\tau} = \frac{f_s}{f_n} = \frac{1}{r} = \frac{1}{s}\,\frac{1}{m} \end{cases}$$

These can be rearranged to give the reciprocal set . . .

$$(15) \quad \begin{cases} s = \frac{1}{Nm - \delta} \\ r = \frac{m}{Nm - \delta} \end{cases} \qquad \begin{cases} \delta = \frac{Nr - 1}{s} \\ M = \frac{r}{s} \end{cases}$$

Now to find the conditions for a regular pattern expressed in terms of δ and *m*. First, δ must under all circumstances be between ±1. From Figure 9, we see that *m* (always positive) may be as large as one pleases, but it has an under limit. This under limit is a function of δ; it is just the slope of that charging line which is tangent to the preceding curve. This condition is independent of *N*. Call this the limiting value of *m*:

$$(16) \qquad M\,(\delta)$$

It is a transcendental function which may be found graphically from Figure 10. We may draw from a series of chosen δ points, a series of tangents to the curve and record their slopes (amplitudes- per-wavelength). The δ points are not carried to the left of the point *a*, for as was shown earlier, the ignition point will not stabilize on the positive slope.

The result of such a graphical determination of *M* (δ) is shown in Figure 11.

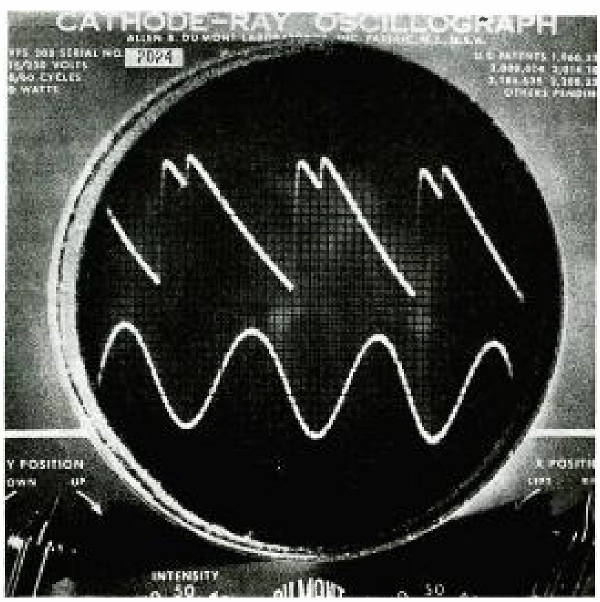
It remains to transform the regular region of Figure 11 onto the (*s, r*) plane by the mapping functions (15). Although the (*m*, δ) conditions are independent of N, the latter is contained in (15); hence *M* (δ) goes over into a family of curves in the (*s, r*) plane as shown in Figure 13.

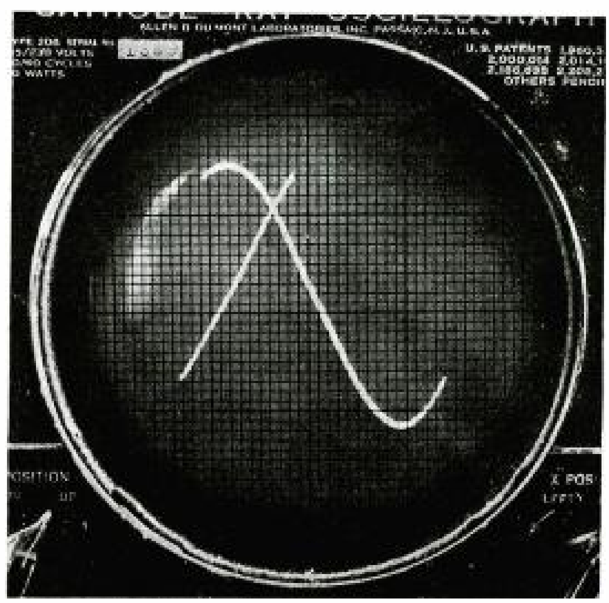
We find readily from (15) that the line δ = −*1* goes over into the family of straight lines through the point (*s, r*) = (*1, 0*) which intersect the vertical axis at the points $\frac{1}{N}$. These points correspond to *m* = ∞. One can return from infinity along the line δ = 1. This gives a series of lines which are the reflections off the vertical axis of the first set. The regions are finally closed by the transformation of the curve *M* (δ) onto the (*s, r*) plane.

A representation of this kind was first given, as far as the author is aware, by the Australians . . . Builder

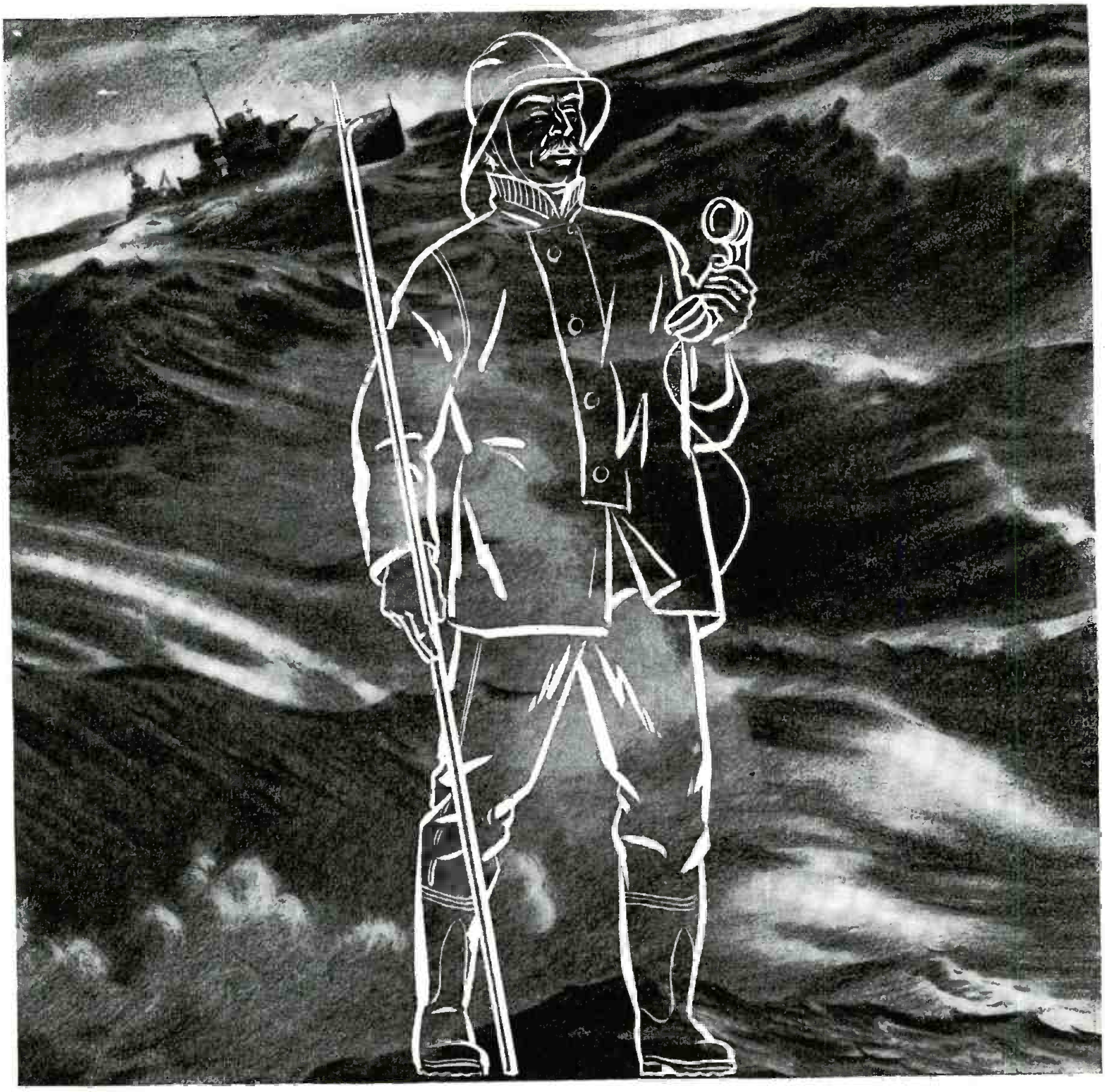
(*Continued on page* 74)

[1]One which provides one or more sine waves on the scope, and not something else.





Figures 15 and 16
Photos illustrating Figures 12 and 14.



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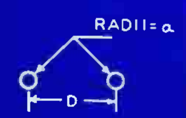
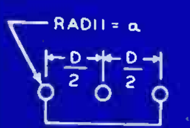
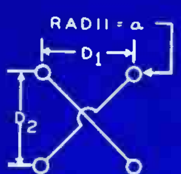
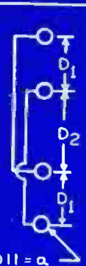
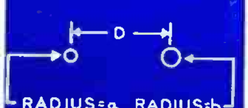
Characteristic Functions of

TRANSMISSION LINES

CONFIGURATION	Z_0 (OHMS)
 BALANCED 2-WIRE	$276 \log_{10} \frac{D}{a}$
 THREE WIRE	$207 \log_{10} \frac{D}{2.52a}$
 BALANCED 4-WIRE	$138 \log_{10} \frac{D_2}{a\sqrt{1+\left(\frac{D_2}{D_1}\right)^2}}$
 TWO BALANCED 2-WIRE IN PARALLEL	$138 \log_{10} \frac{D_1}{a}\sqrt{1-\left(\frac{D_1}{D_1+D_2}\right)^2}$
 BALANCED 2-WIRE, UNEQUAL RADII	$276 \log_{10} \frac{D}{\sqrt{ab}}$

by SIDNEY FRANKEL

Radio Engineer

Federal Telephone & Radio Corp.

In these tabulations are listed the characteristic impedances of various configurations of transmission lines. In the formulas the following assumptions are made.

Formula Assumptions

(1) *The conductors are perfect, of unit permeability and imbedded in a vacuum (or, to a sufficient degree of accuracy, in air) so that the velocity of propagation is* $3(10)^{10}$ *cm per second.*

Circular Wire Conductor Radii

(2) *The radii of circular wire conductors are small compared with the distance between them, or with the distance between them and the nearest extended surface (such as a plane, concentric cylinder, etc.).*

Inductance - Capacity Formulae

From the characteristic impedance, the inductance and capacitance per unit length may be computed by means of the following formulas:

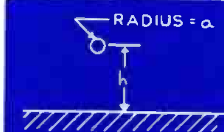
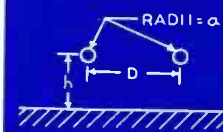
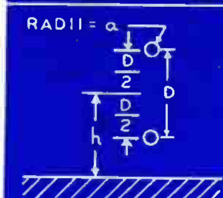
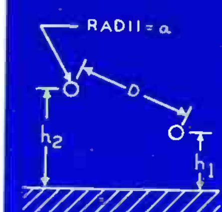
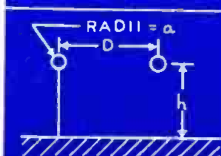
Inductance: $L = 85\, Z_0$ *mmh per inch*
Capacitance: $C = 85/Z_0$ *mmfd per inch*

where Z_0 *is in ohms*

Dimensions are measured in any consistent units.

Reference Data

While some of the configurations listed may not appear to have any direct practical value, they are, nevertheless, useful as intermediate steps in computing the properties of practical configurations. As an example of this see the author's paper, "Characteristic Impedance of Parallel Wires in Rectangular Troughs." Proc. I.R.E., vol. 30, No. 4 (April, 1942), pp. 182-190.

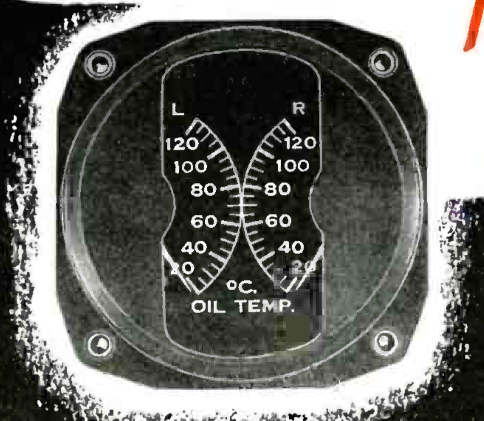
CONFIGURATION	Z_0 (OHMS)
 SINGLE WIRE, GROUND RETURN	$138 \log_{10} \frac{2h}{a}$
 BALANCED 2-WIRE NEAR GROUND	$276 \log_{10} \left[\frac{2h}{a\sqrt{1+\left(\frac{2h}{D}\right)^2}}\right]$
 BALANCED 2-WIRE NEAR GROUND	$276 \log_{10} \left[\frac{D\sqrt{1-\left(\frac{D}{2h}\right)^2}}{a}\right]$
 BALANCED 2-WIRE NEAR GROUND	$276 \log_{10} \left[\frac{D}{a}\frac{1}{\sqrt{1+\frac{D^2}{4h_1h_2}}}\right]$
 2-WIRE, ONE WIRE GROUNDED	$138 \frac{\left[\log_{10}\frac{D}{a}\right]\left[\log_{10}\frac{4h^2}{aD}\right]}{\log_{10}\frac{2h}{a}}$

HICKOK

33 Years of Progress..

1910.. 1 SMALL PLANT
1 EMPLOYEE
2 STYLES OF METERS

1943.. 2 LARGE PLANTS
NEARLY 1000 EMPLOYEES
HUNDREDS OF STYLES OF METERS
AND TEST INSTRUMENTS



HICKOK METER

HICKOK DYNAMIC MUTUAL CONDUCTANCE TUBE TESTER

From its organization in 1910 until now The Hickok Electrical Instrument Co. has always been in the forefront of those companies who have contributed most to Electrical and Radio Instrument progress.

Quality has always predominated over quantity of production—building a reputation for highest grade instruments that is now reflected in the enormous demand for Hickok Meters for Aviation and other War Time uses. The meter illustrated is typical of these War Time Instruments.

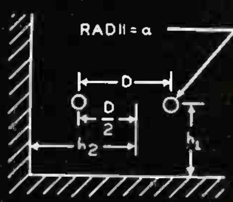
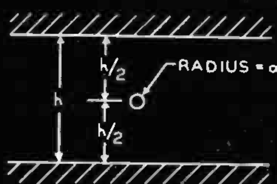
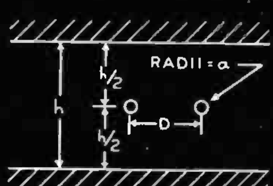
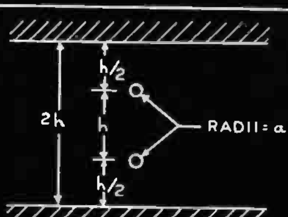
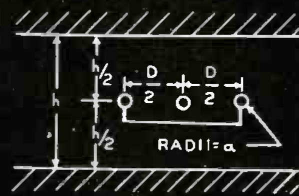
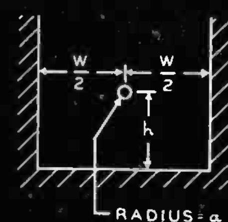
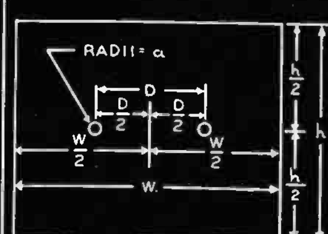
The Hickok Dynamic Mutual Conductance Tube Tester, developed soon after the advent of the 3-element radio tube, is the standard instrument for tube testing today.

New Hickok Meters and Instruments are being designed, or are already in production for the use of our Armed Forces. They will be available to everyone as soon as the present emergency is over.

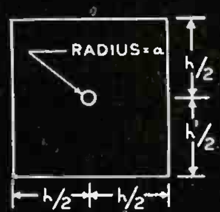
So keep your eye on Hickok for the newest and best in indicating meters and radio service equipment.

Hickok ELECTRICAL INSTRUMENT CO.

CLEVELAND, OHIO • U. S. A.

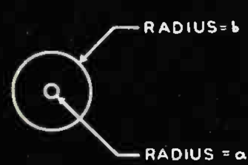
CONFIGURATION	Z_0 (OHMS)
 BALANCED 2-WIRE LINE NEAR GROUNDED CORNER	$276 \log_{10}\left[\frac{D}{a}\sqrt{\frac{1-\left(\frac{D}{2h_2}\right)^2}{1+\left(\frac{D}{2h_1}\right)^2}}\right]$ $-69\log_{10}\left\{\left[1+\left(\frac{D}{2m}\right)^2\right]^2-\left(\frac{Dh_2}{m^2}\right)^2\right\}$ WHERE $m^2=h_1^2+h_2^2$
 SINGLE WIRE BETWEEN GROUNDED PARALLEL PLANES, GROUND RETURN	$138\log_{10}\frac{2h}{\pi a}$
 BALANCED LINE BETWEEN GROUNDED PARALLEL PLANES	$276\log_{10}\left[\frac{2h\tanh\frac{\pi D}{2h}}{\pi a}\right]$
 BALANCED LINE BETWEEN GROUNDED PARALLEL PLANES	$276\log_{10}\frac{2h}{\pi a}$
 THREE-WIRE BETWEEN PARALLEL PLANES	$207\log_{10}\left[\frac{2h\tanh\frac{\pi D}{2h}}{\pi a\left(1+\operatorname{sech}\frac{\pi D}{2h}\right)^{4/3}}\right]$
 SINGLE WIRE, GROUND RETURN	$138\log_{10}\left[\frac{2w\tanh\frac{\pi h}{w}}{\pi a}\right]$
 BALANCED 2-WIRE LINE IN RECTANGULAR-SECTION ENCLOSURE	$276\left\{\log_{10}\left[\frac{2h\tanh\frac{\pi D}{2h}}{\pi a}\right]-\sum_{m=1}^{\infty}\log_{10}\left[\frac{1+u_m^2}{1-v_m^2}\right]\right\}$ $u_m=\frac{\sinh\frac{\pi D}{2h}}{\cosh\frac{m\pi w}{2h}}$ $v_m=\frac{\sinh\frac{\pi D}{2h}}{\sinh\frac{m\pi w}{2h}}$

CONFIGURATION	Z_0 (OHMS)



"CONCENTRIC" LINE, SQUARE OUTER CONDUCTOR

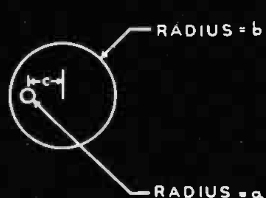
$$138 \log_{10} \frac{0.539h}{a}$$



"CONCENTRIC" LINE

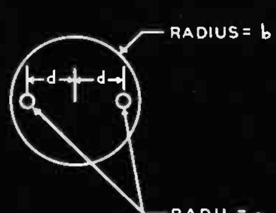
$$138 \log_{10} \frac{b}{a}$$

(ACCURATE FOR ANY $a < b$)



"ECCENTRIC" LINE

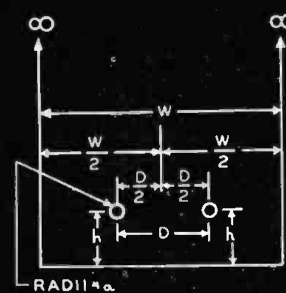
$$138 \log_{10} \frac{b^2 - c^2}{ab}$$



BALANCED 2-WIRE "CONCENTRIC" LINE

$$276 \log_{10} \left[\frac{2d}{a}\left(\frac{1-c^2}{1+c^2}\right)\right]$$

$$c = \frac{d}{b}$$

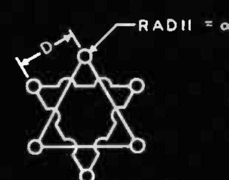


BALANCED 2-WIRE LINE IN SEMI-INFINITE ENCLOSURE

$$276 \log_{10} \left[\frac{W}{\pi a \sqrt{\operatorname{cosec}^2\left(\frac{\pi D}{W}\right) + \operatorname{cosech}^2\left(\frac{2\pi h}{W}\right)}}\right]$$

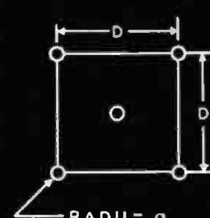
NOTE:- $\operatorname{cosec} X = \frac{1}{\sin X}$

$\operatorname{cosech} X = \frac{1}{\sinh X}$



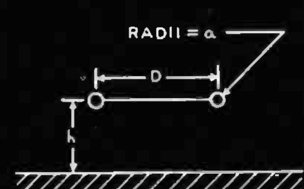
REGULAR HEXAGON, BALANCED TO GROUND

$$92 \log_{10} \frac{2D}{3a}$$



FIVE-WIRE LINE

$$172 \log_{10} \frac{D}{1.75a}$$



2-WIRE PARALLEL LINE, GROUND RETURN

$$69 \log_{10} \left[\frac{2h}{a}\sqrt{1+\left(\frac{2h}{D}\right)^2}\right]$$

ENGINEERS!

CHECK THESE SIX OUTSTANDING FEATURES OF NEW

1 MINIMUM FREQUENCY DRIFT

Absence of hot flow and cold flow, maximum dimensional stability and minimum expansion combine to provide a minimum of frequency drift. Often it is not necessary to use crystals or other compensating devices.

2 NEGLIGIBLE WATER ABSORPTION

Multiform glasses show a water absorption of less than 0.01 per cent (24 hours). Impregnants or added glazes are unnecessary, assuring better dimensional tolerances. Loss of efficiency due to improper impregnation or cracked glaze is eliminated.

3 LOW LOSS FACTOR

Insulators, made from Multiform glasses, offer you definitely greater efficiency. Multiform glass #707, for example, has a loss factor of only 0.40 at 20°C,—1 Meg.

4 UNIFORM ACCURACY

Threads, grooves and holes are accurate from piece to piece because they are molded in the piece. All sizes can be made with tolerances of ±2.0%, not less than ±0.010″.

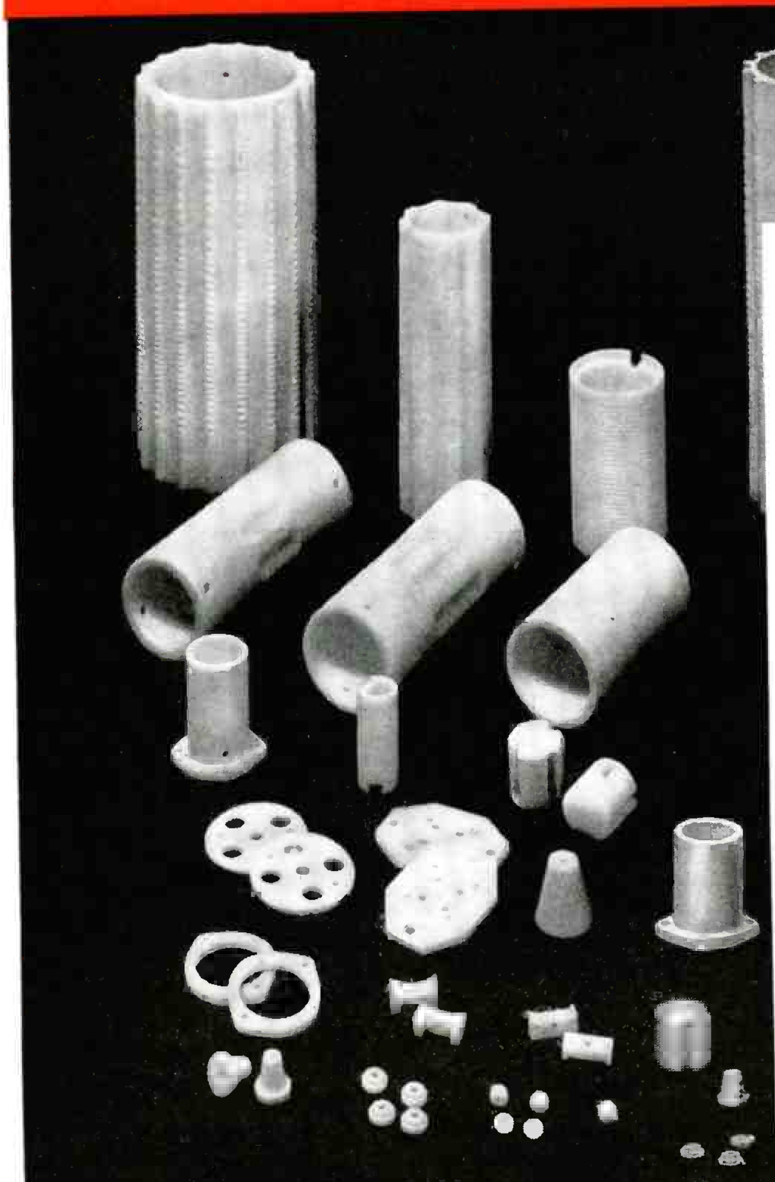
5 EXTREMELY WIDE RANGE OF SIZES AND SHAPES

There's almost no limit on shapes, cylindrical or flat. In size, pieces range from tiny beads, several thousand to the pound, to 25-lb. pieces 15″ or more across.

6 HIGH DIELECTRIC STRENGTH

Multiform glasses have a dielectric strength of 500 volts per mil or more—approximately twice the dielectric strength of porcelains and steatites.

CORNING MULTIFORM GLASS INSULATION



NO SHORTAGE OF GLASS TO REPLACE STEATITE, PORCELAIN AND OTHER ELECTRICAL INSULATION MATERIALS

DELIVERIES slow on electrical insulators? Here's good news! New-type insulators developed by Corning Glass Research—Pyrex brand Multiform Glassware—are available now! Check the six outstanding features on the opposite page. See why all Multiform glasses not only comply with the proposed A.S.A. American War Standard on Radio Insulation Materials of Low Dielectric Constant, but actually offer you more in efficiency and long life!

The characteristics of these glasses plus Corning's new fabrication methods make possible an extremely wide range of shapes and sizes. General dimensional tolerances are: large or heavy pieces, intricate shapes, hollow cylindrical sections— ± 2.0% or 0.010″; flat plates, solid rods, discs, beads, bushings— ± 1.0% or 0.005″, except thickness which should be ± 4% or 0.005″.

If you have an insulator problem, do this today: Fill in and mail the coupon now for a free sample of Pyrex brand Multiform Glass and complete, descriptive booklet.

MAIL COUPON TODAY FOR FREE SAMPLE AND DATA!

Corning Glass Works, Corning, N. Y.
Insulation Division, Dept. C-35
Please send me immediately, without charge, sample and descriptive booklet on new Pyrex brand Multiform Insulators.

Name..

Company..

Street Address..

City.......................... *State*..............

Pyrex Insulators
BRAND

"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works

EMERGENCY RADIOTELEPHONE SYSTEM

Designed To Bridge Breaks In Wire Lines

by DONALD PHILLIPS

IT is natural to expect the demands on telephone systems to be pressing at all times, and particularly so during emergencies. Accordingly, all equipment, including the telephone lines must thus be built to withstand all types of conditions.

Emergency Equipment Necessity

Ninety-five per cent of the telephone lines are of the pole-to-pole type, or underground cable type. The provision for alternate routes in all but sparsely settled areas, is the customary service objective. The elements do raise havoc, nevertheless, and put circuits out of service, isolating groups of people. It is evident, therefore, that in an effort to safeguard this very vital service, some emergency systems must be available. To provide an emergency service of this type, radiotelephone equipment specifically engineered to meet emergency situations of this type has been designed. This equipment, developed by Bell Telephone Laboratories, permits the bridging of gaps in wire lines quickly until breaks can be repaired.

Mobile and Stationary Equipment

There are two types of equipment available for this service. One type includes that equipment which is brought to an established location such as a police station, and operated from there, and the other type includes the mobile or trailer units, which operate from the field. Both perform the same function and service and differ only in their method of application.

The system used in this equipment re-

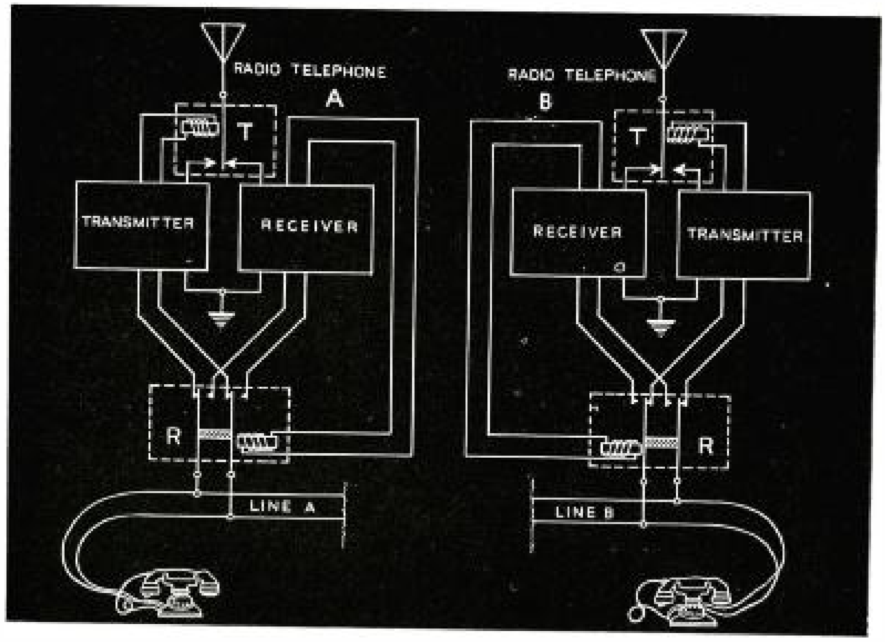


Figure 1
Simplified schematic illustrating operation of emergency radiotelephone equipment now in use.

volves about a single talking channel, with the traffic controlled by regular telephone operators. A typical circuit employing this emergency type of equipment, is shown in Figure 1. It will be noted that two radio telephone terminals are schematically indicated in use, to bridge gaps between line *A* and line *B*. When a subscriber on line *A* begins a conversation, his message is relayed from his telephone through relay *R* to the radio transmitter. These speech currents also actuate a relay which connects the transmitter to the antenna. From there on the usual transmission takes place.

Now when the transmitted signal reaches the *B* point, it travels directly into the receiver through relay *T*.

And as before, a portion of these voice signals are also used to actuate a relay. This relay *R* connects the receiver to the two-wire line and thereby clears the path for speech to travel on to the subscriber on line *B*.

When the subscriber using line *A* stops talking, both relay *T* of the *A* equipment and relay *R* of the *B* equipment return to normal. In this way, the circuit is made available for the line *B* subscriber to reply. The equip-

(*Continued on page 40*)

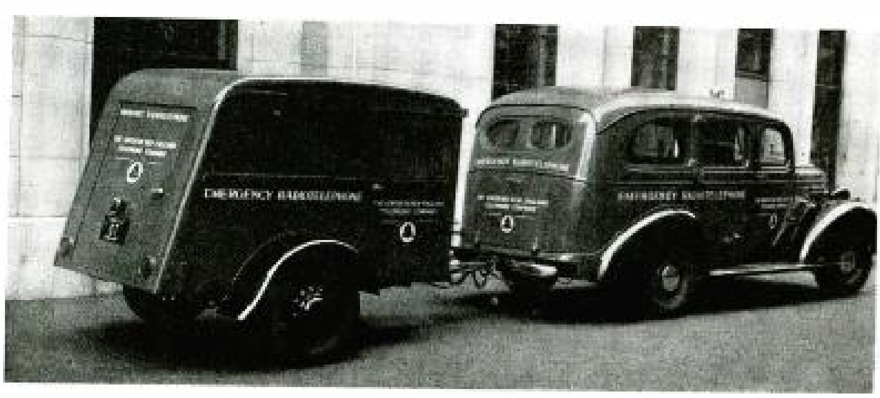


Figure 2
Trailer with transmitter-receiver unit. The transmitter-receiver is located on a 90° rotating hanger at the left of the entrance door. This arrangement provides for easy access for operation and repair. Incoming wire lines terminate on protectors mounted on the wall.

Proving ground for the future of electronics

On the battlefields, electronics is meeting its extreme test. Failure here means death to men, defeat to armies. Conversely, experience here means vastly broadened knowledge, improved techniques, and progress so rapid as to be impossible of description.

The collective brains of Eimac engineers are concentrated full tilt on the new knowledge which is coming out of this holocaust. And are consequently still setting the pace in vacuum tube developments. The fruits of their efforts are going directly to Uncle Sam and our Allies to play a vital role in the war.

When the fighting stops you'll find Eimac still the pre-eminent choice of engineers throughout the world.

Army-Navy "E" awarded for high achievement in production for war.

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Figure 3
The suburban installation. In this installation, the generator is removed from the car for operating purposes.

ment operates similarly in reverse. That is, relay *T* of the *B* equipment and relay *R* of the *A* equipment are now caused to operate, by the talker who is connected with line *B*.

When there are no to-and-fro conversations, both radio transmitters are off the air and the system at both ends are alert to accept incoming signals. On the line side of each radio terminal, the equipment is also in a stand-by position to respond to speech input from a subscriber's telephone.

First Emergency Installation

The first model of this emergency equipment was placed in service in 1938. Today more than one hundred, located at strategic points throughout the country, have demonstrated their value in maintaining telephone service and bringing help.

A-M Used

Amplitude modulation is used. The conventional plate-modulation circuit is employed most effectively in the transmitter. The receiver includes may selectivity features. For instance, a narrow-band filter for signal acceptance and a broad-band noise rejection filter act differentially so that the receiver locks in only when the incoming signal is satisfactory.

Operator Functions

Point to point operation is, of course, possible. But the equipment is designed to bridge the gap in a telephone cable or open wire line which has failed. Incidentally, the regulations of the FCC require technical operators for each radio location, but the radio circuit is controlled by the telephone operator from the usual central office switchboard after it has been established for service. This feature, so important for commercial telephone use, is furnished by a control unit, which contains patching facilities permitting the technical operator to monitor, to be summoned by bell signal, to transfer control to a telephone office, or to control the radio equipment himself. Of course, the customer using regular telephone service is not aware at any time that a radio link is in operation. To provide privacy of conversation, equipment of the speech inversion type is available as an auxiliary unit.

Time delay factors have been introduced to prevent breaks in speech continuity due to short or clipped words. Overmodulation is automatically prevented and full control of modulation is provided.

Mobile Systems

In the mobile systems, such as that in use by the Southern New England Telephone Company, many unusual features have been included. The antenna used here, consists of a suitable vertical radiator and counterpoise assembly. The standard unit is a 25-foot sectional tubular mast which may be elevated another 25 feet by a specially constructed base. The antenna equipment has been designed for rapid and easy erection under field conditions.

Four Units in System

The complete radio telephone terminal is divided into four units. The first is the transmiter-receiver, weighing about 180 pounds, and occupying 44" x 23" x 12". The next unit is the antenna. And then we have the motor generator, and finally a 30" x 15" x 12" trunk which contains the control unit, spare parts and auxiliary equipment. There are two emergency units available in the Southern Bell System installation. One is installed in a suburban car, while the other is mounted in

(*Continued on page 42*)

Figure 4
Emergency equipment in operation in suburban car. Receiver providing monitoring of weather reports, road conditions, data, etc., is mounted just below the glove compartment.

a special trailer which was designed by Bell System engineers. Each has its own particular advantages.

Trailer Cost

The trailer cost is considerably less than that of the car cost, but the motive power must be supplied to the trailer. Several of the company's cars have been equipped as tow cars. In this way, the trailer can be coupled to the suburban type car, if more convenient. The trailer can then be dropped at the near end of the wire line break and the suburban car can proceed to the far end of the break.

Use of Generator in Car

In the car installation, the generator is removed from the car for operating purposes. If necessary, a second complete unit can be transmitted to the scen of action in the same vehicle, and space is available for four men.

Antenna Installation

In Figure 4, we see the motor generator removed and the unit in operation. An all-wave receiver (Hallicrafter Sky Champion) is mounted just below the glove compartment so that all channels may be monitored for weather reports, information on road conditions, etc. A simple antenna installation for temporary use is shown in Figure 5. The upper clamp releases completely, while the lower one rotates through 90 degrees, permitting the 25-foot antenna to be assembled in a horizontal position and then rotated to the vertical position.

Equipment in Trailer

The trailer, Figure 2, houses the transmitter-receiver unit on a 90 degree rotating hanger at the left of the entrance door, which makes it easily accessible for operation and repair. The tunk rests on the floor opposite the door with the control unit mounted just above it, permitting easy access to the incoming wire lines which terminate on protectors mounted on the wall. The receiver that is used for monitoring is mounted to the left of the control unit. The speech privacy or inversion equipment when used, is also mounted on this wall.

A gas-tight bulkhead separates the front and rear compartments. It permits operation of the motor generator without removing it from the trailer. An automobile muffler mounted crosswise beneath the body, reduces motor noise to a tolerable level. A suspended canvas reduces the temperature in the trailer when extended operation in the hot sun is necessary. This particular accessory is quite an essential one. It certainly helps to provide workable conditions when the hot sun starts beating down in the field. And when it rains or snows, the tarpaulin is pulled over on one side of the trailer to provide shelter in front of the door. Both units have screens to keep out insects when the windows are open for ventilation. In the winter, the front compartment can be heated by an aerial tent-heater for which suitable space has been provided.

Figure 5

The antenna installation for temporary use. The upper clamp completely releases the antenna, while the lower one permits a 90° rotation, permitting the 25-foot antenna to be assembled in a horizontal position and then rotated to a vertical position. This flexibility of installation permits a maximum amount of radiation on most types of terrain.

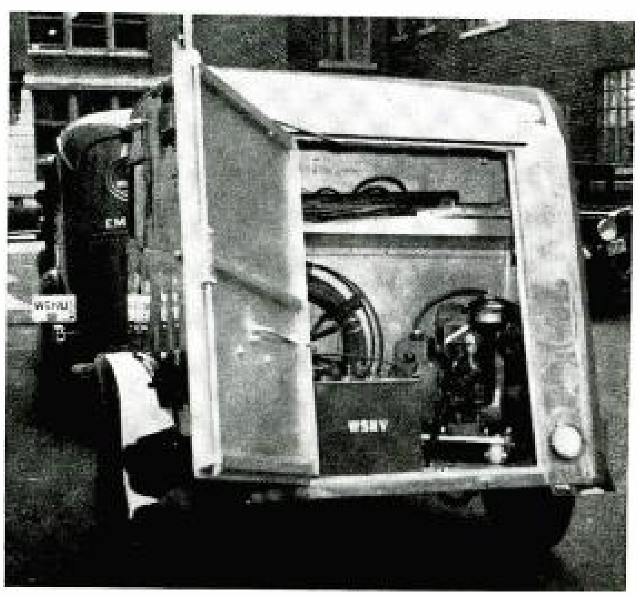


Figure 6

Rear view of the trailer showing the gas tight bulkhead separating the front and rear compartments. This permits operation of the motor generator without removing it from the trailer. Storage capacity is also available in the rear compartment.

Transmitter Output

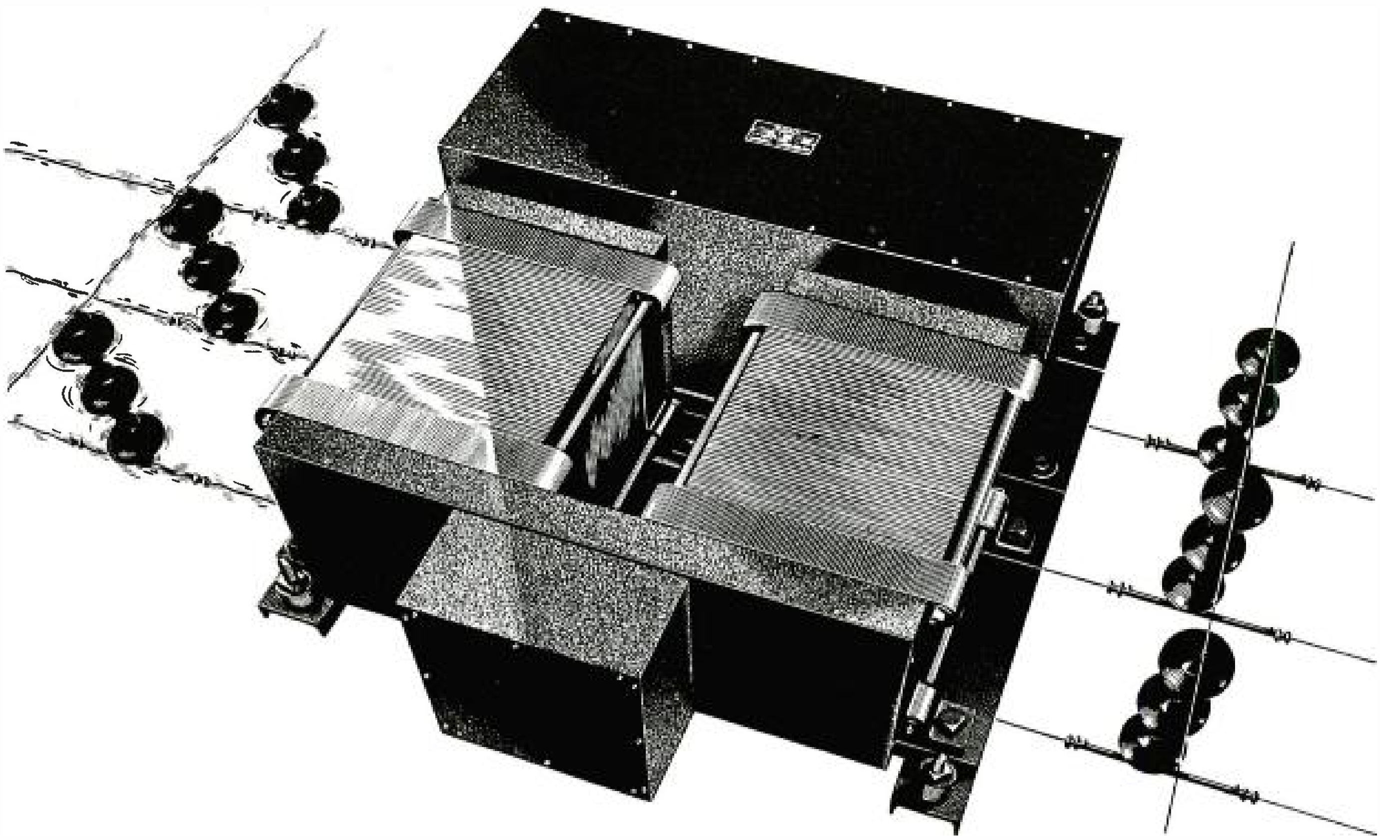
The transmitter has an output of 50 watts. Frequency control is variable between 2,000 and 3,000 kilocycles. Quartz crystals are, of course, used to control the particular frequpencies selected.

The power supply requirement of 440 watts a-c is furnished by a lightweight portable gasoline powered motor generator set, developing 660 watts.

These units are small, but nevertheless, provide a service which is tremendous in scope. As an example, in one

(Continued on page 76)

Industry steadies its "nerves"



FACED with production schedules that have no precedent in history, American industry finds the fluctuating voltages of its over-loaded power lines wholly inadequate to meet the "deadly" precision demanded for total war.

Vital "nerve centers" of production lines are geared for precise performance when operated at specific line voltages. Any variation from these rated values, and there are many these days, may well mean lagging production schedules and a noticeable lack of uniformity in products.

Fluctuating line voltages are no problem in plants where Sola "CV's" have taken over. Even though the peaks and valleys of power consumption may cause a voltage variation of as much as ± 30%—the vital "nerve centers" of their production lines continue to operate smoothly and with unerring precision.

Day and night, without care or supervision, Sola Constant Voltage transformers maintain positive control over electrically operated instruments and machines that are indispensable to the nation's war effort. These transformers are available in standard units with capacities ranging from 15 KVA, which might be used for an entire communications system for instance, to the small 10 VA units for vacuum tubes. Special units can be built to specifications.

Note to Industrial Executives: *The problems solved by Sola "CV" transformers in other plants may have an exact counterpart in yours. Find out. Ask for bulletin ECV-74*

SOLA Constant Voltage Transformers

Transformers for: Constant Voltage • Cold Cathode Lighting • Mercury Lamps • Series Lighting • Fluorescent Lighting • X-ray Equipment • Luminous Tube Signs Oil Burner Ignition • Radio • Power • Controls • Signal Systems • Door Bells and Chimes • etc. **SOLA ELECTRIC CO., 2525 Clybourn Ave., Chicago, Ill.**

TEST-FLIGHT RADIO RECORDER

Aircraft Behavior Recorded Via Aural and Optical Methods

Part II

by RALPH G. PETERS

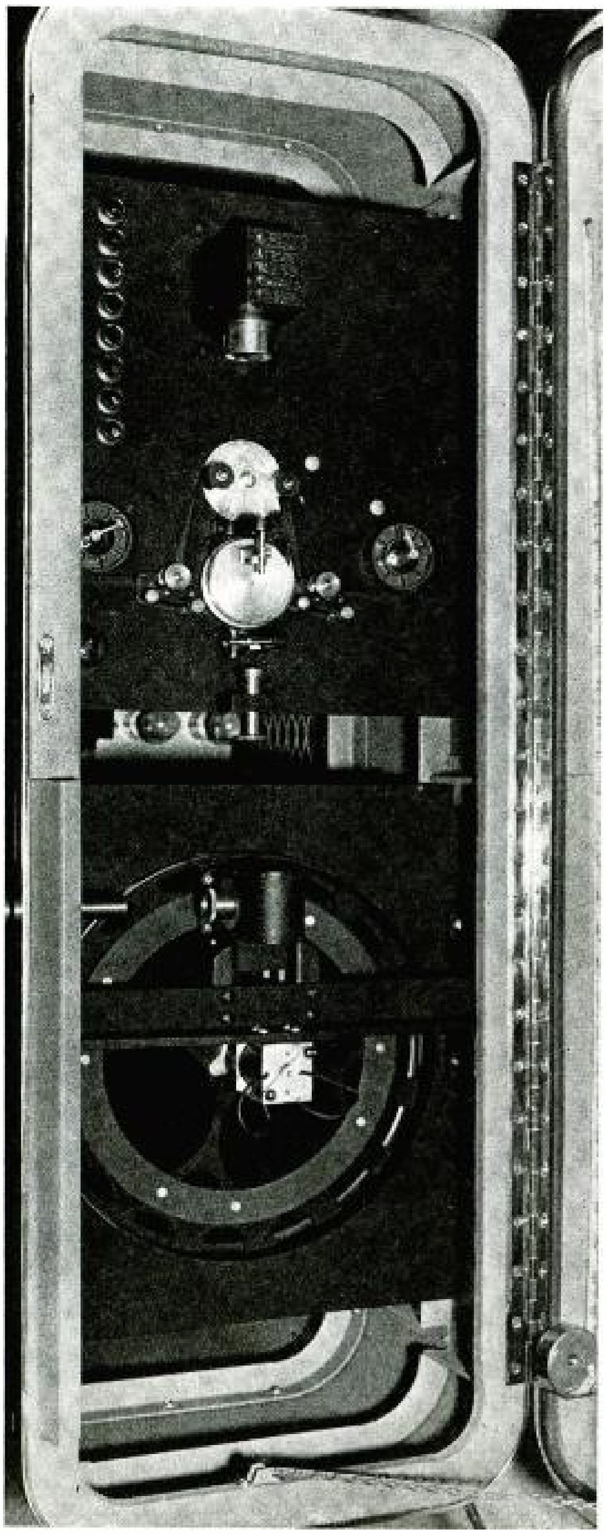


Figure 1
The automatic optical film analyzer. This device provides a means of projecting successively the frequency of each instrument as recorded through a scanning mat, and to a photocell. The scanning mat as we can see at the left, is mounted on a revolving drum. It consists of a transparent film on which is recorded a continuous sound track which varies from 500 cps to 6500 cps.

[*In last month's discussion we pointed out that the problem of obtaining test-flight data, while planes were in actual flight, was a major one. An automatic method of recording such flight data, and then transmitting it to a ground crew by way of radio, has now provided an effective solution. Such a system, developed by Harvey D. Giffen of Vultee Aircraft, now provides a permanent record of the action of a plane, even if it should be lost in a crash. In the study of single place aircraft, this method is particularly useful. For in such a ship, there is no available space for an observer and certainly little space for any elaborate test or film recording equipment.*

In this method, special pickups are used. These are designed to respond to various stimulii from pressure, temperature, strain and movement. The system also provides a means of scanning of the resultant impulses of these pickups at a minimum rate of 100 readings per second.]

THE standard temperature units used in this system have many interesting design features. It will be recalled that a unit for the 150° C range contains approximately 4 ohms of No. 36 wire in series with 100 ohms of zero temperature co-efficient resistance in its arm of the bridge. The zero of the range is determined by the amount of resistance used in the other arm of the bridge. In other words, if 104 ohms are used, with all valuations taken at room temperature of 20° C, the bridge will balance at 20° C, providing a frequency output from the converter of 500 cps. However, when the temperature at the pickup is increased to 170° C, the converter frequency will become 5,500 cps. If now we wish to measure from —70° C to +80° C, the same unit can be used with 100 ohms in series with the active unit, and 100 ohms plus the resistance of the unit at —70° C. Doing this would cause the bridge to balance at —70° C, and would provide a frequency of 500 cps at —70° C, and frequency of 5,500 cps at + 80° C. In actual operation, the units are set to measure the required ranges, with individual chart calibration strips prepared for each unit. So that the entire chart width can be used for all pickups regardless of their respective ranges, these calibration strips are attached to the final charts from the analyzer. This

(*Continued on page 46*)

2 NEW SHAPES IN FORMEX MAGNET WIRE

SQUARE and RECTANGULAR

They save space 2 ways

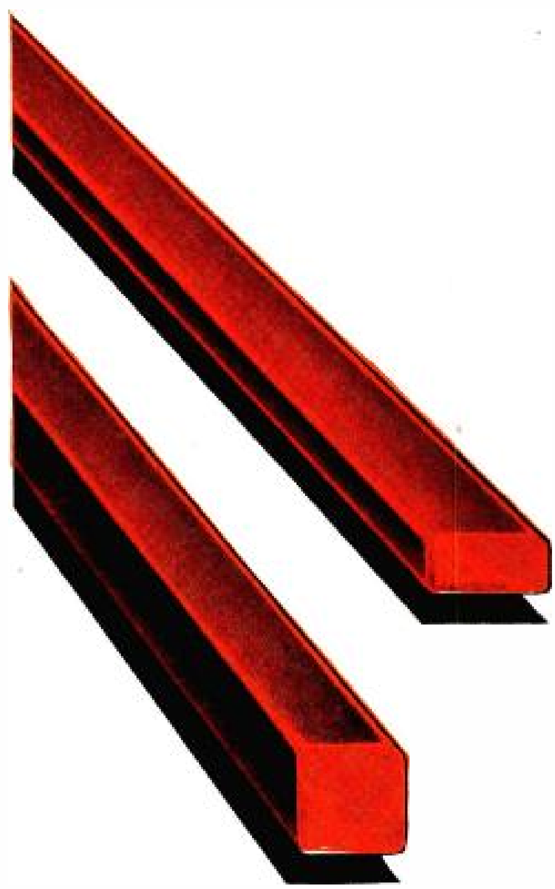
SQUARE and rectangular Formex* is a new answer to the old problem of obtaining compact, easy-to-wind coils. Here are Formex magnet wires that save even more space than round Formex because the corners, like building blocks, fit tightly and accurately together — filling all the waste triangles of space that are unavoidable with round wire.

To the space-saving advantage of round Formex magnet wire is now added this new space-saving factor of square and rectangular Formex. Like round Formex, square and rectangular Formex is flexible, smooth, and capable of being wound at high speeds without danger that the insulation will crack or pull away from the conductor.

Formex magnet wire, as proved by years of outstanding service in the field, saves time because the insulation is tough, and flexible. It stands up under all kinds of treatment, and needs fewer repairs and replacements than conventional wire.

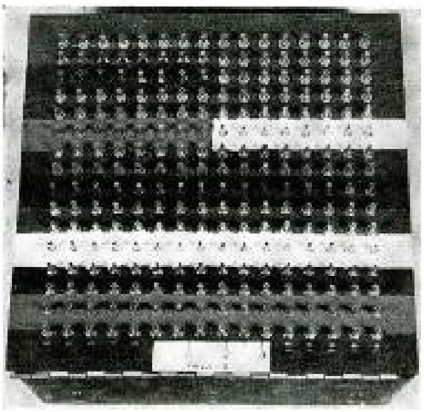
For further information on the use and selection of magnet wire, ask your G-E office for Bulletin GEA-3911, or write General Electric, Schenectady, N.Y.

* Reg. U. S. Pat. Off.



GENERAL ELECTRIC

503-13-1200



Figures 2 (left) and 3 In Figure 2, the plug and jack terminal board of the recorder. Figure 3 shows Harvey Giffen, inventor of the test flight recorder (second from right), examining a section of film containing radioed data on the operation of a plane in flight.

result is obtained because each unit and the graphic recorder cover the same frequency spread.

Flexibility of Pressure Units

In the pressure units, we also have the same degree of flexibility. For instance, a given diaphragm using the same reactance coils can be used to record full scale charts on ranges of 0-20" of water, etc. By adopting a leverage fulcrum that will give approximately full armature movement for the diaphragm deflection at the required range, we secure this flexibility. So that the bridge unbalance will activate the converter to 5,500 cps, the maximum unbalanced condition of the reactance unit is shunted with a resistance of sufficient value.

In the Vultee recorder, the standard reactance unit used in most of the pick-ups consists of two coils. They are ¾" o-d. x 1/16" long, and have an equal inductance of approximately 1.5 millihenries.

Converter Unit Calibration

To calibrate the converter units, the gain of the bridge amplifier is set to produce the desired frequency swing. This is possible because all pickups are set to a common denominator. This denominator has been fixed as the amount of change on the output of an equal arm bridge, there being 100 ohms in each arm, when one of the arms is changed two ohms. This method facilitates calibration. This normal frequency swing of the converter is set at 5,000 cps permitting the operation of the automatic analyzer at any points between 500 cps, and 6,500 cps.

The Scanning Switch

In the scanning switch we have an interesting development. Since the switch must provide rapid switching and because at high speeds, vibration is so intense, the design of such parts of the switch as the wiping contacts, becomes quite a problem. In the present type switch, leaf type contacts actuated by a cam are used. The amplifier imput of each bridge and one arm of the switch passes through the switch; the opposite arm being connected directly to a converter connection common to all pick-ups. To prevent overloading in the amplifier while the bridge is open on one arm, the leaf switches are so adjusted that the arms of the bridge are completed before the amplifier imput contact is made. To suppress vibration and bouncing, the actuating arms of the leaf switches ride on the small circumference of the cam. And to provide uniform pressure on the switch, while in contact, the actuating cam has been specially designed. There are seventy-two contact points sets mounted in three banks of twenty-four each in the switch. Continuous scanning of any of these banks is possible. Or two or three banks may be scanned in succession.

Stop Function of Switch

The switch has another function, in addition to scanning the pickups. For by means of additional gear trains and contact points, the switch stops the signal from the converter during the intervals, between each instrument reading. The resultant unmodulated section serves as a division between instruments during analysis, while on film recordings the black part of the unmodulated track is used as a framing mark in the analyzer, operating an automatic photocell framing device.

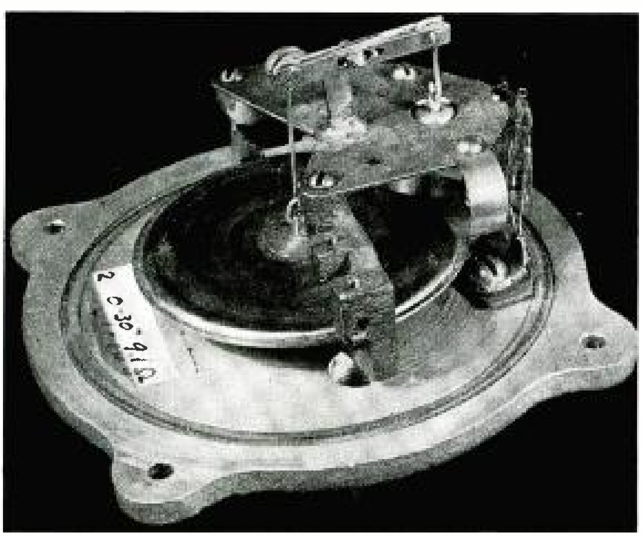


Figure 4

A typical pressure pick-up. Note the method of obtaining leverage. This fulcrum method provides approximately full armature movement for the diaphragm deflection at the required range.

The Optical Analyzer

Instantaneous conversion of changes of stimulii to changes of frequency in the converter unit are possible with an optical electronic analyzer. This device consists of a means for projecting successively each instrument frequency as recorded through a scanning mat, and then to a photocell.

Continuous Recording Available

Mounted on a revolving drum, the scanning mat consists of a transparent film on which is recorded a continuous sound track which varies from 500 cps to 6500 cps. As the scanning image passes across the stationary image of the instrument frequency, a low ampli-

(*Continued on page* 49)

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President RCA BUILDING, 30 Rockefeller Plaza, New York, N. Y. GEORGE H. CLARK, Secretary

Communications

WE acknowledge, with sincere thanks, letters that we have just received from Lieutenant General Thomas Holcomb, U. S. Marine Corps; Captain Carl F. Holden, director of Naval Communications, and Neville Miller, president of the NAB.

Said Lieutenant General Holcomb . . . "The United States Marine Corps is deeply appreciative of the Marconi Memorial Honor Award Plaque presented to the radiomen of the Marine Corps on February 11, 1943. It is the intention to have the names of all radiomen, who distinguish themselves during World War II, inscribed upon this plaque. . . . The Marine Corps, as well as all the armed services, fully realize that it has been the interest and perseverance of the 'old timers,' such as the Veteran Wireless Operators, that has made radio the valuable contribution to our needs that it is today."

Captain Carl F. Holden, Director of Naval Communications, said . . . "I have delayed writing to you in order that I might also acknowledge receipt of the plaque which your Association presented to the radiomen of the U. S. Navy on the occasion of your recent annual dinner. The plaque was delivered to me this morning by Mr. Bailey and already reposes in a place of honor in the Office of Director of Naval Communications. I trust, rather I feel sure, that we will have many names for inscription thereon before the end of the present unpleasantness is reached. . . . May I also take this occasion to extend my most sincere thanks to you and to the members of the Veteran Wireless Operators Association for your kindness to me personally on the occasion of your annual dinner. It was an honor which I assure you, was and is keenly appreciated by me. . . . I should also like to reiterate, merely as a relay station, the 'hearty and 73' from all the radiomen of the United States Navy to your fine Association."

Neville Miller, president of the National Association of Broadcasters, to whom we presented the original Marconi Memorial Plaque in 1940, said . . . "It was a grand banquet and I enjoyed it tremendously. The array of those who have contributed to the development of radio was extremely interesting and you are to be congratulated."

Life Members

WE proudly announce the induction as life members, in our Association, of the following, all of whom are prominent in the communications field . . . W. A. Winterbottom, vice-president and general manager of RCA Communications; Commander Pierre Boucheron, now stationed in the office of the Director of Naval Communications, formerly sales manager of the Farnsworth Television and Radio Corporation; Warrant Officer C. W. Lazenby of the United States Navy, stationed in Boston; Paul Godley, prominent consulting engineer, who has had a long and extremely colorful career in radio; William J. McGonigle, our president these past six years, and for four years prior, secretary; J. F. Rigby, personnel director of RCA Communications; Ted McElory, World's champion radio telegraphist; Wm. Aufenanger, general superintendent of RCA Institutes and assistant to the president of the Radiomarine Corporation of America; E. H. Rietzke, president of the Capitol Radio Engineering Institute; G. L. Taylor, president of the Midland Television and Radio Schools and G. R. Entwistle, president of the Massachusetts Radio School, whose radio career goes back to the last war.

Personals

ENJOYED a phone conversation recently with Lt. Commander V. H. C. Eberlin, a former treasurer of our Association, now stationed at a Naval air station. . . . Our sincere thanks to George H. Clark, Association secretary, for the grand job of writing

(*Continued on page 73*)

At the Hotel Astor dinner-cruise in New York, where, for the first time, all of the directors of communications of the Government assembled, to applaud the work of the radio operator.

tude modulation of the light beam is produced. When the scanning frequency matches the projected instrument frequency, the two images are superimposed, resulting in the transmission of the maximum amount of light. The images then fall adjacent to each other and shut off all the light. Thus a surge of high amplitude light modulation is produced by this alternating sequence. This resultant modulation operates the graphic charting equipment.

Instantaneous Graphic Recording

Instantaneous graphic recording also plays an important part in the radio recorder. With this device, it is possible to make direct paper charts of the instrument readings in the plane at a ground station. The device is used when the radio recorder is operated at speeds not exceeding the mechanical lag of the paper recording unit. To plot the instrument readings, an Esterline Angus graphic recorder can be used with the analyzer, provided these readings are scanned at a rate not exceeding one reading per second. This is the time lag of the recording pen.

Decoding is provided by a vacuum tube device. The device uses a limiter circuit into which transmitted frequencies are fed from the radio receiver. A constant signal amplitude is thus maintained during input variations of from 15 to 25 volts. The resultant signal is fed to a discriminator circuit, producing a direct current, varying in proportion to the instrument frequency. It is this current that operates the meter element of the graphic recorder pen.

The incoming signals also cut a disc. Not only is a permanent record of the flight made with such a recording, but a check against the graphic recording pen device is also provided. In the 33 1/3 rpm. recorder used, crystal units cutting at 130 to 140 lines per inch, are used. These records, by the way, are often used for film re-recording with an optical analyzer.

It is sometimes necessary to record

(*Continued on page 77*)

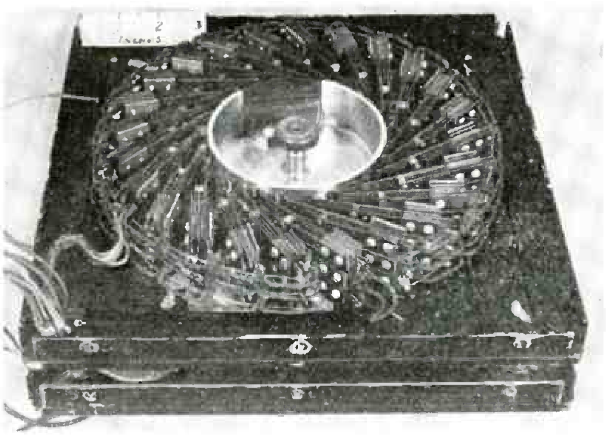


Figure 5

Scanning switch providing rapid switching at high speeds. Leaf type contacts are actuated by a cam. To suppress vibration and bouncing, the actuating arms of the leaf switches ride on the small circumference of the cam.

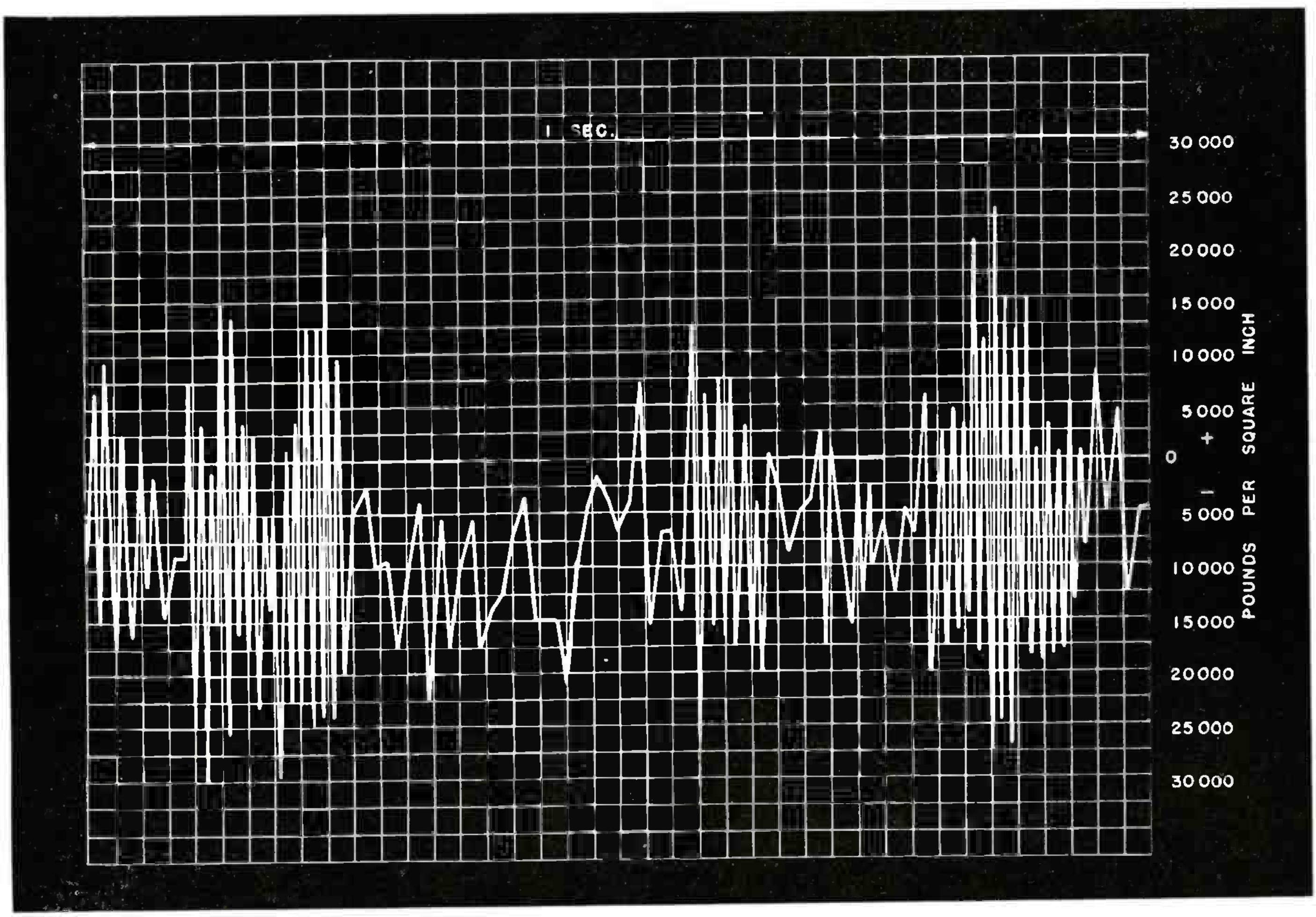


Figure 6

A chart illustrating the buffeting condition of a plane as transmitted to a strain gage pickup.


ARHCO Varieties of 1943
2008
Wartime Essentials
We do stamping, screw machine work, moulding, and general Radio and Radar communications assemblies. Illustrated are but a mere handful of the 2008 wartime essentials which we are now manufacturing. Your inquiries will receive prompt attention.
Now, more than ever, it is important that you keep on buying War Bonds and Stamps.
ARHCO RADIO PRODUCTS
American Radio Hardware CO., INC.
476 BROADWAY, NEW YORK, N. Y.
MANUFACTURERS OF SHORT WAVE • TELEVISION • RADIO • SOUND EQUIPMENT
CMA-49021A
CRN-107
JK-33
PL-68
PL-55
SW-141
PL-112
PL-118
PL-122
J-38
ANT
1st RF
2nd RF
OSC.

NEWS BRIEFS OF THE MONTH...—

WAR MODEL REPLACEMENT PARTS

The first of a series of standards for "war model" replacement parts have now been completed. This new standardized line includes a simplified list of the most critical replacement parts necessary at present. These include nine types of capacitors, eleven volume controls, six power and six audio transformers, two reactors, and nine electrolytic condensers.

A special symbol consisting of a V with three dots and a dash, enclosed in a circle will appear on all parts designed for this purpose. It is also expected that a manufacturer's identification symbol assigned by the WPB will appear on all parts.

* * *

ARH WORKERS SIGN VICTORY PLEDGE

The workers of the American Radio Hardware Company, Inc., 476 Broadway, New York City, have signed a "Victory pledge." In this pledge the workers have announced their intentions of staying on the job conscientiously until final victory has been achieved.

Each pledge is signed by both the worker and D. T. Mitchell, president of the company.

* * *

INVAR CHARACTERISTICS IMPROVED

With the development of a free-machining grade of invar by the Carpenter Steel Company, Reading, Pennsylvania, the customary machining difficulties are said to have been eliminated. Invar, which is 36% nickel alloy, has been effectively used for applications where it is necessary to overcome or minimize the natural tendency of metals to expand when heated. By providing a rate of thermal expansion approximately 1/10 that of carbon steel, at temperatures up to 400° F., this alloy is serving in many vital applications.

* * *

WOMEN AT TELEVISION CONTROLS

Joan Beckett, a graduate of Mt. Holyoke College, has become one of the first women to win appointment as a control board engineer in television. She now operates the complicated light control board in the television studio of WRGB, the General Electric station in Schenectady.

Joan Beckett

AMATEUR EQUIPMENT SOUGHT BY SIGNAL CORPS

Radio amateurs are again being asked to sell their short-wave equipment to the Signal Corps, Army Services of Supply, for training purposes and operational use.

The radio communication equipment needed consists of transmitters (Hallicrafter and Collins), ranging in power from 25 watts to 450 watts and covering various bands in the short-wage range. Also needed are receivers (Hallicrafter, National, RME, Hammarlund and Howard), and such radio components as capacitors, resistors, and installation material. Especially desired are audio-frequency and radio-frequency signal generators and oscilloscopes, Weston a-c and d-c voltmeters, ammeters and milliammeters, and other equipment for testing.

Used equipment will be purchased, if it is in perfect operating condition or if it can readily be restored to such condition. The price paid for each item will be set by a Signal Corps inspector.

Persons in possession of the desired equipment, who wish to sell it for the use of the Army, are invited to send a brief description, including name of manufacturer and model type, to Captain James C. Short, Philadelphia Signal Corps Procurement District, 5000 Wissahickon Avenue, Philadelphia, Pa.

* * *

RCA'S ANNUAL REPORT

The twenty-third annual report of the Radio Corporation of America was recently released by David Sarnoff, RCA president. The report shows the tremendous strides made by radio during the last year, as a vital factor in our war program. It also tells of the many new applications of radio, pointing out that radiophoto circuits between New York and London, Buenos Aires and Moscow, and between other points in this country and Melbourne, Cairo and Hawaii, have been established effectively.

* * *

DEWALT AND GABLE IN NEW G.E. POSTS

K. C. DeWalt has been named designing engineer in the Tube Division of General Electric, Schenectady, New York. A. C. Gable is now an administrative assistant in the Tube division.

* * *

TUBE LIFE EXTENSION DATA

A new six-page booklet with data on how to increase tube life has just been issued by the RCA Tube and Equipment Department. The book, known as "Tips on Making Transmitting Tubes Last Longer," shows how to increase the life of tungsten filament and mercury-vapor rectifier tubes.

Single copies are available from RCA Commercial Engineering Section, Harrison, New Jersey.

* * *

ACRO ELECTRIC COMPANY EXPANDS

The Acro Electric Company has moved into a new plant at 1305 Superior Avenue, Cleveland, Ohio. The president of this company, which manufacturers Acro snap switches, is B. Winston. J. S. McComb is vice-president and sales manager.

STEATITE NO LONGER A BOTTLENECK

Steatite no longer is a bottleneck in the production of military radio equipment, according to manufacturers who participated in a meeting of the Industry Advisory Committee on Ceramic Capacitors and Steatite. The producers stated that they are now able to accept orders for delivery in from four to eight weeks. This is quite a contrast with the backlog problem of last summer, when deliveries were eight months behind.

The chairman of this meeting was Elmer Crane, Chief of the Components Section, Radio Division, WPB.

* * *

CBS PERSONNEL CHANGES

Lester Hatfield, transmission technician at WABC, has left to become a Lieutenant (jg) in the United States Naval Reserve. Replacing him is Harold D. Hastings.

J. Dunham Gilbert, supervisor of studio technicians, has also been commissioned Lieutenant (jg) in the Naval Reserve. Nelson Smith will become the new supervisor.

Robert Bendick, recently studio technician for WABC, has joined the armed forces as Lieutenant in the Air Corps. Robert E. Lee and Bertram Littlefield have joined the engineering department of CBS as members of the maintenance technicians staff. Norman Johnson has been assigned to the shortwave transmitter staff of CBS.

* * *

ELECTRONICS DEPARTMENT NOW AT G.E.

The General Electric Radio, Television and Electronics Department will hereafter be known as the Electronics Department, according to an announcement by Dr. W. R. G. Baker, vice president in charge of the department.

* * *

PIERCE JOINS OWI

R. Morris Pierce, chief engineer of WGAR, has gone overseas for OWI as an advisor to the Signal Corps.

* * *

ADAMS OF WHIO NOW TEACHING

Ernie Adams, chief engineer of WHIO,

(Continued on page 58)

Ernie Adams

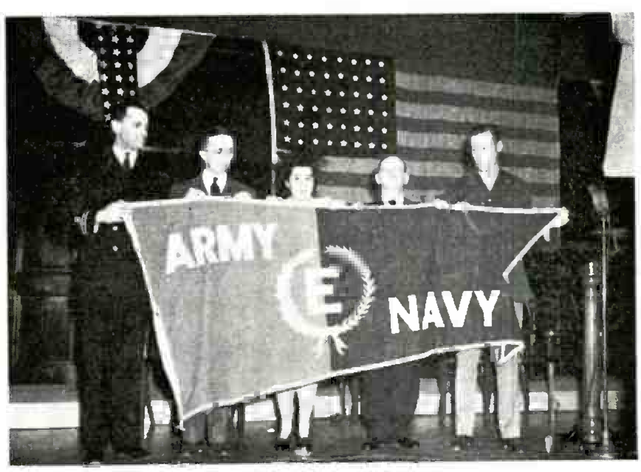
AT "E" AWARD PRESENTATIONS

(Top) . . . at the Formica Insulation Company presentation, Left to right: D. J. O'Conor, president of Formica; Albert Thompson, Mrs. Dora Searcy, and John B. Wirth, representing the employees, and Colonel Alonzo M. Drake, Detroit, Army Air Forces Procurement Supervisor for the Central District.

(Top) . . . at the Electronic Laboratories, Inc., "E" presentation. Left to right: W. W. Garstang, vice-president and general manager of the Electronic Laboratories; Lieutenant Colonel R. L. Finkenstaedt, supervisor, Indianapolis Area, U S Army Air Forces, and Osra Brandenburg, and W. Reed Smoot, representing the employees.

(Top) . . . at the General Radio Ceremonies. Left to right: Mayor John B. Corcoran, of Cambridge, Massachusetts; Captain John J. Hyland, U.S.N. (Ret.), Inspector of Naval Material for the Boston district; Governor Leverett Saltonstall of Massachusetts; Charles H. Riemer, president of the General Radio Mutual Benefit Association; Melville Eastham, president of General Radio, and Colonel James B. Van Horn, USA Chief Signal Officer for the First Service Command.

(Top) . . . receiving the "E" Pennant for De-Jur Amsco. Left to right: Harry De-Jur, Jack Kuscher and Ralph De-Jur. Below, at the Cinaudagraph Corporation "E" award ceremonies. Left to right: Lieutenant John D. Lodge, USNR; Sherman R. Hoyt, president of Cinaudagraph Corporation; Florine Mercer and Kurt Kessler, representing the employees, and Captain Frederick D. Woods, U S Army Air Corps.



AIRCRAFT COMPASS CALIBRATIONS

(*Continued from page* 12)

is leading the *ORB*. As an example, when *ORB* equals 45°, the *TRB* is 57°. The *ORB is* 12° less than the *TRB*. Therefore, in order to indicate *TRB* at 57°, the pointer position is advanced 12° from *ORB* in a clockwise position. *Lagging* is the term that refers to a condition where the *ORB* is greater than the *TRB* and a positive error is present, with a negative correction being applied to the *ORB*. This means that the corrector cam will cause the bearing indicator needle to lag the *ORB*, thereby indicating the true radio bearing.

Determining the Quadrantal Deviation

Any method that will permit taking bearings on one designated radio station through all angles of the azimuth of the aircraft may be used. The aircraft may be on the ground or in the air. The determining factors in the selection of the various methods that may be used are economy, time and accuracy. These methods may be given two major classifications: (1)—ground checks and (2)—flight checks. The latter are more accurate than the ground check methods. There are exceptions to this. For instance, there are certain installations where the loop antenna is mounted on top of the fuselage of a low wing monoplane. In this type installation the ground check is perhaps as accurate as a flight check.

Quadrantal Deviation of Aircraft On Ground

In determining the quadrantal deviation when an aircraft is on the ground, we must first select a location on the airport that is in the clear and free from such structures as hangars and other buildings that may distort the r-f field. The location must be free from electrical interference so that a high gain control adjustment may be used as the null is approached. In case of an automatic radio compass, the presence of an interference with a pronounced center and of sufficient intensity, will cause excess hunting of the *bearing indicator needle*. A compass rose or a pelorus is used to determine the true line to the radio station relative to the aircraft heading for each position of the aircraft. The dolly and tractor that are used to place the aircraft in flying position and to rotate the aircraft to the check angle positions must be tested to determine whether they introduce a deviation.

Two Ground Checking Methods

There are two ground checking methods. In the first, we rotate the aircraft through 360° and take bearings at each 15° to 20° interval, using the pelorus to find the true angle. In the second method, with the aircraft in a fixed position, a small transmitter or oscillator may be used. This is placed at 15° to 20° angles at a radius of several hundred feet through the 360° about the plane. We then use a pelorus or equivalent means to accurately determine the true angle from the aircraft heading to the signal origin.

There are various flight patterns that may be used to calibrate the radio compass in the air. To mention a few of the patterns, there are . . . (1)—a "flat" circle of smallest practical diameter may be flown around a point of which the true direction to the radio station is known; (2) we may fly a dual circle forming a figure-of-eight pattern in which the center of the figure-of-eight is the ground reference point. One circle is flown clockwise and the other in a counter-clockwise direction. Tabulations of headings at points of each circle are averaged to compensate the errors. Should the reading follow fairly much the same in two quadrants, for instance, in the first and third, and vary widely in the second and fourth, it is an indication that sufficient wind exists to cause drift. This is made on the assumption that level flight and flat turns were made while flying the circle. The reason is readily checked by plotting the results and comparing it with a weather report of the wind at the altitude and time that the flight was made. Wind velocity in excess of 8 to 10 miles per-hour are to be avoided during these checks using the circle method. There is a third method, in which the *point flight* method is considered the most accurate one, since the track of the aircraft does not, within a small degree of the heading, effect the accuracy of the gyro and radio compass readings. This is of value when a cross-wind is present. In Figure 6 is shown the procedure to use for this method. It is necessary to fly in level attitude across the ground reference point on headings through the 360° at intervals of 15°

(1) TH	(2) Rel ORB	(3) Rel TRB	(4) CORRECTION
300	0	0	0
290	7	10	+ 3
282	13	18	+ 5
275	18	25	+ 7
266	25	34	+ 9
254	35	46	+ 11
245	43	55	+ 12
242	46	58	+ 12
232	57.5	68	+ 10.5
224	68	76	+ 8
217	78	83	+ 5
213	85	87	+ 2
210	90	90	0
207	96	93	— 3
204	101	96	— 5
200	108	100	— 8
196	115	104	— 11
192	120	108	— 12
184	128	116	— 12+
176	136	124	— 12
166.5	145	133.5	— 11.5
161	150	139	— 11
147	162	153	— 9
139	168	161	— 7
120	180	180	0
112	185	188	+ 3
101	193	199	+ 6
86	204	214	+ 10
79	210	221	+ 11
72	216	228	+ 12
65	223	235	+ 12
58	230	242	+ 12
54	235	246	+ 11
46.5	245	253.5	+ 8.5
41	253	259	+ 6
37	259	263	+ 4
33	265	267	+ 2
30	270	270	0
27	275	273	— 2
25	279	275	— 4
22	285	278	— 7
16	293	284	— 9
10	300	290	— 10
3	307+	297	— 10+
343—	327	317	— 10+
335	335	325	— 10
324	343	336	— 7
317	348	343	— 5
306	356	354	— 2

Figure 9
An example of a typical calibration tabulation for one type of aircraft.

to 20°. When directly above the reference point, readings are taken of the directional gyro and the radio compass. During the approach to the ground reference point the setting of the gyro is made. Accuracy depends upon level, straight flight and the absence of all rudder action, when near the ground reference point. The gyro is checked at 15 to 18 minute intervals to assure absence of appreciable errors that may creep in.

Radio Compass Checks

Precautionary checks of the radio compass installation must be made in preparing for its calibration. The loop antenna assembly must be accurately aligned mechanically with the fore and aft longitudinal line of the aircraft. It is then necessary to determine whether any ungrounded wires or tuned antennae will effect the loop antenna characteristics. This cannot be completely detected on the preliminary test, but the flight check and the plotted data will reveal this information. We must then determine whether an error exists on the zero heading. This is accomplished by lining up for a flight direct to the radio station, with the aid of the radio compass and setting a *directional gyro compass* course. An agreement of the two readings on a course directly to the station indicates zero error on the radio compass for this heading. Should there be an error the cause may be due to the loop antenna assembly not being mounted on the exact longitudinal line parallel with that of the aircraft for level flight, inaccurate flying, interference due to antennae or structure, or drift due to cross winds. In case of the latter it is highly desirable to select a time when no winds exist. However, for this zero heading, it is necessary to check a down or up wind flight, to avoid a drift error.

Should an erratic condition be found due to other antennae, it should be remedied, rather than try to make correction for radical changes. Errors of this kind usually vary to a great degree with a comparatively small change in frequency.

The correct or cam should be checked to determine that no correction has been applied. The use of a cam without correction is desirable because if correction was applied, then this must be accurately known and considered in the calculations.

Selection of a Ground Reference Point

When possible, a point easily recognized from the air at all angles should be selected as a reference point. Reference lines such as straight highway, straight canal, etc., are also very bene-

(*Continued on page* 66)

THE INDUSTRY OFFERS

VIBRATOR VOLTAGE REGULATOR

A new type regulator, that automatically controls the voltage delivered to a vibrator used in aircraft service, has been developed by Amperite Company, 561 Broadway, New York City. With a battery variation of from 20 to 30 volts (50% variation), the voltage on the vibrator with this new device is said to be kept between 6.0 and 6.3 volts (a 5% variation).

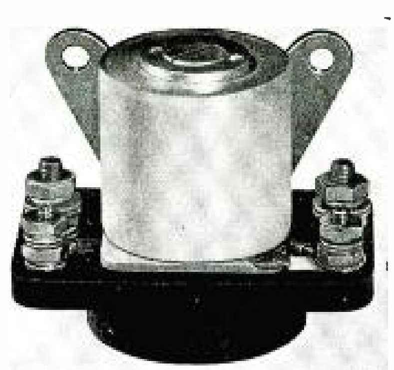
Included in this Amperite is an automatic thermal switch which automatically turns on an auxiliary circuit 10 seconds after the vibrator is started. Similar regulators can be designed, according to the manufacturer, to control the current and voltage applied to any load providing the total wattage consumed by the Amperite itself, is not more than 40 watts. With a 10% change in current through the Amperite the voltage drop increases 200%. An ordinary nichrome wire would only increase approximately 10%, say the manufacturers.

* * *

SOLENOID AIRCRAFT CONTACTOR

Among the five types of solenoid contactor units announced by Guardian Electric Manufacturing Company, Chicago, is the B-5 series. This device has a contact rating of 50 amperes continuous, and operates on 24 volts d-c, producing a coil current of 210 milliamperes. It has double pole, single throw, normally open contacts. Its weight is 11.2 ounces.

The unit is said to resist acceleration and vibration over 10 times gravity. All metal parts are plated to withstand a 200 hour salt spray test.



LEAR COMBINATION UNITS

Four allied units, transmitter-receiver-power supply and loop, have recently been developed by Lear Avia, Inc., Piqua, Ohio.

The receiver, known as RCBB, covers three bands for voice and c-w. Its sensitivity is said to be 50 milliwatts, with two-microvolts per meter on the antenna, and 40 microvolts per meter on the loop, both at a 4 to 1 signal-to-noise ratio on all bands, with input 20% below rated 12 volts. Its power output is said to be 500 milliwatts undistorted. A six tube superheterodyne, it consumes 2.9 amperes at 12 volts.

The transmitter, known as the T-30-AB, is said to provide 100% modulated voice and m-c-w emission at 1000 cps, with a power output of 20 to 30 watts. Its frequency response is said to be ± 2 db at 250 to 2,500 cycles.

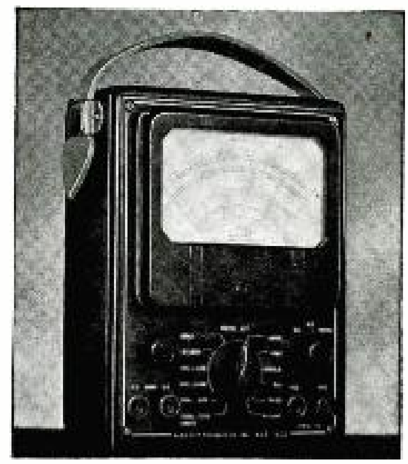
The loop known as the Miniloop is 10 inches in diameter. The power unit contains a dynamotor with the necessary accessories including filters. This unit can be used to supply power to the transmitter and receiver. Both receiver and transmitter operate with a 12 volt aircraft battery in conjunction with this power supply.

ULTRA SENSITIVE MULTITESTER

A new ultra-sensitive multitester, model 461, with a sensitivity of 20,000 ohms per volt on all d-c scales, has been developed by Radio City Products Co., Inc., 127 West 26th Street, New York City. The sensitivity of this device on the a-c scales is 1,000 ohms per volt.

The meter movement on this instrument is adjusted to 50 microamperes. A suppressor type copper oxide rectifier is used.

The ranges of this instrument are . . . d-c voltmeter: 0-2.5-10-50-250-1,000-5,000; a-c voltmeter: 0-2.5-10-50-250-1,000-5,000; output voltmeter: 0-2.5-10-50-250-1,000-5.000; d-c microammeter: 0-100; d-c miliammeter: 0-10-100-500; ohmmeter: 0-1,000-100,000-10,000,000, and decibel meter: minus 10 to plus 50. Overall dimensions of the unit are 7"x5½"x3".



* * *

NEW DRAWING INK

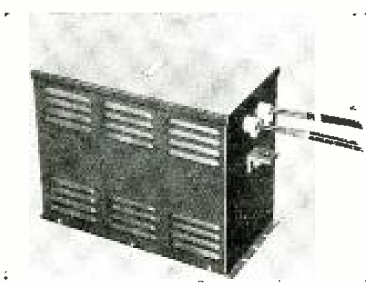
The Louis Melind Company, 362 West Chicago Avenue, Chicago, Illinois, have developed a drawing ink that is said to be free flowing, non-caking, and thoroughly waterproof. It is available in twenty-three colors. Free sample bottles of the ink known as Justrite, are available to design engineers, provided they make their request on their business letterheads.

* * *

G. E. VOLTAGE STABILIZER

A new voltage stabilizer providing a constant output of 115 volts from circuits varying betwen 95 and 130 volts has been developed by General Electric.

This stabilizer is said to be insensitive to load power factor. It is, say the manufacturers, not affected by variations in load from no load to full load, or by changes in



power factor from unity to 0.8 lagging.

The transformers are made in ratings from 50 v-a to 5,000 v-a.

* * *

MICROPHONE CORD ASSEMBLY

A microphone cord assembly comprising a switch, plug and jack, either as an assembled unit or as separate pieces, has been developed by Universal Microphone Company, Inglewood, California.

The switch unit, known as the SW-141, can be used as a press-to-talk switch, although it has a locking button for continuous operation. This switch is 4 15/32 inches long, 1¾ inches wide and ¾ inch thick.

* * *

RAPID PRINT MACHINE

To provide blueprints or black and white prints rapidly, Peck & Harvey, 4327 Addison Street, Chicago, Illinois, have produced a printer that will provide prints up to 12x18 and 18x24.

The device, known as the Spee-Dee, is said to provide prints in about thirty seconds.

Full details are available from the manufacturer.

* * *

SIMPLIFIED INTER-COMMUNICATION SYSTEM

A combination master inter-communication system providing private or complete factory contact, has been developed by Fred E. Garner Company, 53 East Ohio Street, Chicago, Illinois.

The device known as the president model "Convers-O-Call." is available for from ten to thirty stations.

* * *

REFLECTED LIGHT SIGNAL

A signal indicator employing reflected light has been developed by Littelfuse, Inc., 4757 Ravenswood Avenue, Chicago, Illinois.

Known as the signalette, it operates by fluorescence under "black light" from the usual sources within aircraft. A radium-active fluorescent paint used on the indicator shows signals in total darkness. The device uses only 1¼ watts, as against the customary 4½ watts of the usual lamps.

A transparent plastic cap protects the lamp.

The body of the indicator houses a solenoid, the armature of which is con-

(*Continued on page* 75)

NEWS BRIEFS

(Continued from page 52)

is now teaching radio fundamentals at the University of Dayton, Ohio.

* * *

WESTERN ELECTRIC WINS WHITE STARS

All three major works of the Western Electric Company have received white stars for their "E" pennant.

* * *

REVIEW JOURNAL ISSUED BY LEEDS & NORTHRUP

The second edition of the "Modern Precision" journal has recently been published by Leeds & Northrup Company, 4908 Stanton Avenue, Philadelphia, Pennsylvania. It is a sixteen page tabloid size unit in which appears a variety of data on measuring devices. An interesting bibliography is also included.

* * *

PHOTOELECTRIC RELAY FOLDER

A four-page folder describing the applications of photoelectric relays for automatic control has been released by the Electronics Control Section of G.E.

The folder illustrates many types of indoor and outdoor instruments and shows their uses.

* * *

SUN RADIO PURCHASING AGENT FOLDER

An interesting folder illustrating the service available for those purchasing communications equipment today, has been issued by Sun Radio Company, 212 Fulton Street, New York City.

* * *

OHMITE NEWS FEATURES SIMPLIFIED POWER TABLES

The last two issues of *Ohmite News* have contained interesting tables covering simplified explanations of Ohm's Law as applied to d-c and a-c.

Copies of these issues dated January and February are available free of charge from the Ohmite Manufacturing Company, 4835 Flournoy Street, Chicago, Illinois.

* * *

RADIO AND ELECTRONICS

In an interesting sixteen-page booklet published by RCA, the subjects of radio and electronics are effectively described.

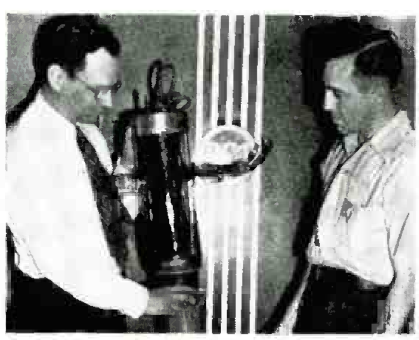
Copies of the booklet are available from the Radio Corporation of America.

* * *

TUBE HAS RECORD RUN

What is believed to be a record for tube life had been established at WWL, New Orleans, according to L. E. N. deTreil, transmitting supervisor, and Joseph E. Gros, transmitting engineer in charge of tubes.

The tube, type 862, one of the two 100 kw tubes used in the final stage of the 50,000-watt transmitter, has been operating for 23,500 hours.



L. E. N. deTreil (left) and J. E. Gros.

* * *

PLASTIC PART POSSIBILITIES EXPLAINED

The unlimited possibilities of plastic parts are illustrated and analyzed in a four-page folder, just released by the Creative Plastics Corporation, Kent Avenue, Brooklyn, New York. The booklet was prepared by the technical sales department.

* * *

WHITE NOW IRE DIRECTOR

W. C. White, engineer in charge of the electronic laboratory of General Electric at Schenectady, New York, has been named a member of the Board of Directors of the Institute of Radio Engineers. Mr. White is known for his work with vacuum tubes. He was for a time an associate of Dr. Irving Langmuir, associate director of the General Electric laboratories.

* * *

POST-WAR PLANNING DEPARTMENT AT UNIVERSAL

The Universal Microphone Company, Inglewood, California, has announced the formation of a post-war planning department, according to James L. Fouch, vice president.

* * *

COLLOIDAL GRAPHITE CATALOGUE

A four-page catalogue, No. 422-W, describing the use of "dag" colloidal graphite, as a parting compound, has just been released by the Acheson Colloids Corporation, Port Huron, Michigan.

The bulletin discusses the use of the graphite for screw threads, lamp bulbs; its application to aeronautics, the glass and rubber industries, and in the foundry.

* * *

BELDEN WAR EDITION CATALOGUE

A four-page war edition issue of the Belden radio wiring line has just been released by Belden Manufacturing Company, Chicago, Illinois.

The catalogue, known as "843," contains data on those products that use a minimum amount of critical materials, reduce idle inventory, and yet make possible the servicing of a maximum range of equipment. According to the manufacturer, the 171 units described in this catalogue will service all essential needs, as compared with the 467 units listed in the previous catalogue.

* * *

CORROSION DATA WORK SHEET

To facilitate the study of corrosion problems, the technical service division of the International Nickel Company, 67 Wall Street, New York City, has developed a corrosion data work sheet. The form when properly filled out, provides an evaluation

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of all factors influencing corrosion action. When problems involve corrosive or parting conditions not previously encountered these work sheets can be submitted to International Nickel for a comparative study, using the corrosion data on file with over 2,000 plant tests of approximately 40,000 metal specimens, as a guide.

Copies of the work sheet are available without charge.

* * *

LEVEY SIGNED TO FIVE-YEAR CONTRACT

Arthur Levey has been given a five-year contract to serve as president and general manager of the Scophony Corporation of America, 527 Fifth Avenue, New York City.

* * *

CO-ED TECHNICIANS RECEIVE RCA TRAINING

A program designed to provide women radio technicians will be undertaken by the RCA Victor Division of RCA, according to F. H. Kirkpatrick.

The first courses, which will begin around May 1st, will be given at Purdue University in Lafayette, Indiana. A group of from eighty to one hundred girls, between the ages of eighteen and twenty-two, will be selected from the RCA plant and from colleges and universities. To obtain admittance, two years of college study with satisfactory grades, some knowledge of mathematics, good health, and an interest in technical radio work, are necessary. A salary will be paid to the "employees in training." The courses will consist of two terms of twenty-two weeks each.

* * *

MORE CONSISTENT USE OF PD-1X FORM URGED

Because many jobbers are not taking the time to check their inventory and fill out the PD-1X form to replenish their stock of civilian repair parts, they're easing themselves out of business, warned Charley Golenpaul of Aerovox Corporation recently.

"No one denies the fact that there are many business details to cope with today," said Mr. Golenpaul. "Nevertheless," he continued, "it is imperative that the task of maintaining an adequate stock of parts be considered an essential one.

"Many of us at the manufacturing end have done everything possible to keep the jobber in business in spite of the tremendous production strain placed on us by war requirements. The jobber should be appreciative of such cooperation and take advantage of the medium by which he can secure replacement parts for his customers," said Mr. Golenpaul.

* * *

LITTLE, NOW POSTAL TELEGRAPH GENERAL SUPERINTENDENT

G. P. Little, with Postal Telegraph since 1922, has been appointed General Superintendent of that company. Mr. Little is a technical advisor to the Telegraph Committee of the Board of War Communications.

* * *

LIGHTING HANDBOOK PREPARED

A Government manual and price schedule on lamps and lighting has just been issued by the Birdseye Electric Corporation, 335 Carroll Street, Brooklyn, New York, for distribution to Government procurement

(*Continued on page* 60)

NEWS BRIEFS

(*Continued from page 59*)

agencies, purchasing personnel, and Government lighting engineers.

The handbook analyzes the five main types of lighting requirements and also discusses a variety of available lamps.

* * *

WAR SOUND EFFECT DISCS

A new series of sound effects containing warfare sounds have been prepared by Standard Radio, 45 West 45th Street, New York City.

A catalogue supplement, containing descriptions of the new effects, are available, free of charge.

* * *

BLIND RIVETS HANDBOOK

A sixteen-page handbook designed to aid those who are concerned with riveting operations on aircraft, has just been issued by the Cherry Rivet Company, Los Angeles, California.

In the handbook are charts, diagrams, dimensional sketches and illustrations. Copies are available gratis.

* * *

COLVIN A.A.C. EXECUTIVE VICE-PRESIDENT

Timothy E. Colvin has become executive vice-president in charge of the Burbank Division of the Aircraft Accessories Corporation.

* * *

MALLORY WINS "E" STAR

An additional white star for the Army-Navy "E" pennant has been won by P. R. Mallory & Company, Inc., Indianapolis, Indiana.

Mallory was the first company in Indianapolis to receive the Navy "E" pennant and flag of the Bureau of Ordnance. These were awarded in December, 1942, by Secretary of Navy Knox.

* * *

RADIOMARINE WINS "M" PENNANT

The Maritime "M" Pennant, the Victory Fleet Flag, and Maritime Merit Badges for all employees have been awarded to the Radiomarine Corporation of America. Radiomarine received the Army and Navy "E" flag during the latter part of last year.

* * *

SANDLER TO DIRECT AIRCRAFT PLASTICS WORK

Jack Sandler has joined the staff of Aircraft Parts Development Corporation, Summit, New Jersey, as chief plastics engineer.

* * *

ALPHA SOLDER FOLDER

Solutions to solder problems are offered in the newest folder published by Alpha Metal & Rolling Mills, Inc., 363 Hudson Avenue, Brooklyn, New York. The folder known as "Solders That Stand Up" also contains a graph covering Tin-Lead fusion characteristics.

* * *

RCA TUBE INSTRUCTION BOOK

An unusually interesting chart type book, known as the RCA Tube Picture Book, has just been released by the Commercial Engineering Section, RCA Victor Division, Radio Corporation of America, Harrison, New Jersey. The presentation contains sixteen 17 x 22 inch pages with eight charts printed on each side of the sheet, for display mounting purposes. The book has been developed especially for war training centers and shows structural details of representative receiving transmitting, cathode-ray, and other special types of tubes.

Copies of this interesting booklet are available to readers in the United States and Canada for 10c a copy.

* * *

FUNDAMENTAL BOOK ON RADIO

Questions, laboratory experiments and other study data on fundamentals in radio appear in a 104-page book recently released by the American Radio Relay League. Written by George Grammer, the book contains data that should be of interest to those studying radio today. Copies are 50c each.

* * *

CONNECTICUT GETS F-M POLICE RADIO

Eleven Connecticut cities and towns have adopted two-way f-m police radio systems developed by General Electric.

The installation of this equipment was facilitated by the recent reserve pool set up by the WPB.

The instruments feature iron core tuning which has proven so popular and so practical in many recent installations.

* * *

MALLORY LECTURES ON ELECTRONICS BY DR. HEYL

A series of four lectures on the future of electronics in the industrial field was started recently by Dr. Paul R. Heyl, through the courtesy of P. R. Mallory & Company, Inc.

The lectures, the first of which was given on March 1st, will develop the history, theory and practical applications of electrons, and indicate the progress which the science of electronics has made. Although the lectures are planned primarily for the Mallory engineering, sales and production personnel, a number of individuals from manufacturing plants, colleges, high schools, broadcasting stations, and training schools of the armed forces, have been invited.

Dr. Heyl, for many years, was a physicist with the U. S. Bureau of Standards. Recently retired from this Bureau, he has been retained as a consultant for Mallory.

* * *

EMBY PRODUCTS CHANGES NAME

The Emby Products Company, Inc., 1800-1804 West Pico Boulevard, Los Angeles, California, will hereafter be known as the Selenium Corporation of America.

Eric Lidow is vice-president and chief engineer of the company. C. O. Rich is president and Maurice N. Burlin is general sales manager and secretary-treasurer.

* * *

DR. MACK DEVELOPS AIRCRAFT FASTENER

Dr. Edward L. Mack, formerly of the Faculty of Cornell University, and for ten years director of research and development for the Reynolds Metals Company, has been granted two United States patents covering an improved type of fastening device, which have been assigned to Aircraft Parts Development Corporation.

* * *

JOHNSON, HAZELTINE ENGINEER, NOW IN NAVY

John Kelly Johnson, for many years engineer in charge of the Hazeltine laboratories in Chicago, has resigned his position as senior engineer, to become a special representative, assigned to the Office of

(*Continued on page 63*)

CRYSTAL PRODUCTION

(*Continued from page* 15)

fifty or sixty blanks are waxed together in a bar or loaf, preparatory to being ground to the exact dimensions. These loaves go to the hand laps where operators grind them to within .001 of the exact dimensions of length and width. This is another precise operation, since the crystal dimensions must be held very closely or the crystal will have poor activity.

Crystal Thickness Problems

After having gotten the crystals to the exact dimensions of length and width, the next procedure is to get them to the desired thickness. The loaves are next taken apart and the crystals washed and *miked* for thickness. They are next placed in groups of approximately the same thickness, and then placed in a plastic holder between two perfectly flat plates and a mixture of abrasive and water added. The holder revolves eccentrically between the two plates and the crystals are ground to the desired thickness. The first part of the procedure is done on coarse abrasive, then medium abrasive, then fine, and lastly the crystals are polished. Each of these operations is done on a different lapping machine and the crystals are turned often enough so that they are perfectly flat and become very nearly the same thickness. On the final or finish lap, crystals are ground to the approximate frequency by making them oscillate between the plates. The oscillations are picked up on a radio receiver and the frequencies checked. However, as fine as have been our measurements (to .0001 inch), the crystals will very several hundred kilocycles in frequency. These are next further classified by machine and placed in groups to be finished by hand in the finishing department.

It all sounds quite simple, but there are so many chances for slip-ups. Suppose, for instance, either the person determining the direction of cut or the mounter makes an error. This throws the sawman off. If the sawman has to spend a large part of his time correcting errors of the two preceding operations, he gets no production. Suppose the sawman is careless and has his angles off, even a matter of half a degree. This causes the crystal to have a bad drift; that is, to have a large frequency change over the temperature range. Assuming that the mounter and sawmen do their work perfectly and someone in the inspection department allows impurities to slip into the blanks, the finished crystals are no good. Suppose even the inspectors do their work thoroughly and the bar men slip on their dimensions, the finished crystals do not have the proper

(*Continued on page* 77)

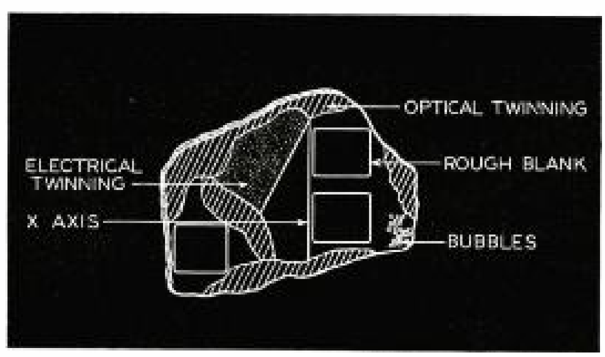


Figure 8

A wafer that has been thoroughly checked with blanks and is now ready for cutting.

NEWS BRIEFS

(*Continued from page* 61)

Procurement and Material of the Office of the Under-Secretary of the Navy, with headquarters in Washington, D. C.

* * *

HIGH SPEED AUTOMATIC STAMPING PRESS

The Di Machine Corporation, 3654 Lincoln Ave., Chicago, Illinois, have developed a high speed stamping press with variable speed control between 180-550 strokes a minute to suit the various punching requirements. The machine also provides for the addition of spacers to provide a die space to 5¼ inches, with provisions in the ram to permit boring it out for punch shanks to 1 9/16 inches.

The press will take die sets measuring up to 6¼x8 inches. It is driven by a ¾ horsepower, 1,140 rpm, 60-cycles, 3-phase motor, mounted under the bed.

A four-page illustrated folder, describing this device, is available from the manufacturer.

* * *

NEW RCA BEAT-THE-PROMISE DRIVE

The RCA Victor joint labor-management War Production Drive Committee in the Camden plant has launched its fourth Beat-the-Promise production drive. The Camden plant has already won two stars on its Army-Navy "E" flag. This reward was made recently by Admiral C. C. Bloch, U.S.N. (Ret.).

* * *

ALLIED'S BUYING GUIDE

A buying guide covering radio and electronic equipment has been issued by the Allied Radio Corporation, 833 West Jackson Boulevard, Chicago, Illinois.

Data in the guide covers components, as well as complete equipment and recent textbooks. Copies are available free of charge.

* * *

TEST SET DATA

Newly revised catalogues describing test sets have been published by the Leeds and Northrup Company, 4934 Stenton Avenue, Philadelphia, Pennsylvania.

The instruments described are especially useful in measuring resistance and capacitance in the laboratory or field.

Copies are available gratis, from the company.

* * *

E. H. FRITSCHEL PROMOTED

E. H. Fritschel has been placed in charge of sales of industrial electronic tubes of General Electric at Schenectady, New York. Mr. Fritschel succeeds Dr. H. A. Jones, now with the U. S. Army Signal Corps, as a Lieutenant-Colonel.

* * *

TURRET LATHE BULLETIN

A four-page file size bulletin describing and illustrating turret lathes and their constructional features has been released by the South Bend Lathe Works, South Bend, Indiana.

The bulletin, known as 1002, lists tabulated specifications for capacities, feeds, speeds, and dimensions.

* * *

STORY OF RADIO TOLD BY HARBORD

In an interesting address before the Newcomen Society recently, Lieutenant General James G. Harbord, Chairman of the RCA

(*Continued on page* 64)

NEWS BRIEFS

(*Continued from page 63*)

Board, spoke on the march of radio during the past forty years. The address has been reprinted in a twenty-eight page presentation.

This unusual message portrays effectively the growth of the science of communications.

* * *

SNYDER MOVES TO NEW PLANT

The Snyder Manufacturing Company will soon move to a new plant at 22nd and Ontario Streets, Philadelphia, Pennsylvania.

* * *

RADIOMARINE PROMOTES MacKENTY

John Gilman MacKenty has been elected vice-president and general manager and director of Radiomarine Corporation of America. Mr. MacKenty has been with RCA for twenty-one years, and in charge of foreign contracts for RCA since 1930.

* * *

RUSSELL NOW WITH HALLICRAFTERS

Robert L. Russell, formerly with the legal section of the Chicago Signal Corps depot, has joined the Hallicrafters Company, Chicago, Illinois, as administrative assistant, according to Raymond W. Durst. Mr. Durst also announced the appointment of Cletus Wiot as manager of the Government contract section.

Left to right, R. W. Durst, R. L. Russell and C. Wiot.

* * *

HENRY KASNER, DEAD

Henry Kasner, for thirty years with RCA and its predecessor, the American Marconi Company, died recently, after a short illness.

Mr. Kasner joined RCA in 1920 as a radio constructor. At the outbreak of the present war, Mr. Kasner was assigned to

Henry Kasner

the Field Procurement Division and assisted in procuring vital war materials.

* * *

FCC NEEDS RADIO INTERCEPTORS

Persons qualified to intercept radio messages are needed by the Federal Communications Commission. The positions pay $2,000 and $2,600 a year, plus overtime, which increases the salaries about 21 per cent for 8 hours of overtime a week.

Radio intercept officers will participate with Army Air Forces in effecting radio silence and insuring compliance with silence orders. They will test the efficiency of methods of controls, maintain a continuous watch on distress channels, and otherwise participate in monitoring assignments relating directly to the war effort.

For the assistant radio-intercept-officer post ($2,600 a year), persons must have had either a full 4-year course in electrical engineering or physics at a college or university of recognized standing, 4 years of technical experience in the field of radio, or a time-equivalent combination of such education and experience. For the $2,000 grade, less education and experience is required. Applicants for both grades must be able to transmit and receive in International Morse Code, and in some cases may substitute experience as a radio-telegraph operator, or as an amateur holding a Class A license, or radio and engineering study at a recognized college or radio institute for part of the prescribed education or experience.

No written test is required, and the only age limitation is that applicants must have reached their eighteenth birthday. Positions are to be filled throughout the United States.

Persons using their highest skills in war work are not encouraged to apply. War Manpower restrictions on Federal appointments are given in form 3989, posted in first and second-class post offices. Complete information and application forms may also be obtained at these post offices, as well as from civil service regional offices and from the commission at Washington, D. C.

* * *

WRIGHT NEW I. T. & T. VICE-PRESIDENT

John S. Wright has been elected vice-president of International Telephone and Telegraph Corporation. Mr. Wright has been associated with International Standard Electric and its predecessors for thirty-seven years.

* * *

NATIONAL UNION PROMOTES CLANCEY

J. A. Clancey is now plant manager of the National Union factory at 57 State Street, Newark, New Jersey.

Mr. Clancey entered the radio tube manufacturing business with Westinghouse Lamp Works at Bloomfield, New Jersey, in 1926. He joined National Union in 1930.

* * *

DYNAMOTOR MAINTENANCE DATA

Information covering the operating, servicing and maintenance of dynamotors will appear in a new technical journal that will be published by the Carter Motor Company, 1608 Milwaukee Ave., Chicago, Illinois. The publication, to be known as the Carter Magmotor Memo, will be mailed without charge to those directly associated with or interested in dynamotors, generators and other rotary equipment. It will also contain news on new developments.

* * *

BOB HENRY IN NAVY

Bob Henry has recently been appointed to the Radio Procurement Division of the Bureau of Ships, U. S. Navy.

* * *

KGEO WINS AWARD

The Committee of Alfred I. Dupont Radio Awards has presented to KGEO, the General Electric station at San Francisco, California, a $1,000 award in recognition and appreciation of its outstanding service.

* * *

R. S. LAIRD NOW OHMITE VICE-PRESIDENT

Roy S. Laird, Sales Manager of Ohmite Company, Chicago, Illinois, has been named vice-president. Mr. Laird will also continue as manager of sales.

F. E. GARNER OPENS NEW PLANT

Fred E. Garner Company has opened a second plant at 1100 West Washington Street, Chicago, Illinois.

* * *

DR. HECTOR JOINS NATIONAL UNION

Dr. L. Grant Hector has joined the National Union Radio Corporation as director of engineering.

Dr. Hector is well known for his textbooks on Modern Radio Receiving (1927), Introductory Physics (1933), and other technical papers that have appeared in journals throughout the world. His newest book on Electronic Physics will soon be published.

COMPASS CALIBRATION

(*Continued from page* 55)

ficial. The location must be free of high voltage transmission lines, electrified railways and industrial sections. A point near a large lake or the beach must not be chosen, since an error known as coast-line effect will be present. Small rivers, canals or ponds will not exhibit this effect. An island of very small area, which is not near any other land, may be used as a reference point. However, the desirable reference lines will not be present. It is preferable that the reference point selected be a distance of 50 to 100 miles from the station that is to be used for calibration purposes. For this reason it is mandatory that a high power transmitting station on a clear channel be selected. A station nearer than 50 miles and flying at altitudes greater than 2,000 feet can only be used by sacrificing accuracy. This is due to a greatly reduced tolerance in determining when the aircraft position is over the ground reference point. Usually the aircraft radio compass covers in three bands, the frequency range of 200 to 1,700 kilocycles. Because the calibration varies to a small degree with frequency, the check should be near the center of the band that is most likely to be used for direction finder work. All bands that are subject to use should be checked to determine whether a resonance loop effect is present. This will cause an extreme calibration error. The time period used to make the calibration flights must be several hours before or after sun rise or sun set so as to preclude erroneous bearings.

An illustration of a very satisfactory *ground reference point* with *reference lines,* that is used by the writer, is shown in Figure 7. This is used as a basis of the examples given of flight calibration checks in this article.

Prior to flight, a form prepared to tabulate the data will be of assistance in avoiding the wasting of flying time. The heading of this form should include certain identification data which obviously will be of importance as a

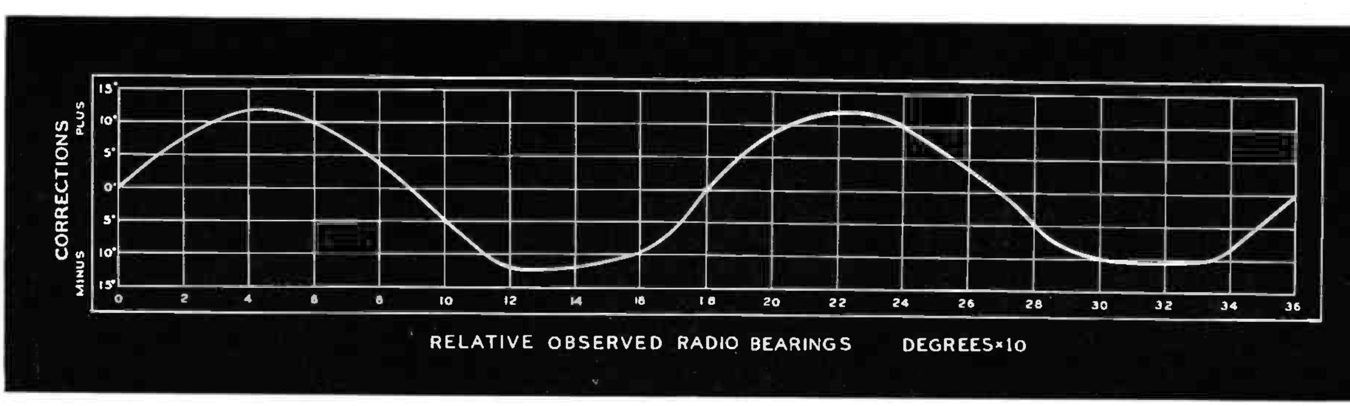


Figure 10
A typical quadrantal curve as plotted from columns 2 and 4 of Figure 9.

record. This should include . . . (*1*)—date; (*2*)—time, giving the starting time and finish time; (*3*)—type and number of aircraft; (*4*)—location of ground reference point and the true bearing to the radio station; (*5*)—location and call of transmitting station; (*6*)—frequency; (*7*)—the aircraft's altitude that is maintained during the flight checks; (*8*)—wind at that altitude, if any, giving miles per hour and direction; (*9*)—drawing number or reference to the location of loop and other antennae on that particular aircraft. Two columns should be provided for the purpose of recording the *direction gyro readings* and the *observed radio bearings.* These readings need not be taken at exact intervals, but may be varied at 10° to 20° intervals through 360°. All other needed figures may be obtained after the completion of the test flight. However, it is good practice to periodically check and re-fly any point that appears to be doubtful, thereby avoiding a second flight for the purpose of obtaining original data. It is considered mandatory that a second flight check be made in order to verify the accuracy of the original calibrating data. This recheck flight is made with quadrantal corrections applied to the loop antenna compensating cam. This procedure offers a very thorough recheck and accurately made will indicate any errors made in the original flight check and in the calculations.

Applying the Quadrantal Corrections

For practical direction finding work there are several methods that may be used to apply the quadrantal corrections. A curve may be plotted to show the degrees that are to be added or subtracted from the radio bearing. The quadrantal deviation can be incorporated in the bearing indicator dial in such a manner that the corrected bearing is read directly from the bearing indicator. Or the quadrantal deviation can be applied to a bearing indicator that is equipped with a dial that reads in true degrees. A cam lever mechanism can be used to advance or retard the bearing indicator needle in the relative position in order to provide the required compensation.

During the radio compass calibration flight checks all *directional gyro readings* are taken with reference to true north. The radio compass bearings may be taken with reference to *aircraft heading* or with reference to true north. If the former is selected, which will be called method *A,* the radio compass bearing indicator dial zero must be accurately set to the index line and remain in that position throughout the flight test.

When using the latter, method *B,* the radio compass bearing reference is from from true north. This means that for each heading that a reading is taken, the radio compass bearing indicator azimuth dial must be adjusted so that the aircraft true heading as taken from the gyro, is set to the index.

When considering which method to use, it is well to consider the advantage of method *B* which will clearly indicate the deviation at a glance. This method does require accurate setting of the radio compass azimuth dial for each heading.

Quadrantal Deviation Calibration Method "A"

From the radio calibration checks using method *A,* the values for two factors . . . *observed radio bearings relative to the aircraft heading* (rel ORB) and *aircraft heading from true north* (TH) were obtained. These readings are taken from the *radio compass bearing indicator* (with the dial "zero" set to the index, Figure 3(a)) and the gyro compass adjusted with reference to true north. Tabulation of these readings, that were made when the aircraft was

(*Continued from page 67*)

directly over the ground reference point, will be all that is needed to calculate the loop antenna deviation and its sign. For each aircraft heading and its corresponding *observed radio bearing*, we must find the values for the corrector cam azimuth and the connection that is to be applied to the *rel ORB*.

In Figure 9 the *rel TRB* (column 3), and the deviation are shown. This was calculated from the *TH* and *rel ORB* readings by using the formula given in Figure 8. For example, when *TH* is 300, *rel ORB* is 0, and the bearing to the radio station from the ground reference point (*K*) is 300, we find that *TH 300* — *K 300* equals zero and the *relative observed bearing* is zero. Since no deviation exists the plane of the loop is at right angles to direction of signal arrival. When *TH* is 290, and *rel ORB* is 7, the condition is that *TH* is less than *K*; therefore, 300 — 290 equals 10 *rel TRB* and the *rel ORB* is 7. The difference is a deviation of —3. This is a +3 correction (column 4), that is applied to *rel ORB* of 7, which equals the *rel TRB*. This minus deviation is present because the distorted r-f field has displaced the loop antenna null 3° towards the nose. When *TH* is 335 and *rel ORB* is 335 the condition is, *TH* is greater than *K*, therefore, *TH* 335 — *K* 300 gives *K'* 35, and 360 — 35 equals *rel TRB* 325. Therefore, *rel TRB* is less than *rel ORB* and *rel ORB* 335 — *rel TRB* 325, provides a +10° deviation and requires a —10° correction.

Plotting of Quadrantal Corrections

For practical use it is necessary that the radio compass *corrections* be plotted with their signs as determined from the calibration check tabulations. It is preferable that linear cross-section paper, ten divisions per unit, be used to plot the corrections against the *relative observed radio bearings*. Thus the corrections plus, are plotted above the *X* axis *rel ORB* and minus corrections below.

It is from this curve that values are taken by interpolation and applied to the corrector compensating unit. This is shown by referring to the curve of Figure 10, and the table given in Figure 11, for the set-up of the corrections on the compensators. The points that are selected on the curve are those that correspond to adjustment positions as indicated on the compensator azimuth.

Because of the several possible methods that can be used to obtain the radio compass deviation data, it is possible that the results may be confused, producing the introduction of serious errors. For this reason it is well to mention an isolated case where radio bearing errors were obtained with a supposedly calibrated radio compass. An examination showed that maximum quadrantal deviations were present at approximate positions relative to the aircraft heading at 60°, 120°, 240°, and 300°. When the compass compensator

(*Continued on page 70*)

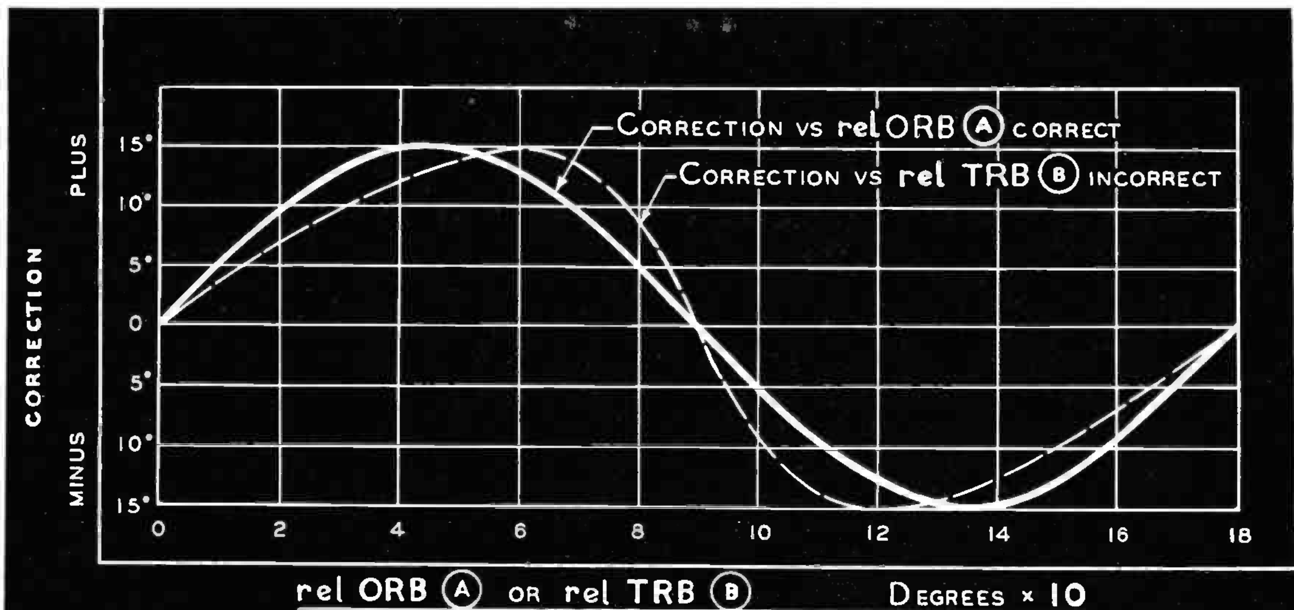


Figure 12

Illustration of the correct and incorrect method of plotting the quadrangle correction curve. This curve represents assumed values.

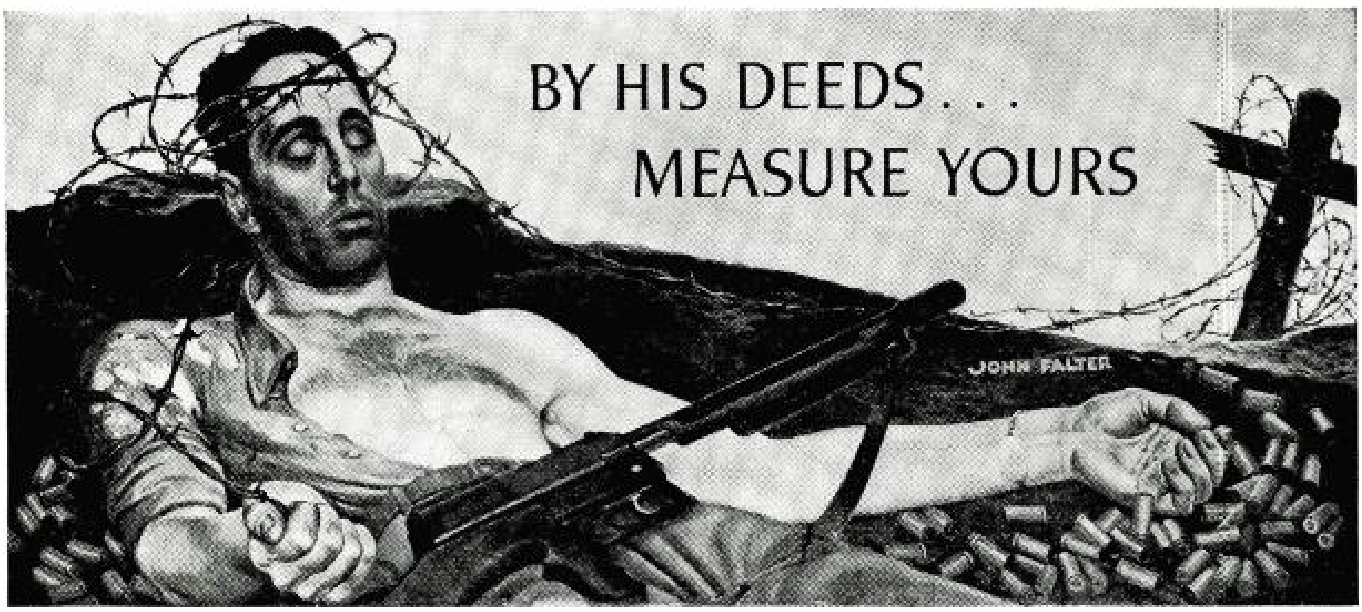
CALIBRATION DATA

rel TRB	rel ORB	CORR.
0	0	0
15	10	+5
30	20.5	+9.5
45	31.5	+13.5
60	45	+15
75	63	+12
90	0	0
105	117	−12
120	135	−15
135	148.5	−13.5
150	159.5	−9.5
165	170	−5
180	180	0

COMPENSATOR ADJUSTMENT

AZIMUTH SCALE	CORR.
0	0
15	7.5
30	13.
45	15.
60	13.
75	7.5
90	0
105	7.5
120	13
135	15
150	13
165	7.5
180	0

IT is not pleasant to have your peaceful life upset by wartime needs and restrictions and activities.... It is not pleasant to die, either.... Between you who live at home and the men who die at the front there is a direct connection.... By your actions, definitely, a certain number of these men will die or they will come through alive. If you do everything you can to hasten victory and do every bit of it as fast as you can... then, sure as fate you will save the lives of some men who will otherwise die because you let the war last too long.... Think it over. Till the war is won you cannot, in fairness to them, complain or waste or shirk. Instead, you will apply every last ounce of your effort to getting this thing done.... In the name of God and your fellow man, that is your job.



The civilian war organization needs your help. The Government has formed Citizens Service Corps as part of local Defense Councils. If such a group is at work in your community, cooperate with it to the limit of your ability. If none exists, help to organize one. A free booklet telling you what to do and how to do it will be sent to you at no charge if you will write to this magazine. This is your war. Help win it. Choose what you will do—now!

EVERY CIVILIAN A FIGHTER

CONTRIBUTED BY THE MAGAZINE PUBLISHERS OF AMERICA

COMPASS CALIBRATION

(*Continued from page* 68)

was so adjusted from this data, it was found that errors of five to ten degrees in some sectors were consistently observed. Assuming that the data obtained from the calibration procedure was correct, it would be a logical assumption that the cause of these errors was due to the fact that the quadrantal corrections had been plotted and applied against the heading of the aircraft (*rel TRB*,) instead of against the relative observed radio bearings.

The following discussion may clear up the confusion that apparently existed in this incorrectly adjusted compensator. Let us take the instance of a voltmeter to be calibrated, using a standard voltmeter as a checking guide. When the standard voltmeter reads 100 volts and the meter being calibrated indicates 95 volts, then the correction of 5 volts would be applied to the 95 volt reading of the meter being calibrated, not at the 100 volt reading. By another method, if adjustments are made for a given reading of the voltmeter being calibrated, at say 100 volts, and the correct voltage is read from the standard, say 106 volts, the correction of 6 volts would be applied to the 100 volt reading of the meter under calibration, but not to the 106 volt reading. In other words, the voltmeter may be calibrated by either setting the voltage to given values as noted on the standard meter and noting the corresponding readings of the meter being calibrated, or the voltage for given readings on the meter being calibrated may be read directly from the standard meter. The corrections are always applied to the observed readings of the meter under calibration for either method, not to the readings of the standard voltmeter.

Applying this voltmeter analogy and studying the progressive angles, as illustrated in Figure 8, we see that the radio compass quadrantal calibration may be made either by orientating the aircraft for given headings with respect to the radio station and recording the observed radio bearings, or by orientating the aircraft for given observed radio bearings and recording the corresponding headings of the aircraft. The algebraic difference between the aircraft heading and the observed radio bearing will be the correction to be applied at that particular point on the relative observed radio bearing. The term heading or relative true radio bearing (*rel TRB*) is used to refer to the angle at the aircraft, between the fore-and-aft center line of the aircraft and the line from the radio station.

The compensator unit that is in the MN-31 Compass Loop is provided with adjustment screws at 15° intervals of 360°, so that corrections may be easily applied at those points. Since the *correction pointer* on the compensator unit is clamped to the shaft of the autosyn transmitter* the position of the pointer on the azimuth or outer scale of the compensator corresponds to the position of the needle pointer in the bearing indicator. The circular plate carrying the cam roller and having the correction scale marked on its surface is coupled directly to the loop through a pin which acts as a crank arm. The position of the zero index mark on the *correction scale* corresponds to the null position of the loop, that is, the *rel ORB*. For zero correction of the compensator at all points, the pointer and the correction scale zero will coincide. The results obtained from a normal calibration procedure (zero correction settings at all points on the compensator) show the "null"

(*Continued on page* 79)

*The autosyn transmitter and receiver is a motor type device used to electrically transfer angular indication from one point to another.

(1) AZIMUTH	(2) POINTER	(3) CORRECTION
0	0	0
15	21	+ 6
30	40	+ 10
45	57	+ 12
60	70	+ 10
75	80.5	+ 5.5
90	90	0
105	98.5	— 6.5
120	108	— 12
135	123	— 12
150	139	— 11
165	157	— 8
180	180	0
195	202	+ 7
210	221	+ 11
225	237	+ 12
240	250	+ 10
255	260.5	+ 5.5
270	270	0
285	278	— 7
300	290	— 10
315	305	— 10
330	320	— 10
345	336.5	— 8.5
360/0	360/0	0

Figure 11
Data taken from "A" curve of Figure 10. These are the twenty-four points that correspond to the corrector cam unit adjustment points.

SUPER-REGENERATION

(*Continued from page 22*)

Where the highest frequency involved is 4,000 cycles per second, $X_c = 40$ megohms per mmfd. Since most of the power of speech lies in frequencies just below 1,500 cycles, it is apparent that most of the high percentages of modulation will be at these frequencies. A safe percentage to use for 4,000 cycles, even with 100% modulation at voice frequencies, is 60% to 70%. This is equivalent to a ratio of $\frac{X_c}{R}$ of 1. Since one mmfd. of capacitance, is approximately equal to 40 megohms, it is only necessary to divide this value by the value of *R* to ascertain the valuation of *C*. Some representative values are: $R = .5$ megohms, $C = 80$ mmfd.; $R = 1$ megohm, $C = 40$ mmfd.; $R = .25$ megohms, $C = 160$ mmfd.

We now have our first determinant for values of *C* and *R*. As long as we adhere to this rule, the fidelity characteristics of the detector may be neglected.

Signal-to-Noise Ratio

The next characteristic, the signal-to-noise ratio involves the entire design. Actually, there are two signal-to-noise ratios. One is the signal-to-noise ratio in the presence of a signal; that is, the signal-to-noise ratio for a modulated signal to the back-ground noise. The other is a signal-to-noise ratio, or an unmodulated carrier to the natural noise inherent in a s-r detector. The first ratio involves an audio frequency characteristic; the second a r-f characteristic. Since we are interested in optimum design, we can set up any modulation percentage, that is 30%, and say that the signal-to-noise ratio shall be 10 db. The ultimate determinant of efficiency will then be the smallest signal which will give us this ratio. The noise referred to in this ratio is the inherent noise and not the background noise in the presence of an unmodulated signal. The modulation frequency may be any frequency, but since most generators are set at 400 cycles, this can be the accepted standard.

Selectivity

At this point it will be necessary to investigate the factors which determine the selectivity of the s-r detector, and what relationship selectivity bears to

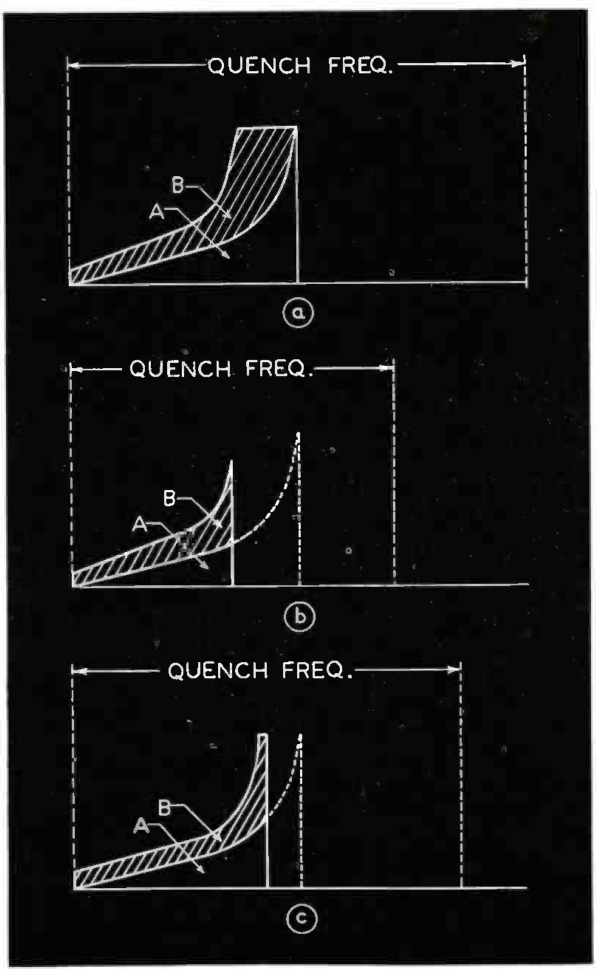


Figure 15

The effect of a received signal on a resonant rise of voltage amplitude. At (a), the logarithmic action. At (b), we have the linear action, and at (c) appears the combined linear and logarithmic action. The shaded areas are representative of the increase in grid bias due to the received signal.

(*Continued from page* 71)

sensitivity. The ultimate determination of the selectivity of any circuit is the Q of that stage or the ratio L/R. This is particularly true of the s-r detector. However, in this particular circuit, R becomes a variable factor because of the voltage fed to the grid by the plate. Due to this fact, R may vary from $+R$ to $-R$. When R is negative, which will be true of the grid circuit of a tube used as for feed-back oscillation or quench oscillation, the relationship $\frac{-RT}{\varepsilon 2L}$ determines the extent of voltage growth or decay, when

T = time of ½ cycle of frequency,
L = inductance in grid circuit in ohms for resonant frequency, and
— R = negative resistance introduced into the grid circuit by feed back.

As R approaches zero, that is, as feed back is reduced, the time necessary for the grid driving voltage to reach its maximum, would be longer. This is merely another way of saying that the quench frequency would necessarily be lower. At the same time, the ratio would increase, increasing the Q of the circuit and the selectivity. This can be attained, however, only at a cost of sensitivity, since as the selectivity increases, the sensitivity decreases.

From the above, it can be seen that increasing the value of time L, would increase both the gain and the selectivity.

Mode of Operation

It is important in the designing of a super-regenerative detector to determine the mode of operation; that is the relationship of quench frequency to resonant frequencies. The method of application of quench frequencies, will to a large extent, determine the values of the various components.

Self-Quenched Detectors

The use of a separately quenched detector has been outmoded by the satisfactory results obtained by the use of self-quenched detectors. Of the two methods used for self-quenching the writer prefers the method of having a tube oscillate at both frequencies. Though this method means the use of additional components, the control attained by this method more than repays for the use of the extra parts. In actual design, sine wave quenching is used exclusively. This means that the decay factor is not as abrupt as with square wave voltages. This factor will be treated upon in the discussion of a factual design. Another factor to be treated upon in the factual design of

(*Continued on page* 79)

NOTICE

Inductions into the armed forces and demands of war production industries have created shortages of labor necessary in the printing, handling and mailing of publications.

If your monthly copy of COMMUNICATIONS should be late in reaching you — remember that the delay is due to war conditions and the war effort must come first.

Please bear with us.

Thank You!

VWOA NEWS

(*Continued from page* 50)

many of the articles in the Year Book and conducting the broadcast of "Radio in the last War" over WOR and the Mutual Broadcasting System. . . . "Bill" Simon, our treasurer, together with Bob Pheysey, and some others did a swell job on the tickets for the dinner-cruise. . . . Our grateful appreciation to "Jack" Poppele, chief engineer of WOR for the fine public address system at the dinner and the services of Dr. Wm. Standley Simms, American humorist of the WOR artists bureau, who kept the assembled guests in a continuous state of laughter ("Jack," on behalf of our Association, sent recordings of the acceptance speeches to each of the representatives of the armed services and the Merchant Marine). . . . "Steve" Wallis, Lt. Commander in the Maritime Service, who was at the dinner with Mrs. Wallis, will open the Maritime Service Radio School at Huntington, L. I., some time in March. . . . Commander Fred Muller had two tables of Navy personnel at the dinner including several very attractive WAVES. . . . Mrs. Follett Bradley, wife of General Follett Bradley, who received our Marconi Memorial Commemorative Medal attended the dinner and was thrilled at the honor bestowed upon the General. . . . Mrs. Dawson Olmstead, wife of the Chief Signal Officer, Major General Dawson Olmstead and Major Ketterer, the General's aid, accompanied him from Washington and were guests at the dinner. . . . Our deepest appreciation to George W. Bailey, our special Washington representative for his outstanding job of coordinating the dinner activity in Washington, making possible the most imposing representation of top ranking communications people ever to attend one of our dinners. Keep up the good work, George, and feel assured we all are genuinely grateful. . . . Glad to see E. A. Nicholas, life member and president of the Farnsworth Television and Radio Corporation at the dinner. . . . Shocked at the death of Henry Kasner, who contributed so much to the development of communications. We at the VWOA will particularly miss him, for his efforts in our behalf were always outstanding. . . .Ted McElroy, who accepted the medal of achievement for Bill Halligan at the recent New York dinner-cruise, presented the medal to Bill at the Chicago dinner-cruise. Reports are that Bill was speechless when Ted made the presentation. We felt particularly proud in presenting this medal to Bill, and we hope that next year he will be table to take a run out to our dinner in the East and say hello to us here.

OSCILLOSCOPE SWEEP CIRCUITS

(Continued from page 30)

and Roberts.[5] Ghiron[4] gives zones of synchronization which seem to consider only the straight line portions of Figure 12.

Since δ is the sine of the phase angle, ψ, one can superimpose on the Builder-Roberts diagram the lines of equal phase. The equation for δ, (15), can be rearranged as . . .

$$r = \frac{s\delta + 1}{N} \qquad (17)$$

For fixed values of N and δ this is a straight line. For a given N value it is a family of straight lines through the point: $(s, r) = (o, 1 \div N)$. These are the equiphase lines. They have a slope . . .

$$\frac{dr}{ds} = \frac{\delta}{N} \qquad (18)$$

A few are drawn into Figure 13.

We now have a complete picture of the action of the synchronizing mechanism, as the strength of sync and frequency ratio are varied. It is handy is have this diagram in mind when operating a scope.

One can correlate the earlier equation (11) with this diagram. In terms of the quantities N, r, s, δ, equation (11) becomes . . .

$$\delta = \frac{Nr - 1}{s} \qquad (19)$$

which is precisely the same as (17).

Equation (8) for the maximum deviation of f_n for a regular pattern with $N = 1$ becomes . . .

$$|r - 1| \leq s \qquad (20)$$

which gives the region between the straight line portions of the $N = 1$ zone. This is correct for small sync amplitudes.

Oversynchronization

There has been nothing said of the action of the sweep circuit outside the shaded areas other than to say it is not "regular." To investigate the manifold possibilities would be an extensive and probably useless research. Experimentally one observes either a rapidly slipping picture or a superposition of pictures.

Construction of Figure 12

There is one strange pattern, however, that might warrant explanation. One derives it from the following construction. . . . Figure 12. Let us draw a sinusoidal curve, then pick a point *a*, part way up the curve, and a point *b* near the bottom. Let us now draw horizontal and vertical lines through *a* and *b*. Locate *c*, and draw a vertical line through *c*. Now let us draw a line through *b* so that $\triangle\, bde = \triangle\, gcf$. Let us now draw a horizontal line through *e*. This is the base line and *ebhc* is the sweep wave. If the points *a* and *b* are not luckily chosen, the line *hc* will cut the lower sinusoid and then the construction will not work. Just from the drawing we have $r \sim 1\frac{1}{4}$, $s \sim \frac{1}{2}$. On the zone diagram of Figure 13, it lies somewhere near the mark ⊗. The reader might like to determine the region of the (s, r) plane where this pattern prevails. Patterns such as this might be said to be due to oversynchronization.

Sweep Wave as Time Base

When such a sweep wave is used as a time base for observing the synchronizing wave, the picture appears somewhat as in Figure 14. (On most scopes the sinusoid is turned over as shown.)

Figure 15 is an oscillogram taken with an electronic switch showing the wave of Figure 12. Unfortunately the saw tooth is upside down. Figure 16 shows a sine wave tied in a knot by such a sweep. This should be compared with Figure 14.

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(*Continued from page* 57)

nected with "butterfly" indication vanes by a simple lever hookup. The fluorescent "butterfly" opens instantly to show signals reflecting the proper indicator light. These "butterflies" are furnished in red, amber and green. When not indicating, the signalette is black. Its overall length is 2 5/32 inches. It can be mounted in panels up to 3/8 inch in thickness.

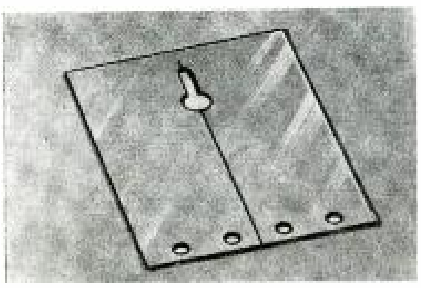
* * *

PLASTIC HAIRLINE INDICATOR

A plastic indicator, with a hairline type index line, has been produced by Printloid, Inc., 93 Mercer Street, New York City.

The fine line engraving can be made in widths as narrow as 1/1,000 of an inch thick.

Other sizes, thicknesses and line widths are available.



* * *

ACME ARMORED INSULATION TRANSFORMER

To overcome the effects of high voltage aging, the Acme Electric & Manufacturing Company, Cuba, New York, has developed an armored-insulation high voltage plate supply transformer. It is rated at 3300 volts and contains a 1.8 ampere secondary.

* * *

LIGHTWEIGHT THYRATRON TUBE

Designed for applications where weight and space must be considered, a new thyratron tube with both a control and a shield grid for control applications, has been announced by G-E. Designated as the GL-502, the new tube is a little over two and one-half inches long, weighs about two ounces, is inert-gas-filled and of all-metal construction. Applications for the new tube will be found in industrial welding and any general control equipment.

"The control characteristic is practically independent of ambient temperature over a wide range," according to O. W. Pike, G-E engineer. "Since the grid current is low enough to permit the use of a high resistance in the grid circuit, the new thyratron has high sensitivity characteristics. The grid-anode capacitance is low enough so that the new tube is relatively unaffected by line-voltage surges. It has a maximum peak inverse anode voltage rating of 1300 volts, instantaneous current rating of 500 milliamperes, and an average current rating of 100 milliamperes. The cathode is quick heating and is rated at 6.3 volts, 0.6 ampere."

* * *

GIVE TO THE RED CROSS

EMERGENCY RADIOTELEPHONE SYSTEM

(*Continued from page* 42)

instance over 5,000 messages were completed via circuits using this equipment following a recent storm. After the New England hurricane, some years ago, it was these emergency radio telephone sets that spanned a river, where floods had washed away river crossings, and linked homes and persons in countless isolated areas.

Incidentally the gasoline driven generator can provide all of the power necessary to operate not only the radio equipment, but some auxiliary equipment which may be needed. The radio unit may be operated from a commercial power supply whenever it is conveniently available. However, it is always possible that the same difficulties which are hampering telephone service will also affect power service. Accordingly, a power supply is provided with every unit.

Today, more than ever before, the importance of these emergency systems has become truly vital. We all hope that they will never have to be used for the dire emergencies of war. But they are available and ready to serve when the call is made.

Figure 6

At a recent IRE meeting in Cleveland, a typical emergency radiotelephone system was effectively demonstrated. The speed with which this system may be put into operation was shown. Members at the meeting being called by this emergency system, were unaware that the emergency unit was in operation, so thorough was the circuit link and equipment operation.

CRYSTAL PRODUCTION

(*Continued from page 62*)

activity and are difficult to finish. Even if the crystals get clear to the laps in perfect condition, they can still be ruined. If the lappers do not lap the crystals to the desired flatness, the activity of the crystal is decreased and even an abrasive scratch on the surface or a broken corner will keep a crystal from oscillating.

Yes, it is pretty ticklish business. There is plenty of room for research and new ideas. Perhaps after this "hustle bustle" of war production, there will be more time to solve all the little problems that are now going unsolved, for today production must be maintained at any cost.

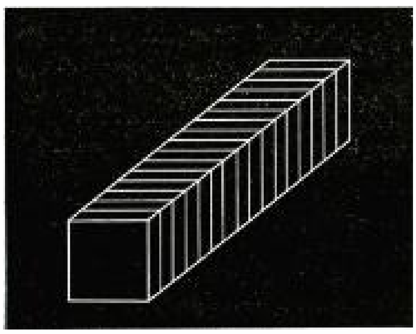


Figure 9
A loaf of crystals.

AIRCRAFT RECORDER

(*Continued from page 49*)

instrument readings at definite time intervals. This is possible with an intervalometer. This device is quite an important one, particularly in those instances where it is necessary to make a study of, for instance, climbs. Controlling this intervalometer are especially designed cams and selector switches.

Thus far, the pickups designed for use with this recorder, provide a variety of information ranging from strain, height, speed, pressures, and differentials, to exhaust gas temperatures. Plans are now afoot to even expand this wide list of applications so that our planes will continue to establish new records of performance in speed, reliability and safety.

* * *

BUY UNITED STATES WAR SAVINGS STAMPS AND BONDS FOR VICTORY

SUPER-REGENERATION

(*Continued from page 72*)

a s-r detector will be the factor of large signals and the design of an r-f stage to prevent reradiation and increase of both the sensitivity and selectivity.

[In the April issue of COMMUNICATIONS, the design of an actual s-r receiver will be traced from specifications to final construction, by Mr. Meyerson.]

COMPASS CALIBRATION

(*Continued from page 70*)

position of the loop with respect to the center line of the aircraft for various headings of the aircraft.

Since the null postions of the loop will not change in use under similar conditions from the positions noted in the calibration procedure for the various headings of the aircraft, corrections are applied to the null positions of the loop (*rel ORB*), to make the readings of the pointer on the compensator or the bearing indicator agree with the respective headings of the aircraft.

For example, as shown in the table (Figure 11), the azimuth 15°, has a correction of plus 6°. The corrector scale zero index is placed at 15° on the azimuth and the adjustment is made so that the pointer reads 21° on the azimuth and plus 6° on the corrector scale. While this adjustment is being made, we must be careful to hold the correction scale index at 15° on the azimuth scale.

The corrections to be applied at 15° intervals on the compensator may be determined directly if the headings of the aircraft are noted for 15° intervals in observed radio bearing indicator readings, since the data is obtained under conditions when the zero of the *correction scale* is over each adjustment screw. This is not recommended for flight check calibration procedure; first, because of the required exceedingly precision flying and second, because the practice of flying given radio bearing indicator course headings and observing the heading of the aircraft (or relative true radio bearings) is not generally done, since most pilots are in the habit of establishing the heading of the aircraft by the use of the directional gyro compass.

In Figure 12 a one-half assumed correction curve is shown; 12(a) shows the correct method of plotting the corrections against the *rel ORB,* while 12(b) shows the incorrect method of plotting the corrections against *rel TRB.*

For each type of aircraft and loop antenna installation the deviation will vary accordingly. However, it will be found that the quadrantal error for a given type aircraft and loop antenna location will be correct for other identical aircraft and installations provided no differences in the antennae, projection, etc., exist. From this it is recognized that any external changes on the aircraft will necessitate a recheck of the loop antenna calibration.

Loop Antenna Compensator Units

The cam lever mechanism is so arranged that a radial travel in an outward direction will cause the bearing indicating needle to advance, i.e., to exceed in a clock-wise direction the angular position of the loop antenna. When the cam actuates the lever in the opposite direction, the result is a retardation of the needle with reference to the loop position.

Credits

To Wilbur L. Webb and Gerald O. Essex of Bendix Radio, the writer wishes to acknowledge their assistance in furnishing references for the preparation of this article and the use of Essex's voltmeter analogy. The writer also wishes to extend thanks to W. E. Price of Sperry Gyroscope Co. for his assistance. (*Photographs are by courtesy of Bendix Radio; Figure 3 courtesy of Eastern Air Lines.*)

[To Be Continued]

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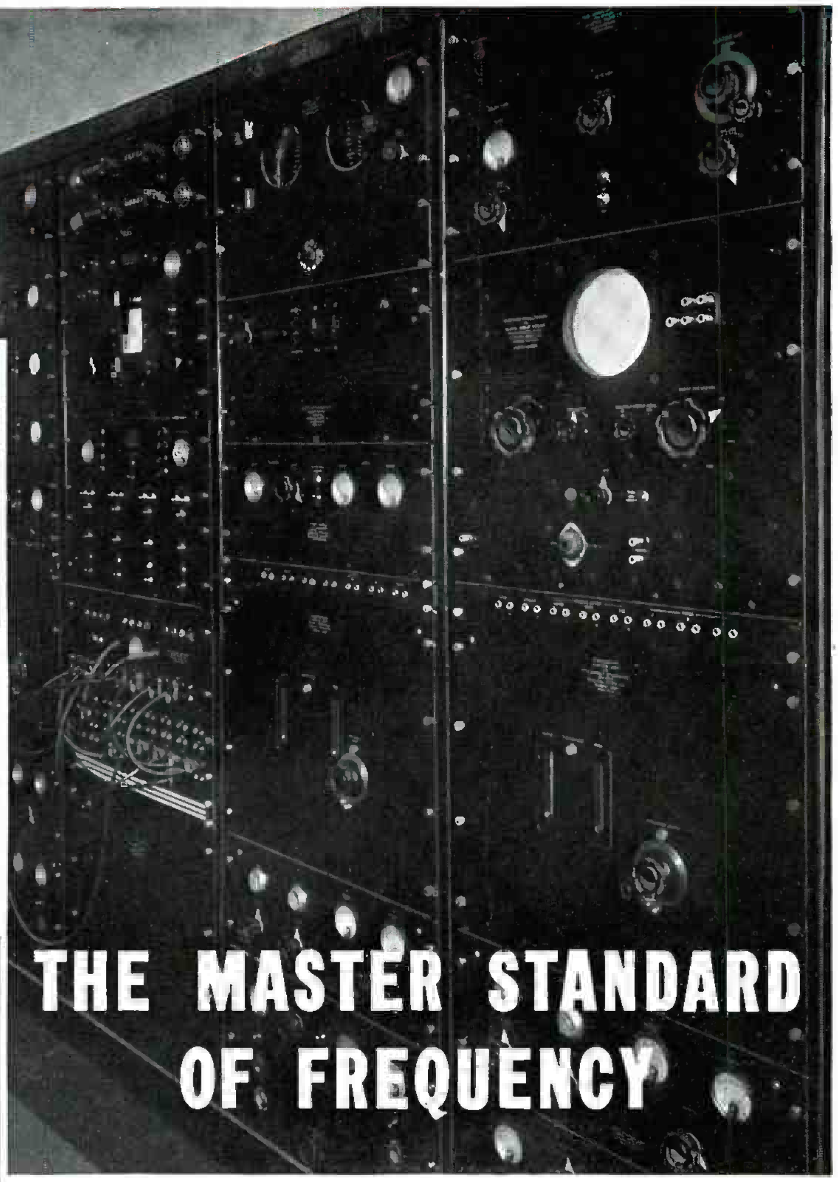
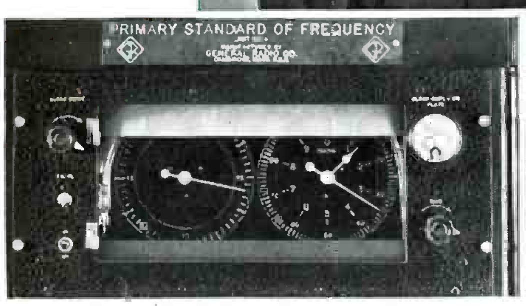
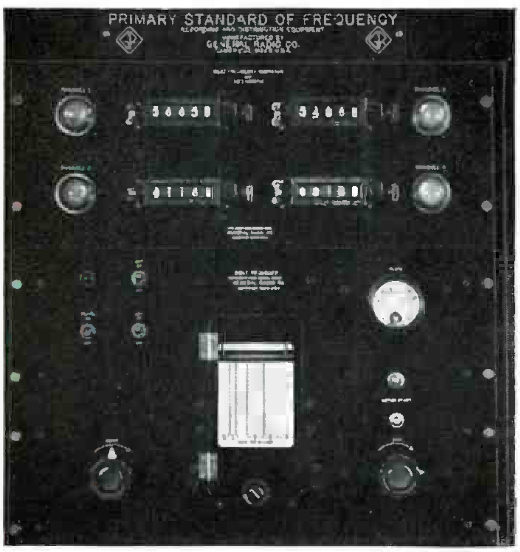




The stroboscopic clock is for comparison of integrated oscillator frequency with radio time signals. The hand on the dial at the left indicates seconds; the two hands at the right indicate tenths and thousandths of seconds. The received time signal flashes a stroboscopic lamp, which arrests the motion of the tenth-and thousandths-seconds hands once each second. The precision of reading is about 0.0002 second, which is equivalent to approximately two parts in one billion for a twenty-four-hour interval. Variations in radio-time-signal transmission, of course, make it impossible to utilize this precision completely.



Note the recording panels which show the beats between pairs of oscillators. The deviation from a vertical line is a measure of the variation in frequency of one oscillator with respect to the other, as indicated by the scale at the bottom of the chart. The precision of reading can be increased or decreased if desired. Beats are recorded between each of four oscillators and a common reference oscillator. If all beat records show identical deviations, the reference oscillator is drifting, while if only one line deviates, the drift is in the oscillator being measured.

Above the recorder are counters which indicate the time in seconds for a predetermined number of beats.

Nearly twenty years ago, the General Radio Company started a program of research and development in the field of frequency standardization, which has produced many general-purpose and specialized frequency measuring instruments for the world's civil and military communication systems.

The center of this research program is the master primary standard of frequency shown here, which supplies standard frequencies for the calibration of General Radio instruments and for measurements in the General Radio laboratories. Consisting of five quartz-crystal-controlled oscillators, with means for timing and intercomparing their frequencies, this standard is far more accurate than present-day commercial requirements. In addition to the frequency standard itself, the racks shown in the photograph include experimental equipment in which new circuits and methods are proved before their incorporation into commercial instruments.

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RCA Victor Division, *Camden, N. J.*

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