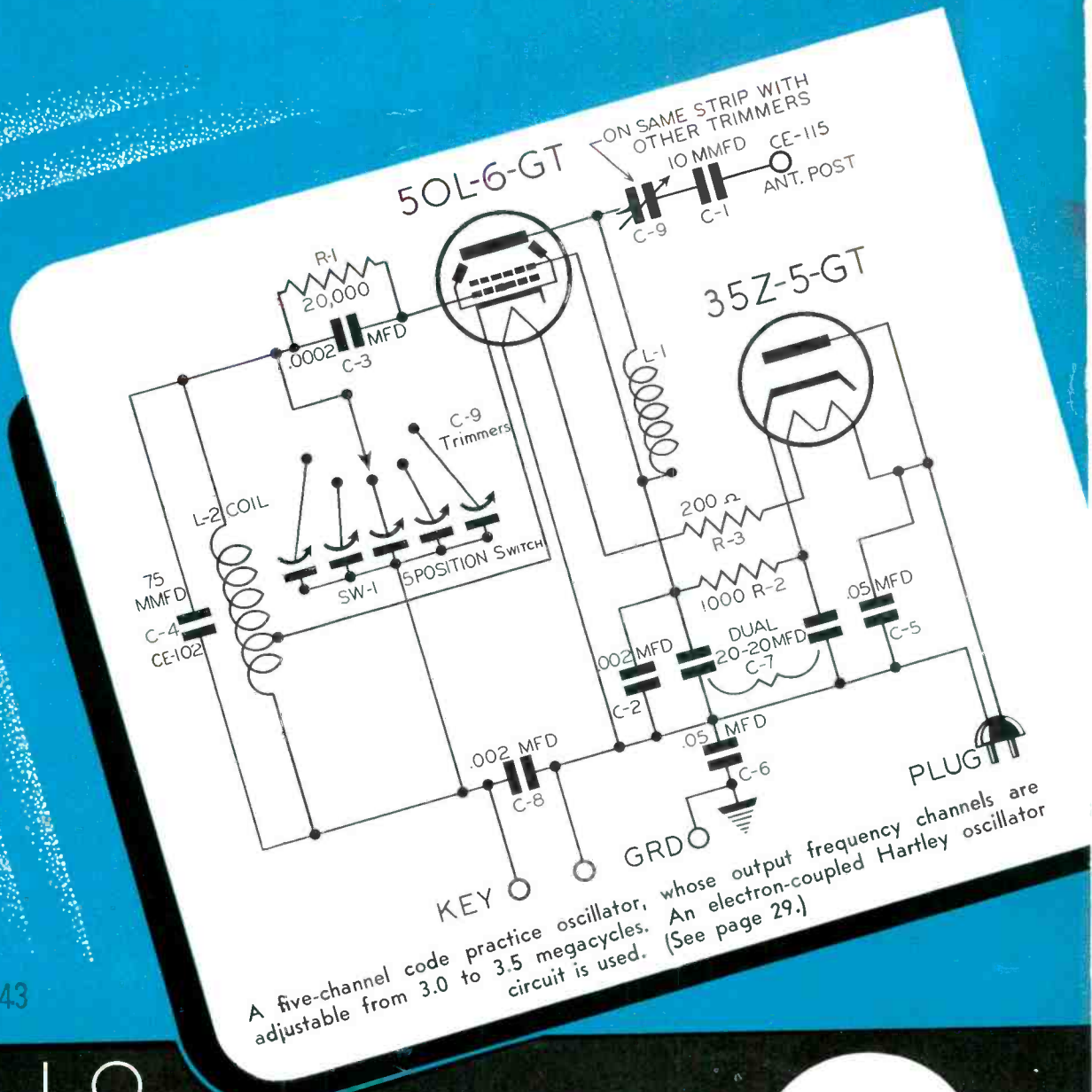
SERVICE

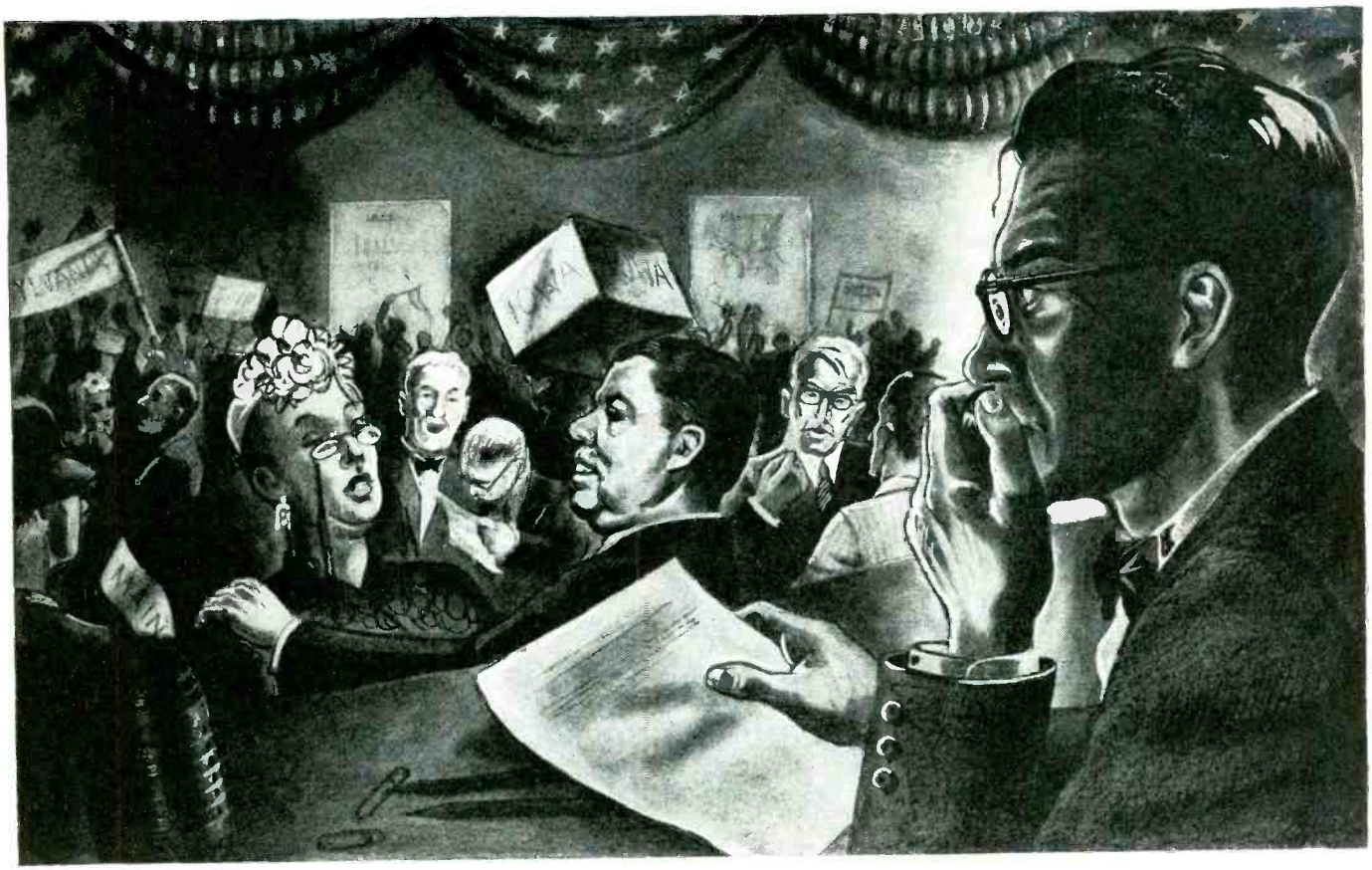
A MONTHLY DIGEST OF RADIO AND ALLIED MAINTENANCE



A five-channel code practice oscillator, whose output frequency channels are adjustable from 3.0 to 3.5 megacycles. An electron-coupled Hartley oscillator circuit is used. (See page 29.)

★ RADIO
★ TELEVISION
★ ELECTRONICS

AUGUST
1943



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EDITORIAL

RECEIVER maintenance has again received headline prominence in dispatches from Washington. For, according to WPB vice-chairman Arthur D. Whiteside of the Office of Civilian Requirements. . . . "Adequate replacement parts and labor must be made available to maintain existing essential equipment in the hands of civilians in operating condition. . . . The distributive and service trades must be maintained to the extent necessary to make essential goods and services available to civilians when and where needed. . . . Every effort will be made to economize the use of resources and conserve the goods now in civilian hands."

Radio, which is included in the *essential services*, has its part in this vital plan to strengthen the civilian economy of the nation. Mr. Whiteside is directly familiar with consumer problems and a true friend of the consumer. So watch for action from A. D. Whiteside of the OCR.

FOR the Service shop that finds itself forced to place its precious test instruments in the hands of relatively untrained new personnel for the duration, Alfred A. Ghirardi's timely series of articles on *"First Aid" to Test Instruments*, which begins in this issue, is *must* reading. The information provided will prevent damage to many a meter and will enable the average Service Man to make minor repairs on those instruments which require them.

THE show must go on is more than a phrase to the theatrical world. And today, the show must go on, is more than just a phrase to everyone, particularly those in the business of Servicing.

Regardless of the problems that face us, we must keep going. Shops should be kept attractive; that may mean many extra hours of effort. Display-piece life must be extended. We have to be carpenters, electricians, delivery clerks and what have you. But that's still better than ducking bombs. Don't get sour. . . . keep the show going!

SERVICE

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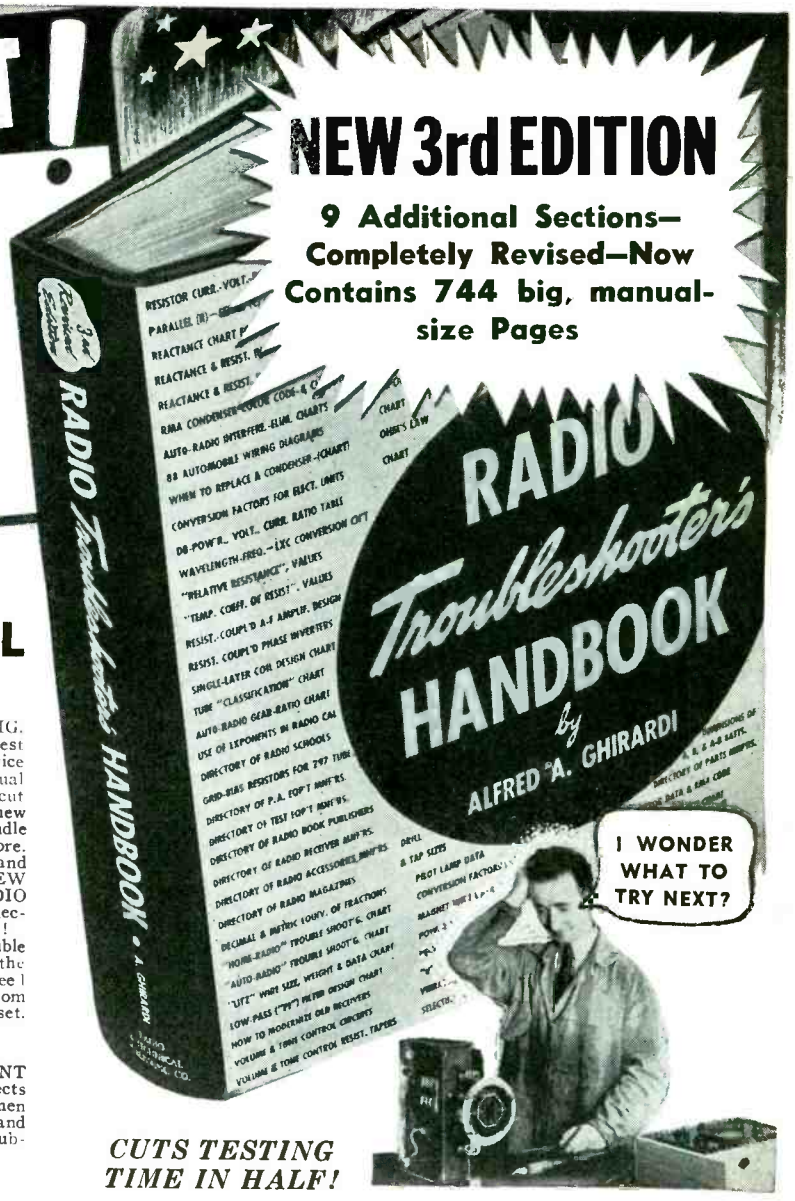

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SERVICE
A Monthly Digest of Radio and Allied Maintenance

"FIRST AID" TO TEST INSTRUMENTS

By ALFRED A. GHIRARDI
Advisory Editor

PART 1 *TROUBLES*

IN these days of national emergency the acute shortage of radio test instruments and the necessity for the greatly increased use of those on hand by relatively untrained personnel in radio service shops, radio manufacturing plants and military training schools, makes it more than ever necessary that they be better understood and cared for.

A knowledge of their construction, natural limitations, the troubles and inaccuracies that may occur in them through use, abuse and normal wear and, finally, suggestions for diagnosing their ailments and correcting such of those as are within the practical ability of the average radio Service Man to tackle himself, will help us to make better use of those precious instruments we are fortunate enough to possess, and to greatly lengthen their useful life.

We are concerned mainly with the small moving-coil d-c, rectifier type a-c, and moving-iron a-c indicating instruments, since they serve as the foundation for most of the indicating type test instruments now employed in radio service work.

The fundamental constructions of both the moving-coil and moving-iron type indicating instruments are well known to every Service Man so they will not be reviewed again here.*

Electrical Instruments Are Delicate

The propelling energy of as tiny a current as the 1 milliampere or less that will produce full-scale deflection of the moving parts of indicating instruments commonly employed in radio-electronic test equipment, is very slight. Consequently, friction and the mass and inertia of moving parts in these instruments must be reduced to a minimum. Friction is minimized through the use of carefully ground and highly polished hardened steel pivot points seated in bearings of sapphire jewels, to support the moving coil (see Fig. 4). Then, with friction substantially eliminated, a precisely controlled degree of retardance must be introduced by means of the springs (see Fig. 3). These springs represent a very high achievement of the metallurgical arts. Not only do they provide just the right retarding value for a given coil, current range, and magnet combination, but this action must be progressive in order that the extent of the coil (and pointer) movement will vary directly with the amount of current applied to the coil. Then, in addition, the springs must be permanent in their mechanical characteristics if the instrument accuracy is to be maintained and if the pointer is always to return precisely to the zero point on the scale when no current is applied.

To take fullest advantage of the slight electrical energy being measured, it is necessary that the air gap in which the coil moves be very narrow, thus providing high concentration of the magnetic flux. This involves precise alignment of all related parts if the moving coil is to swing clear without striking the core or pole pieces which constitute the walls of the gap.

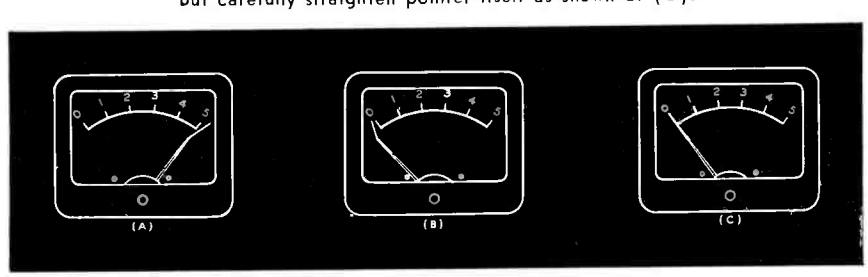
All this indicates something of the delicacy and precision with which the modern indicating instrument is manufactured. In many respects such a movement is comparable with that of a fine jeweled watch, and it should be treated with much the same care. If it is to retain its original inherent accuracy, every part must remain in perfect condition. Once this fact is recognized, the Service Man will enjoy a much greater degree of freedom from instrument troubles. Too often the fact that instruments will withstand considerable abuse often leads to carelessness and excesses in this direction. They are bumped around on the bench, tossed into the service kit which as often as not rides on the floor of the car or truck on service calls, are electrically overloaded, and in other ways treated as one would not think of treating any other comparably delicate device.

The effect of such treatment is likely to be cumulative. Perhaps for a time no apparent damage results (a factor for which the instrument manufacturer deserves full credit). A day will come, however, when the accumulating effect of this sort of treatment passes the instrument's limit of endurance. Its inherent accuracy becomes seriously impaired, or it may stop functioning altogether.

Even permanently-installed instruments that are not subjected to such extreme physical abuses, can have their readings made unreliable because of damage caused by an accidental knock or a blow, continual vibration, powerful nearby magnetic fields, or electrical overload.

The common troubles that may develop in electrical indicating instruments and cause either *inaccurate indications, erratic operation,* or *no*

Fig. 1. How to correct a bent pointer condition. At (A) we see the condition of the pointer if it slams against the stop at end of scale. Do not bring bent pointer back to zero mark by means of the "zero adjusting screw," as shown at (B). But carefully straighten pointer itself as shown at (C).



*For a thorough explanation of the construction and operation of these, see the author's servicing textbook, "*Modern Radio Servicing.*"

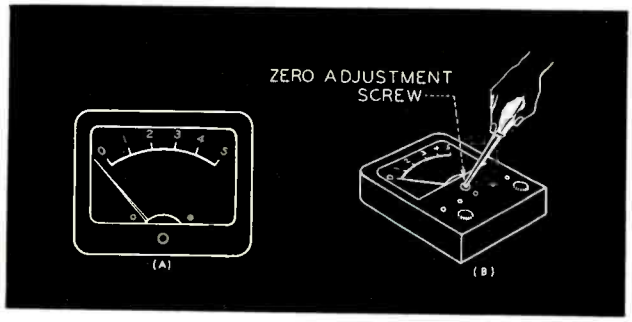


Fig. 2. How to correct for "zero shift." If the pointer is "off zero" (A) all readings will be in error. The pointer should be set exactly to zero by carefully adjusting the "zero adjusting" screw (B).

operation at all are of two major types:

(*1*)—*Mechanical troubles.*
(*2*)—*Electrical troubles.*

Mechanical troubles are mentioned first because they are the cause of the majority of instrument troubles. A few of them will now be analyzed.

Bent Pointer and Overload

As we see in Fig. 1, one of the inaccuracies that may develop through wear, handling, and abuse of the instrument is that caused by a bent pointer.

If too great a voltage is applied across the indicating instrument terminals (or stated another way, if too much current is allowed to flow through its coil), the pointer may strike against the end stop with sufficient violence to bend it; see (*A*) of Fig. 1. This is sometimes referred to as "pegging the instrument." If this occurs, *never* bring the pointer back to zero by means of the *zero-adjusting screw;* this does not bring the indications of the straight, unbent portion into even approximate agreement with the scale markings. It does, however, bring the movable coil into a position far different from that which it had when the instrument was initially calibrated, and reading inaccuracy therefore results. This is illustrated at (*B*).

To bring the bent pointer correctly back to zero, remove the cover from the instrument so you can carefully straighten the pointer itself; see (*C*). Bent pointer errors are almost always detected by lack of parallelism between the pointer tip and the scale division lines.

How much overload a given indicating instrument can withstand without mechanical injury depends upon its design and on how the overload is applied. Overloads of reasonable magnitudes do not harm properly-designed instruments. If the overload is *gradually* applied for only a short time, so there is not violent movement of the pointer, the instrument can probably take considerable overload without damage (the instruments of at least one prominent test instrument manufacturer are designed to stand such short-duration overloads of as high as *10 times* normal full load value). However, if the overload is applied suddenly, causing violent movement, a smaller overload will certainly bend the pointer and possibly dull the pivots or crack the jewel bearings, creating retarded or sticky action.

Incidentally, a d-c overload of the wrong polarity, forcing the pointer *backward* off-scale is very hard on indicating instruments. It should be carefully guarded against, for it is likely to be far more damaging than the same amount of overload of correct polarity.

Overloads, if sufficiently large, or if applied for appreciable durations, may also produce sufficient heating in the moving coil or the springs to damage them.

Overloads, therefore, should be studiously avoided. In a multi-range instrument it is always best to start measuring an unknown quantity with the range selector of the test instrument in the *highest range* position first, gradually backing it down until a range is reached at which the needle deflects most, without going past full-scale. This range, of course, gives most accurate readings, and the *working down* to the proper range saves many an instrument from slamming or burning-out from either too strong a deflection forward or backward, or a disastrously high voltage or current through the springs and moving coil.

It is not uncommon practice when handling unfamiliar circuits, for Service Men to check for polarity by momentary contact of the test leads without regard to the range for which the instrument is set. The subconscious thought probably is that such a momentary contact cannot harm the instrument even if it is set for a much lower range than required. This is quite incorrect. True, the chances of burning out the instrument are reduced, but that momentary contact is sufficient to slam the needle against the stop, subjecting both the pointer and the coil bearings to abnormal strain.

It is easy to be careless in these respects when making a series of voltage measurements on a radio chassis, etc., but it will be found definitely advantageous to do it the careful way. Even though an instrument may withstand a 10 to 1 overload without burning out, this does not mean that the pointer will go through such an experience unbent, or that a pivot will not be dulled or a jewel cracked. Such things can and do happen, and they spell lost time and expense.

Fuses for Instrument Protection

Where the danger of repeated careless and incorrect use of indicating instruments is great, as in their use by relatively untrained personnel, students, etc., their protection by means of instrument fuses is frequently resorted to.

Fusing the instrument circuit can provide simple, fast and effective protection against overload. Standard sizes of fuses are available and are quite low in cost. Whereas a 1/100 ampere fuse was the smallest available only a few years ago, today vacuum-enclosed fuses are available in sizes down to 1/1000 ampere.

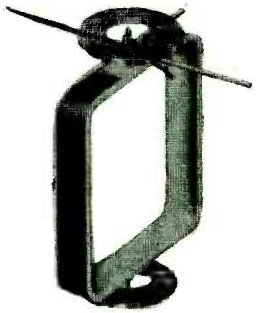
Of course these fuses add some resistance to the circuit, so whenever possible, the fuse should be inserted *before* the instrument shunt or multiplier. In most cases, the added resistance of the fuse will add negligible error to the instrument reading. If the error is greater than the permissible tolerance, however, a hold-down push-button switch may be shunted across the fuse to short it out for final readings only.

The time required for an instrument fuse to blow is an inverse function of the degree of overload. An overload of 0.02 ampere will blow a 1/100 ampere fuse in 0.1 second, an overload of 0.1 ampere will blow the fuse and interrupt the circuit in 0.0002 second, and an extreme overload will make the blowing time practically instantaneous. This is an important and desirable characteristic when protecting the calibration and balance of a delicate instrument.

These fuses seldom have the same thermal characteristic as the instrument, and they cannot protect the instrument for all possible combinations of applied voltage and current and time, but there is no doubt about the advantage of their protective value under severe conditions of instrument use such as those outlined above.

Zero-Shift Error

It is apparent that accurate readings demand that the pointer be not only perfectly straight but also stand exactly at *zero* on the scale when the instrument is without current, or all



indications at other points of the scale will accordingly be in error.

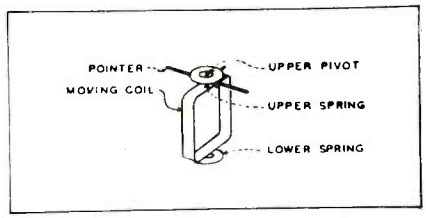
The pointer, having a latitude of movement over several scale divisions on each side of zero, is held in place by control springs. It may diverge from its correct position (*zero error*) because the control-spring tension becomes too great or too low. The correct tension can be restored, together with accurate pointer position, by carefully turning the zero-adjustment (*Zero-Adjust*) screw provided on the instrument case (see Fig. 2).

Always make sure that the instrument pointer is in correct zero position before taking a reading! If the zero error is beyond the range of the adjusting screw, or if a sudden very great zero error occurs, the instrument undoubtedly needs to be checked for trouble and possibly repaired.

When zero-adjusting an instrument, avoid *parallax-error,* particularly in ohmmeters; in these, the zero-adjustment screw does not usually adjust the instrument pointer position directly, but adjusts a resistor which compensates for variations in the potential of the instrument battery. A fresh battery, of course, applies a higher voltage to the instrument circuits than one partially discharged. Furthermore, these instrument circuit resistors are not absolutely precise in value and the accuracy of the instrument ranges varies. The instrument should always be zero-adjusted, therefore, for each range, before taking measurements on that range.

The megohm ranges of ohmmeters are usually fed by a miniature power supply operated from the house or shop line voltage. Variations in this line voltage can and should be compensated-for by the *Ohms Zero Adjustor* or by whatever the manufacturer terms this control.

Do not confuse simple *zero error* with bent pointer error. If the pointer has been bent appreciably off-zero by overloading which caused it to slam against the stops, it should *not* be brought back to zero by *manipulating the "zero-adjusting" screw.* Any attempt at this will throw the whole scale calibration off because to make



(Courtesy Weston)

Fig. 3. Two spiral springs are attached to the moving-coil, pointer and pivot assembly as shown in the diagram and illustration here.

the bent end of the pointer coincide with the zero position it will be necessary to rotate the moving coil to an abnormal zero position. This changed position of the coil introduces one error, and the resulting altered spring tension introduces another, with the result that the operating conditions of the moving element are thrown entirely out of kilter and the relationship of its movement to the scale calibration is basically altered. The bent pointer itself should be straightened.

Spring Troubles

The two spiral springs employed in electrical indicating instruments (Fig. 3) are most important in maintaining the accuracy of the instrument. They not only conduct the current to the movable coil but also supply the *restoring* torque (or twist) which resists the *actuating* torque of the movable coil, then return the coil and pointer to the zero position when the current is shut off. Any change produced by the springs in the restoring torque causes a change in the position of the movable coil and pointer—and *reading error!*

Within the past few years, phenomenal metallurgical advances in spring design have almost eliminated the *fatigue* and *aging* of the springs which caused calibration *drift* in older instruments. The improved springs in reliably manufactured instruments render negligible any probable error from this source, so long as they are not subjected to mechanical or electrical abuse.

Of course, if the springs become over-heated by prolonged abnormal current flow, they lose some of their *temper.* This *decreases* their restoring torque, making the instrument more sensitive, and its readings inaccurate insofar as its original scale calibration is concerned; the errors introduced are often of considerable magnitude. This prolonged overload abuse of the springs is difficult to detect because, as a rule, the indicating instrument seems perfectly normal in operation; no sluggishness or stickiness is evident.

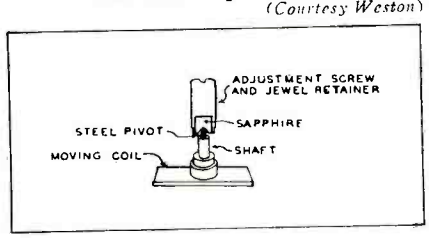
The springs may also become *kinked,* frequently made evident by the fact that the reading at a certain scale point is different *on increasing* from that on *decreasing* values. Another error can creep in from sagging, *softened* springs causing uneven torque, an abnormal zero error of the pointer, and inaccuracy of the scale calibration. Sometimes the pointer will fail to be on zero, or return to it after current has been applied. This can be caused by one of the spring convolutions jumping over the support, and can be rectified by carefully removing it with a needle or similar tool. As this may occur either on the bottom or the top spring, it is well to examine both when this trouble is suspected.

Springs loose on the shaft or holders will be revealed by the presence of friction when tapping the instrument, since the pointer takes a new set when the spring slips. A check of the end play present will indicate whether the friction is caused by insufficient end-to-end motion of the shaft (tightness of pivots in jewels).

In general, the instrument control springs should be kept as mechanically perfect as possible by not abusing the instrument with suddenly applied electrical overload, rough handling, etc. If the springs have received any damage, the instrument should generally be returned to the manufacturer, or to an authorized repair shop for repair or spring replacement and subsequent recalibration of the instrument.

Fig. 4. Magnified views of the hardened conical steel pivot and polished cup-shaped sapphire jewel that comprise each delicate jeweled bearing in an electrical indicating instrument.

(Courtesy Weston)



Bearing Troubles—Friction

The hardened, highly-polished conical steel pivots and the almost fric-

(Continued on page 22)

SOLVING PHOTOCONTROL APPLICATION TROUBLES

By S. J. MURCEK

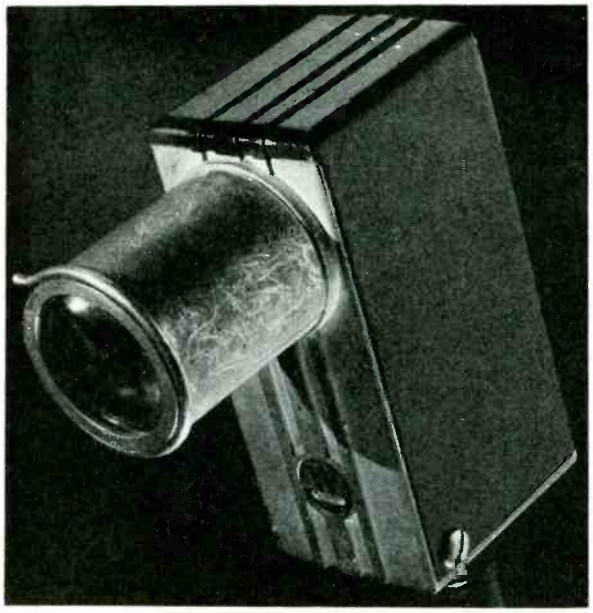


Fig. 1. A commercial light source. (*Courtesy Westinghouse*)

SINCE the modern electronic photocontrol may be viewed as a device which converts visual phenomena into corrective mechanical reactions, it is not surprising that difficulties in the application of the device are the rule, rather than the exception. These difficulties are usually the result of improper arrangement of the optical system associated with the device, rather than the device itself. In remote instances, difficulties may arise because of peculiarities associated with the photocontrol end system. Either of two distinctly dissimilar optical systems may be employed with modern photocontrols. By far the most elementary is the *direct* type, in which the phototube is directly subject to illumination from the light source. Here, reduction in the illumination on the phototube through introduction of an opaque mass between the source of the illumination and the phototube causes operation of the photocontrol. The illumination level comprising part of such a system may radiate directly from the mass passing before the phototube. However, such an arrangement as this, is found only in specialized applications.

Normally, the source of illumination in the direct type of optical system is derived from an incandescent lamp. Such a lamp is technically known as a *phototube exciter lamp*. The filament is carefully designed to emit the greatest possible illumination from a small filament area. Further, this filament is operated at a temperature which permits the radiation of a great portion of its illumination in the yellow-orange section of the visible light spectrum. As a result, the filament of this lamp draws appreciable current, and is fragile when heated.

Under practical application, the exciter lamp is mounted in an enclosure, or lamp housing, having an orifice directly opposite the filament. For certain applications, a lens tube and lens are provided for projection of the light in the form of a light beam. A commercial *light source* of this type is shown in the photo of Fig. 1.

Since the phototube of a direct optical system is, in some instances, mounted a few feet distant from the photocontrol unit proper, it may be conveniently mounted in a housing identical with that of the light source. Use of the lens and lens tube may, on occasion, be applied in conjunction with the phototube. It is obvious, from this, that the housing used with either the phototube or exciter lamp are nearly identical, the difference lying in the tube or lamp socket requirements.

Illustrated in Fig. 2 is a direct optical system, arranged to accomplish the separation of large and small packages on a conveyor belt. The light source is focused so that a light beam is transmitted to the phototube, the housing of which is also provided with a lens and lens tube. In operation, a large package, passing between the light source and the phototube housing, will obstruct the light directed on the phototube, the photocontrol operating as a result. However, a small package passes beneath the beam and the photocontrol does not operate.

This type of optical system is troublesome if the light source and phototube housings are not in proper focus. Where the phototube elements are illuminated through a lens, the light source must be so focused that a clear image of the lamp filament is projected on an object in the locus of interruption. Thus, in the case of Fig. 2, a clear image of the lamp filament must appear on a sheet of paper, for example, held just over the center of the conveyor belt and in the light beam.

Focussing of the lens system used with the phototube is a more difficult matter. Here, an object smaller than that which will eventually obstruct the light beam is placed at the locus of interruption. This test object is then subjected to strong illumination, and the phototube lens system is so adjusted that an image of the object appears on the phototube cathode. Removal of the test object will, if the light source is energized and the two lens systems are properly aligned, enable observation of an appreciable

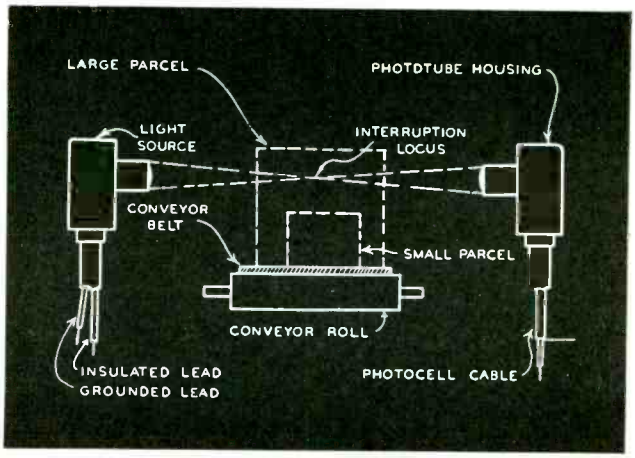


Fig. 2. A direct optical system providing operation of large and small packages on a conveyor belt. In this system the light source is so focused that a light beam is transmitted to the phototube, the housing of which is also provided with a lens and lens tube. In operation, a large package passing between the light source and the phototube housing obstructs the light directed.

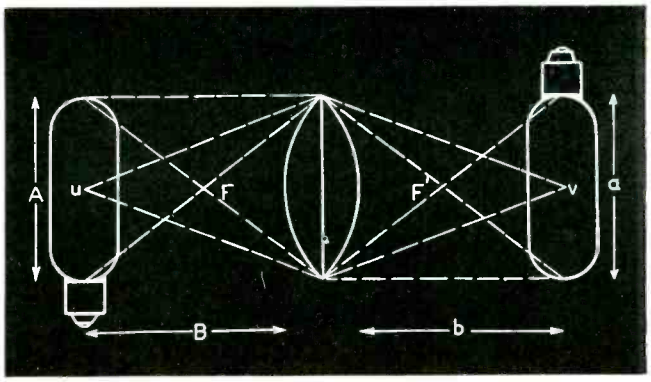


Fig. 3. How any lens can be constructed to possess two foci, F and F' at equal distances from the lens surface. F to center line is the focal length in one direction.

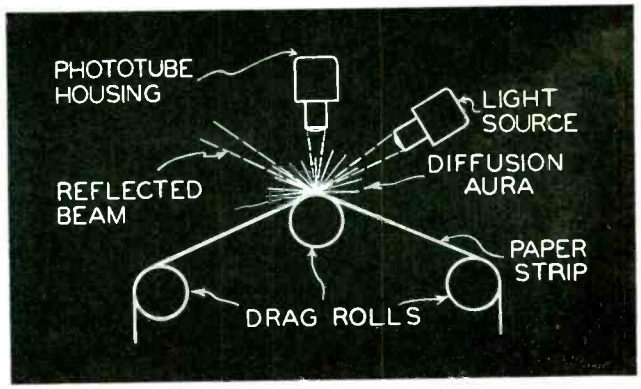


Fig. 4. The indirect or reflection method used in photocontrol systems.

increase of the illumination level on the phototube cathode. Unless the distance between the light source and phototube are great, the illumination on this phototube should never take the form of a small, brilliant spot.

Reasons for the careful procedure recommended in focusing the lens systems in Fig. 2 become apparent from a brief study of the basic laws governing the use of lenses. The real focal length of an optical lens depends on its physical characteristics, and it is this factor which determines the ability of the lens to project an image. Actually, any lens may be construed to possees two real foci F and F', at equal distances from the lens surfaces, as in Fig. 3. The image vertices, or secondary foci, u, v, occur at twice the focal length. Thus

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}, \qquad (1)$$

from which, if u and v are equal,

$$u = 2f; \; v = 2f. \qquad (2)$$

Thus, from equation (1) and Fig. 2, it may be seen that an image of an object placed behind the lens will be projected on an *objective* placed before the lens. The distance over which the image is projected may be readily calculated from equation (1).

Further, if the object lies between the focus and the image vertex, the object image is enlarged. Conversely, if the object lies behind the image vertex, the object image is reduced. The dimensions of the image may be readily calculated from the following:

$$\frac{a}{b} = \frac{A}{B}, \text{ where} \qquad (3)$$

a is the image height or width, A the similar dimension of the object, b the distance of the image before the lens, and B the distance of the object behind the lens.

Now, since the intrinsic brilliancy of the lamp is given in intensity units per unit area of the filament, it follows that the intrinsic brilliancy of the enlarged image is less. That is, the larger the image area, the less the illumination level per unit area of the image. From this, it is evident that if the light source of Fig. 2 were so adjusted as to project a large image on the phototube housing, the phototube would receive only a portion of the total illumination available from the light source, resulting in the necessity of a sensitive photocontrol adjustment with its attendant difficulties.

Since the mathematical methods used in conjunction with phototube illumination problems are invariably useful in making photocontrol installations, a few of these will be discussed here.

Phototube sensitivities are given by tube manufacturers in microamperes per lumen, or the current in microamperes conducted by the tube per lumen of element illumination. However, the intensity of light produced by an exciter lamp is given in candlepower. The relation between the two is dependent on the distances involved. Since light is radiant energy, it obeys the law of inverse squares. Therefore, the intensity of the illumination on an object located a given distance, d, from the lamp is given as follows:

$$\varphi = \frac{W}{d^2}, \text{ where} \qquad (4)$$

φ is the illumination on the distant object in foot-candles, W is the candlepower of the lamp, and d is the distance, in feet, between the lamp and the illuminated object. But the illumination on the distant object may be given in lumens, L. The illumination level may be readily derived, in such units, from the equation;

$$L = \varphi S, \text{ where} \qquad (5)$$

φ represents the illumination level in foot-candles, and S is the area of the illuminated surface in square feet.

In combination, the two previously given expressions provide a ready means for determining the illumination on a phototube obtained from a simple source, such as a street lamp. Thus

$$L = \frac{W}{d^2} S, \text{ where} \qquad (6)$$

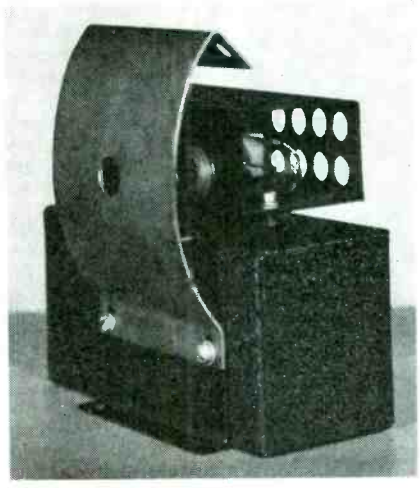
S is the exposed area of the phototube cathode.

Where lens systems are employed, certain singular circumstances will make application of the equations (1) to (5) involved, unless it is borne in mind that an image forming beam consists of *parallel rays*, that is, rays which do not diverge, but form a tight beam. Under such a condition, the only losses of illumination intensity are due to transmission impedance, such as vapors or smoke, or small particles suspended in air. It is customary to give the intensity of the beam in *beam candlepower* units. Thus, the beam candlepower projected by a given light source depends on the distance between the lamp filament and the lens, from equation (4), and the ratio of the image with respect to the filament from equation (3). The two may be readily combined as a single expression for convenient usage, thus

$$Q = \frac{bA}{B_2} \qquad (7)$$

where Q is the beam candlepower. It

Fig. 5. An indirect scanner. *(Courtesy Westinghouse)*



should be observed that the factor B is in feet when applying this expression.

The mathematical formulae discussed here are not an absolute requisite in installing photocontrols. However, the prudent usage of such analyses provide ready means for determining distances for proper operation of the devices, and for selection of the proper items from the manufacturer's stock. It is, also, obvious from the preceding investigation that careful arrangement and adjustment of the light source and phototube housing in a photocontrol installation is an absolute necessity to insure dependable and trouble-free operation, with respect to systems incorporating the direct type of optical system.

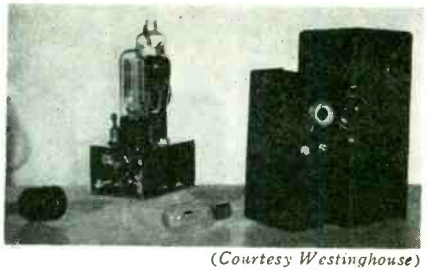
Where the optical system of the photocontrol is of the reflection, or indirect type, the phototube receives illumination by reflection from the scanned objective. The pictorial diagram of Fig. 4 depicts such an optical system. Here, the light source projects a brilliant spot of light, or a small filament image, on the objective, which may be paper strip, package labels, and other surfaces which must be inspected by appearance. The phototube is so placed as to receive the illumination reflected by the objective. Obviously, if the objective surface is dark, the illumination reflected to the phototube is small. A bright objective surface reflects copious illumination to the phototube. Thus, a photocontrol employing such an optical system may be arranged to operate with the passage of a dark surface through the filament image. An exemplary application would involve paper inspection, where dark or dirty sections of the paper strip must be rejected.

Since the maximum illumination level which may be realized from a reflective optical system is invariably low, it becomes necessary to incorporate a phototube preamplifier into the photocontrol system. In actual practice, it is convenient, and sometimes necessary, to incorporate this preamplifier into the phototube housing, much in the same manner as the preamplifier for a condenser microphone. This arrangement provides a low impedance source for operation of the remote photocontrol obviating the difficulties encountered in long, high impedance transmission systems.

A third industrial electronic stratagem often applied in commercial photocontrols utilizing reflective scanning is the incorporation of the light source and phototube housing, together with the phototube preamplifier, as a single unit. The photos in Fig. 5 and Fig. 6 show a commercial scanner of this form.

Practical application of reflective optical systems are prone to be troublesome if not properly installed, and sometimes when the installation has been properly accomplished. Nearly all such difficulties may be corrected either through correct re-installation, or through minor system modifications.

From Fig. 5, it may be observed that the beam projected by the light source strikes the objective at an oblique angle. The greatest portion of the energy contained in the beam is reflected at an angle with the objective as the beam incident angle. This reflected light should not be utilized in photocontrol applications, since it is not truly indicative of the objective surface conditions, and varies considerably with displacements of the objective surface.



(*Courtesy Westinghouse*)

Fig. 6. Components of a commercial scanner.

A portion of the illumination from the filament image is in the form of diffused light, this illumination being constant for any displacement of the objective surface. Further, the intensity of the diffused illumination varies directly with, and assumes the color of, the objective surface. Again, since the diffused light is constant from any angle of observation, it follows that it is subject to the law of radiant energy transmission. As a consequence, the illumination varies as given by equation (4).

Technically, the diffused light radiated by the objective surface in the vicinity of the filament image is termed the *diffusion aura*. Since the diffusion aura varies inversely as the square of the distance between the objective surface and the phototube elements, either of two resources is open in arranging the reflective optical system. Where no lens is to be incorporated into the phototube housing, the latter must be mounted as closely as possible to the objective strip near the filament image, *and in such a position as to avoid the reflected beam.* However, if a lens system is to be incorporated into the phototube housing, the distance between the object surface and this lens may be any convenient distance provided that the lens system is so adjusted as to reproduce, on the phototube cathode, a clear image of the filament or light spot incident on the object surface. Here, also, the phototube housing must be so located that illumination of the phototube by the reflected beam is avoided.

A reflective optical system arranged in either of the forms described will operate perfectly with black and white color differences. However, since each particular type of phototube is responsive only to a portion of the color spectrum, the system may not operate where, for example, it is desired to operate the photocontrol from color marks printed on the edges of a roll of lithographed labels.

Fig. 7 is a graph of the spectra to which each of the phototubes indicated are responsive. The spectral response

(*Continued on page 20*)

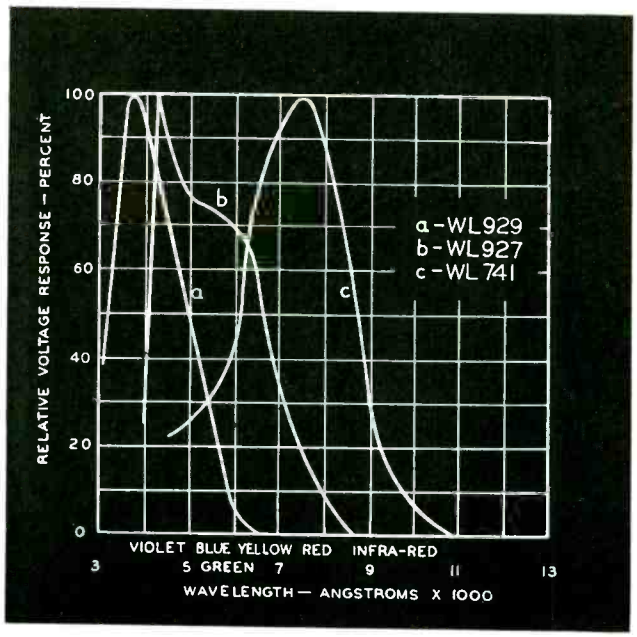


Fig. 7. A graph of the spectra to which phototubes are responsive. It will be noted that the spectral response of each tube overlaps that of the others shown. For most reliable operation, a tube having a peak in color sensitivity nearest that desired must be selected for color detection application. Incidentally, the wavelength of orange is around 6,200 angstroms.

Color selection becomes a vital factor in many installations. For instance, if it is desired to detect a blue mark on a red surface a phototube that is sensitive to red spectra may be selected, since then the blue mark will appear black to such a phototube.

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A STUDY OF VIBRATORS

By M. E. HELLER

VIBRATORS are rapidly displacing dynamotors as inverters for low frequency a-c applications in many fields of activity.

Car radio receivers were responsible for the development of the modern type vibrator. Dynamotors were expensive and radio sets had to be popular priced. The first attempt at a new interrupter design was brave but short-lived. It was a half-wave job, with a tuned reed carrying a contact, an adjustable spring carrying a second contact and a low resistance coil operating in a series circuit; a sort of glorified buzzer. A power transformer had to be used to step up the a-c output and a half-wave cold-cathode gaseous rectifier supplied the *B* voltage. The contact resistance had to be low for sure starting and the load current had to be of the right order to get the reed going at the proper swing for successful operation. The freqency ran around 80 to 100 cycles.

The next vibrator went a big step forward in proving the practicability of synchronous rectification. It had two matched reeds, one being the half-wave interrupter of the first model, the other being a half-wave rectifier for the high voltage, eliminating the rectifier tube. This unit had to have a constant and proper load or it would arc terrifically and destroy something; hence, it was operated in conjunction with a low current cut-out relay which switched in an artificial resistance load when the *B* load dropped below a predetermined value.

The next big step added both full-wave interruption and full-wave rectification with a single reed. The magnet coil, or driver coil, was wound with a high resistance winding for shunt operation instead of series operation. This made the vibrator operation independent of load current for both starting and proper swing, increasing the life and efficiency many times over. Fig. 3 shows this type of vibrator with the driving coil across the transformer primary and both input and output filters. Other features will be discussed later. The shunt coil may be connected in other ways, as shown in Fig. 1 and Fig. 2 (*a*) and (*b*). Let us consider Fig. 1.

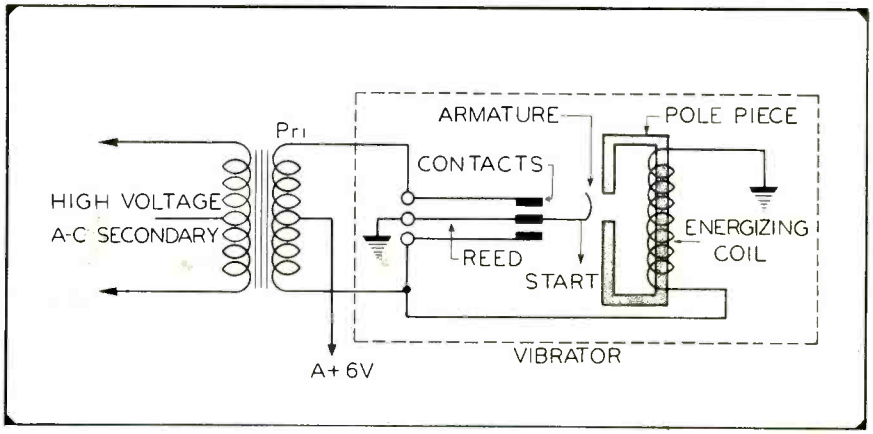


Fig. 1. Vibrator built around a U-shaped frame.

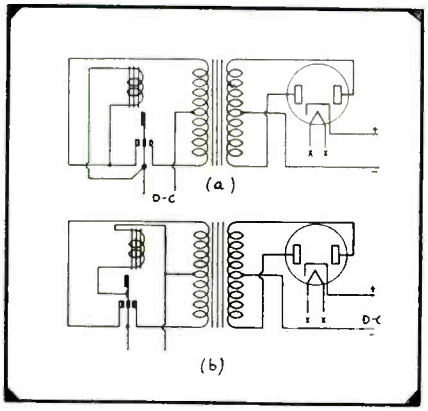


Fig. 2. Non-synchronous vibrators using separate contacts for driving.
(*Courtesy Mallory*)

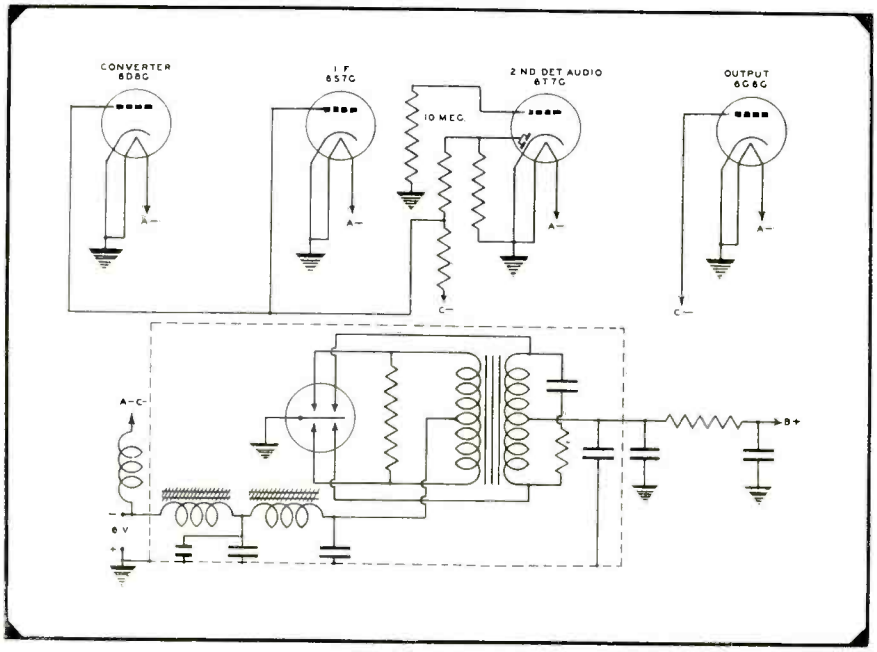


Fig. 3. Vibrator with driving coil across transformer primary.
(*Courtesy Mallory*)

The vibrator is built around a *U* shaped frame with the coil mounted in the bottom of the *U* and the vibrating reed and insulated side-springs at the open end. The reed is grounded and makes contact with two sets of contacts, one for the primary interruption, the other for high voltage rectification. Adjustments are provided for the contacts to aid the rectifying action, or improve the waveform. The grounding of the reed offered no objections because the use of heater type tubes permitted cathode bias resistors to be used for *C* bias.

All the contacts are open at rest. When d-c is applied the magnet coil is energized through half of the transformer primary, thus attracting the reed armature. When contact is made with the upper contact the coil is shorted out, collapsing the magnetic

field and releasing the armature which causes the reed to approach its original center position. However, the inertia of the reed carries it beyond the center position to the other contact. The mechanical period is such that smooth vibrator action is set up. The frequency of this type of vibrator was approximately 120-140 cycles. Mallory was one of the early manufacturers of this type.

The vibrator of Fig. 2(*b*) operates in a different manner. Note that the coil has a separate contact which is used only for driving, being completely independent of the load circuit. The coil here is a high resistance coil wound for the full d-c voltage but it operates as a buzzer coil. The contact resistance need not be low for positive starting as in the case of the early series coil vibrators. A short-circuited second winding on top of the driving winding was used in this type of vibrator to absorb the inductive kick when the contacts broke. This greatly reduced sparking at the starting contacts.

There were two schools of thought among engineers . . . the synchronous and non-synchronous. Development of hot cathode, indirectly heated rectifier tubes suitable for use with vibrator transformers took away some of the former advantage of synchronous self-rectifying vibrators. Being simpler, with fewer adjustments and contacts to go bad, the non-synchronous types could be expected to give better all-around performance and longer life but the synchronous types saved space by eliminating the rectifier tube. Full-wave non-synchronous units (Figs. 1 and 2) became more and more practical. While the early units were housed in large, dual shielded cans with large rubber boots and heavy armatures, the newer units were lighter, smaller, quieter, longer lived and were free of adjustments and external unwanted vibration. Cases were made of die castings, or shells of aluminum or zinc, fitted with a base for plug-in mounting. Sound and vibration absorbers used either rubber or felt. With felt, the contacts had to be covered with a wrapping to keep the lint from the felt from interfering with the contacts.

Mallory pioneered in the introduction of a split reed rectifying unit in which the interrupter and rectifier circuits were insulated from each other as in the early dual reed vibrator, but the two reeds in the new unit were tied together mechanically so as to operate in enforced synchronism. This type unit may be used in a great variety of circuits.

A combination vibrator-transformer assembly introduced by Oak had many interesting features. The leakage flux of the transformer was utilized to drive a dual vibrator, completely eliminating the driving coil and pole piece usually used. The dual contacts reduced contact heating thereby increasing the vibrator life. A unique voltage control was also incorporated which maintained an output voltage of 180 volts at either full load or no load by inserting an artificial load when subnormal current was drawn. The combined unit was also incorporator in a complete *B* eliminator.

A considerable amount of research and development was necessary to produce the present crop of vibrators for industrial, radio and direct war

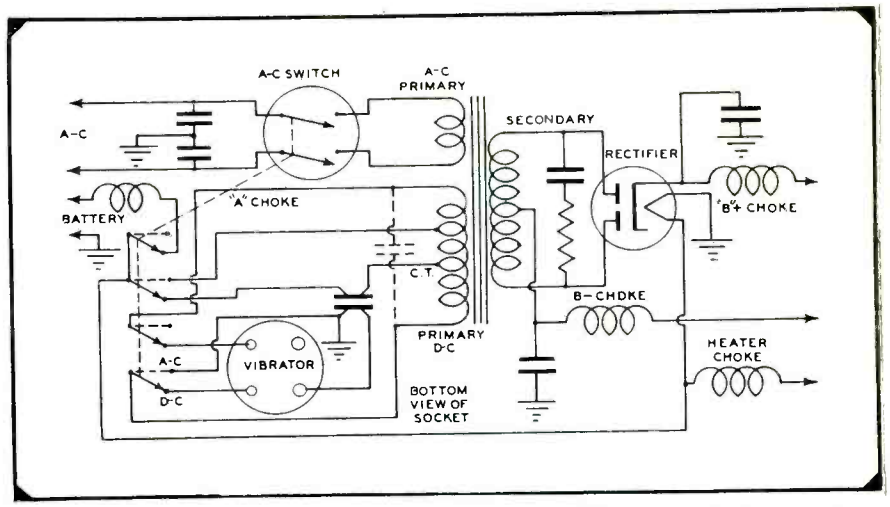


Fig. 4. Vibrator used from storage battery source.
(*Courtesy Mallory*)

Fig. 5. An application where high voltages are required.
(*Courtesy Mallory*)

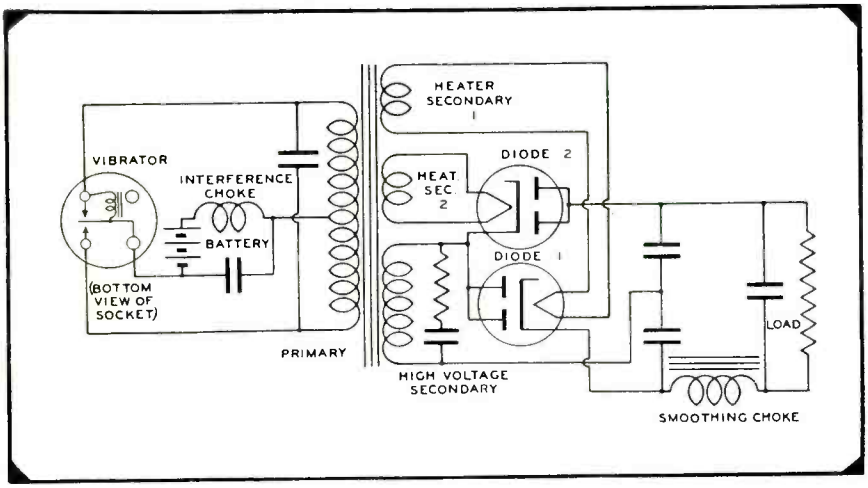
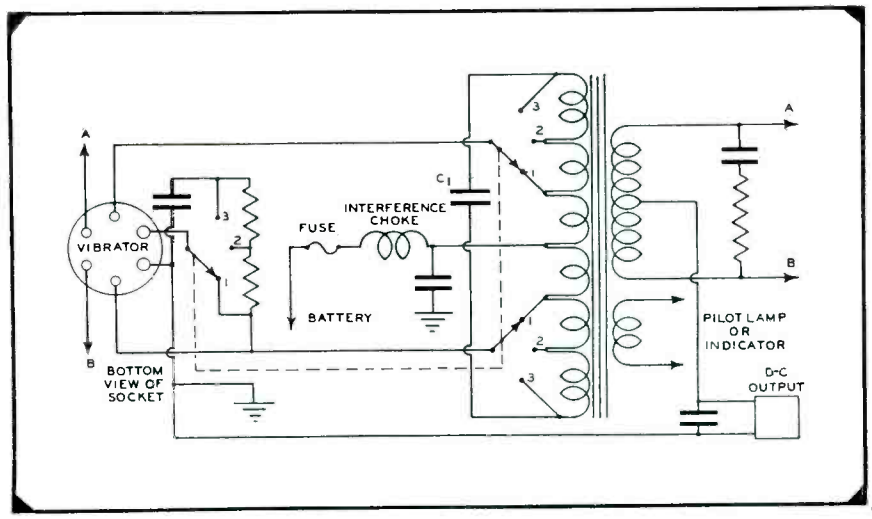


Fig. 6. A method of operating a vibrator on more than one voltage input.
(*Courtesy Mallory*)



applications. Electronic Laboratories, Mallory, Radiart, Utah and others have made important contributions to war radio equipment, as well as other types of vibrator-supplied devices. One of the outstanding developments of these companies has been the gas-filled, hermetically sealed vibrators which will give normal performance under the trying conditions of high altitude and low temperature. Standard types of vibrators are unsatisfactory at altitudes above 10,000 feet. Destructive flaring of the contacts is common around 15,000 feet while higher up they just go out *cold* in a matter of minutes. These phenomena are caused by the reduced atmospheric pressure but similar troubles occur even at low altitudes when the temperature is very low. Sealing of the vibrator from the outside air also eliminates oxidation, a common cause of poor starting.

Radiart is also producing a Stratosphere series of Vipowers, complete power units built around their gas-filled vibrators. Other companies are probably manufacturing similar units. Mallory has a new tuned-reed four-contact vibrator in which a mechanically tuned relationship exists between the flexible, oscillating reed arms and the reed itself. The arms are selected and matched so that their natural period is five times that of the reed. Because of this tuning, the contacts close with practically no velocity difference while they open very fast. The slow closing eliminates chatter and the fast break limits the arc. Also, wiping action, while in contact, is eliminated, which greatly increases contact life. An output of 20 watts is obtainable at a frequency of 115 cycles. An 8-contact unit, either synchronous or non-synchronous, is also available which is extremely compact in spite of its high output . . . 30 watts.

Fig. 7. Vibrators require many detailed steps of inspection before final approval. Here we see a view of a test laboratory with a number of special test units devised to check on a variety of operating phases of vibrators.
(*Courtesy Mallory*)

The problem of noise is still not completely solved, although much has been accomplished in reducing this nuisance. While sine wave output is obtainable from some vibrator transformers under critical circuit and load conditions, most waveforms resemble a square with a steep slope which is a notorious noise generator. Vibrator leads must be kept short to minimize both r-f and a-f pickup. In loop receivers, the transformer must be very well shielded in order to prevent radiation. With filament type tubes, as in portables, the noise filtering problem is a beat. Series a-f and r-f chokes and condensers are required. In Fig. 3, note that two condensers are paralleled in both the input, low voltage d-c, and the output-rectified a-c. One is an audio bypass, the other an r-f bypass.

Another annoying fault of vibrator supplies is the rapid change of performance with changes in load. Where the application demands a good waveform, vibrator adjustments, transformer constants and the exact buffer condenser (or condensers) combine to do a fine job . . . provided the load doesn't change; for, when it changes, so does the waveform, and, sometimes entirely too much.

Some types of equipment are made to operate from an a-c line while at home or base, and from a storage battery in the field, or mobile in a car. Fig. 4 shows the power unit developed for this type of operation. Besides the vibrator primary and high voltage secondary an a-c primary is wound. A suitable switch cuts in this winding for a-c operation while opening the vibrator circuits. The heaters are run from the battery on d-c operation and from a part of the d-c primary on a-c operation, thus saving a filament winding.

For higher voltage applications a voltage-doubler rectifier may be used, as in Fig. 5. Two rectifier tubes with individual filament sources are required in order to protect the tubes from voltage breakdown so two filament windings are provided on the power transformer. The output voltage is limited by the plate-to-cathode breakdown voltage of the diodes.

Fig. 6 shows a satisfactory method of operating a vibrator power supply on more than one voltage input. The percentage voltage range is limited somewhat by the driving coil which must be wound for the lowest voltage. Resistors are added in series with the coil for higher voltages but, in so doing, the coil current becomes an increasing part of the total input current. If carried too far, the primary will be unbalanced. Mallory developed such a unit for operating d-c razors.

(*To be continued*)

Fig. 8. A tandem-type vibrator
(*Courtesy Electronic Laboratories*)

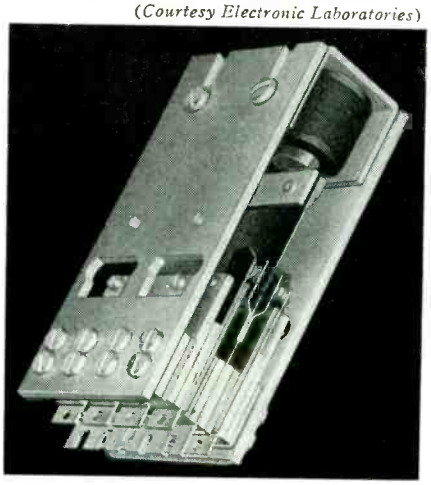
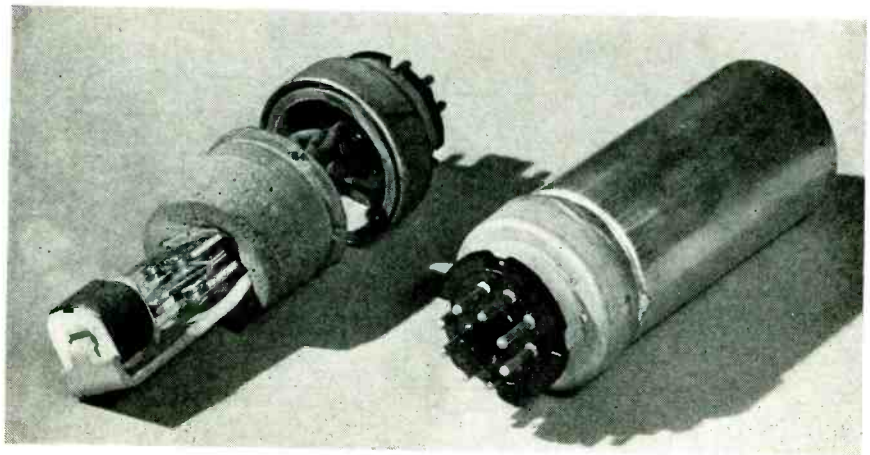
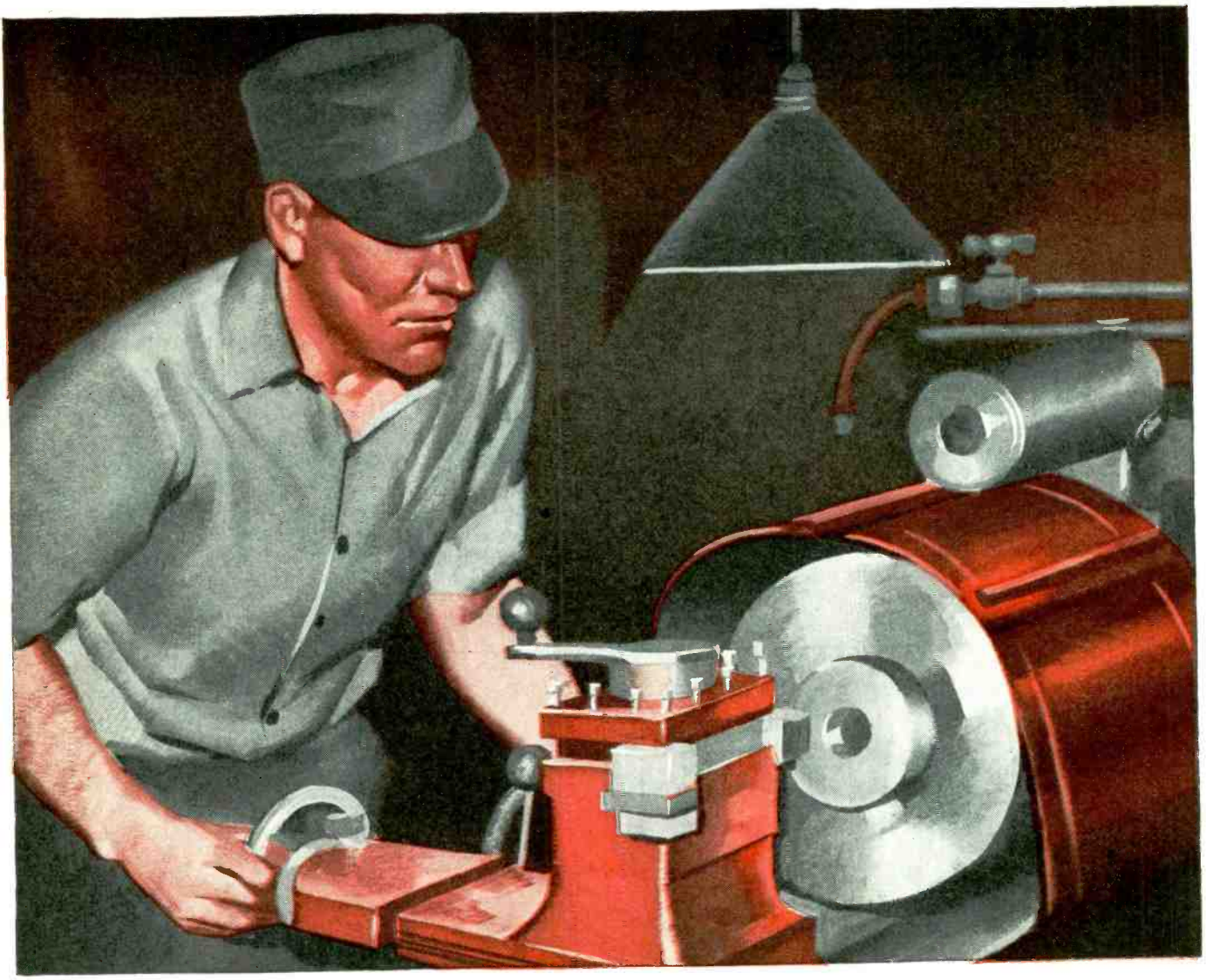


Fig. 9. A hermetically-sealed type vibrator.
(*Courtesy Mallory*)





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Utah

SER-CUITS

By HENRY HOWARD

UNIQUE design features are included in amplifiers built primarily for microphone and low level electric pickups for musical instruments. Some of the amplifiers have combination input circuits for low and high level, such as for microphone and phono pickup. One of these amplifiers is shown in Fig. 1. This is a 22-watt, 7-tube, 4-stage unit, Silvertone 12856. This unit contains a record player, but no speaker is included. Two separate high impedance inputs feed into separate full-gain 6J7G pentode amplifiers. Each tube feeds a triode section of a 6SC7 through separate volume controls.

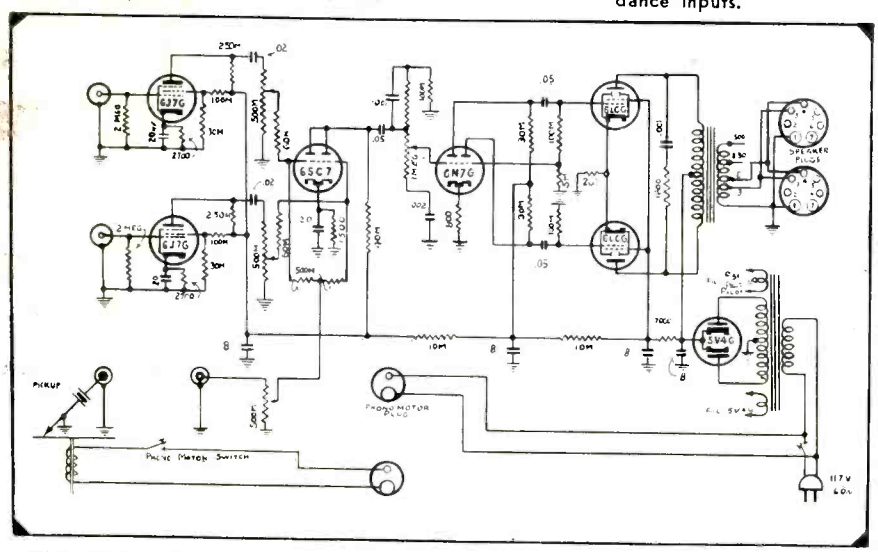

Fig. 1. The 7-tube Silvertone 12856 amplifier with two separate high-impedance inputs.

The triode plates are connected in parallel to feed a 6N7G third stage which acts as an inverter. A trick tone control is placed between the dual triode and the 6N7G. This consists of a 1-megohm center tapped potentiometer, with no alteration being introduced at the center. Treble boost takes place in the top half where a .001-mfd parallel condenser favors the highs. Bass boost occurs in the bottom half, where a .002-mfd condenser shunts the highs to ground. A standard 6L6G push-pull output stage completes the lineup. The overall gain is 125 db, sufficient for any type crystal, velocity or dynamic mike.

A third input with a gain of 80 db is also provided, primarily for phono use. The mike and phono inputs can be mixed at different levels, since each has its own volume control. The phono input, through a ½-megohm control, feeds both 6SC7 grids in parallel through a pair of ½-megohm resistors, the input going to the center of the potentiometer arrangement. The output transformer is tapped at 3, 6, 250 and 500 ohms, which are wired to two 7-prong speaker sockets for p-m speakers.

Silvertone 8922

Fig. 2 shows another version of a similar amplifier, with 8 tubes and 4 stages. Also, two high gain, high impedance input jacks are provided, together with a phono input jack with a separate 6C5G for mixing. The top channel has a standard volume control in the second stage, while the bottom channel has a fader control instead, for fading from microphone to phono. A standard shunt-capacity tone control is provided. A multi-tap output is provided with three speaker sockets.

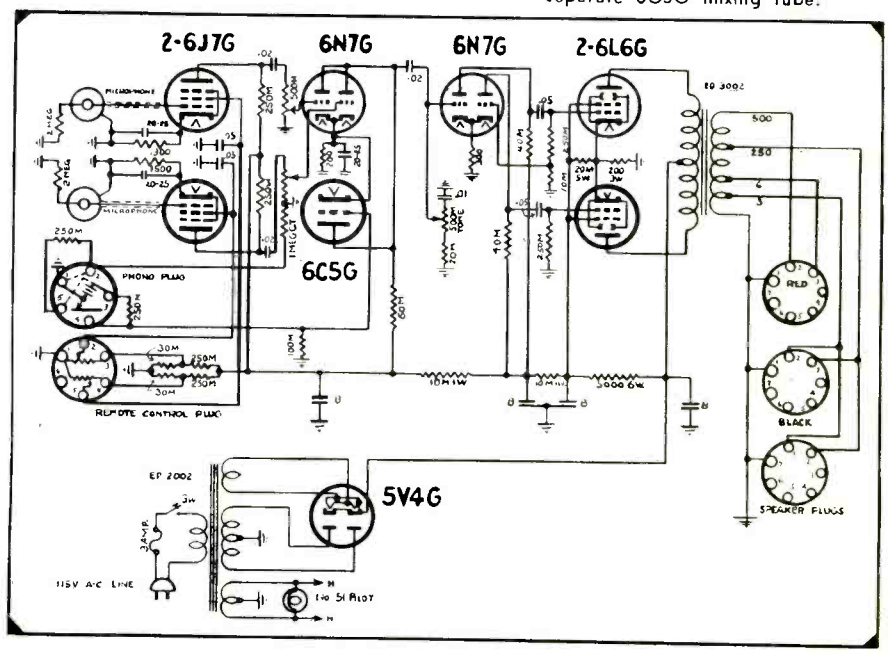

Fig. 2. Silvertone 8922 amplifier with a separate 6C5G mixing tube.

Silvertone 2341

Fig. 3 shows a 7-tube guitar amplifier, Silvertone 2341, with a 16-watt maximum output. Two input jacks are provided for magnetic pickups and one for a high impedance microphone. Both channels get the full benefit of a 6J7 pentode. The dual pickup jacks are shunted by 100,000-ohm resistors and each has a 20,000-ohm series resistor between jack and input grid. Each channel also has a 100,000-ohm volume control at the input to the second stage (a dual triode similar to previous amplifiers described). This is the mixer stage which feeds the third stage and inverter. A 60,000-ohm degeneration resistor connects the mixer plates and the third audio plate.

Silvertone 7356

A deluxe 7-tube, 3-stage, 18-watt phono amplifier with volume expansion and separate bass boost and treble controls, is shown in Fig. 4 (Silvertone 7356, 12870 or 7984). A 5-prong socket is used for the input. Connections *1* and *3* are for a crystal pickup which automatically connects the ½-megohm equalizer in the high side. *1* and *2* are used for a magnetic pickup or radio detector output. The input voltage splits two ways . . . to the 6J5G voltage amplifier for expansion voltage and to the third grid of the 6SA7GT for audio amplification. A ½-megohm volume control serves as an expansion control, admitting amplified input voltage to the 6H6G diode rectifier and filter, which is applied

The SPRAGUE TRADING POST

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WANTED—Crystal detector, mica; 2.5 induction coil; condenser .002. Send details and price to Stan Marcus, 2832 W. 15th St., Brooklyn, N. Y.

WANTED — Superior dynarometer and channel analyzer. Will pay top price. R. A. Snitgen, 3824 N. W. 15th Ave., Miami, Fla.

FOR SALE—Solar BQC condenser checker used; new Jensen 8" auto speaker; used speakers in good condition, some with new cones 10" and smaller; 1-50Z7G, 2-35Z5GT, 2-35L6GT, 1-50L6GT, 1-0Z4 metal, all brand new and in original sealed cartons. History! L. R. Benorden, Box 52, Llano, Texas.

WILL SELL OR TRADE—Costly velocity and dynamic microphones, crystal pickup, all in perfect condition; also assorted radio parts and tubes. Would like a good candid, or plate camera, or what have you? D. Pommers, 401 Schenectady Ave., Brooklyn, N. Y.

WANTED AT ONCE — Hickok model 510X combination 1942 tester. Must be in good condition. Will pay cash. Claude Smith, Laurel Hill, N. C.

TUBES WANTED AT ONCE — Will pay good price for 12SA7, 12SQ7, 12SK7, 35L6, 50L6—any quantity. Write at once. E. J. Kuhn Radio Service, 17th & Elm, Murphysboro, Ill.

FOR SALE OR TRADE — Radio tubes, 1 Type 8, 1-19, 1-30, 1-32, 1-36, 1-79, 2-89, 1-1B5, 1-1E7G, 1-1H6G, 1-1F5G, 1-1F4, 1-6A4, 1-6L7, 1-6L6G, 1-6SC7, 2-6SJ7GT, 2-12SC7, 1-12SJ7G, 1-12SR7, 1-12-J5GT, 1-12SF5GT, 1-25Z5, 1-25-Z6GT, 1-35A5LT, 2-50Y6GT. Most of tubes are RCA or Sylvania in original cartons. Will sell single tube or all. Interested in Stancor Super-pack No. 132 or Economy pack No. 131, which delivers 6 volts D.C. Kindly submit offer. J. H. Snyder, Richfield, Penna.

FOR SALE—Clough Brengle model 88 vacuum tube voltmeter in excellent condition; 0-1.2RMS volt scale and 0-10, 0-100 peak volt scales. Price $45. Fox Radio Service, 435 So. 5th Street, Richmond, Indiana.

WANTED—RADIO NEWS—Issues Sep., Oct., Nov., Dec., 1943; Jan., Feb., March, 1943. Would exchange British Radio magazines. L. Marks, 14 Avenue Rd., Kingston, Surrey, England.

WANTED FOR CASH — Recorder unit with crystal cutting head, with or without case; must have depth cut adjustment and be in usable condition. L. R. Benorden, Box 52, Llano, Texas.

WANTED—Will pay cash for Voltohymst, Jr., or good analyzer; late model tube tester. What test equipment do you have to sell? Frank D. Stephens, Rt. 1, Box 22, Jacksboro, Texas.

URGENTLY NEEDED — AC-DC multitester, prefer R.C.P. Supertester, model 411, or Jackson tube and VOM model 580, or other equipment of that type. Chet's Radio Service, Box No. 1735, Delray Beach, Fla.

FOR SALE—Jackson 627 tube-tester; Superior 1230 oscillator; Triplett 1671 vibrator tester; 2" oscillograph; Tungar 2 amp. charger; Sunbeam Shavemaster; Superior 1240 tube-tester; R.C.P. 446 V.O.M.; Solar condenser tester; Rider's No. 11; Gernsback's 1-2-4-6-7; RCA T.M.V. 128-A Frequency modulator. The Radio Man, 1724 Central Ave., Middletown, Ohio.

FOR SALE OR TRADE—Remington adding machine, like new, adds to 9 million, subtracts, multiplies, figures fractions. Will trade for Supreme 585 Radio tube and set tester, or later model with oscillator and cathode ray oscilloscope. C. M. Rebelein, Kiester, Minn.

WANTED—V.O.M. meter, combination tube and set tester output meter, and capacitor analyzer. E. L. Johnston, 172 W. North St., Akron, Ohio.

WANTED FOR CASH—30 feet of single conductor microphone cable, new or used, in two pieces, if necessary. Clement Blair, Box 86, Gap, Pa.

'SCOPE FOR SALE—One 2" Triplett scope; also one frequency modulated signal generator, making a matched set; will sell the pair for $70, F.O.B. Also 2 metal locators or radio treasure finders complete. Kenneth E. Mayhall, Belmont, Miss.

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The "Trading Post" is Sprague's way of helping radio servicemen obtain the parts and equipment they need, or dispose of the things they do not need during this period of wartime shortages. Send in your own ad today—to appear free of charge in this or one of several other leading radio magazines on our list. Keep it short—WRITE CLEARLY—and confine it to radio items. "Emergency" ads will receive first attention. Address it to:

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North Adams, Mass.

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TRADE OR SELL—60-plate three-gang variable condenser, like new. Donald Garrett, 2108 First St., Lake Charles, La.

WANTED — Hallicrafters SX28 or SX32 and 2½ meter equipment. Will pay highest cash prices or swap Zenith portable and Hallicrafters HT4. Paul K. Heim, Seminary Campus, Gettysburg, Pa., c/o Radio Dept.

WANTED — A.C.-D.C. multitester and signal generator, new or in good condition. Will pay cash. F. Stuart Godfrey, 602 E. State St., Saint Johns, Michigan.

WANTED—Rider voltohymst; model 188X Universal signal generator; model RFO-5 3" oscillograph. Raymond Papineau, 725 N. Rockhill, Alliance, Ohio.

FOR TRADE—Hallicrafter S 20 R, original condition, for one of the following electronic multitesters; Weston 669, Supreme 549, R.C.P. 662. Must be in good condition. Give details and price. Carol Radio, 115 Witthoff St., Queens Village, L. I.

URGENTLY NEEDED—0.1 milliammeter and two 140 mmfd. variable condensers. Give details. Robert E. Waif, Clarksdale, Ariz., Box 885.

FOR SALE — Brand new automatic record changer No. 8 made by General Industry Co. Will hold 10" or 12" records at one time. Has Astatic crystal pickup and built-in volume control. $36 cash, or will trade for an up-to-date tube tester or 'scope. E. E. Johnson, Shelter Island, N. Y.

SIGNAL GENERATOR WANTED —Any good make or model considered. State condition, frequencies covered and price. Cash sale, but needed immediately. Willis G. Jenkins, 408 Woodhams St., Plainwell, Mich.

WANTED — Sprague Tel-O-Mike, Solar capacity exammeter or capacity bridge model CB, CC, QBC, QCK; Cornell-Dubilier BF50 or BN; Aerovox L.C. checker. Will pay cash or trade for any of these. State condition and lowest price. Anthony Pusateri, 1101 Fleming St., Coraopolis, Pa.

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Vital materials *must* be conserved for war uses—and this means that servicemen are now faced with the problem of making a "Victory Line" assortment of 18 Capacitors do the work of the approximately 473 types and sizes previously supplied.

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Fig. 3. A 7-tube guitar amplifier, Silvertone 2341, with 16 watts output.

to the first grid of the 6SA7 first audio as a bias voltage. This varies in proportion to the program level.

Time Constant Considerations

The r/c filter components have been carefully chosen for the proper time constant. The time constant is very important in an expander for, if too short, the gain will try to follow the low frequencies and, if too long, the entire effect will be lost. The *zoom* would not occur at the proper spot, but, rather a moment later.

6SA7 Usefulness

The 6SA7 has been chosen for the first audio stage because its amplification can be made to vary considerably by varying the bias voltage. This is accomplished with a minimum of distortion. Since the program, through the 6H6G, feeds positive bias to the first grid, a method must be used to secure a larger negative bias. This is accomplished by the voltage divider R_{10} to R_{13} which forces the cathode positive to ground and also supplies negative bias to the third program grid and positive screen grid bias. Note the absence of a screen bypass condenser.

Tone Control Circuits

The coupling from the first to the second audio contains the tone control circuits. The treble control uses a small and large coupling condenser, gradually cutting out the large one for an increase in treble. The bass boost introduces a regenerative feedback voltage from a divider on the output transformer through a low-pass filter to the 6N7G second audio grid. The filter consists of three elements . . . first, the sum of the voltage divider resistance and the amount of the control potentiometer in the circuit; second, the .02-mfd condenser and, third, the 250,000-ohm resistor. This filter limits the feedback to low frequencies only. The second triode of the 6N7G serves as the usual phase inverter and the 6L6 output stage is also conventional. Where a sufficient degree of expansion is employed (say 10 db) the output stage must be capable of delivering at least 30 watts, hence, the 6L6s.

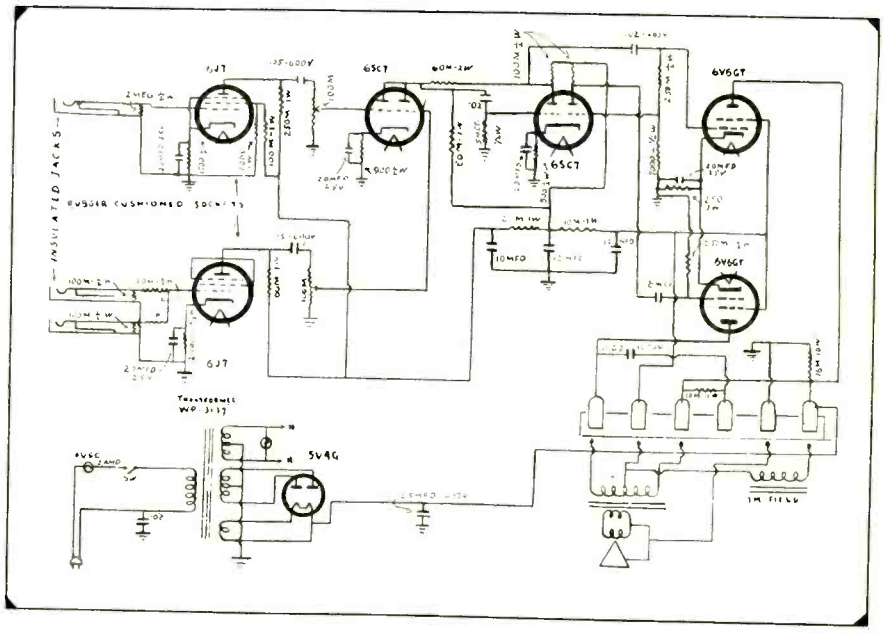
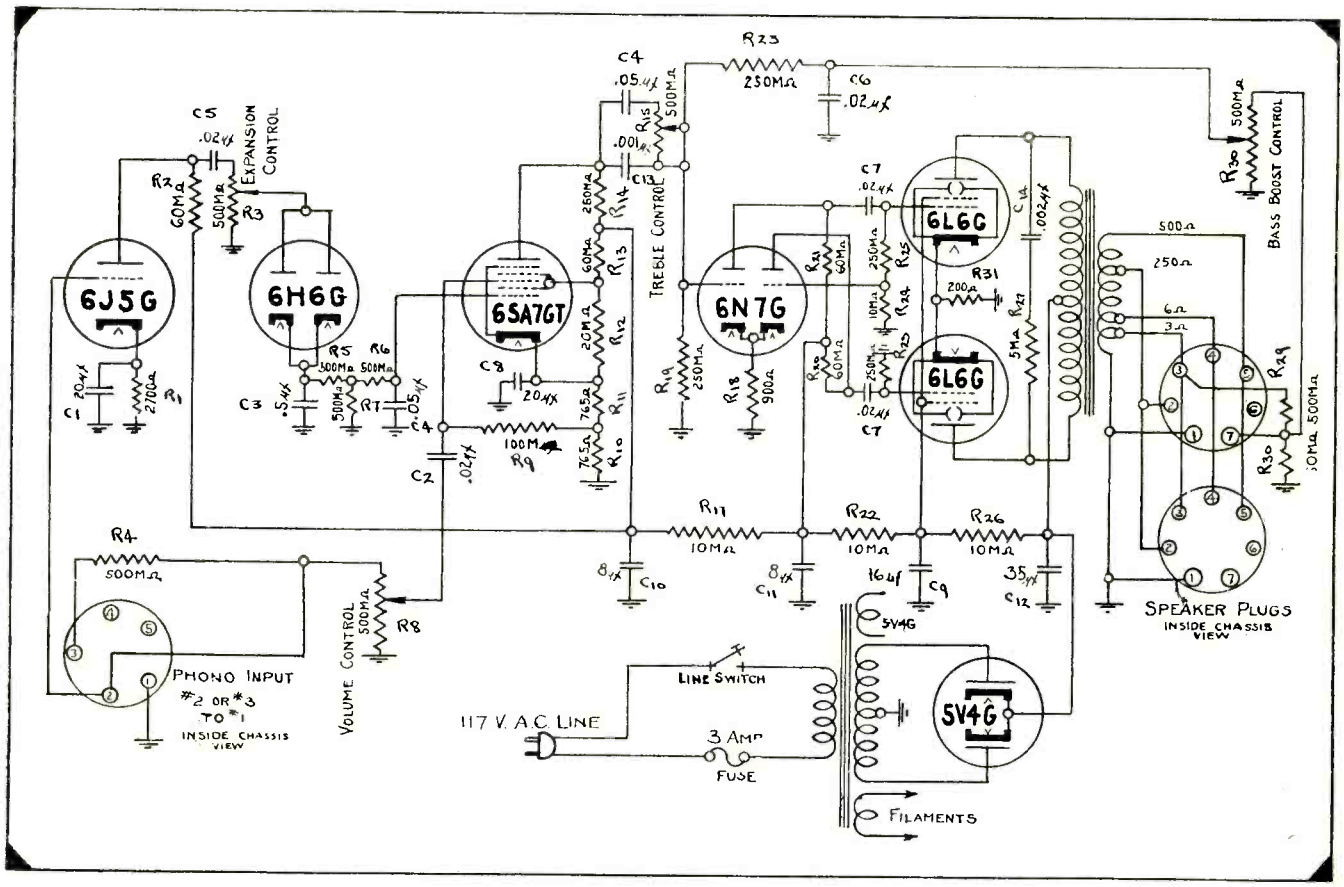


Fig. 4. Silvertone 7256 18-watt phono amplifier.



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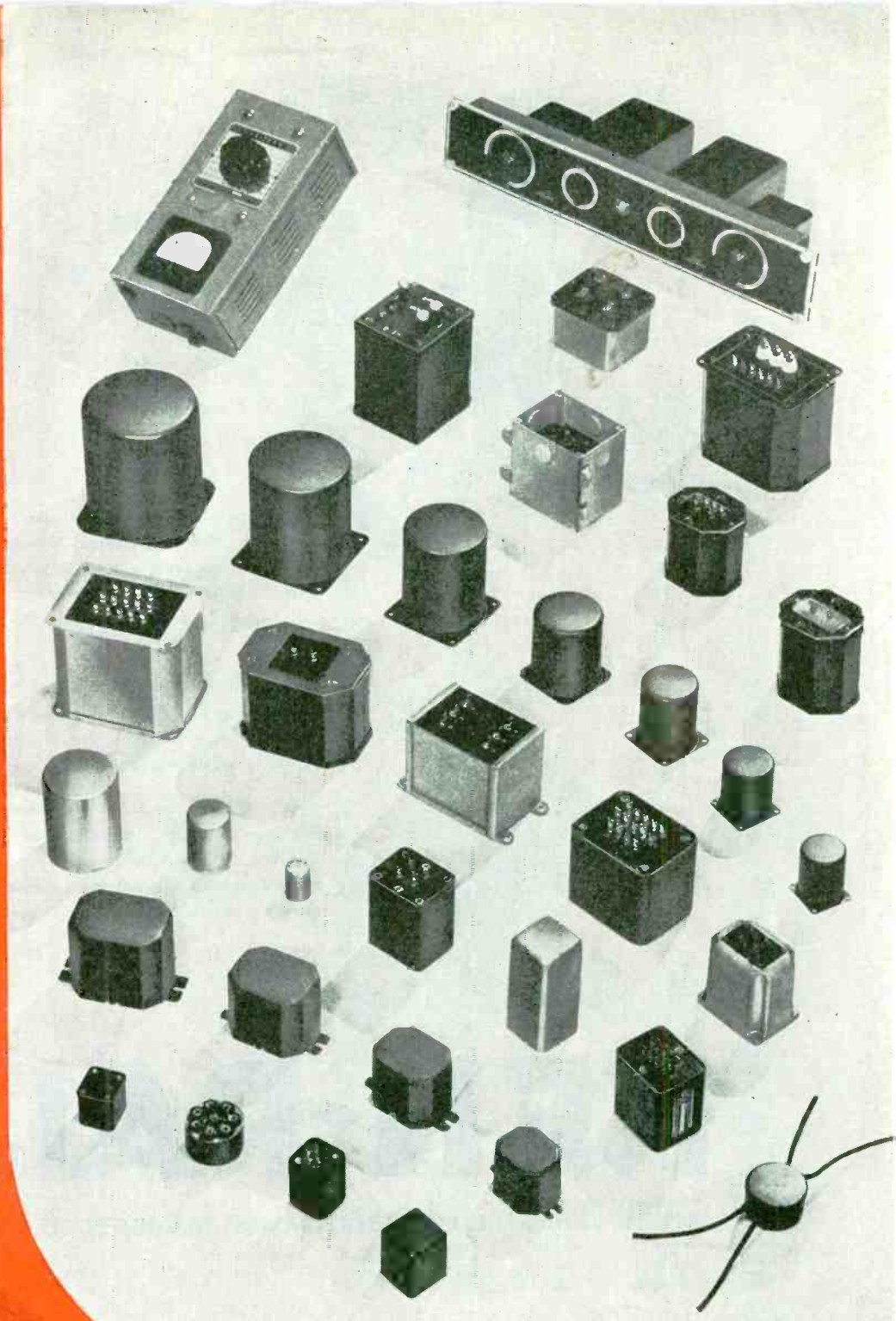

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PHOTOCONTROLS

(*Continued from page* 10)

of each tube will be seen to overlap that of one of the others shown. For the most reliable operation of the photocontrol system, a tube, having a peak in color sensitivity, nearest that desired, should be selected for a particular color detection application.

Selection of the proper phototube for any application may be readily accomplished through the process of elimination. Thus, if it is desired to detect a blue mark on a red surface, a phototube sensitive to red spectra may be selected, since then the blue mark will appear black to such a phototube. Detection of a yellow mark on a white background requires that the tube be sensitive to blue light, the paper appearing black to such a tube, and the mark itself, white.

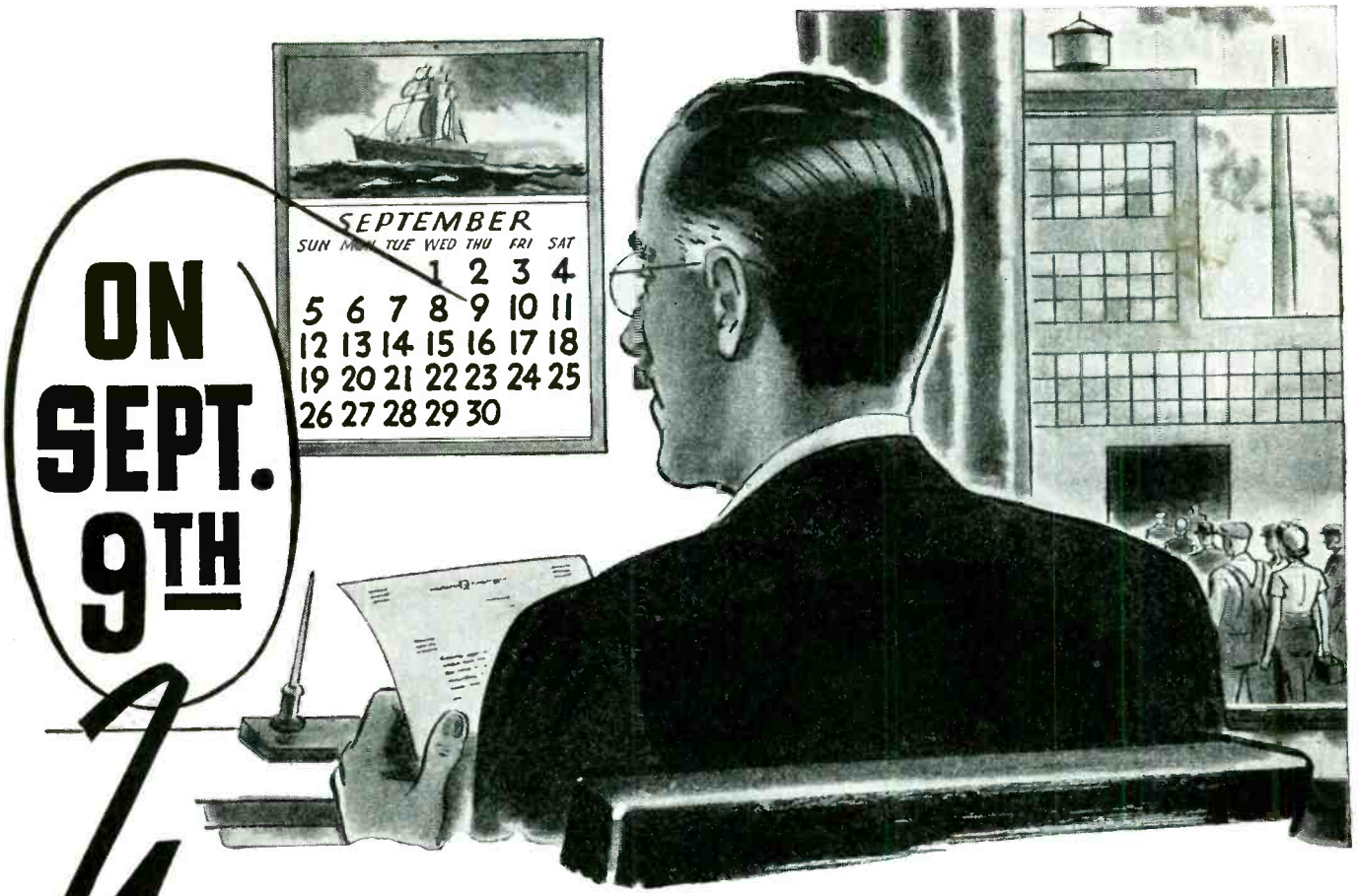
Certain color detection applications involve two colors near each other in the color spectrum. Here, selection of a proper phototube is not sufficient to insure detection, since phototube color selection peaks are broad, as in Fig. 7. Under such conditions, color selection is enhanced by means of glass color filters, such as are used in conjunction with theatrical projection spotlights. The use of such a color filter provides a means for eliminating or re-inforcing the offending color, through creation of a color difference where no such difference obtains. An example of color filtration involves a blue mark on a yellow background. A phototube sensitive to blue is also sensitive to yellow, and in comparatively the same degree. Introduction of a purple filter between the lens and the phototube causes the blue mark to appear black, and the yellow background a very light gray to the phototube, which in itself then resolves to simple black and white detection. Utilizing a blue filter causes a yellow mark on a white background to appear as black on a light blue background. These examples should suffice for average reflection scanning applications.

Once the optical system of the photocontrol is properly installed and adjusted, other operational difficulties, involving end control arrangements, may arise. The majority of such difficulties center on the inability of the photocontrol end relay, or equipment operated by this relay, to function rapidly enough to perform the required operation at the desired instant. Further, this difficulty appears as a lag in the time between the instant of detection and the operation. Since the relay in the photocontrol is of small size, and has but a short armature traversal, the time lag is usually not located here, and must be investigated for in the balance of the control system. In order that the complete electronically controlled system functions properly, the entire controlled system must be able to complete the end operation within several seconds after the operation of the photocontrol end relay.

A few photocontrol applications will be found in which the lag in the end control system may be compensated for by permiting the optical system to perform the detection a fraction of a second before the operation is required. In such an installation, for example, it is desired to operate a cutting blade immediately on the appearance of a color mark under the knife blade. The correct scanner location here may be ascertained experimentally by moving the scanner against the progression of the color marks, thus causing detection to occur a short period of time in advance of the knife operation.

Once the photocontrol installation is properly made, customer gratification is secured by speeding up the now electronically controlled operation experimentally until the maximum speed of the entire system is carefully de-

(*Continued on page* 22)



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Starting September 9th, your Government will conduct the greatest drive for dollars from individuals in the history of the world—the 3rd War Loan.

This money, to finance the invasion phase of the war, must come in large part from individuals on payrolls.

Right here's where YOUR bond selling responsibilities DOUBLE!

For this extra money must be raised *in addition* to keeping the already established Pay Roll Allotment Plan steadily climbing. At the same time, every individual on Pay Roll Allotment must be urged to dig deep into his pocket to buy *extra* bonds, in order to play his full part in the 3rd War Loan.

Your now *doubled duties* call for these two steps:

1. If you are in charge of your Pay Roll Plan, check up on it at once—or see that whoever is in charge, does so. See that it is hitting on all cylinders—*and keep it climbing!* Sharply increased Pay Roll percentages are the best warranty of sufficient post war purchasing power to keep the nation's plants (*and yours*) busy.

2. In the 3rd War Loan, every individual on the Pay Roll Plan will be asked to put an *extra two weeks salary* into War Bonds—over and above his regular allotment. Appoint yourself as one of the salesmen—and see that this sales force has every opportunity to do a real selling job. The sale of these *extra* bonds cuts the inflationary gap and builds added post-war purchasing power.

Financing this war is a tremendous task—but 130,000,000 Americans are going to see it through 100%! This is their own best *individual* opportunity to share in winning the war. The more frequently and more intelligently this sales story is told, the better the average citizen can be made to understand the wisdom of turning every available loose dollar into the finest and safest investment in the world—United States War Bonds.

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BACK THE ATTACK With War Bonds!

This space is a contribution to victory today and sound business tomorrow by SERVICE

PHOTOCONTROLS

(*Continued from page 20*)

termined. Maximum rapidity of the operation is reached when the photocontrol begins to omit occasional operations. A good example involves photoelectronic counting of production objects. In this instance the limit of counting speed is due to the slow response, relatively, of the electromechanical recording counter operated by the photocontrol. However, speeds of 300 objects per minute are not unusual.

Speed Limit

When the speed limit of the photocontrol system and the end control is thus ascertained, the production speed of the system is reduced approximately twenty-five percent to insure final reliable operation.

Color Detection Problems

In conclusion, it may be stated that color detection problems will constitute the most important consideration with each new photocontrol application. Hence, an intensive study of tube manufacturer's phototube data, with regard to spectral responses and operating characteristics, is essential.

TEST INSTRUMENTS

(*Continued from page 7*)

tionless sapphire jewel bearings supporting the moving coil (Fig. 4) are accurately shaped, smoothly-surfaced and accurately adjusted before the instrument leaves the factory, but friction may develop later due to excessively worn or damaged jewels or pivots. Tampering with, rough handling, overloading and dropping of the instrument are common causes of damage to the bearings.

Friction of the bearings usually manifests itself in stickiness and lag of pointer movement, and a noticeable uncertainty in its zero position. To check for excessive bearing friction, gradually applying an increasing current to cause the pointer to advance slowly to a point well up on the scale. Then gently tap the instrument. If the tapping causes the pointer to show an *increase* in reading, it indicates that excessive bearing friction is present. For most commercial instruments the change in reading caused by the tapping should not exceed ½ per cent. The excessive friction may be caused by broken, flat, distorted, dull or dirty pivots, cracked or dirty jewels, or the presence of lint in the bearings. There is no remedy for dull pivots other than having them sharpened or replaced by one well experienced in this work.

Bearing friction will not usually cause reading errors if the instrument is gently tapped each time a reading is taken; but since its causes can very easily produce more serious troubles, they should be remedied.

Bearing Troubles—Looseness

In those rare cases where the jeweled bearing adjustment gets too loose (Fig. 4), the moving coil falls away from its true center position and touches the core or one of the pole pieces, resulting in excessive friction. To rectify this condition, the bearings must be carefully tightened, as will be explained later. If the condition is not serious enough to warrant repair, the errors caused by it can be materially reduced by *gently* tapping the instrument during readings.

In some cases when jeweled bearings become loose, the moving coil frame touches and rides on the top of the core, causing friction on that point. In such instances, the condition is corrected by tightening the bottom jewel screw instead of the top one. Loose end play may also cause variations in readings, and shifting of element balance.

If the pivots become loose in their shafts, or the jewels become loose in the jewel screws (Fig. 4) they must be tightened, or replaced. This is

usually a job for the factory or experienced instrument Service Man.

"Sticking" Movement

Perhaps the most common internal mechanical trouble in instruments is *sticking*. A *sticky instrument* is one in which the pointer halts in its travel over the scale when the current is applied, or does not return immediately to zero after the current has been removed. *Stickiness* is usually caused by tiny particles of foreign matter lodging at some point where they interfere with the action of the moving coil in d-c instruments, or the movement of the vanes in moving-iron type a-c instruments. These may be minute metal filings, dirt, paper fibres, tiny hairs or lint lodged within the instrument or case during the manufacturing process, and subsequently shaken into harmful positions by handling or transportation. Instrument manufacturers take every precaution to insure against this, but even their best efforts cannot always avoid it. Then too, when one opens an instrument case to straighten a bent pointer, replace a broken glass face, etc., there is always the likelihood of dust, hairs, lint, or metal particles gaining entry. Consequently, an instrument case should never be opened unless for a necessary repair—and then carefully and in a *clean location* free from drafts.

The same condition is likely to result from a broken or cracked glass face, and for that reason a damaged face should always be replaced at the earliest possible opportunity. A good temporary repair can be made by covering a crack with transparent *scotch tape* or, lacking this, by cementing a strip of cellophane over the damaged area.

The particles of foreign matter, especially if they are filings of a magnetic metal, often work their way into the short air gap between the pole pieces and the core of the magnet. They cling tenaciously to these magnetic surfaces, obstructing the movement of the moving coil assembly in the air gap and generally make the operation *sticky* and the pointer indications erratic.

Friction may also be caused by the pointer rubbing on the scale, or even on fine, loose fibres projecting from the surface of a paper scale. Such irregularities, evident perhaps only during certain atmospheric conditions and usually only at certain parts of the scale, are difficult to discover. Sometimes a small hair on the inside of the instrument case or glass face will also interfere with the pointer travel. This should be checked for in cases of sticking.

Interestingly enough, instruments

made *sticky* in action by foreign substances lodged in their mechanism seem to rank first among those most frequently requiring repair not due to owner negligence or carelessness.

A *sticky* indicating instrument, easy to detect immediately, should be repaired at once; if you force yourself to cope with any instrument of less than 100% performance, you subconsciously build up a psychological *mad* against it. Every time the pointer sticks, you consign it to a deeper and hotter furnace, putting energy into *it* rather than into your work. If you have it repaired immediately, you forget past difficulties in present good performance. No longer constantly aggravated, you actually enjoy your

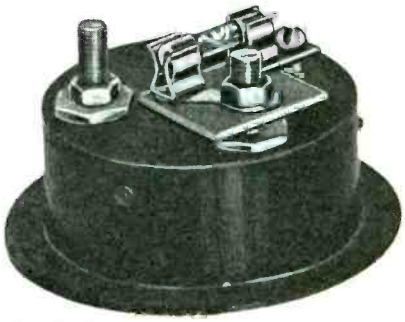


Fig. 5. Typical fuse mounting on meter. (*Courtesy Littelfuse*)

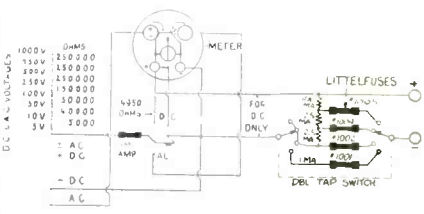
work and cannot avoid doing it better.

A qualified instrument repair service should make the repair if it is available; the average radio Service Man is not capable of cleaning and adjusting the delicate movement, and the usual instrument manufacturer's guarantee covers the repair cost if it becomes necessary within ninety days after the purchase date. However, if the Service Man is forced to rely on his own skill for correcting this trouble, he may proceed as outlined here later.

Never be tempted to blow out foreign material with a blast of compressed air, or with the breath. The former will damage the sensitive movement of the instrument; the latter will cause trouble eventually because the human breath carries moisture into the instrument.

Electrical Troubles

Electrical troubles that develop in



(SWITCH SHOULD BE SET AT 1 MA WHEN READING VOLTAGES)

Fig. 6. How to fuse a multi-range meter. (*Courtesy Littelfuse*)

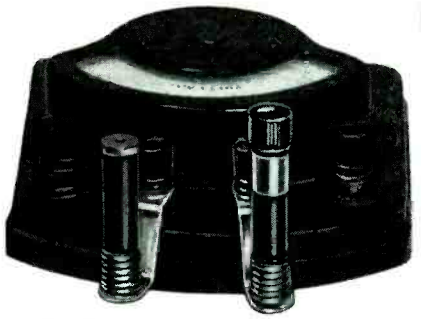


Fig. 7. A dual fuse mount on meter.
(*Courtesy Littelfuse*)

indicating instruments may cause any one of these effects:

(1) *Total failure to indicate.*
(2) *Erractic indication.*
(3) *Inaccurate indication.*

No Indication — If an instrument fails to indicate on one or more ranges (or altogether) when the current or voltage is applied, it may be caused by a break in one of its own electrical circuits. Open-circuit, due to breakage of the extremely fine movable-coil wire, or of that in voltmeter multiplier resistors, causes the trouble in some cases. Faulty, or weakened soldered joints also are frequent offenders.

Weakened soldered joints, loose or broken conductors, partial or complete short-circuits or grounds (that tend to decrease the field strength of the moving coil by changing its effective ampere-turns), faulty contact in range switches, etc., frequently cause erratic operation and introduce errors in the instrument reading. It is surprising how many loose or faulty-soldered joints develop in supposedly well-assembled, tested and calibrated instruments, unless their manufacturers subject them to the most rigid inspection at the factory. They require careful, complete repair to make the instrument again reliable. Remember that even a small amount of resistance change (due to poor mechanical contacts, faulty soldered joints, etc.) introduced into the moving coil circuit, or the shunt circuit of milliammeters, etc., can introduce sizeable errors. *Open* shunt circuits not only cause the instrument to read high on those particular current ranges, but also cause the moving coil and associated circuits (springs, etc.) to carry the full load current. This may cause coil or spring damage due to overheating, or outright failure. A partially *shorted* or *grounded* series multiplier resistor in a voltmeter will cause inaccuracy in that particular range.

Fig. 8. Another type of instrument fuse mounting.
(*Courtesy Littelfuse*)

Contact resistance in switches, pin jacks and test prods often causes erratic operation and sometimes causes error, although small enough to cause trouble only in very *low-resistance* or *high-current* tests. In hot, humid weather, certain metals corrode very rapidly; if erratic readings are consistent, suspect *contact resistance* due to this. The remedy? Wipe all open contacts with a small piece of heavy canvas, and clean all tips with very fine sandpaper or an ordinary eraser. Most rotary switches have *self-wiping* contacts; these can be cleaned by revolving control knob about ten times.

The copper-oxide rectifiers in rectifier type a-c instruments can increase the inaccuracy of the instruments they are used in, because of their inherent delicacy and tendency to become easily overloaded. The rectifiers, usually not guaranteed and impossible to repair, if damaged, should be replaced by an instrument repair station or by the manufacturer.

[*The second part of this discussion will appear in September,* SERVICE.]

NEWS

AMENDED TUBE RULING

In an amendment to Limitation Order L-76, which restricted the production of many tubes, production of type 5Y3G will hereafter be made for civilian needs.

* * *

W. B. GILLEN WINS G.E. PROMOTION

W. B. Gillen has been named manager of manufacturing of the tube division of the General Electric Electronics Department. Mr. Gillen will be responsible for all G. E. tube manufacturing activities at Buffalo, Cleveland, Lynn, and Schenectady.

POPE REELECTED TO RMA POST

H. A. Pope, credit manager of National Union Radio Corporation, Newark, N. J., has been reelected as vice-chairman of the Eastern Credit Group of the Radio Manufacturers Association.

* * *

HOME RECORDING DISC APPEAL DENIED

Recently Sidney Gould, president of the RecordDisc Corporation, appealed to the Radio and Radar Division of WPB for a repeal of the restriction on the manufacture of home recording discs. In the appeal, Mr. Gould pointed out that home recording discs were made on a cardboard base, coated with material which is priority free and produced with readily available equipment. These discs, he said, are entirely different from the professional type, for a very wide range of materials can be used. And sufficient substitute materials are available in case shortages should prevail.

Continuing with his explanation, Mr. Gould said that these home recording blanks are used for the greatest number in homes on existing equipment which are of the radio phonograph combinations with a cutting arm attachment. These combinations are not special recording machines, he explained. Accordingly, he pointed out, a home recording disc should not be interpreted as "a component part of an acoustic phonograph."

Replying to Mr. Gould's appeal, WPB said that home recording discs are used on electronic equipment. As such these discs fall into the Limitation Order L-265, and thus no "further action can be taken," WPB said.

A second appeal has been submitted by Mr. Gould. A further explanation of the available phonograph equipment in which these discs are used and also a discussion of the manpower and material situation, showing that sufficient manpower and materials are available for home record disc manufacture, has been submitted.

* * *

RCA PROMOTES TEEGARDEN

L. W. Teegarden has been named assistant general sales manager of the RCA Victor Division of the Radio Corporation of America.

In his new capacity, Mr. Teegarden will have direct supervision over the selling, distributing and warehousing of all RCA products. In addition, the company's four regional directors in the Eastern, Central, Western and Southern territories will report to him.

* * *

AIRCRAFT ACCESSORIES ACQUIRES CONTROL OF PHONETTE CO.

Aircraft Accessories Corporation has acquired a controlling interest in The Phonette Company of America, Los Angeles.

Phonette will be operated as a subsidiary, under the supervision and direction of the electronics division of Aircraft Accessories Corporation.

The Phonette Company of America formerly engaged in the development, manufacture and sale of the *Phonette*, a music vending device invented by W. S. Farrell, its president.

Officers and directors of The Phonette Company now are: Randolph C. Walker, chairman of the board; W. S. Farrell, president and director; C. N. Kimball, vice president and director; Ray Eller, secretary-treasurer and director, and C. F. Skinner, director.

FORMER N. U. CLERK CITED

Marine Corporal Robert J. Chenoweth, former clerk in the maintenance department of National Union, has been awarded the Silver Star.

* * *

N. U. EMPLOYEES ATTEND WAR WEAPON EXHIBIT

Employees of National Union Radio Corporation, Newark, N. J., were invited guests at the official exhibition of Army War Weapons in New York City, during August 8 to 14. This period was set aside as National Union Radio Corporation week.

The exhibit included anti-aircraft guns, anti-tank cannons, ammunition, aerial bombs including a *block buster*, combat vehicles, sectionalized bomber plane, field guns, typical Army barracks, captured enemy weapons, *booby traps* and demonstrations by American soldiers.

* * *

K. C. PRINCE RECEIVES NAVY COMMISSION

Kenneth C. Prince, Chicago attorney, who has served as executive secretary of the Sales Managers Club, Western Group (now Association of Electronic Parts and Equipment Manufacturers) for nine years, has been commissioned Lieutenant (j.g.) U.S.N.R. He has also served as general counsel for the Radio Parts Manufacturers National Trade Show Inc., and Radio Servicemen of America, Inc., and acted as the legal consultant for the Priorities Committee of the Radio Parts and Associated Industries.

KAAR AND NEVIN IN NEW G.E. POSTS

I. J. Kaar and G. G. Nevin have been appointed managers of the receiver and tube divisions, respectively, of General Electric's electronics department. The receiver division is located in Bridgeport. Conn., while the headquarters of the tube division are located in Schenectady.

Mr. Kaar formerly was managing engineer of the receiver division.

Mr. Nevin was chairman of the management committee of the tube division of the electronics department.

* * *

SUGGESTIONS WIN AWARDS AT KEN-RAD

A system of weekly awards for suggestions tending to increase production, eliminate waste, and promote a greater intensity in the war effort has been inaugurated for employees of The Ken-Rad Tube & Lamp Corporation, Owensboro, Kentucky. Originators of accepted suggestions receive cash awards of from $2 to $25.

Recent winners were: Joseph Strehl, who suggested an adjustment on a grid machine control box, and Everett L. Bivine and Joe Temple, jointly, who originated an idea for an unwinding device for a cutter for heating wire.

(*Continued on page 29*)

BUY UNITED STATES

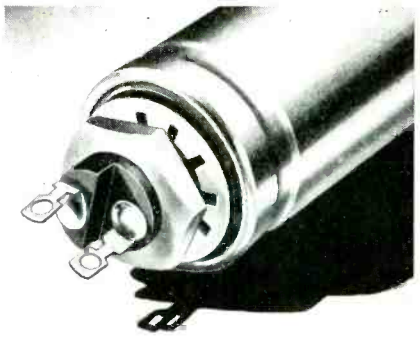
WAR SAVINGS BONDS AND STAMPS

EVERY PAY DAY

NEW PRODUCTS

TWO-TERMINAL OIL CAPACITOR

The Aerovox type 10 oil capacitor has been improved with a new double-terminal feature. Heretofore this capacitor has had a single insulated terminal and grounded



can, although when screw-mounted on a metal chassis it could be fully insulated by an insulating washer.

The new double-terminal feature provides insulation for both terminal lugs from the *floating* can. Thus no insulating washer is required. These capacitors, made by Aerovox Corporation of New Bedford, Mass., are hermetically sealed. A new one-piece molded bakelite terminal assembly is used to prevent penetration of moisture and leakage of oil. These capacitors, available on high priorities only, are filled with either Hyvol vegetable oil or mineral oil, rated up to 4.0 mfd at 600 v. d-c and to .5 mfd at 1500 v. d-c. The can, similar in design and dimensions to the usual inverted-screw-mounting metal-can electrolytics, is of aluminum or an approved substitute.

* * *

ELECTRONIC DESK

For critical check-ups of cathode ray tubes, on a mass testing basis, engineers of Allen B. Du Mont Laboratories, Inc., Passaic, N. J., evolved an *electronic desk* test position.

The *electronic desk* is a steel cabinet in the form of a modified flat-top desk. An inclined platform supports the cathode-ray tubes which are plugged into their respective receptacles at the rear. Directly beneath the inclined platform or shelf is a battery of meters covering all required readings. Directly in front is the writing

space, and beneath a drawer for paper, forms, pencils and so on. On either side of the writing space are more meters. Where the desk drawers would be there are switches and controls for the power supply which forms part of the test position and which provides all required voltages for the widest array of cathode-ray tube types.

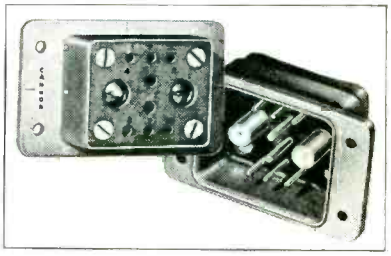
The operator can check for brilliance, focus, deflection, leakage resistance and other characteristics.

CANNON DP-B CONNECTORS

A rack type connector, adapted to radio rack assemblies, transmitters and general applications where both plug and receptacle must be fixed permanently in their respective units of equipment, has been announced by Cannon Electric Development Company, 3209 Humboldt Street, Los Angeles, Calif.

Differing from the standard round or oval-faced connectors, these connectors, the DP-B type, are designed to fit rack equipment. The shell is tapered to effect a close fit when engaged and the two units of the complete connector are self-aligning but are dependent upon the accuracy of the equipment it connects.

The insert insulation is made of molded phenolic, having 8 standard contacts of brass, silver-plated, and 2 coaxial contacts



of the same material and finish, with isolantite insulators. Two contacts are 30 amp and six are 15 amp. Shell is die-cast aluminum alloy, with sand blast and clear lacquer finish. Four mounting holes have diameter of .144 countersunk for No. 8 flat head machine screws. Weight of receptacle .276 (lb) and plug .266 (lb).

* * *

STACKPOLE HIGH-ALTITUDE GENERATOR BRUSHES

Generator brushes have been engineered by the Stackpole Carbon Company, St. Marys, Penna., for airplane use at altitudes above 30,000 feet.

These brushes are treated with a special process developed by the Westinghouse Electric & Mfg. Company.

GOTHARD PILOT LIGHTS

A series of pilot lights for grounded pilot light panels have been developed by Gothard Manufacturing Company, 1300 N. Ninth Street, Springfield, Ill. Bulb change is accomplished from the front of the panel without disturbing body mounting or wiring. The bulb automatically comes out when the jewel holder is unscrewed. Bayonet socket lamps (long or round) may be used.

BONDS — BONDS — BONDS
KEEP BUYING 'EM — AS MANY AS YOU CAN. THERE'S NO BETTER WAY TO HASTEN ULTIMATE VICTORY

NEWS

(*Continued from page 27*)

LIEUT. G. BERMAN VISITS SHURE PLANT

Lieutenant E. L. Berman, U. S. Signal Corps., recently paid a surprise visit to Shure Brothers, his former Alma Mater.

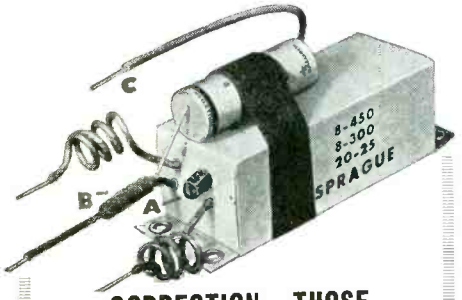
He was greeted by his brother, Jack, and S. N. Shure. "Gene" Berman was formerly radio sales manager of Shure Brothers.

* * *

CERAMIC CONDENSER CHART

A chart, in the form of a loose-leaf data sheet, describing a new compact type of ceramic condenser, has been released by Erie Resistor Corporation, Erie, Penna.

Two types, 160 (¾" diameter) and 170 (15/16" diameter) are described. Capacity charts, blueprint style illustrations and other essential data are provided.



CORRECTION—THOSE GREMLINS DID IT!

One of those hard-to-catch typographic errors that make life miserable for printers and advertising men did a "gremlin" job on a recent Sprague Condenser advertisement appearing in this publication.

This advertisement contained the accompanying illustration demonstrating how a Sprague UT-8 8 mfd. 450 volt Atom Midget dry electrolytic could be used to replace the 8 mfd. 450 volt section of a 3-section condenser rated at 8 mfd. 450 v., 8 mfd. 300 v., and 20 mfd. 25 v. So far, well and good—but the trouble came when our little pet gremlin mixed up the "B" and "C" portions of the accompanying directions. Actually, they should read as follows:

(A) Cut lead to defective section and tape end.

(B) Connect cathode (-) side of Atom to common minus lead of multi-section condenser.

(C) Connect cut circuit lead to positive (+) side of Atom.

By following this procedure, you'll find that it is seldom necessary to replace an entire multi-section condenser simply because one section has gone bad. Most defective sections can be replaced by using a Sprague Atom of the proper capacity and voltage in the manner illustrated. The Atom can either be fastened by tape to the multi-section container, or simply held in place by means of its sturdy wire leads.

CODE OSCILLATORS

(*See front cover*)

THERE are many interesting circuit innovations in code practice oscillators. The Silvertone 100 code practice oscillator (on this month's cover), for instance, is actually a five-channel miniature c-w transmitter.

In this circuit stable output in the frequency range of from 3.0 to 3.5 mc is available. An electron-coupled Dow type Hartley circuit with a 75-mmfd silver-ceramic negative coefficient condenser, is permanently connected across the tank circuit. A 5-position switch selects one of five trimmer condensers set to given frequencies. Another trimmer is provided for varying the output voltage of the oscillator. A fixed 10-mmfd condenser is connected in series with this trimmer to limit the output. Only an 8-inch length of wire is recommended for an aerial and, for maximum stability, this should be rigid.

Speaking in d-c terms, the key is located in the cathode circuit, completely interrupting oscillations. Furthermore, the key is at low potential and, if the polarity of the line plug is correct, it will be at ground potential. The .002-mfd bypass condenser across the key terminals keeps r-f away from

the key proper. In the resistance-capacity filter, the second 20-mfd electrolytic condenser is bypassed with a .002-mfd mica condenser. This is necessary because the electrolytic condenser is a very poor bypass at 3.5 mc. In the Dow circuit, the screen serves as a feedback anode which is at ground potential, the cathode being lifted above ground. Coupling to the plate of the tube is by way of the electron stream only, since no capacity coupling can exist by way of the grounded electrode. The plate is untuned, but it is kept at high r-f potential by L_1, a 2½ mh choke. The oscillator frequency is unaffected by plate loading.

Allied Radio Beginner's Oscillator

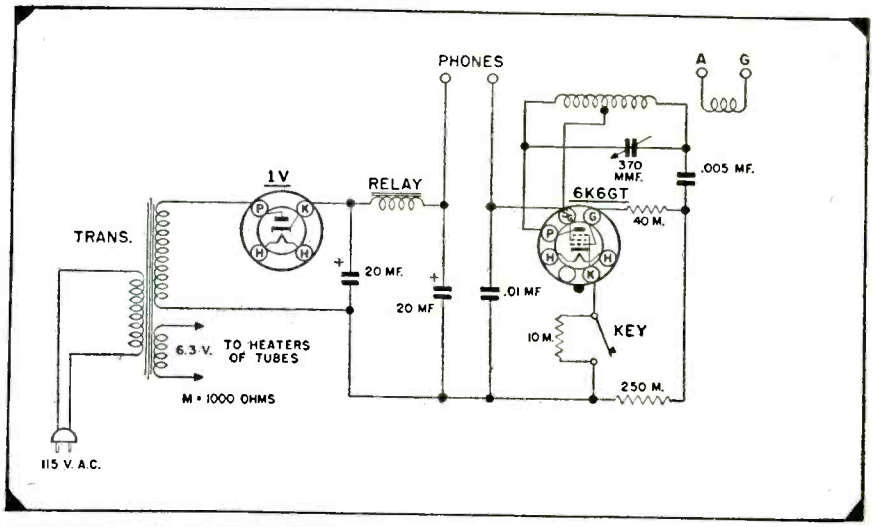
Another code-practice oscillator (Allied Radio Beginner's Oscillator), arranged to oscillate at both audio and radio frequencies, is shown in Fig. 1. This oscillator may be used for individual or group practice. For individual use, a pair of magnetic phones are connected as shown in series with the screen and plate. Keying the oscillator produces an audio tone in the phones. For group use, the oscillator is used as a modulated c-w or i-c-w oscillator which is to be used in conjunction with any standard broadcast receiver. The same tone that is picked up in the headphones will then be heard through the speaker. In this circuit, the phones are at the *B* potential.

Unlike the oscillator on the cover, this Hartley oscillator is a standard pentode type, but the constants are so selected that the tube oscillates simultaneously at two frequencies. The 40,000-ohm series grid resistor and ¼-megohm grid leak cause grid choking at an audio rate which modulates the r-f output. The key in the cathode is shunted with a 10,000-ohm resistor which reduces surges and prevents clicks. The relay in the *B* circuit may be used as a sounder or may be connected to a lamp for light signalling. It doubles as a filter choke. No antenna is recommended with this outfit as the radiation from the coil is sufficiently strong for all practical purposes.

Allied Radio A-F Code Oscillator

Another Allied Radio code practice

Fig. 1. A simple code-practice oscillator wherein the Hartley oscillator is a standard pentode type. Since the output from this unit is quite strong, no antenna is recommended. The relay in the B circuit is used as a sounder and also doubles as a filter choke.

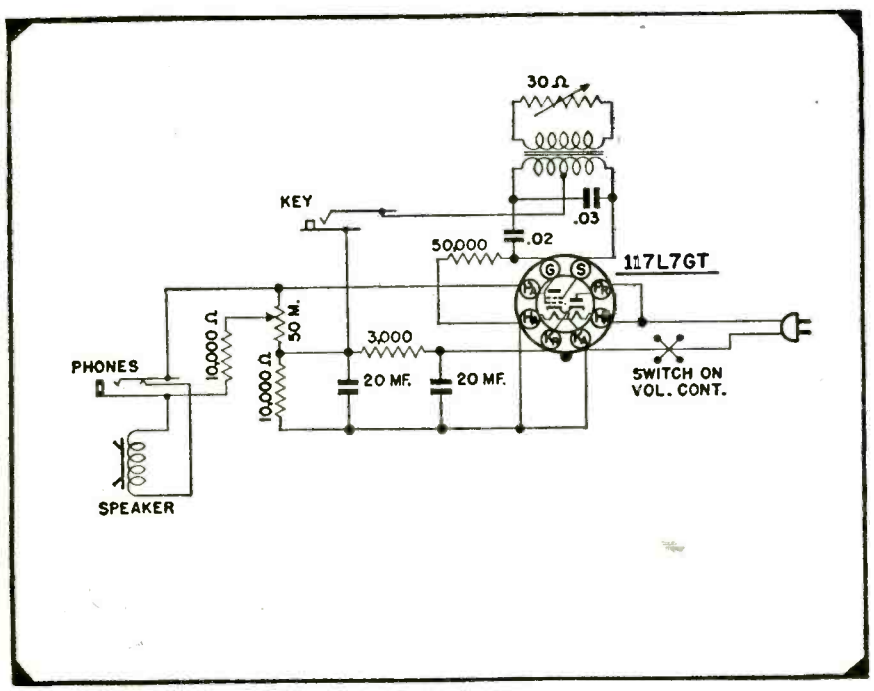


WHEN YOU CHANGE YOUR ADDRESS

Be sure to notify the Subscription Department of SERVICE at 19 E. Forty-seventh St., New York 17, N. Y., giving the old as well as the new address, and do this at least four weeks in advance. The Post Office Department does not forward magazines unless you pay additional postage, and we cannot duplicate copies mailed to the old address. We ask your cooperation.

oscillator is shown in Fig. 2. This unit oscillates at audio frequencies only, being provided with a speaker and phone jack. The 117L7GT permits across-the-line operation. A center-tapped output transformer is used as an oscillation transformer, with a 30-ohm rheostat connected across the secondary for varying the frequency. The change in the resistance load is reflected into the primary, thereby varying the inductance. A .03-mfd tuning condenser is permanently connected across the primary. The key is located in the $B+$ circuit, so key and ground must not be touched at the same time.

Fig. 2. A code oscillator providing audio-frequency tones only. Capacity and electron coupling links the oscillator and output circuits. This unit will operate with several sets of phones without the necessity of impedance matching. Since a 117L7GT tube is used, across-the-line operation is possible.



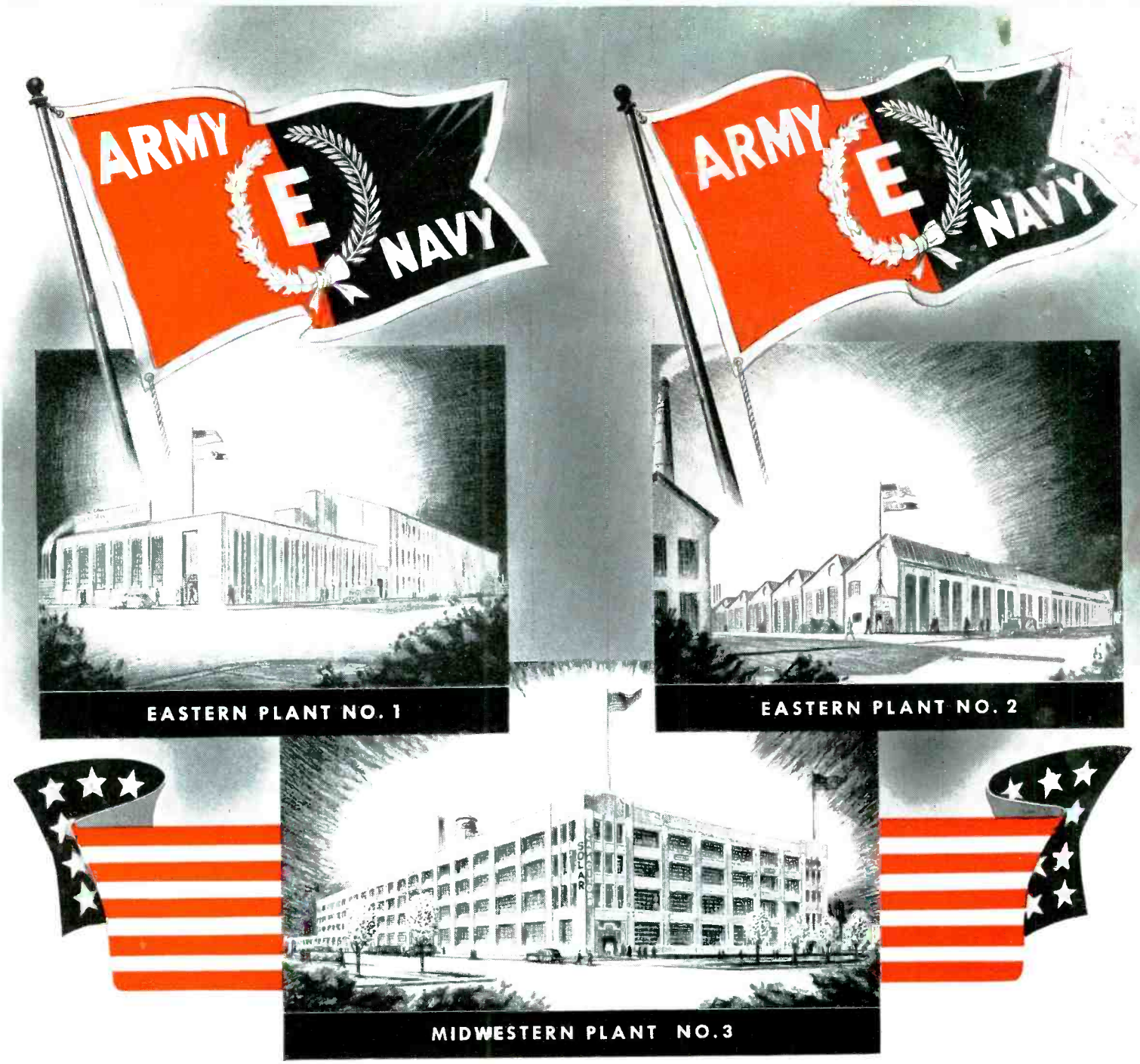
The tetrode screen serves as the oscillator anode, the load being applied to the plate circuit. Both capacity and electron coupling exists between the oscillator and output circuits. A 50,000-ohm potentiometer with the arm connected to the speaker and phones serves as the plate load. A 10,000-ohm series resistor limits the output. The closed circuit jack cuts out the speaker when inserting the phone plug. The unit will handle up to twenty pairs of ordinary phones but, for maximum output, the load should approximate 10,000 ohms. This impedance may be obtained by connecting the phones in series, parallel or series-parallel, depending upon the type used. Where only a few sets of phones are used, sufficient volume will be obtained without considering an impedance match. The potentiometer acts as a volume control for all loads.

JOTS & FLASHES

JOHN Q. ADAMS, formerly sales manager of Champion Lamp Works, joins Hytron as sales executive . . . welcome back, John . . . W. B. Gillen appointed manager of all G-E tube manufacturing . . . Emerson labor-management committee publishes attractive monthly magazine for employees and men in Service . . . new daughter born to the Robert S. Berks . . . proud father is associated with Electronic Corp. of America . . . P. M. Craig named radio engineering director by Philco . . . Duotone appoints A. J. Beck as sales manager . . . white star for their Army-Navy "E" pennant awarded to General Radio for continued excellence of production . . . the same distinctive award made to Sylvania . . . if you are not getting the pertinent and newsy *Sylvania News* better advise the company at Emporium, Pa. . . . it's chock-full of material of value to every servicer . . . glad to welcome Raytheon advertising in SERVICE once again . . . if your copies arrive late please bear with us . . . printing and mailing conditions under wartime stress present plenty of difficult problems . . . be certain to read A. A. Ghirardi's article in this issue . . . contains vital information on the maintenance and repair of test apparatus which is irreplaceable these days . . . we like *Micro Topics*, a bright and newsy house organ published by Universal Microphone Co. . . . Solar sales and executive offices now located at 285 Madison Ave., New York City . . . Howard B. Jones' new address is 2460 W. George St., Chicago 18, Ill. . . . swell new primer titled *How Electronic Tubes Work* offered by G. E., Schenectady . . . contains 24 pages with 117 sketches and photos . . . Army-Navy "E" awarded G. E. Plastics Plant, Pittsfield, Mass. . . . industrial safety award to Zenith Radio for record in prevention of accidents . . . new Sylvania plant opened in Warren, Pa. . . . that's the 15th . . . Army-Navy "E" to Cannon Electrical Development Co., Los Angeles, on August 10th . . . Judson C. Burns, Inc., Philadelphia, appointed distributor for The Crosley Corp. . . . Westinghouse Lamp Division, Bloomfield, N. J., appoints Ralph G. Stuart as manager . . . Eugene H. Fischer, Westinghouse ceramic engineer, awarded 'Order of Merit' chiefly for development of "Prestite" . . . Army-Navy "E" awarded to United Electronics, Inc., transmitting tube manufacturers of Newark, N. J. . . . despite the favorable news from the various fighting fronts DON'T STOP BUYING WAR BONDS.

ADVERTISERS IN THIS ISSUE

SERVICE — AUGUST, 1943



3 Plants... 2 Flags... ONE PURPOSE

To beat the band of Axis bandits, three Solar factories are now operating "round the clock". The men and women of Eastern Plants 1 and 2 were told "Well Done" by the Army and Navy; they proudly wear the Army-Navy "E".

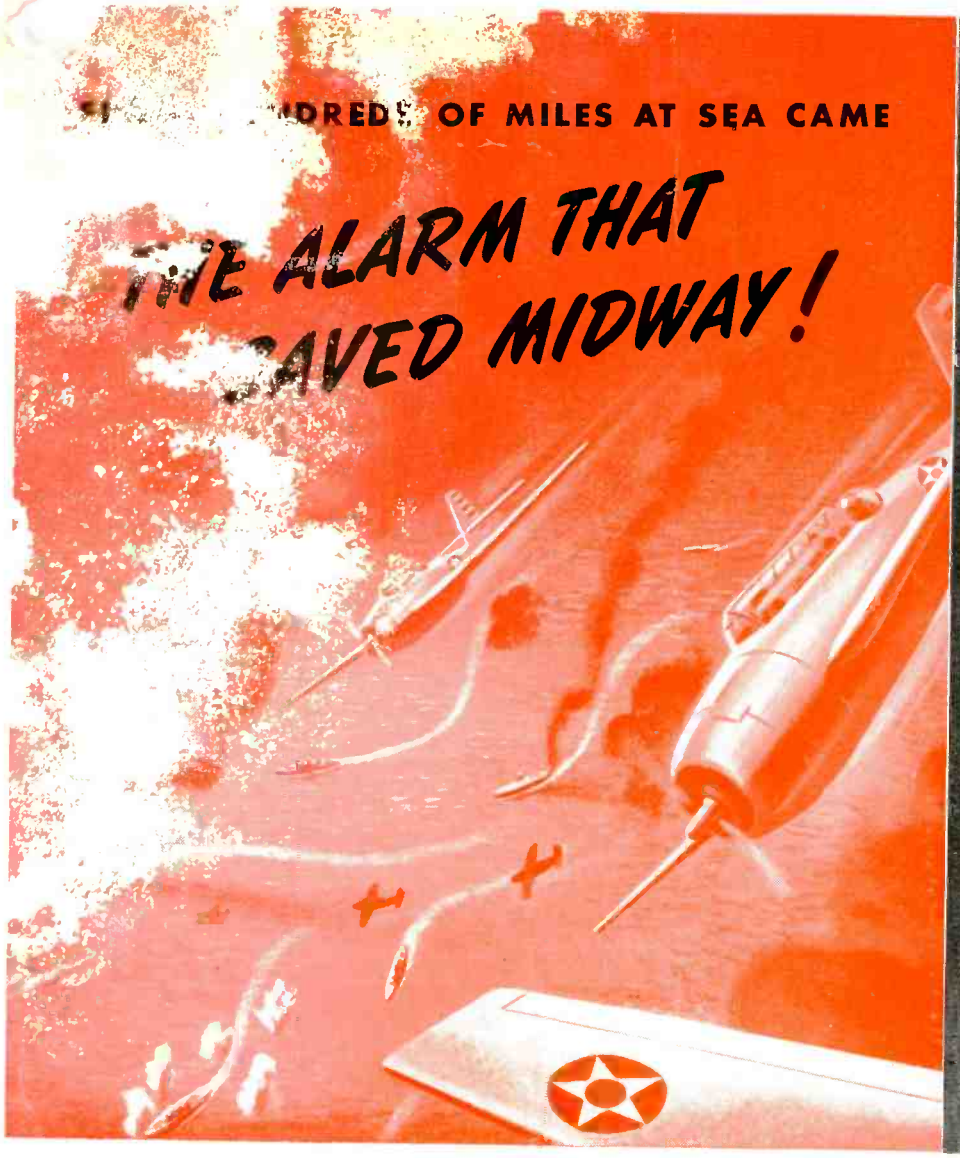
The Midwestern Plant has just started production; the men and women of this modern air-conditioned factory are ready to help you speed the day of Victory.

If your capacitor or filter problem is made ours, you can be certain of "Quality Above All".

Solar Manufacturing Corporation, General Offices: Bayonne, New Jersey.

Solar SOLAR CAPACITORS

CAPACITORS and RADIO NOISE-SUPPRESSION FILTERS



Midway was ready when the Jap attempt to capture this strategic U. S. outpost came June 4 to 7, last year. Long before the Jap fleet of battleships, carriers, cruisers, destroyers and transports could bring their big guns into range—vigilant patrol planes with modern radio communications equipment had sounded the alarm. Many miles from Midway's shores American planes blasted their fleet . . . drove their survivors into a frantic homeward retreat.

REPEATEDLY it has been said—"this war is different". Yes, different because, on land, at sea and in the air, battles are being planned and fought with weapons never before available to our fighting men. Among these is the electronic tube. It is reassuring to know that no nation is making wider or better use of this great weapon of modern warfare than the U. S. A. To help serve the vast requirements of our Army and Navy National Union, for example, is producing electronic tubes on a scale far exceeding its peace-time peak. Yet, dramatic as are the achievements of electronics in war, there will be even more miraculous peace-time tasks for tubes to perform. Expansion in the use of electronic devices will bring many new calls for service work. With quality tubes, fine test equipment and new merchandising plans, National Union will be prepared, as never before, to help steer this profitable business your way.

NATIONAL UNION RADIO CORPORATION • NEWARK, NEW JERSEY • LANSDALE, PENNSYLVANIA

NATIONAL UNION
RADIO AND ELECTRONIC TUBES

Transmitting Tubes • Cathode Ray Tubes • Receiving Tubes • Special Purpose Tubes • Condensers • Volume Controls • Photo Electric Cells • Exciter Lamps • Panel Lamps • Flashlight Bulbs