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December 10, 1944

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COVER PICTURE

This 19 year old leatherneck typifies the vigor and spirit of the marine corps.

The DIGEST of Airborne Radio and Radar News is published twice a month by the Technical Information Unit of the Airborne Coordinating Group at the direction of the Bureau of Aeronautics of the Navy Department. Its purpose is to disseminate information of interest and value to the fleet on airborne electronic equipment. Contributions, comments, and letters are solicited. They should be directed to the Airborne Coordinating Group. Opinions expressed by individual contributors do not necessarily express the official attitude of the Bureau of Aeronautics of the Navy Department.

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RADAR REFRESHER TIMING CIRCUITS

Part I

THE circuits in a radar set that control and synchronize the operation of the several components of the set are known as timing circuits. Sometimes these are assembled in a separate unit called a timer, synchronizer, keying unit, modulation generator, or central. Often, however, the timing circuits are built into the same unit as other parts of the set, such as the indicator.

Radar systems may be divided into the following two classes with respect to the manner in which the timing functions are carried out:

(1) Master-oscillator systems
(2) Self-synchronous systems

In systems of the first class a master oscillator in the timer determines the pulse repetition frequency, and from its output trigger and gate pulses are derived for controlling the entire system. In systems of the second class the transmitter delivers a trigger pulse to the timer at the beginning of each pulse of radio-frequency energy, and other operations of the system are timed from this trigger. The transmitter of a self-synchronous system may be pulsed by a modulator synchronized by an oscillator in the timer or by a spark-gap modulator, or it may be self-pulsed—that is, the transmitting oscillator may be a kind which of itself generates high-frequency power in a series of short, equally spaced pulses.

Self-synchronous systems are often simpler than those of the master-oscillator type. Furthermore they are suitable for use with such modulators as rotary spark gaps, where the exact instant of transmission of a pulse varies somewhat from one cycle to another. Timing the entire system from the transmission of the pulse prevents errors in range measurement or a blurred appearance of targets on the indicator which would otherwise result from such operation of the modulator. A difficulty encountered with self-synchronous systems is the delay which sometimes occurs in the starting of range sweeps. This delay may be compensated in master-oscillator systems by triggering the sweeps before triggering the modulator, but in self-synchronous systems such compensation is not possible. For search-type radar the present tendency is toward simple self-synchronous systems using range-sweep circuits which minimize the delay in starting.

The functions which the timer must perform depend to a large extent upon the purpose of the set, the type of modulator used, and the method of data presentation employed. For this reason the diagram of Fig. 1 does not apply to any particular set but shows the more common control pulses which are used in many systems. Fig. 2 shows these same control pulses in the proper time relationships to the transmitted pulse. The diagrams are drawn for a master-

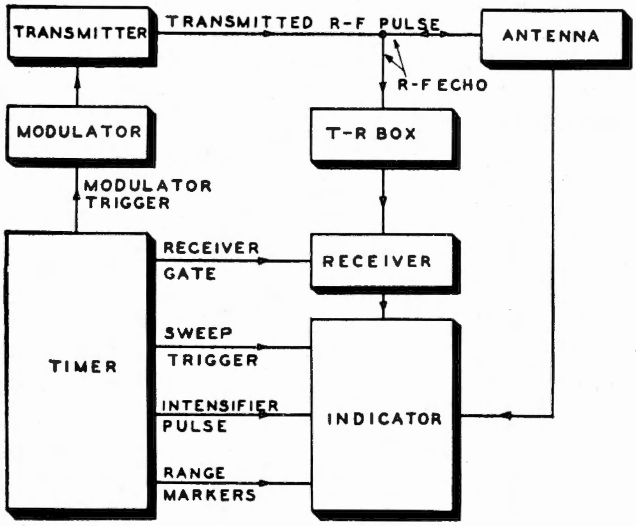


Fig. 1. Possible functions of a radar timer.

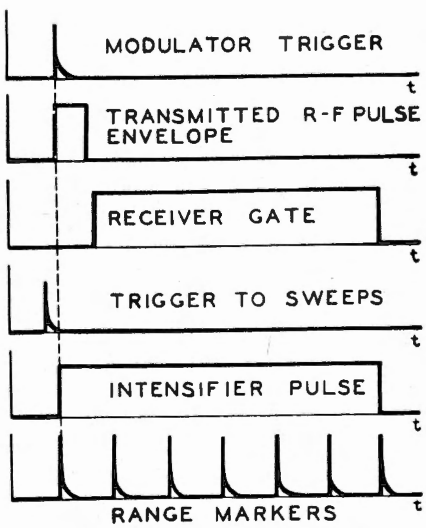


Fig. 2. Control pulses furnished by the timer of Fig. 1.

oscillator system, but they would apply also to a self-synchronous system if a trigger pulse were supplied from the modulator to the timer, instead of the reverse.

The first control pulse shown in these figures is the modulator trigger, which causes a pulse of radio-frequency energy to be transmitted having the envelope shown in Fig. 2. The trigger also acts as a reference point from which the other operations are timed.

A second control pulse shown in Figs. 1 and 2 is the receiver gate. This pulse is necessary in some sets to prevent blocking of the receiver. Blocking may occur if the signal that enters the receiver at the time of the transmitted pulse is sufficiently strong to drive the grid voltage of one of the video-amplifier stages below the cutoff value. Then the capacitor coupling this stage to the next is charged to a large voltage. After the transmitted pulse is over, this capacitor maintains the grid to which it is connected at a voltage below cutoff and thus makes the receiver inoperative. Unless the recovery time of the receiver, or time for the blocking charge to leak from capacitor, is short, blocking interferes with the reception of echoes from nearby targets. The T-R box may not prevent blocking, for while it does limit the signal that can enter the receiver to a value that will not damage the crystal mixer, it nevertheless allows a very strong signal to enter the receiver at the time of the transmitted pulse. To prevent blocking, the timer may be made to supply the screen-grid and plate voltages of one or more of the early stages in the intermediate-frequency amplifier of the receiver. This voltage, which is the receiver gate, is supplied only during the time interval beginning just after the end of the transmitted pulse and ending after the echoes from the most distant targets in the desired range have been received, as shown in Fig. 2. Thus the receiver is inoperative during the transmitted pulse, and blocking does not occur. Improvements made in receiver and T-R box design have so shortened the receiver recovery time that a gate is often unnecessary and in many recent sets is not used.

The timer may supply also a trigger to start the range sweeps. In Fig. 2 this trigger-pulse is shown as preceding the modulator trigger, so as to compensate for delay in starting the sweeps. This delay is greatest if the rotary transformer method of obtaining range sweep is used with a PPI indicator. With other forms of range sweep and properly designed sweep circuits the delay may be negligible and no advance in the sweep trigger needed.

Another voltage which the timer may supply is an intensifier pulse, as indicated in Fig. 2. In order to avoid confusion in interpreting the targets appearing on the indicator screen, no signals arising outside the time interval corresponding to the desired range should appear on the screen. This objective may be accomplished in one way by applying electrode potentials to the indicator tube which render it inoperative, and adding as an intensifier pulse a positive gate to the potential of the control grid or an anode, so that the tube is operative during the required interval. An alternate method is to make the tube normally operative and to apply a negative gate, or blanking pulse, to blank the screen when signals are not to be received.

An important function of a radar set is determination of the range of the targets observed. The methods of range determination vary from the use of a transparent overlay for the indicator screen, upon which ranges are marked, to complex circuits used for very accurate range measurement. A very common method for search-type sets is the use of range markers generated in the timer. The markers are pulses of very short duration, as shown in Fig. 2, separated by a specified time—for example, 107.4 μsec if the distance between marks is 10 statute miles. These pulses are applied to the indicator in the same manner as signals, and result in straight lines at known ranges on a "B" indicator, or circles on a PPI indicator.

Note that all the control pulses described are repetitive; that is, the master oscillator determines a pulse repetition frequency for the set, and each control pulse occurs once during each cycle. The timer, then, furnishes several series of pulses, each having the proper waveform and each properly related in time to the others.

In order that a timer may provide these control pulses, it must contain the following elements:

(1) A master oscillator to determine the pulse repetition frequency (except that the master oscillator is not needed with a self-pulsed transmitter or a rotary-spark-gap modulator).

(2) A means of forming pulses of the desired shapes and in the desired time relations. These pulses may be produced by clipping and peaking the output of a sine-wave generator, or they may be formed by multivibrators and blocking oscillators.

(3) Circuits designed to supply the pulses to the desired loads without a change of waveform resulting from currents taken by the load or by the capacitance of connecting cables. Such a circuit is the cathode follower.

In the remainder of this chapter, circuits to perform these functions are considered in detail. The order is not that in which the pulse progresses through the circuits in the timer; rather, the simpler circuits are treated first so that an understanding of them may be used as groundwork for the study of more complex circuits.

PULSE-SHAPING CIRCUITS

If the master oscillator of a radar timer produces a sine wave, clippers may be employed to cut off the sinusoidal peaks and from a nearly square wave. Peakers may then be used to form pulses of very short duration from the vertical edges of the square wave. Multivibrators (treated in Part B) may produce rectangular pulses of any desired duration from the peaker output. In this way short trigger pulses and rectangular gate pulses may be formed in the timer. Even if the master oscillator itself produces pulses rather than sine waves, clippers may still be used to flatten the tops of the pulses, and peakers to shorten their duration. In a similar way, clippers and peakers may be used in the formation of the narrow pulses used as range markers.

1. Diode Clipper

Fig. 3 is the circuit diagram of a simple diode clipper. The input voltage is e_1 and the output voltage e_2. The load connected to the output terminals is assumed to have a very high impedance, so that the output current is negligible. Further, the tube is supposed to behave as a switch.

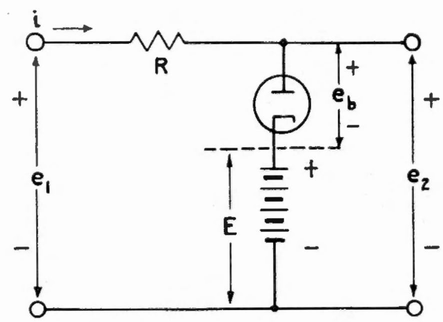


Fig. 3. Diode clipper.

If the input voltage e_1 is less than the battery voltage E at any instant, the net voltage in the circuit tends to send current from cathode to plate through the tube. Thus the tube behaves as an open switch, no current flows, no voltage drop occurs across R, and the output voltage e_2 equals e_1. If e_1 increases to a value greater than E, the net voltage sends current in the conducting direction through the diode, and the diode behaves as a closed switch connecting the top output terminal to the positive battery terminal. Thus e_2 equals E, and the difference between e_1 and E appears as an iR drop across R.

If any input voltage wave, such as e_1 in Fig. 4, is applied to this circuit, the output voltage follows the input whenever both are less than E, but is limited to the voltage E whenever the input exceeds this amount. This process of cutting off the tops of the waves is known as clipping: hence the name diode clipper. The alternate name limiter is sometimes applied to the circuit.

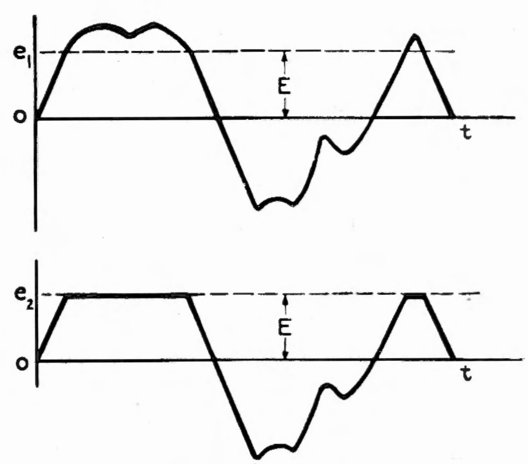


Fig. 4. Clipping of positive peaks.

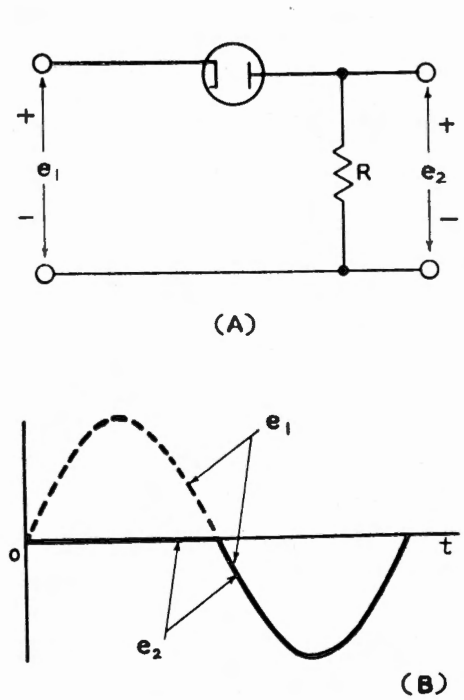


Fig. 5. Alternate diode clipper.

A slightly different clipper, shown in Fig. 5, is commonly used to clip the positive peaks from a sine wave. The circuit is the familiar half-wave rectifier circuit. To see that it clips a sine wave as shown in the figure, consider the diode as a switch.

So far the diode has been assumed to behave as a closed switch—that is, as a short circuit—when conducting. This assumption is justified if R is very large compared with the resistance of the diode, but if R has a smaller value, the voltage drop across the diode when conducting may have an appreciable effect. The static, or average, plate resistance of the diode is defined as*

$$\bar{r}_p = \frac{e_b}{i_b},$$

where

e_b is the plate voltage of the diode,

i_b is the plate current of the diode.

To see the effect of this resistance, suppose that R in Fig. 3 is 4500 ohms, and that r_p for the diode is 500 ohms. The current flowing when e_1 is greater than E is then

$$i = \frac{e_1 - E}{4.5 + 0.5} = \frac{e_1 - E}{5} \text{ ma},$$

* This resistance is nonlinear; that is, its value changes as i_b and e_b change. As an approximation, it is here assumed to have a constant value whenever e_b is positive.

where e_1 and E are in volts, and thus the voltage across the diode is

$$e_b = ir_p = (e_1 - E)\frac{0.5}{5} = \frac{e_1 - E}{10}.$$

The output voltage is

$$e_2 = E + e_b = E + \frac{e_1 - E}{10}$$

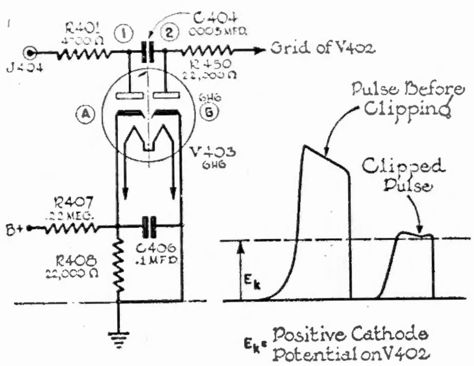
whenever e_1 is greater than E. Equation 4 shows that the resistance of the diode interferes with clipping the wave exactly at E. A fraction of the excess voltage of e_1 over E—in this case 1/10—is added to E in the output voltage. Thus if effective clipping is to be had, R must be very much larger than $\bar{r}_p$. In the example, if R were changed to 0.5 megohm, only 1/1000 of e_1/E would appear in the output, and clipping would occur almost exactly at the voltage E.

The method of analysis used here should be noticed. The diode is considered either as an open switch or as a closed switch in series with a resistance, depending upon the direction of the voltage applied. This method will be used extensively in discussing pulse-shaping circuits. It is a simple, useful way of studying many circuits found in radar sets.

The method of indicating directions of currents and voltages on diagrams should be noticed also. For example, in Fig. 3 the arrow near i does not indicate that current must flow in the direction of the arrow; rather, it means that if current is in that direction, it is called positive; if in the reverse direction, it is called negative. Because of the diode, current can flow only in the direction of the arrow in Fig. 3. Therefore, i must always be positive or zero in this circuit. Similarly, the plus and minus signs by e_1 indicate that if e_1 has that polarity, it is called positive; if it has the reverse polarity, it is called negative. The signs do not mean that the top terminal of e_1 must always be positive. The signs by e_b and e_2 have a similar meaning, but those by the battery indicate the actual battery polarity.

ASB-6 Diode Clipper

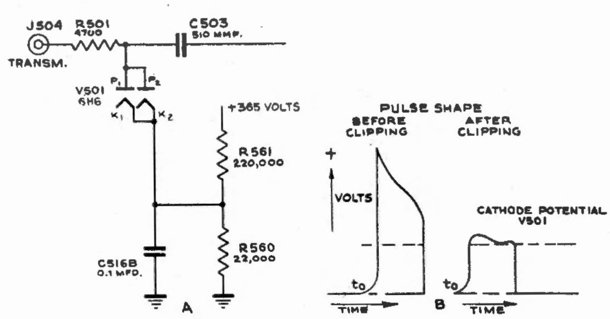
This stage consists of the half of the Type-6H6 limiter tube V403 indicated as "A" in the following diagram. It serves to limit the shape of the positive video pulse supplied by the transmitter and to transform it from a peaked pulse to a pulse or relatively square shape. The cathode of this half of the tube is placed at a positive potential by connection to the junction point of R407 and R408 which serve as voltage divider resistors across the 375 volt d.c. supply. The plate of the diode is directly connected to the pulse input circuit at the junction of the pulse input series resistors R401 and C404. The diode will only conduct current when the plate rises to a positive potential above that of the cathode, which has been set to the desired voltage by resistors R407 and R408. It can be seen that, as long as the instantaneous positive voltage amplitude of the pulse from the transmitter is below that of the cathode, the limiter will not operate and the shape of the pulse will not be affected.



Range Indicator Unit.

ASB-8 Diode Clipper

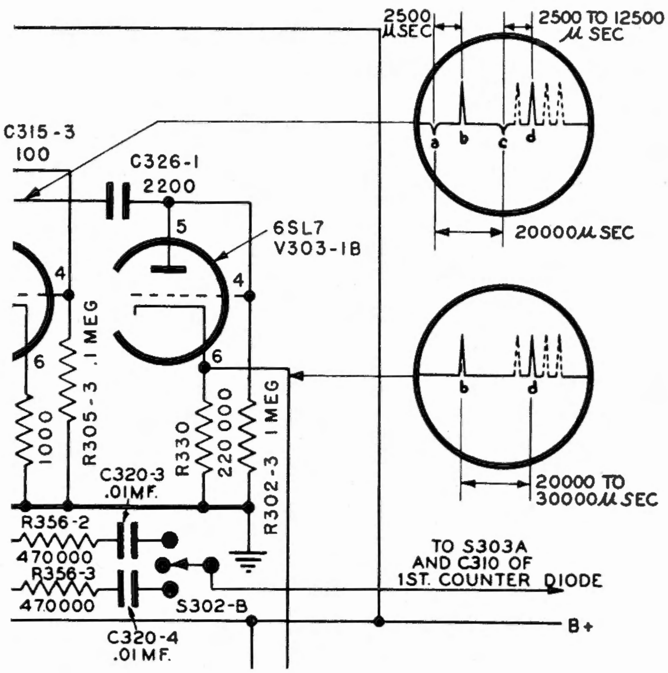
The positive video pulse from the Transmitter is received at the coaxial connector J-504. Referring to the Figures, it is subjected to a limiting or clipping operation, in a circuit using both diodes of the double diode limiter 6H6 (V-501), the cathodes of which are placed on a fixed positive potential determined by the values of the bleeder resistors R-560, R-561. The junction point of the two resistors is bypassed to ground by the capacitor C-516B. The anodes of these diodes are connected to the pulse input through the resistor R-501. The principal advantage gained through this clipping operation is that the height of the pulse is fixed which in turn fixes the time interval during which the discharge tube grid is biased beyond cut-off.



Indicator Limiter Stage—Circuit and Wave Shapes.

AN/APN-4 Diode Clipping

A rising voltage is fed through capacitor C326-1 into the diode-connected triode V303-1B. The positive pulse derived from the delay mixer develops pulse voltage across cathode resistor R330 of tube, V303-1B.



AN/APN-4 Diode Clipping

2. Grid-Circuit Clipping.

Before considering the ways in which triodes, or other tubes with grids, may be used as clippers, it is well to note the meaning of the voltage and current symbols used with these tubes. Fig. 6 represents a tube which may be a triode, tetrode, or pentode (no grids except the control grid are drawn), together with the symbols to be used for plate and grid voltages and currents. The symbol e_b is used to denote the plate-to-cathode voltage. The polarity marks are so assigned that e_b is positive when the plate is at a positive voltage with respect to the cathode. Similarly, e_c is the grid-to-cathode voltage and is positive when the grid is at a positive voltage with respect to the cathode. The symbols e_b and e_c will always stand for the plate and grid voltages, respectively, measured with respect to the cathode voltage. The symbol i_b denotes the plate current. It is positive when current flows from the external circuit toward the plate of the tube; that is, when electrons from the cathode move toward the plate inside the tube.

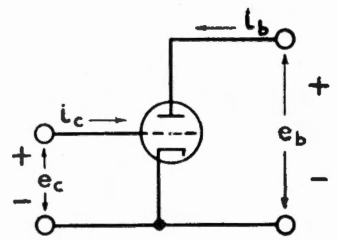


Fig. 6. Voltages and currents in amplifier-type tube.

Since electrons can never cross the tube in the reverse direction, i_b must always be positive or zero. Similarly, i_c denotes the grid current and is positive if current enters the grid from the external circuit. Thus i_c, like i_b, can never be negative. These symbols and reference directions will always be used in discussing tube currents and voltages.

With this agreement as to the meaning of the symbols used, the circuit of Fig. 7 may be discussed. In this circuit the grid and cathode are connected exactly as are the plate and cathode in Fig. 3. Since the grid-to-cathode path in a triode, like the plate-to-cathode path in a diode, behaves as an open switch when the grid voltage is negative, and as a closed switch when the grid voltage tends to become positive, the circuit of Fig. 7 must clip an input wave exactly as a diode would. Thus the grid-to-ground voltage e_2 is determined by the input voltage e_1 and the bias-battery voltage E, as was the output voltage of the diode clipper (see Figs. 7B and 7C). To obtain the waveform of e_c shown in Fig. 7D, subtract the bias-battery voltage E from the waveform of e_2, since e_c is the voltage from grid to cathode.

Alternative circuits for clipping the positive peaks from the input voltage wave are shown in Fig. 8. In Fig. 8A the bias battery is shifted to a different place from where it was in Fig. 7A. In Fig. 8B, a resistance-capacitance self-bias circuit is used in place of the bias battery of Fig. 7. The plate current flowing through the resistor R causes a voltage drop across R which is applied as a negative bias voltage to the grid. The capacitor C is large and serves to smooth out the fluctuations in the voltage produced by variations in the plate current, so that a steady bias voltage is obtained. Often the bias voltage E is omitted altogether. The tube then operates as an unbiased amplifier, and the entire positive part of the input wave is clipped. Note that unless an auxiliary diode is used it is not possible to clip the negative peaks of the grid-voltage wave—only the positive part of the input voltage may be cut off in the grid circuit.

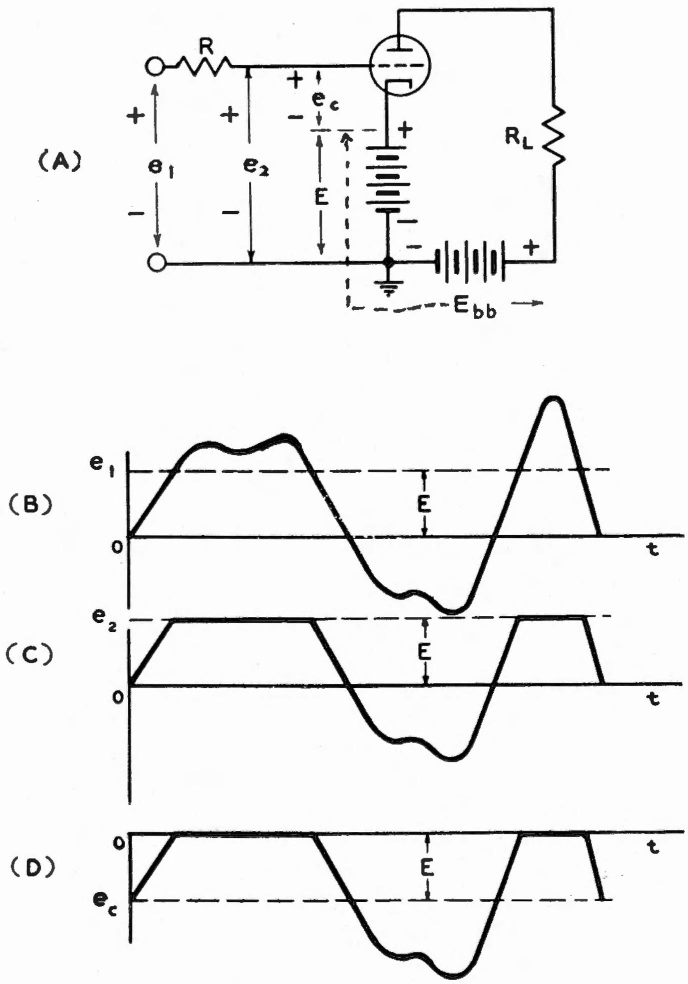


Fig. 7. Grid-circuit clipping.

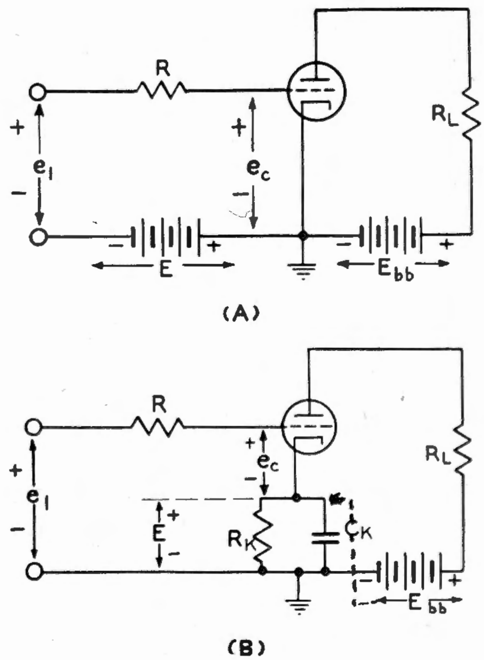


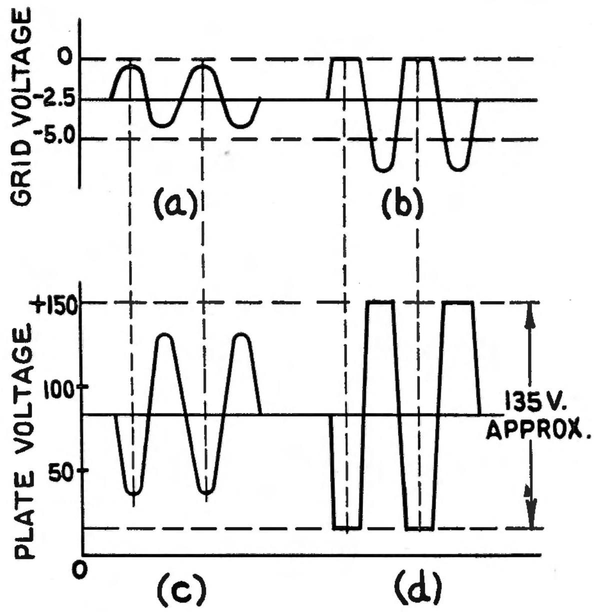
Fig. 8. Additional grid-circuit clippers.

Like that obtained with a diode, the clipping obtained in the grid circuit of a triode is not perfect. Corresponding to the static plate resistance of the diode, the static or average grid resistance* of a triode, $\bar{r}_g$, is defined as

$$\bar{r}_g = \frac{e_c}{\bar{i}_c}.$$

Thus, to obtain accurate clipping, the resistance R in series with the grid should be much larger than $\bar{r}_g$. For example, if R is 1 megohm and $\bar{r}_g$ is 1000 ohms, then the positive voltage attained by the grid is reduced by the factor $\frac{1}{1 + 1000}$. (See eqs. 2, 3, and 4.)

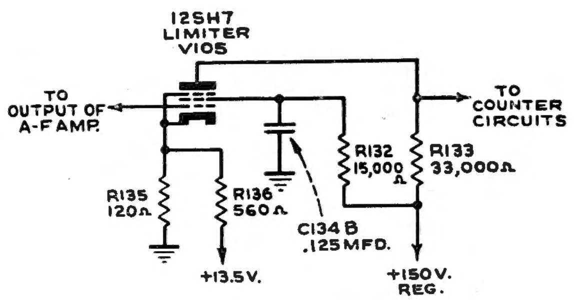
* The grid resistance of a triode varies considerably, not only with the grid voltage but also with the plate voltage. Nevertheless it is a sufficiently good approximation here to consider $\bar{r}_g$ as a constant whenever e_c is positive.



Voltage Characteristics of Clipper

AN/ARN-1 Grid and Plate Clipping

Referring to the circuit diagram, below, the 12SH7 tube V105 operates as a plate voltage limiter. Semi-fixed bias is provided for this tube by resistors R135 and R136 placed in the cathode circuit. Referring to the Figure, when the grid of the limiter tube is supplied with a signal of less than 2.5 volts peak as shown in (c) is not limited over any part of the cycle. With an input signal greater than approximately 2.5 volts peak as shown in (b), the positive half cycle is limited due to grid current. During the negative half cycle of input, the plate voltage is limited to a maximum due to plate current cutoff by the 150 volt regulated supply, resulting in a substantially square-wave output of 135 volts peak to peak across the load resistor R133, as shown in (d).



Square Wave Clipping Circuit

3. Plate-Circuit Clipping.

A wave which has had its positive peaks clipped in the grid circuit of an amplifier tube may give rise to a plate-voltage wave having peaks of both signs clipped. The additional clipping is the result of plate-current cutoff. An example of such clipping is the formation of a nearly square wave from a sine wave in a circuit such as that shown in Fig. 9A.

Fig. 9B shows the plate family of the tube, and plotted on it the load line for the particular plate-supply voltage e_{bb} and load resistance R_L used. The grid voltage corresponding to the lower end of the load line (-7 volts on the curves shown) is the grid voltage needed to prevent the flow of plate current—it is a negative voltage called the cutoff grid voltage. Its magnitude is denoted by the positive number E_{c0}; thus the cutoff grid voltage is $-E_{c0}$. It is assumed that the input voltage e_i is a sine wave of peak value much larger than E_{c0}. Since the positive peaks of this wave are removed by the clipping resistor R, the grid voltage e_c has the form shown in Fig. 9C when plotted to a scale determined by the curves of the plate family. Projecting from points on this curve to the load line and out through the i_b and e_b axes determines the curves of i_b and e_b shown in Figs. 9D and 9E, respectively. Since the negative peak of e_c is of much larger magnitude than E_{c0}, the grid voltage changes from zero to below cutoff in a small fraction of the cycle. Thus e_b and i_b switch from maximum to minimum values very quickly, and the resulting waves are nearly square.

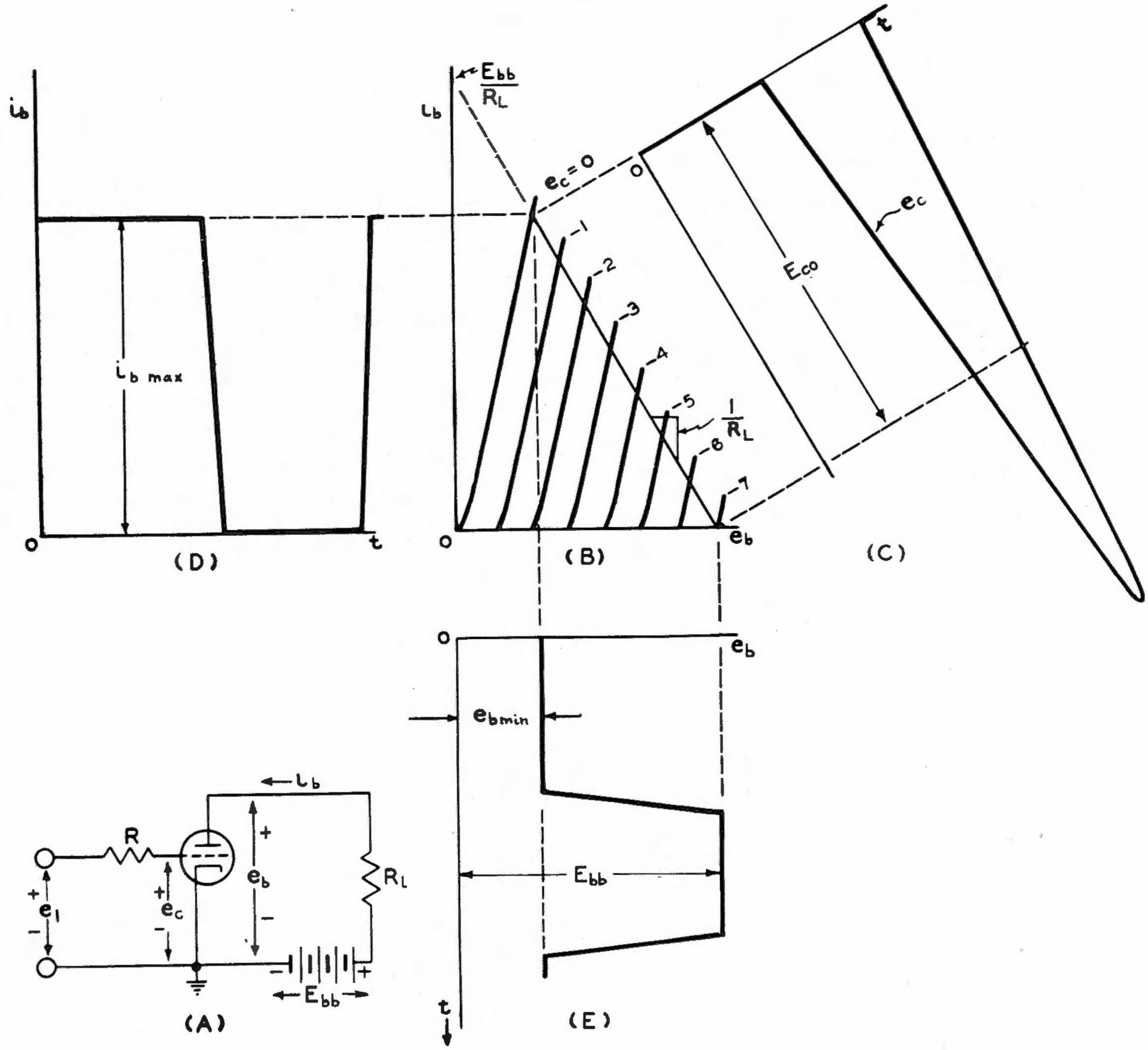


Fig. 9. Formation of a square wave by clipping a sine wave.

Because of the shortness of the switching parts of the cycle, the exact shape of the sides of the wave is not important, and it is generally sufficient to determine the horizontal parts of the plate-circuit waves as follows: (1) When the grid voltage is below cutoff, the plate voltage is E_{bb} and the plate current is zero. (2) When the grid voltage is zero, the plate current has its largest value, $i_{b\ max}$, and the plate voltage its smallest value, $e_{b\ min}$. These quantities are determined from the intersection of the load line with the $e_c = 0$ curve as indicated in Fig. 9B. The difference between the maximum and minimum values of e_b, which is the peak-to-peak amplitude of the square wave of plate voltage, is called $\Delta\ e_b$. If these values have been determined, the output waves may be drawn as in Fig. 10.

In determining these curves, it is convenient to think of the plate circuit of the tube as a switch which is open when the grid voltage is below the cutoff value, and closed in series with a resistance when the grid voltage is zero. This resistance is the static plate resistance of the triode defined as

$$\bar{r}_p = \frac{e_b}{i_b}$$

The static plate resistance varies somewhat with the plate voltage, but as an approximation this variation may be neglected. However, $\bar{r}_p$ changes greatly when the grid voltage changes, and even as an approximation this variation in $\bar{r}_p$ cannot be neglected. Thus the grid voltage to which any given value of $\bar{r}_p$ corresponds must be stated. In Figs. 9 and 10, a value of $\bar{r}_p$ corresponding to a grid voltage of zero—that is, to a plate voltage $e_{b\ min}$ and a plate current $i_{b\ max}$—may be used.

An approximate relation that is often useful in determining the cutoff voltage of a triode is

$$E_{c0} = \frac{e_b}{\mu}$$

where

e_b is the plate voltage when the current is cut off,

μ is the amplification factor of the triode. In the circuit of Fig. 9, e_b rises to the supply voltage E_{bb} when the current is cut off. Thus in this special case, E_{c0} is E_{bb}/μ. Note that eq. 7 is not valid even as an approximation for tetrodes or pentodes.

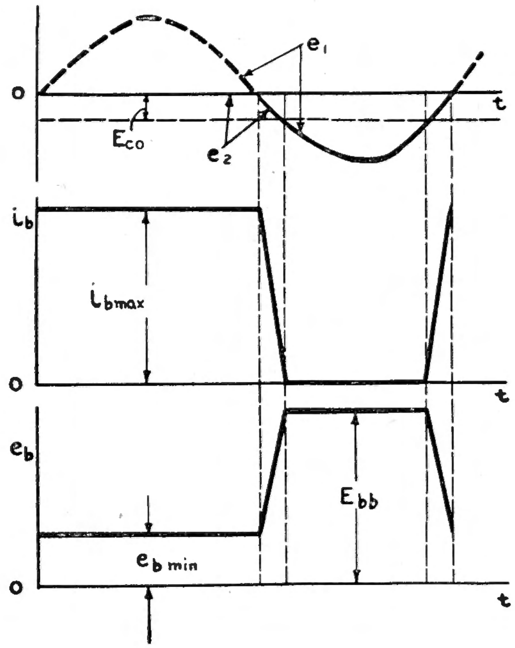


Fig. 10. Waveforms in clipper.

From the waveforms of Figs. 9 and 10, observe that the positive part of the input-voltage wave produces the low-voltage portion of the plate-voltage wave, while the negative part produces the maximum-voltage portion. This condition corresponds to the usual 180° phase shift in a sine-wave amplifier. It is better, however, where non-sinusoidal waves are concerned, to refer to the effect as a polarity reversal; that is, a correspondence between a positive change in grid voltage and a negative change in plate voltage, and vice-versa. This concept gives correct results for any wave shape, whereas the 180° phase shift—though correct for sine waves—is incorrect for many other wave shapes. The polarity reversal accounts for the fact that grid-circuit clipping removes the positive peaks from the input voltage and the negative peaks from the output voltage. Clipping by plate-current cutoff removes the positive peaks from the output voltage; it does not affect the grid voltage.

As long as a clipping resistor R is used so that the grid is never driven to an appreciable positive voltage, the clipping effects obtained are those already described. If the clipping resistor is omitted and the source of the grid signal is a low-impedance high-power source, grid-circuit clipping may be avoided and the grid driven to a large positive voltage. Nevertheless the negative peaks of the output voltage may still be clipped, because of plate-current saturation. This effect, described in the next paragraph, should not be confused with emission saturation. The tubes ordinarily used in timer circuits have oxide-coated cathodes, and for these there is no definite limiting or saturation value of the emission current that may be obtained from the cathode.

In Fig. 9C, if grid clipping does not occur, the grid voltage wave has a positive half-cycle as large as the negative half-cycle shown. During the positive half-cycle, the dotted projection of the load line describes the operation of the tube. No matter how far positive the grid is driven, the plate voltage can never become negative; that is, the plate current can never exceed the value E_{bb}/R_L indicated in Fig. 9C. As a matter of fact, the plate voltage can never be reduced to zero, for a small potential $e_{b\ sat}$ is needed to attract electrons from the cathode. Correspondingly, the plate current can never exceed the value $i_{b\ sat}$, a little smaller than E_{bb}/R_L. These limiting values depend upon the value of R_L; in fact, the saturation current is determined mainly by the load resistor, and plate-current saturation may be considered to occur because the current that the supply battery can force through the load resistance is limited.

When a tube is driven to saturation, it is often convenient to think of the plate circuit as a closed switch in series with the saturation static plate resistance,

$$\bar{r}_{p\ sat} = \frac{e_{b\ sat}}{\bar{i}_{b\ sat}}$$

This is somewhat smaller than the static plate resistance obtained with zero grid voltage. Thus clipping in the grid circuit and saturation clipping produce results which compare as shown in Fig. 11. Saturation clipping, then, has the advantage of producing an output wave of greater amplitude, but it has the disadvantage of requiring much more power to drive the grid because of the large currents required, and the possible difficulty of overheating the grid because of these currents.

Thus far the formation of a square wave by clipping the peaks from a sine wave has been discussed as an example of clipping with an amplifier-type tube. These tubes may be used as clippers in many other ways. To illustrate the possibilities, the circuits of Figs. 12 and 13 show methods of forming positive and negative pulses, respectively, from a wave containing pulses of both signs. In Fig. 12, the positive pulses are clipped from the input wave in the grid circuit. The negative pulses remaining are inverted in polarity and appear as positive pulses in the plate-voltage wave. In Fig. 13, the tube is biased nearly to cutoff, so that no clipping occurs in the grid circuit. However, the positive pulses are removed from the plate-voltage wave because of plate-current cutoff, and only negative pulses appear in the output.

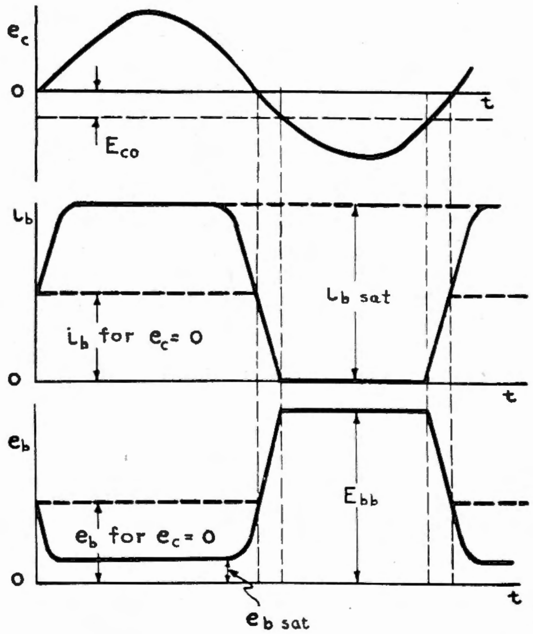


Fig. 11. Clipping by plate-current saturation.

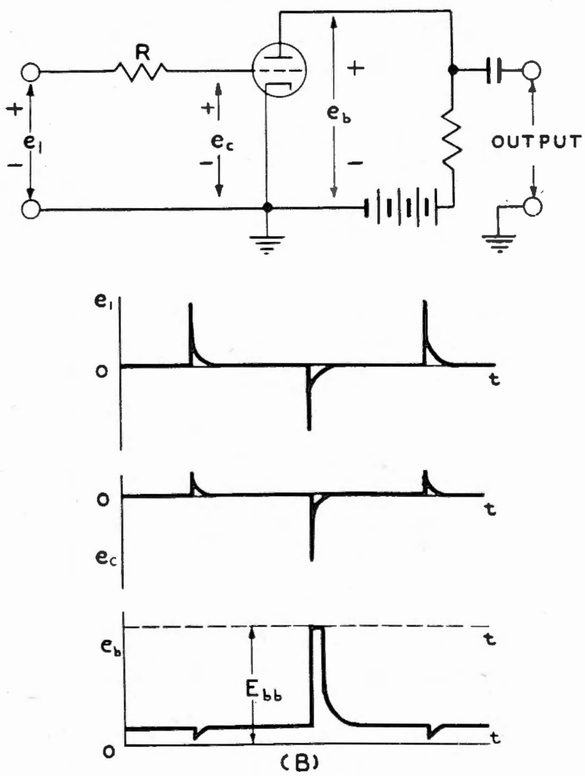


Fig. 12. Formation of positive triggers.

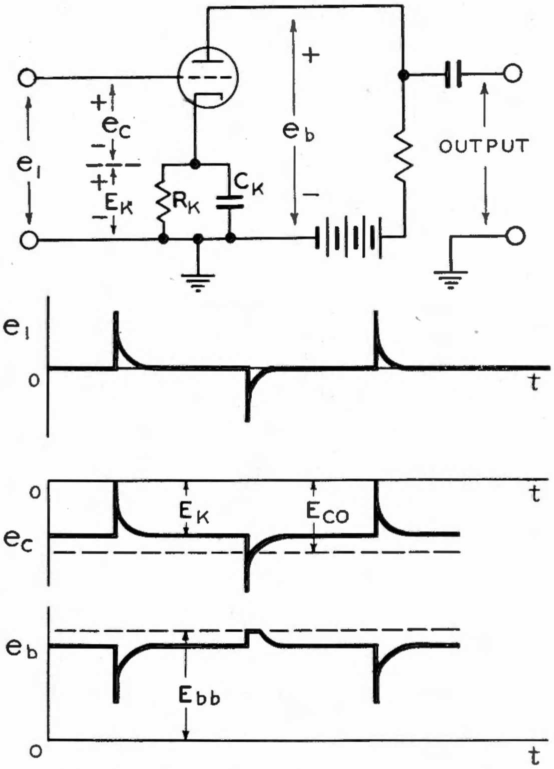
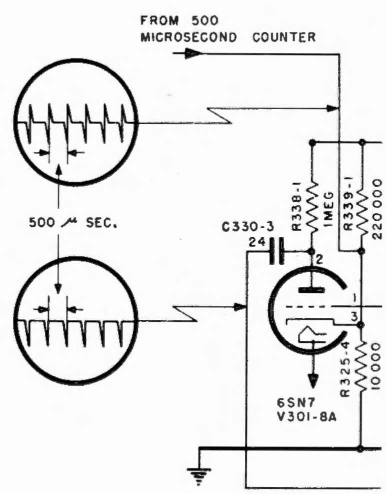


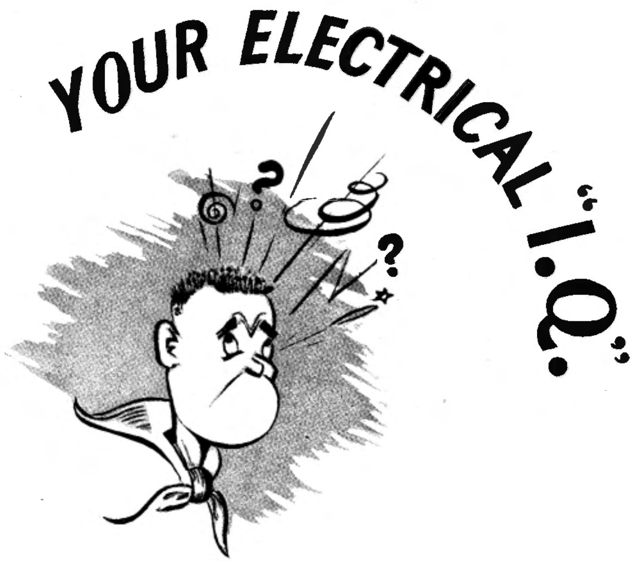
Fig. 13. Formation of negative triggers.

AN/APN-4 Plate Circuit Clipping

A pulse developed in the 500-microsecond counter oscillator is fed to the cathode of this tube so that its negative swing will lower the bias, causing plate current to rise and plate voltage to drop. The positive swing from this oscillator will have little effect on the output from this tube. Therefore, a negative output pulse occurs every 500 microseconds and is fed to the input grid of another tube.



This article was compiled from information obtained from the MIT Navy Radar Training School.



How Many Can You Answer?

1. QUESTION:

When power for engine starting is supplied through the external power receptacle, why should the battery switch always be closed?

ANSWER: The airplane battery should be used to supplement the external power because electric starting is one of the heaviest power demands in an airplane. Use of the battery assures higher starting voltage, which provides higher cranking r.p.m., and results in quicker engine starting.

2. QUESTION:

Why should a pilot be alarmed if the voltmeter on a 24-volt system reads 24 volts or under?

ANSWER: He should be alarmed bacause low voltage readings indicate that only the battery is supplying power to the airplane. At such times the load must be kept at an absolute minimum, as the battery is unable to supply power for the entire load for any prolonged period. The pilot may have to land in a short time if an important unit fails to function because of lack of electrical power.

3. QUESTION:

Why is it important to turn off the battery switch when securing an airplane?

ANSWER: If the pilot fails to turn off the battery switch, he may find a run-down battery when he attempts to use the airplane again. Turning off the switch also reduces the fire hazard because this action completely kills all electrical circuits while the engine is not running.

4. QUESTION:

What three switches in combat airplanes should always be left on the "OFF" position when the airplane is secured?

ANSWER: Ignition Switch, Battery Switch and Master Armament Switch.

5. QUESTION:

In checking a battery it is noticed that the specific gravity reading is 1.250 and voltage is normal in all cells except one, which has a specific gravity of 1.150 and voltage below normal. What does this condition indicate?

ANSWER: If the voltage and specific gravity readings of one cell are very far out of line with the readings of the other cells, the battery should be removed and sent to the battery shop for investigation of trouble. The checker should not assume that such a battery will come up to normal charge simply because all but one cell are normal.

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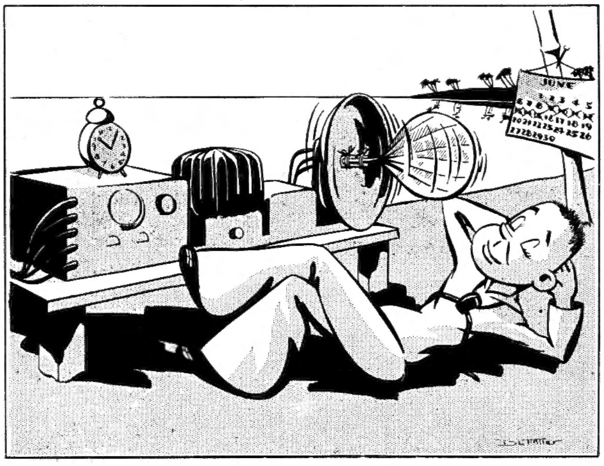
AN/APS-3 HIGH VOLTAGE TRANSFORMER

Several fleet activities have reported that on the high voltage transformer (T302) of the AN/APS-3 equipment, the lead from pin 2 is dressed too closely to pin 3. Arcing from the lead on pin 2 to pin 3 has occurred and has been especially prevalent under humid conditions. When a breakdown arc occurs between those points, the high voltage output of transformer T302 is thereby shorted.

A redesigned transformer is being incorporated in late model Philco AN/APS-3 systems and is expected to correct the difficulty. In systems where it is found that the lead from pin 2 is dressed too closely to pin 3 on this transformer, it is recommended that the lead be moved slightly to provide some space between the pins.



This is a sure fire Radar fatigue test for a June day

RACKS for servicing AN/ARC-1

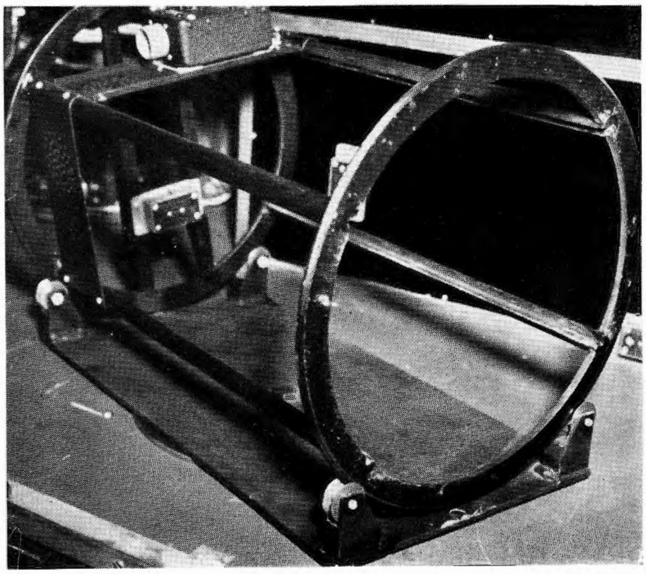


Photo shows mounting rack which rotates.

Since it is necessary when aligning the AN/ARC-1 to work on three sides of the unit, a type of mounting is highly desirable which facilitates rotation from one side to another.

The photographs on this page show the rack designed by CASU-1. This rack permits rotation in all directions, in a vertical as well as a horizontal plane, and provides access to all sections that are normally accessible. The only portion being covered is the dynamotor, thereby providing a guard for same as well as a mounting for the control box. The control box rotates with the rack and is permanently connected to the cannon plug that is mounted on the rear end of the rack.

The only leads connected to the rack are for input power, and it was not considered important enough to bring these in through connector rings, therefore they are connected to a counter-weighted system that is outletted from the top of the bench test panel.

The photographs on the adjoining page show the rack designed and built by CASU-31. This differs in that the control box does not rotate with the set. Also, it is more compact and leaves more of the set exposed.

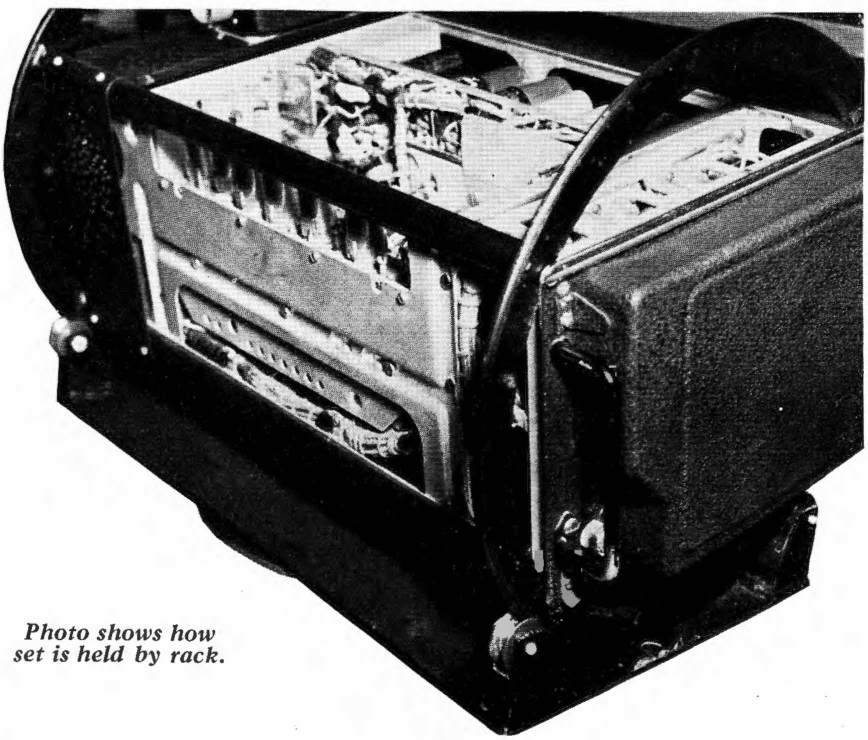
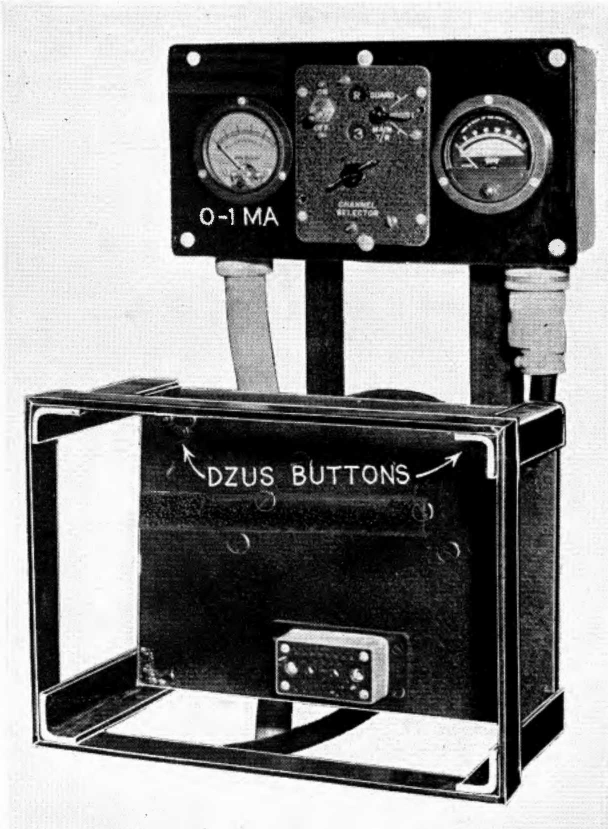
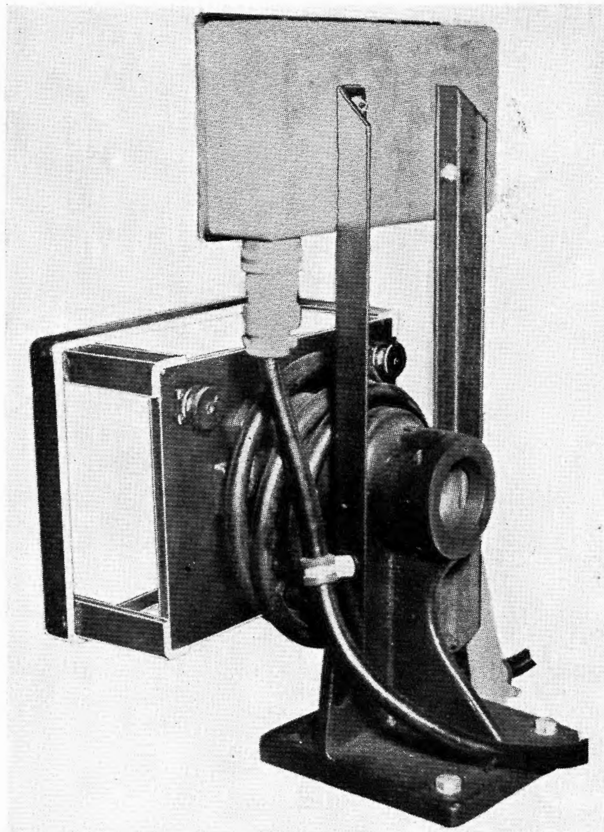
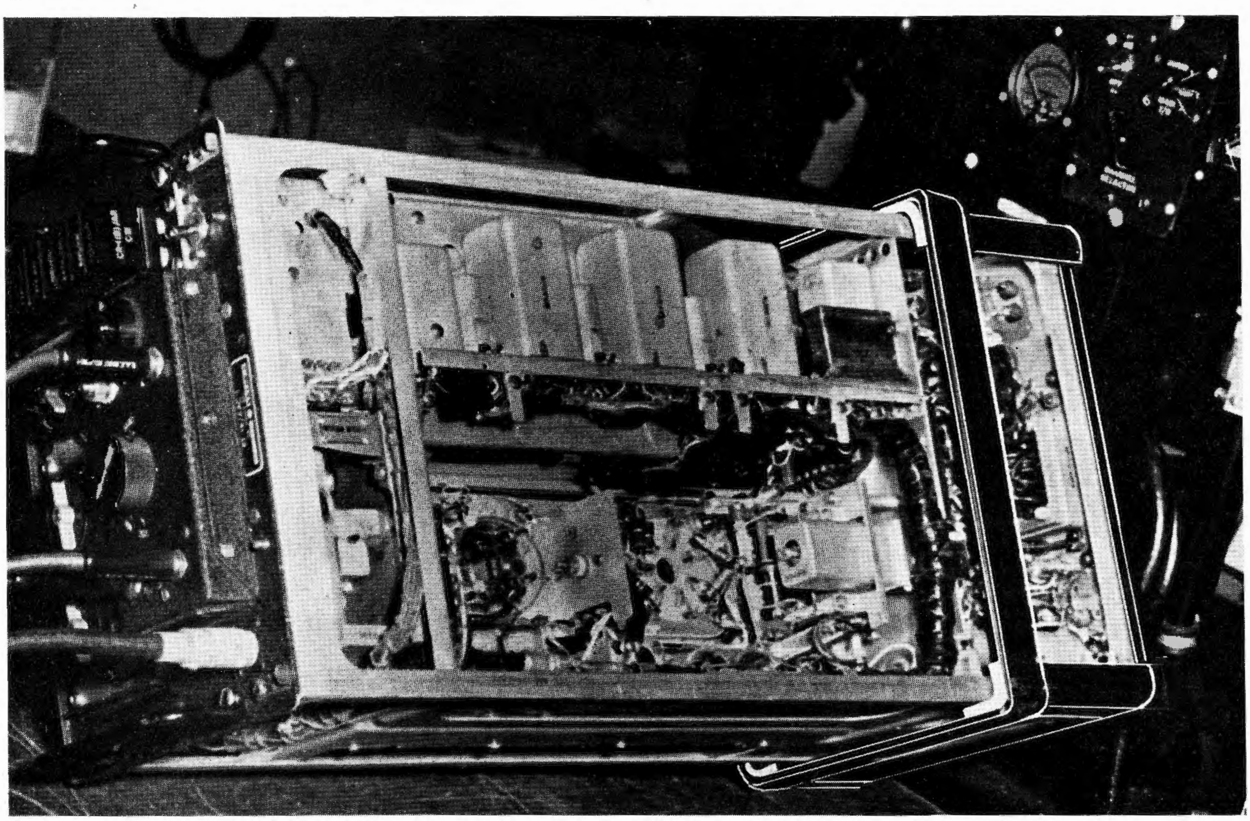


Photo shows how set is held by rack.


0-1 MA
DZUS BUTTONS





B Scope Interpretation

HELP in interpreting the B-type scan used in ASD, AN/APS-3 and AN/APS-4 airborne radars is provided by the accompanying diagrams, which have been suggested to the Bureau of Aeronautics by field activities.

The diagrams can be used to supplement an article on page 15 of the September 10 DIGEST, which showed several drawings of B-scope presentations compared with maps of the actual areas scanned. Those drawings presented a somewhat static concept illustrated by an instantaneous view, whereas the diagrams provide a more dynamic concept and a stronger feeling of motion, as if the reader were flying parallel to or perpendicular to a relatively straight coastline.

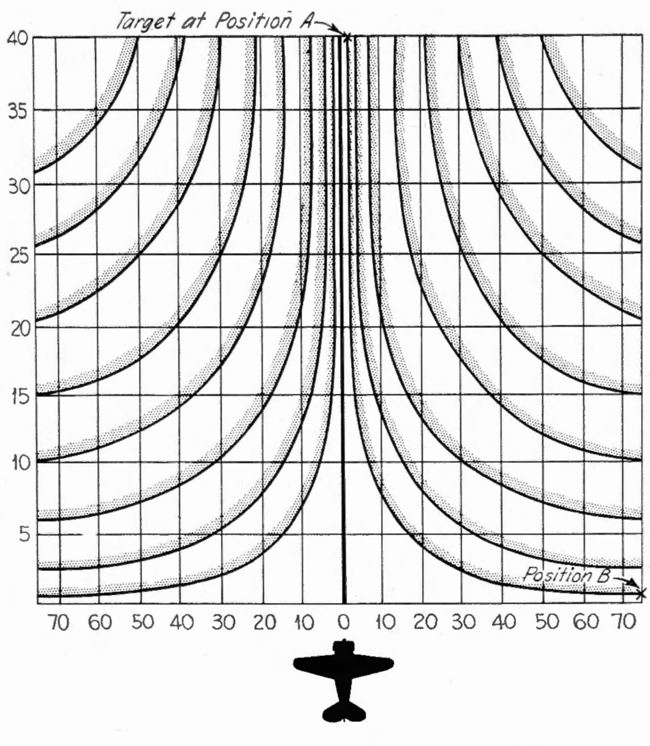


***Figure 1.** If an aircraft is flying parallel to an approximately straight coastline and its radar sights a target at position A, the target indication will move down the scope and veer off to the right as the plane approaches. When the aircraft is almost abeam of the target, the indication is at point B.*

Figure 1 illustrates what can be expected when flying *parallel* to a straight coastline. A selected target on or near the coast will first appear as at position A when the plane is a considerable distance away. Then, as the plane approaches, the target will travel down the scope and veer off to one side, depending upon which side of the aircraft the coast and target lie.

When the aircraft is almost abeam of the target, the indication will be on the 75-degree azimuth line, as at position B. Approximate range of the target is indicated by the range marker on that azimuth line. The nearer the plane is to the shore line, the longer the target will approximately parallel the zero azimuth line before veering off to one side of the scope.

Figure 2 illustrates typical parabolic curves obtained when flying at a *right angle* to a straight coast line. If such lines were engraved on the scope filter and made to coincide with one set of range marks, then the distance between targets off shore and the shore line could be interpolated by following around the parabolic curves.

Scope filters with the curves shown in Figure 2 etched on them are being prepared by the Bureau of Aeronautics and will be sent to the Naval Aviation Operational Training Command for evaluation. If they prove of definite value, a number will be made for general distribution to field activities.

Lt. W. C. McDowell, USNR, of NAS Quonset Point submitted to the Bureau a copy of the curves shown in Figure 2, which he engraved on a scope filter. Later Lt. John W. Vorys, USNR, ACG field engineer with Bombing Squadrons 127 and 132, described use of the curves in a report to ACG.

In his letter Lt. McDowell pointed out that "the parabolic guide lines indicate target patterns perpendicular to the flight path of the plane. A shore line, for instance, which appeared on the screen to follow the same curvature

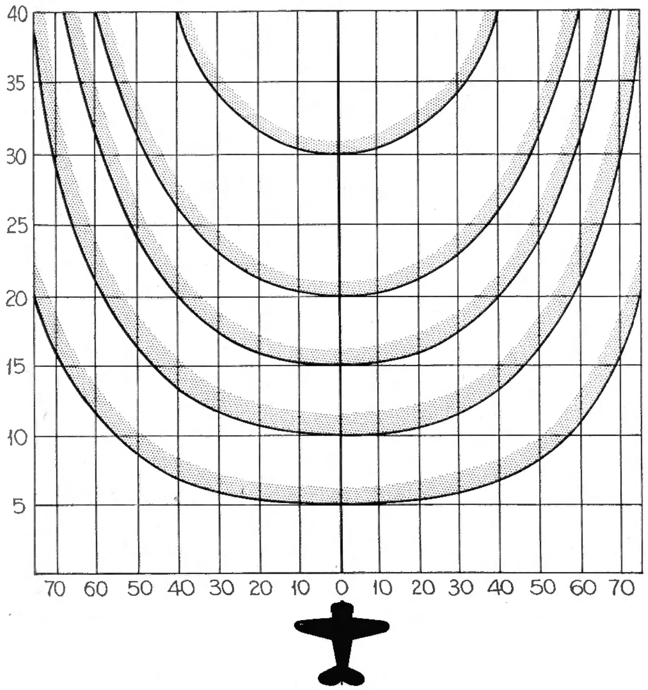


Figure 2. If an aircraft is flying perpendicular to an approximately straight coastline, the shore will appear as above. The closer the aircraft, the broader the indication will "fan out".

of one of these guide lines, would indicate that the plane is approaching a straight beach, and on a course that would cross the beach line at a 90° angle. Around harbors, inlets and bays, various prominent points can be aligned by maneuvering the plane on its approach so that a predetermined course may be flown for mine-laying missions and other similar operations. Dispositions of surface craft in groups are more readily determined. Range is determined by the regular electronic range marks, and the parabolic guide lines correctly show the distortion pattern on any range used."

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TURN OFF AZIMUTH STABILIZATION BEFORE FLUX GATE COMPASS

It is recommended that all personnel operating AN/APS-15 gear, using Azimuth Stabilization (AN/APA-14), turn the Azimuth Stabilization off at the control box *before* the Flux Gate compass, or amplifier, is turned off. This allows the lubber line to return to the zero position. Otherwise, (if the Flux Gate is turned off first) the lubber line will remain at the point where the Flux Gate or amplifier is turned off, which may confuse an operator starting the gear up again and finding a wrong heading.

BuAer Directs Rework of Early AN/ARC-1

Reports on first runs of the AN/ARC-1 equipment indicate a lack of proper inspection at the points of manufacture. Many of the sets can be put into first class condition by a complete alignment while others will require replacement of parts.

The Maintenance Division of BuAer has issued instructions to appropriate Naval Activities that the sets listed below are to be made available to manufacturer's representatives for indicated action.

a. Overseas.—All WE (CW) equipments Serial #150 to #4000 and all Westinghouse (CAY) equipments Serial #7900 to #10000 will be returned to factories for reworking via ASA Oakland and NASD Norfolk.

b. Sets within continental limits.—All WE (CW) equipments #150 to #1200 will be returned to factory for rework.

1. All sets at NASD Philadelphia between CW #150 and #4000 and between CAY #7900 and #10000 will be returned to factories for reworking.

2. All sets WE (CW) #1200–#4000 and Westinghouse (CAY) under #10000 at NASD Norfolk, ASA Oakland, NAS St. Simon Island to be reworked at these locations by factory men.

3. All sets WE (CW) #1200–#4000 at BAR's are to be checked by Western Electric Co. radio engineers and defective units are to be returned to the Western Electric Co. for repair and in the future all sets are to be checked and defective units returned to the factory by the airplane manufacturer's engineers.

All reworked equipment will have the letter "M" stenciled with yellow paint on tip of each reworked AN/ARC-1. The same letter will be stenciled with black paint on all packages and boxes containing reworked equipments.

The newly reworked equipment is expected to meet all performance characteristics of the later production models by Western Electric over number CW 4000 and Westinghouse over CAY 10000.

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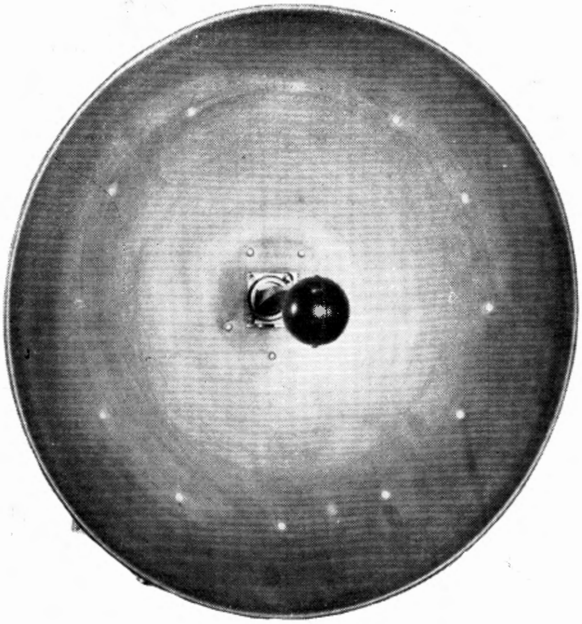
POLARITY OF EXTERNAL POWER CONNECTIONS

Fires have started when ground power units have been connected to PBM-3R and PB2Y-3R aircraft. Some aircraft still have external power receptacles to which external power unit plugs can be connected with polarity reversed. This is true of receptacles and plugs which have become worn from use.

Fires also result from use of external power units which are connected to their plugs with wrong polarity.



Improvements Incorporated In AN/APS-3A Radar

Antenna dipoles of the AN/APS-3A equipment are enclosed in a plastic sphere, as shown above. The RF plumbing is pressurized from magnetron to antenna.

OPERATIONS at higher altitudes, clearer scope indications, easier tuning for beacon stations, and numerous other advantages will be provided by the AN/APS-3A radar, scheduled to go into production shortly as a new version of the widely used AN/APS-3.

Because the production program scheduled for the AN/APS-3 would have been slowed down excessively if interrupted for all desired changes, the improved model was designed and the letter "A" added to distinguish it from the older equipment.

Improvements incorporated in the AN/APS-3A are: Pressurized RF plumbing from antenna dipoles to magnetron, IAGC with video filter, Beacon reference cavity, Crystal current meter, Video stretching, Directional coupler, New light-weight magnet, New Blower motor, Vernier manual tuning, Three-position switch for AFC-Search-Beacon, New AFC sweep circuit, New receiver coils for increased gain, Capacitor for uniformity of range marks, 1B24 TR and RT tubes, Wide-band video, and Video input to accommodate the AN/APA-16 bombing attachment.

Some of these improvements are being incorporated in late-model AN/APS-3 equipments and are being carried over into AN/APS-3A production.

Pressurization of the RF plumbing from antenna to magnetron will permit the new model to operate as high as 35,000 feet, far above the 20,000-foot ceiling of the AN/APS-3. At lower altitudes, pressurization excludes from the RF plumbing dirt and moisture which have lowered perfomance in unpressurized equipment.

Clearer scope indications will be made possible by the IAGC (instantaneous automatic gain control) and video filter which are incorporated in the receiver strip. With their use, an operator can more easily distinguish between land and cloud targets, weaken sea clutter, and reduce interference from possible enemy jamming. A switch will permit selection of either IAGC or video filter, both, or none, for optimum results.

Beacon indications on the scope will also be clearer as a result of video stretching, generally known in radar circles as "beacon-smear", which causes the beacon presentation to be expanded and made more obvious to the operator.

Use of the beacon reference cavity and crystal current meter will permit easier tuning for beacon stations and will save operators from random, trial-and-error tuning without knowing at which point the tuning control will respond. The reference cavity is preset to the beacon frequency and resonance with it is indicated on the crystal current meter.

The three-position switch, permitting either AFC or manual tuning for search and beacon operation, is also a worthwhile improvement. With its use the set can be returned to AFC from either radar operation or manual beacon tuning without disturbing the manual tuning adjustment.

In outward appearance the AN/APS-3A will closely resemble its predecessor except that the antenna dipoles will be enclosed in a plastic sphere; a new crystal current meter will be installed at the radar operator's position; and a small, motor-driven pump will be provided near the antenna to maintain relatively constant air pressure in the RF plumbing system.

The AN/APS-3A will be interchangeable with the AN/APS-3, but it is not intended for replacement purposes. The new models are expected to be in production in January 1945, and are scheduled for installation in TBY-2, PV-2D, and PBJ-1 aircraft.

The new equipment is the latest in the family of microwave radars which began with the ASD or Dog radar. The Dog was succeeded by the Dog-1, later named AN/APS-3 in the Army-Navy nomenclature system. As the newest offspring, the AN/APS-3A will incorporate the best features of other members of the family as well as the improvement described above. A new "equal energy reflector" developed to help the AN/APS-3 stalk surface targets from low altitudes can also be used with AN/APS-3A when desired.

Already the Dog family of radars has been used for bombing operations in all war theaters, and the new model is expected to aid even more in bombing missions because it can be used more easily with the AN/APA-16 radar bombsight. A video input circuit is provided to accommodate that attachment, which indicates bomb-release points more accurately than search radar equipment.

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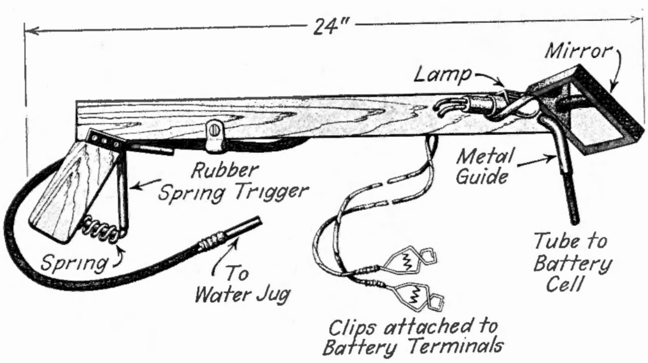
Speeding Up Battery Service on "Hard-to-Get-at" Installations

Mark A. Brady, ARM3c of Hedron 11 Detachment, found it difficult to check the level of electrolyte in a PBM's batteries and decided to find a way to speed up the inspection. In so doing, he not only made it easier to work on a PBM's batteries, but also provided the means for easier battery service on all planes with "hard-to-get-at" installations.

Brady made a gun with a wooden stock and barrel, on the end of which he mounted a mirror and lamp. He then attached a rubber hose to a battery water container, running it through a metal trigger and down the length of the barrel. At the forward end of the gun and extending down from the mirror, he reinforced and guided the rubber with a metal tube. The lamp, energized by the battery under inspection, directs its light downward and the mirror clearly reflects the interior of the cell under inspection.



To use the gun, the operator simply removes the vent cap from each cell and holds or places the water container above the level of the battery. The gun is directed over each cell, in turn, and the level of the electrolyte is noted. If additional water is needed, the trigger is pulled and a stream of water flows into the cell until the correct operating level is attained.

Watergun built to speed up battery inspection and service in "hard-to-get at" installations. It is 24 inches from tip of mirror to tip of gunstock. Mark Brady, ARM3c, found the mirror at the ship's store and salvaged the other materials.

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Change in Color Coding of the Range and Alarm Unit Cabling

The following information has been received from the Navy relating to the color coding of Range and Alarm unit cables in the AN/APS-4.

In order to eliminate discrepancies between the color of the irvolite tubing and color coding of the coax cables entering the range and alarm unit, the colors have been changed and numbers stamped on the coax plugs.

A table showing the old and new design follows:

OLD DESIGN

Transmitter Receiver Cable			Range & Alarm	
Coax Leads	Irvolite	Plug Code	Code	Color
Black	Green	None	J( )2	Green
Blk-Green	Blue	None	J( )3	Blue
Black	Yellow	None	J( )4	Yellow
Black	White	None	J( )5	White
Blk-Red	Black	None	J( )6	Black

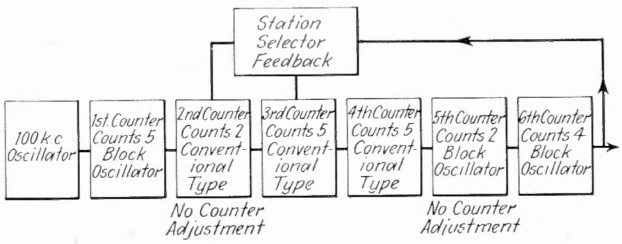
NEW DESIGN

Transmitter Receiver Cable			Range & Alarm	
Coax Leads	Irvolite	Plug Code	Code	Color
Black	Black	P( )2	J( )2	Black
Blk-Green	Green	P( )3	J( )3	Green
Black	Yellow	P( )4	J( )4	Yellow
Black	White	P( )5	J( )5	White
Blk-Red	Red	P( )6	J( )6	Red

It should be noted that by following the plug markings no confusion could result in using new or old range and alarm units. This would not hold true in the case of the old units, but since the coax leads are secured together it would be difficult to interchange the leads. This change was incorporated on Western Electric range and alarm unit #3559 and Western Electric equipment, Navy Serial No. 3000.

INDICATOR *ID-6B/APN-4, MODIFICATION V

A NEW Loran Indicator, Modification V, designated *ID-6B/APN-4, has been designed to improve the stability and operation of the equipment under all conditions. Some of the most outstanding features of the new Indicator are:



1. Counters.—

To improve stability, the high ratio counters have been eliminated; the 10:1 counter has been replaced by a 2:1 and a 5:1 counter, and the 8:1 counter by a 2:1 and a 4:1 counter. No adjustment is necessary for the 2:1 counter, resulting in 4 controls as in previous indicators. The operation of the 2nd, 3rd, and 4th counters is similar to that of Mod. III. The 1st, 5th, and 6th counters are free-running blocking oscillators triggered by positive pulses from a preceding stage; their count rate is controlled by the time constant in the grind circuit.

2. Station Selector and Left-Right Circuits.—Because of the revised counter chain, feedback for station selector operation must now be applied to both the 2nd (2:1) and 3rd (5:1) counters. This revision necessitated a simplified padding procedure and only three padders are now required for all station adjustments. Stations 2, 4, and 6 are aligned by means of the display pattern (SWEEP SPEED SW. position 8). Station 0 requires no feedback, and all odd stations are automatically in adjustment when the even station below is correctly aligned.

Left-Right action on slow sweep, no longer associated with the pedestal generator, is accomplished by changing the feedback to the 2nd and 3rd counters, as when changing stations. The speed of L-R action has been made exactly equal to that which would be obtained by changing the STATION SELECTOR SW. by one station.

3. Display Pattern.—A new display has been substituted for the dot pattern, see figure 1 (SWEEP SPEED SW. position 8) used in Mod. III Indicators. The sweep is now triggered by the output pulse from the 4th counter, and the charge steps on the 3rd counter storage capacitor appear on the screen of the cathode-ray tube. This pattern is used to pad station selector padders and check L-R and station selector circuit operation. It is also useful for checking 3rd and 4th counter operation.

4. E-J Square Wave Generator.—Revision of this circuit has resulted in greatly increased stability, allowing the use of fixed bias. The control formerly used in the cathode circuit has therefore been eliminated.

5. Recurrence Rate Switch.—A switch marked PRR has been added to the front panel, permitting selection of either 25- or 33-1/3-cycle pulse recurrence rates. This switch changes time constants in the 6th counter grid; causing the counter to operate at either a 4:1 or 3:1 rate. This revision required an additional adjustment for the last counter, for the 33-1/3-cycle rate, which is labelled E on the front panel.

6. Pedestal and Sweep Duration.—In Modification III, the length of the pedestal was fixed and the sweep duration on various Indicator units differed because of variations in components. In Modification V, the pedestal duration is adjustable. The control, located on the right side of the chassis, is now adjusted for the fast sweep position and should be set for 250 microseconds. This adjustment also affects the medium sweep duration but must be set only for the fast sweep.

7. Friction Brake.—In Modification III, trouble was

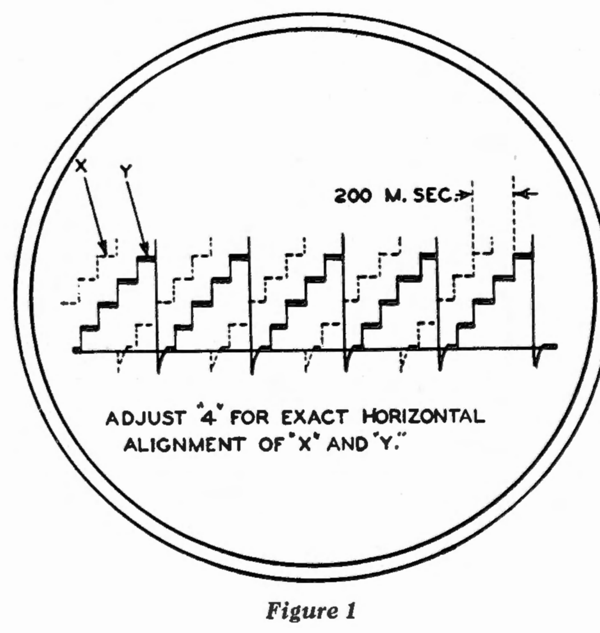


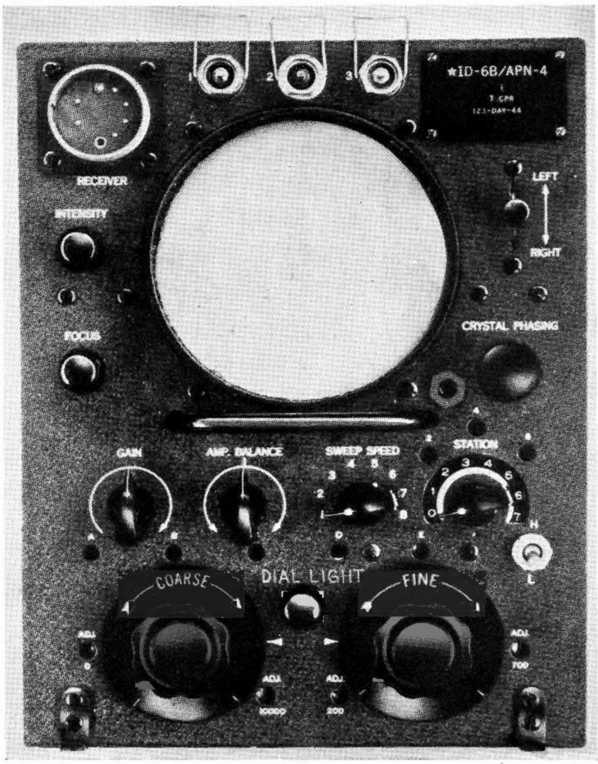
Figure 1

sometimes encountered because of the free moving Delay Control dials. In Modification V, friction brakes have been applied to these controls to prevent their being accidentally knocked out of position when other controls are being adjusted.

8. Elimination of "A" Delay Adjustment.—"A" Delay circuits have been stabilized to such an extent in Modification V that the "A" Delay Adjustment could be eliminated.

9. Illumination of Station Selector Dial.—In Modification V, a dial light has been added to illuminate the Station Selector Dial.

10. Instruction Manual.—A new instruction manual is being prepared and will soon be available for Modification V. Test procedures, specifications, and schematic circuit diagrams will appear in LORAN ARMB #23.



Dial light on station selector dial.

ADJUSTMENT OF LORAN INDICATORS

To Accommodate Basic Pulse Rate of 33 1/3 Per Second

Until recently, all Loran stations have operated at a basic pulse recurrence rate of 25 per second. Stations operating on the same radio frequency are assigned rates which differ from the basic pulse rate by small amounts. These rates are numbered 0 to 7 and are selected by the station-selector switch. Rate 0 is 25 per second, rate 7 is 25-7/16 per second, and the other rates are in between.

In order to increase the number of Loran stations which may operate on the same radio frequency channel, an additional basic recurrence rate of 33 1/3 per second will be used for certain new Loran stations. The new stations will be assigned rates which differ from the new basic rate of 33 1/3 per second by small amounts. These various rates are also numbered 0 to 7 and are selected by the same station-selector switch that is used for stations operating at a basic pulse rate of 25. Rate 0 will then be 33 1/3 per second, rate 7 will be 33 11/12 per second and the other rates will be in between.

The family of eight rates (numbered from 0 to 7) based on 25 per second will be known as L (low) rates and the family of eight rates (numbered 0 to 7) based on 33 1/3 per second will be known as H (high) rates.

When the ordinary alignment instructions for the AN/APN-4 and SCR-722-A are followed, a basic rate of 25 per second (L) results. To obtain a basic rate of 33 1/3 per second (H) it is necessary to adjust the fourth counter in the indicator to count 6 rather than 8. This adjustment is made as follows:

(a) AN/APN-4 With the sweep speed switch on position 7, turn the indicator front panel adjustment "D" until there are 6 groups of 2500 microsecond spaces on each trace rather than 8 groups of 2500 microsecond spaces.

(b) SCR-722-A With the test lead in the "3-4" test position and the sweep speed "slow", the indicator front panel adjustment "D" is turned until a pattern of six groups of five stairs on each trace is obtained, rather than a pattern of eight groups of five stairs.

(c) Most recent production AN/APN-4 (Modification V) provides a switch for changing the basic pulse rate. This switch is marked "Hi" for 33 1/3 and "Lo" for 25 pulses per second.

CAUTION: When changing the basic pulse rate of LORAN indicators from 25 to 33 1/3 in accordance with the above instructions, it will be found that the Station Selector Circuits will be out of adjustment. It is imperative that these circuits be readjusted, but it is neither necessary nor desirable to use the trimmer capacitors for this operation, since it may be very easily accomplished by means of the Fourth Counter Output Control, R341-2. Readjustment of this control on position 7 of the Station Selector Switch will bring all of the dots back into line simultaneously. This readjustment is, of course, also required when changing from 33 1/3 to 25 cycles basic pulse rate.

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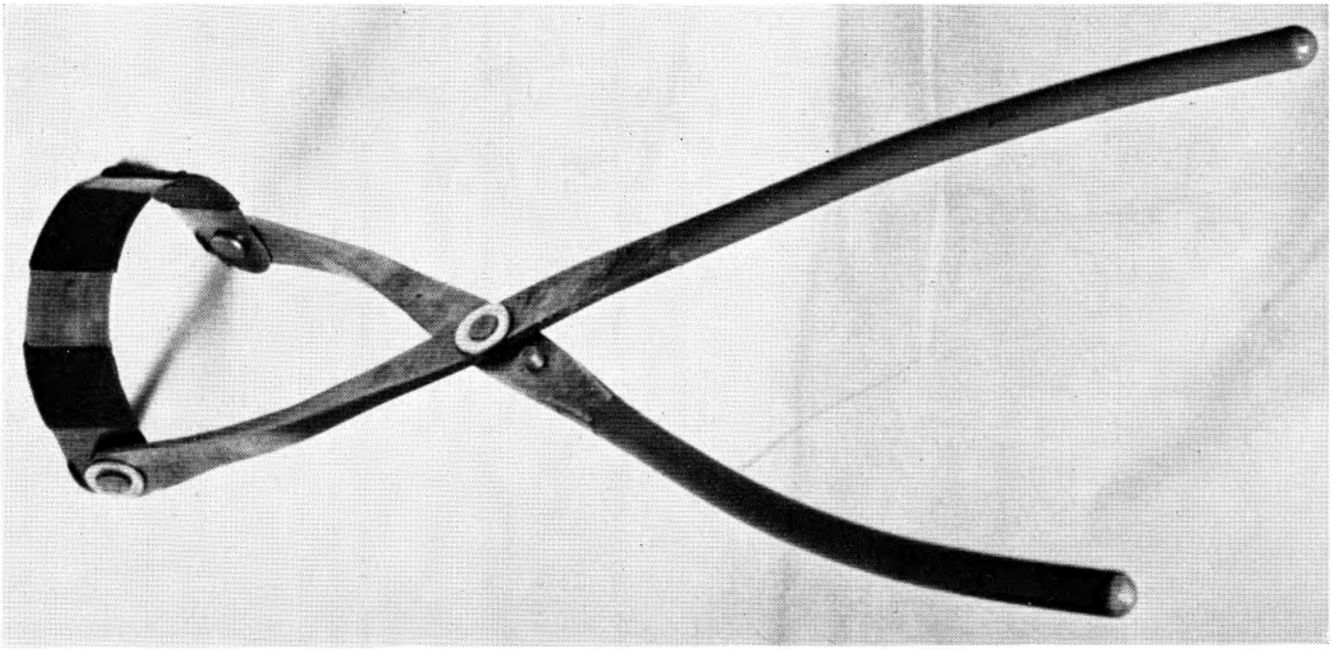
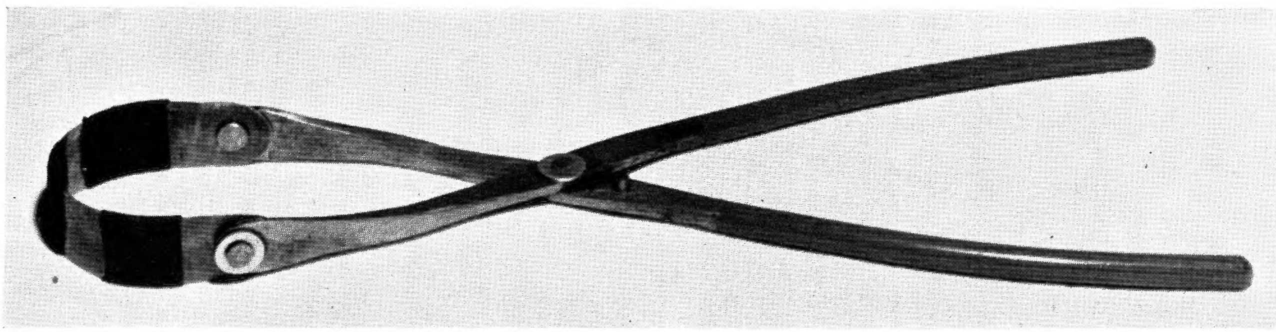
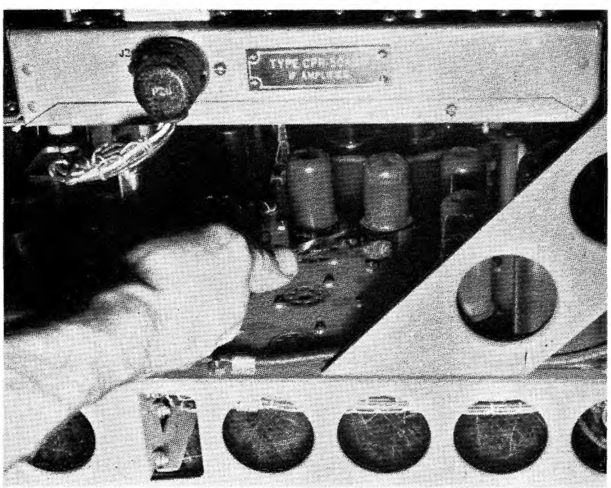
Lt. W. E. Jenkins, U. S. N., Communications Officer of CASU-22 is now disseminating information of general interest to local radio-radar personnel by means of a mimeographed Radio-Radar Bulletin.

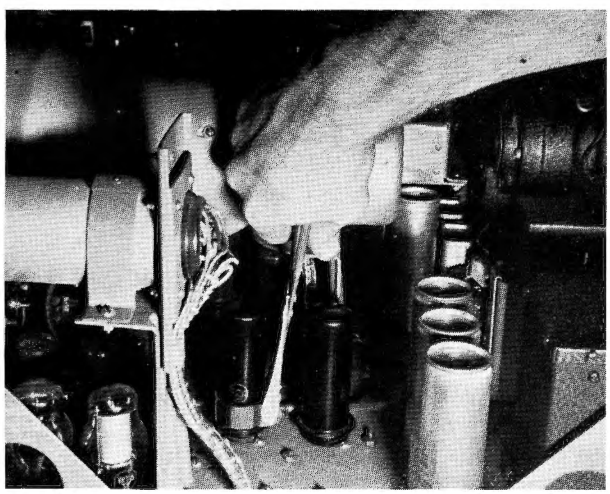
This Bulletin is proving to be of great value in getting the word around locally.



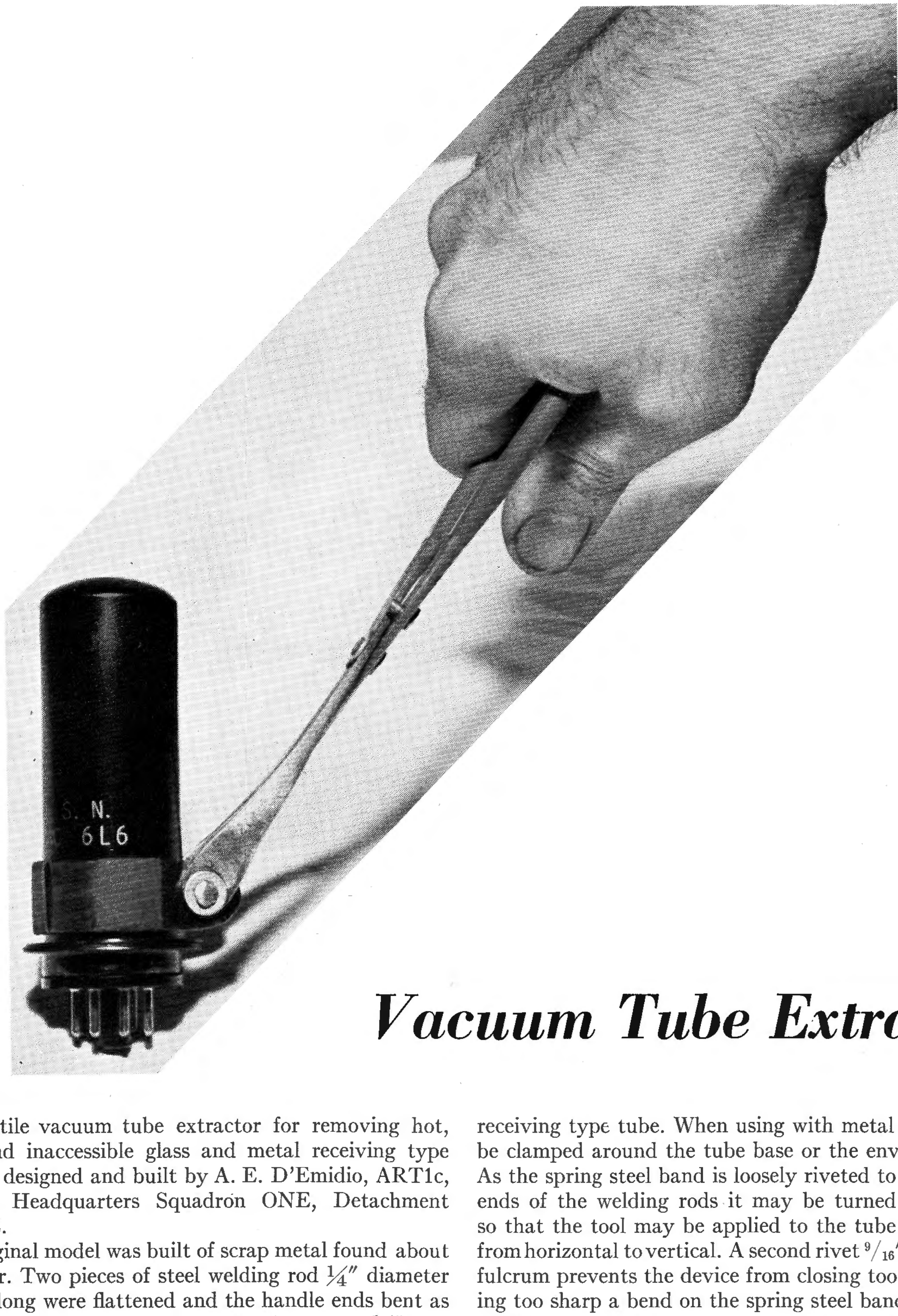


The two views above show how the band on the vacuum tube extractor is flexible so that it may be used in flat or or upright position.





The above photos demonstrate how the vacuum tube extractor may be used in tight and awkward places.

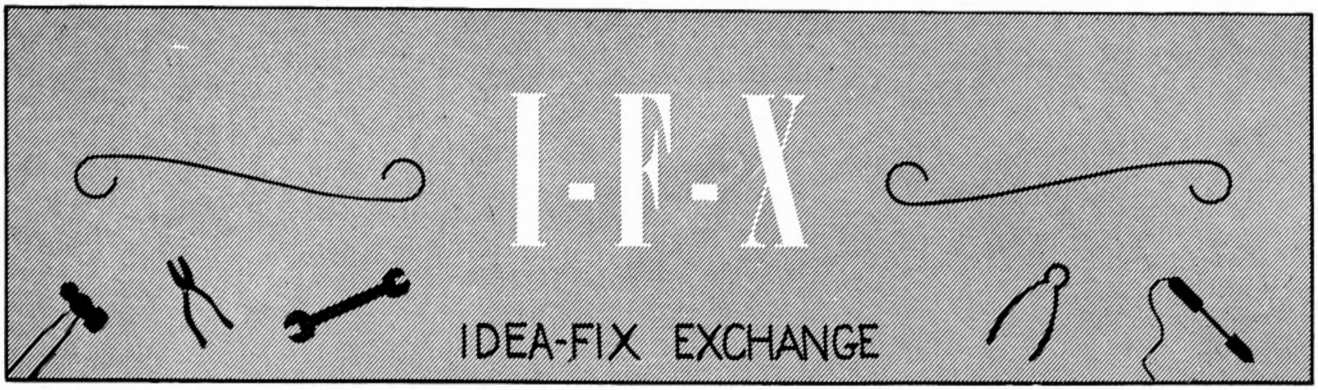


Vacuum Tube Extractor

A versatile vacuum tube extractor for removing hot, broken and inaccessible glass and metal receiving type tubes was designed and built by A. E. D'Emidio, ART1c, of Blimp Headquarters Squadron ONE, Detachment TWELVE.

The original model was built of scrap metal found about the hangar. Two pieces of steel welding rod ¼″ diameter and 8½″ long were flattened and the handle ends bent as shown in the photograph. A piece of spring steel, 4½″ long and ⅝″ wide salvaged from a broken clock spring, forms the band which clamps around the tube base when the handles are compressed. This band fits around the base of any receiving type tube. When using with metal tubes it may be clamped around the tube base or the envelope proper. As the spring steel band is loosely riveted to the flattened ends of the welding rods it may be turned 180 degrees, so that the tool may be applied to the tube at any angle from horizontal to vertical. A second rivet $^9/_{16}$″ out from the fulcrum prevents the device from closing too far and placing too sharp a bend on the spring steel band.

This vacuum tube extractor may be used to replace as well as remove tubes in inaccessible places such as under the I.F. strip and in back of the front panel of AN/APS-2 receiver indicator units.



CENTERING SWEEP OF PRI'S

A number of cases have been reported of trouble encountered in making the centering adjustment on Plan Repeat Indicators of both the AN/APS-2 series and AN/APS-15 radars. In most instances the trouble was caused by previous incorrect adjustments. In some instances, the screws supporting the deflection coil yoke in the housing had been turned in until the housing of the remote indicator was dented, making further adjustment of sweep centering impossible.

Preliminary centering is accomplished by adjusting the focus coil assemblies. The "CENTERING", "HOR" and "VER" controls to their center positions before adjusting focus coils (½ rotation).

If it is necessary to adjust the deflection coil mounting screws to bring the start of the sweep to the exact center of the scope, these screws should be loosened carefully to allow motion of the coil, and tightened a little at a time rather than tightening any one of them to its limit before attempting to tighten the others. Since these adjustments are quite critical, gentleness, NOT force does the trick.

BAND SWITCHING MOTORS FOR AN/ARC-5

A report has been received from the field that band switching motors have been shipped minus lubrication. In the particular case the lack of lubrication was observed by the activity involved. However, it would not be difficult to overlook this discrepancy which would result in bearings searing and freezing. Hence, it is recommended that replacement motors be carefully inspected before installation, and lubricated, if necessary, with a grease which meets the standard specification, AN-G3 for low temperature operation.

SHATTERING OF DISCRIMINATOR SECONDARY COIL IN AN/APS-4

Several reports from activities using the AN/APS-4 have indicated failure of the discriminator, due to the tuning slug being screwed too far down, thereby shattering the coil form, and breaking the connection from the coupling condenser C(5D)41 to the center of the coil.

To prevent the tuning slug from being projected too far down in the coil, the following method has been recommended:

Remove the tuning slug from the coil, and run a lock washer, and nut, down to the head of the tuning slug, then replace the slug in the coil.

Production equipments will correct this with a shortened screw about 1 November 1944, however the serial Nos. of equipments are not available.

723 A/B MAINTENANCE

Several activities have reported that equipment, tuned completely on the bench (local oscillator tuned to the correct mode, AFC locked in, etc.), when reinstalled in aircraft, became out of tune with resultant poor operation, after a few minutes of airborne use. When the gear was checked, it was found that normal plane vibration, etc., had caused the 723 A/B to go out of tune. This condition was remedied by flexing the bows (to remove static tension) when making the final tuning adjustments, and then putting a spot of glyptol on the adjusting screw to prevent further unwanted movement. This was found sufficient to eliminate this trouble and has proven to be an excellent bit of preventive maintenance in all radars employing this type of tube. The glyptol is easily removable for further bench maintenance.

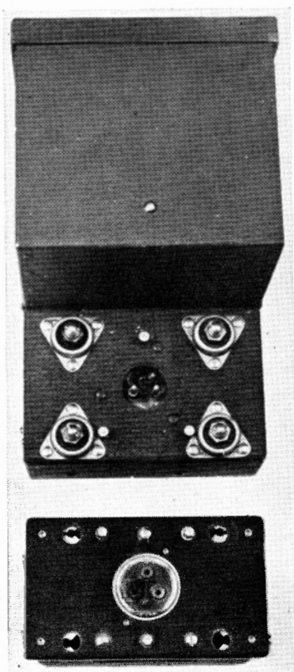
FAILURE OF P1 IN THE RL-7 EQUIPMENT

Several instances have been reported where insulating material of plug P1 between pin 3 (H. V.) and ground breaks down due to excessive moisture. This effectively short circuits the H.V. with consequent damage to the dynamotor. Canvas covers are satisfactory as long as the gear is inoperative but something more in the nature of a permanent fixture is preferable.

CASU-31 personnel solved the problem temporarily by positioning a synthetic rubber disc ¼ inch thick and 1¼ inches in diameter, with three holes for the contact pins, between the dynamotor and the base to keep moisture from entering.

Tests have been completed on a number of subject dynamotor plugs which lead to the conclusion that leakage currents flowing through moisture on the surface of the plug insulation are not the basic cause for insulation failure. In all of the plugs tested, failure occurred due to current flowing between pins through the moisture absorbed by the bakelite insulating material. This current flow apparently develops sufficient internal heat in the bakelite insulation to cause carbonization of the fibers with the result that the leakage current progressively increases until complete failure ensues.

Dynamotor plugs which have not failed, such as the ARC-5 plug, are all insulated with mica which has very low moisture absorption and will not carbonize in the presence of heat. Thus, any leakage paths which may develop due to moisture dry out without damage to the insulation.



The Magnavox Company, Fort Wayne, Indiana, is now procuring improved dynamotor plugs assembled on a micabase insulation material known as Micelroy which will be used on all AM-40/AIC and all future RL-7 interphone amplifiers. Micelroy insulation has extremely low moisture absorption under the most adverse conditions and will not carbonize in the presence of heat.

A Technical Order is being prepared which will require replacement of existing dynamotor plugs on RL-7 and RL-9 interphone amplifiers with the improved Magnavox type dynamotor plug (part No. 180203).

USE OF DYE MARKERS WITH SONO BUOYS

A safer and simpler procedure for using the Mk. 1, Mod. 1, dye marker with the AN/CRT-1A sono buoy has been reported by ACG Field Engineer Ken Gookin stationed with ComFair West Coast.

Difficulty is sometimes experienced in the use of dye markers, he wrote, because markers at present are loaded with three ounces of black powder. Detonation, designed to split the marker case and release the dye inside, has sometimes caused damage to the buoy. One buoy dropped on a practice run sank immediately. The casein covering of the buoy seems susceptible to cracking if a sharp shock occurs nearby, the ACG engineer found.

In the modified procedure, the marker is taped to the buoy as before, but the arming handle is bent up, unscrewed and discarded. The resulting hole in the marker is covered with masking tape, and the buoy is dropped as formerly.

The 40-mile-per-hour impact force with which the buoy strikes the water has in all trials split open the marker and normal dissemination of the dye follows.

The modified procedure not only saves buoys but also eliminates the danger of injury to personnel. When black powder was used, explosions sometimes occurred when men released the arming handle and injuries resulted. The suggested procedure also eliminates several steps in preparation of the buoy and some of the materials formerly required.

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CALIBRATION CHANGES IN AN/APG-4

Changes in calibration of AN/APG-4 may occur because of variation in V107 and V108 heater-cathode leakage with time or with variation in heater voltage. This calibration variation is eliminated by the addition of a 3.9 ohm, one watt, 10 per cent resistor in series with the heaters of these two tubes. Some early equipments were produced without this resistor. Others were produced with this resistor shorted out because of failure to remove the black-brown jumper lead between pin 7 of X108 and pin 7 of X109. It is suggested that all equipments be checked, and the resistor added, or the jumper removed as may be required.

To add resistor: Substitute resistor for black-brown lead between TB104 terminal 2, and X107 pin 7; add lead between TB104 terminal 2, and X109 pin 7; remove black-brown jumper lead between X108 pin 7 and X109 pin 7.

Supply Notes from ASO

MK-30/AP Adapter Kits

100 MK-30/AP Adapter Kits, consisting of a set of adapter cables, have been purchased for use with the TS-102/AP range calibrator. One of these kits will be supplied with each TS-102/AP. In cases where a TS-102/AP has already been supplied without a kit, a kit (MK-30/AP) will be forwarded.

The TS-102/AP with one of the kits will be designated TS-102A/AP and will include: 4 each CG-107/U (5 ft.) (former CD-800) cables; 2 each CG-177/U (6 in.) cables; 1 each CX-234/U (10 ft.) power cord. Thus, the TS-102A/AP will not require the MK-30/AP kits.

New, Smaller Packing Case for ASB-7B

Beginning with serial #9501 the new packing case, reducing the existing volume of 28.3 cubic feet to approximately 13 cubic feet, will be employed for ASB-7B.

ASB-7B equipment bulk spares will be provided in three boxes, as follows: (a) One box with CPR-46ACJ receiver spares on the basis of 1/20; (b) Two other boxes with bulk spares for the remainder of the ASB-7B equipment on a 1/10 basis.

Correction in Test Equipment Manual

The Weston 341 Voltmeter, listed on pages 3–5 of the "Manual of Test Equipment" is both a.c. and d.c. instead of a.c. only, as the Manual states. The 341 has a 0–150 voltage range instead of 0–150–300 and is for 25–1000 cycles, not 0–1000.

Proper Substitutes for Test Equipment

Proper substitutes for test equipment are listed in the "Manual of Test Equipment" (NavAer 08-5S-78), page 1 and 2. The bracketed items in Enclosure A (Allowance List) of Aviation Circular Letter 85-44 (2 October 1944) are also substitutes. For example, in the Allowance List Item 6, Page 2A, the three voltmeters are all for measuring 800 cycle voltage. Item 8, meggers, voltohmmilliammeters of approximately 20,000 ohms per volt. The milliammeters enumerated under Item 10 are all smaller type, 1,000 ohms per volt. In the Test Equipment Manual items marked with an asterisk (*) are to be covered by a supplement which is being prepared.

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AN/ARR-2 TUNING CORES

Some activities have reported that vibrations and aircraft carrier landings cause the modulator frequency cores in the AN/ARR-2 to become detuned.

This condition may be corrected in the majority of cases by giving special attention to the spring locking washer, checking to see that it is properly seated in the detent groove of the bakelite or fibre insulating piece. Any receivers which have obvious manufacturing defects should be replaced.

The Handbook of Maintenance Instructions for AN/ARR-2 (CO-AN-08-25E-1), dated 30 September 1943, gives two internal views of the Z-101 modulation frequency tuning unit on page 33. On page 43 detailed maintenance information is given on the care of the oscillator and tuning coils. Each activity servicing the AN/ARR-2 equipment should make up a check-off list to insure that the required maintenance is not neglected.

When the receiver units are brought into the radio shop for adjustment or repair, all the oscillator and tuning cores should be checked for tightness. Remove the top and right side cover of the receiver. Remove tubes V-106, V-107 and the four screws holding the twelve-hole cover of Z-101 in place. Remove the twelve-hole cover, and then with a small screwdriver, tighten the twelve screws which secure the tuning coils, being careful not to damage the bakelite or fibre insulation. As this insulation material tends to change with age, these screws may require tightening once a month. Each of these screws is secured by a small lock washer under the head of the screw.

Next, adjust the tuning cores for a friction fit by using the hexagon tuning wrench or aligning tool (H-503). When necessary, tighten the 12 tuning core spring tension washers. Make tension adjustments carefully so that cores turn smoothly and the screw threads will not be damaged by too much tension. A spring leaf of the washer must be secure in the detent groove of the bakelite or fibre insulating piece. If this is not done vibration may cause the spring tension washer to turn, thus detuning the oscillator or tuning core.

Replace the twelve-hole cover. With a soft pencil write on the aluminum twelve-hole cover: "Tuning cores tightened***," giving the date. Then realign the receiver according to standard practices.

NOTES ON ASB-7B RADAR EQUIPMENT

In an effort to prevent confusion in the minds of service personnel concerned with the handling, operation and maintenance of ASB-7B radar equipment, the following information is given.

The complete ASB-7B equipment is made up from the following mixture of components:

Receiver (Series)	CPR-46ACJ
Transmitter (ASB-7B)	CAY-52ACV
Indicator (ASB-7A)	CJP-55AER
Ant. Sw. Unit (ASB-7)	CJP-14AAC
Rect. Power Unit (ASB-7)	CJP-20ABX
Control Unit (ASB-7A)	CJP-23ADY

The major changes that will be encountered in the use of the ASB-7B gear is centered in the CAY-52ACV transmitter.

(1) To obtain full use of the "A" band feature, the model Bb antenna is required. The transmitter will work satisfactorily with the DB, B or Ba antenna, but *only* on the basic ASB series frequency (515 Mc.).

(2) The overall height of the transmitter is 17/32 inches higher than the ASB-3 "penthouse". The ASB-7B transmitter is a full rectangular box, whereas the ASB-3 was not.

As to spare parts, operating and bulk, there is a definite problem. Service personnel should be warned that although the indicator unit, for example, may carry the same service type designation as the indicator issued with the ASB-7A, it is not entirely possible to rush to the nearest ASB-7A bulk spares and expect to find a replacement for a defective part in the indicator furnished with the ASB-7B. Changes in circuits and the incorporation of improved parts, or changes in part values, are incorporated from time to time in the interest of improving the overall performance. The cliche "any similarity between this and the original is purely coincidental" applies as much to the ASB-7B as it did to the rest of the series.

The operating spares for the 7B will contain the normal run of tubes, fuses, etc.

The bulk spares for the 7B are packed in a manner that will be advantageous in some ways. The bulks will consist of three boxes:

(1) One box will contain enough spare parts to maintain twenty CPR-46ACJ receivers.

(2) Each of the other two boxes will contain enough spare parts to maintain ten sets of the remaining ASB-7B components.

The bulk spare sets will be furnished to the field in the ration of 1 set to each 20 sets of equipment.

The ASB-7B gear is being furnished for replacements of the ASB-3 and ASB-4 now in service. Additional equipments are being provided to the fleet pools for spare equipments against the ASB-6/7/7A and 8. Production is installing a quantity of ASB-7B's in TBM's, but the exact total has not been determined this time.

The complete tune-up procedure for the ASB-7B transmitter and the calibration procedure for the ASB-7A indicator, as well as schematics, are included in the ASB section of the ARMB.

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A time-saving tool for Allen-head wave guide screws may be made by using a straight section of the proper size Allen wrench brazed to the end of a 10-inch by $\frac{3}{16}$-inch rod, terminated with a screwdriver handle.

NOISE IN ARC WELDER OUTPUT

N.A.A.S. Fallon, Nevada, discovered that the output of a modified Lincoln arc welder power supply was being modulated with a strong audio tone which measured exactly 962 cps. This audio tone, which is probably commutator ripple, affected sensitivity measurements of all d.c.-operated gear.

A cure was affected by taking the large stabilizing circuit choke, which is removed from the circuit when converting an arc welder to a power source, and putting it in series with the output. A 300 mfd. condenser was also shunted across the output. In this way the level of the audio tone was lowered to where it was barely audible.

CORROSION DIFFICULTIES

An ACG technician reports: an apparently trivial, nevertheless important difficulty is often caused by corrosion on test prods used with various test gear. It is necessary to clean the test prods daily in order to eliminate serious errors in voltage and resistance readings. The corrosion, apparently caused by unfavorable atmospherics in certain areas, forms a resistance coating which results in erroneous but often steady readings. Such a condition, if undetected, may lead to hours of unnecessary work. Removal of the corrosion requires the industrious application of emery cloth or a file, rather than merely rubbing the prods together. Replacement prods made with stainless steel or other non-corrosive material would eliminate much wasted time.

Correction Please!

Modification of 6C4 Peak Emission Tester

An ACG Field Technician recommends that a switch which requires holding in the on position be added to the cathode circuit of the 6C4 Peak Emission Tester described in the October 10, 1944 "Digest" because 6C4 tubes will be damaged if allowed to operate at peak emission much over 30 seconds.

It is recommended that the cathode circuit be closed only long enough to take a reading.

Removal of AN / ARR-1 and AN / ARR-2 Equipment from VPB Planes

Page 19 of the 25 October 1944 DIGEST is in error; the Radio and Electrical Branch of the Engineering Division, BuAer has no directive to remove subject equipment from carrier-type planes. R & E is at this time preparing new airborne homing equipment performance specifications.

ERROR IN DIGEST 25 OCTOBER 1944

In the October 25th issue of the Digest an error appears on page 28. The article describing a crystal holding device for AN/ARC-5 receivers states, in part: "This device consists of an aluminum channel, $2\frac{1}{2}$ inches in length, $\frac{3}{8}$ inches in width".

The dimension of $\frac{3}{8}$ inches for width is incorrect both in the text and in the photograph labeled "inside view". The crystals are $\frac{3}{8}$ inches in width in each tier. To cover both tiers the aluminum channel must necessarily be $\frac{3}{4}$ inches wide.

AN / APS-4 Noise in SB2C-4E's

AN/APS-4 recurrence rate noise in the communication gear of modified SB2C-4E's may be eliminated by cleaning the paint and anodizing from under the twenty-seven (27) contact AN/APS-4 wing plug and from under the 8001-C alternator.

Bluish-White Streamers Inside Landing Light Lamps

Reports have been received by BuAer that sealed-beam landing-light lamps AN3130-4560 and AN3130-4562 sometimes develop a milky-white or bluish-white streamer or cloud condition inside the bulb.

This condition is due to a very small quantity of air which has leaked into the lamp through minute cracks which sometimes develop, usually in the area of the lamp where the clear glass cover is annealed to the reflector glass. These tiny cracks may occur at any time during the handling and shipment from the lamp manufacturer to the airplane.

The filament of a lamp with air in it will deteriorate more quickly than normal, and the useful lamp life will be reduced. Also, a small crack may become larger as the lamp is flown, reducing lamp life to a few hours, or even a few minutes!

It is recommended that, if such a defective landing-light lamp is found on an airplane, it be replaced at the earliest opportunity. Should the number of faulty lamps be 10% or more of those being used or in stock, forward six representative samples to BuAer for examination. The RUDM accompanying them should state the percentage of the total number of replacements represented by the defective lamps. Activities having infrequent failures of this type should (1) destroy defective lamps and (2) submit an RUDM.

AN/APS-4 PRESSURIZATION IMPORTANT

You don't drive far on low-pressure tires with no pressure in them—and the AN/APS-4 radome won't take it either with no pressure on the inside.

Proper pressurization is especially important in the new radome for the AN/APS-4 which has been in production for several months. This antenna housing was designed to be as light as possible, not only to reduce weight but also to provide the best possible transmission characteristics. This light construction was achieved by using a material of high tensile strength and by relying on the internal pressurization to provide rigidity under extreme loads. Without this internal pressure, the AN/APS-4 radome will not stand the air loads occurring in flight of high-speed aircraft.

Proper pressure for the AN/APS-4 "bomb" has been established at *5 pounds*. This pressure should be applied by means of the MK-20/UP or MK-20A/UP pump (ASO stock #R16-D-1165, which is available through regular supply channels), and the pressure should be gauge-checked.

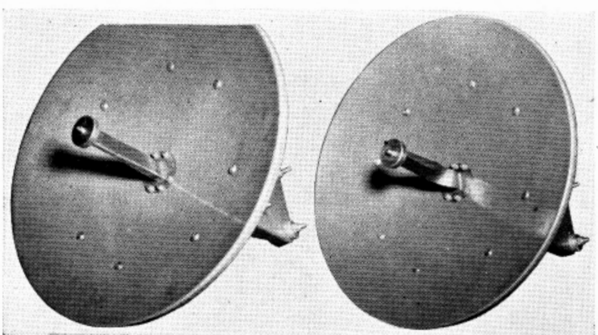
This is a pre-flight check. The AN/APS-4 should not be flown unless properly pressurized.

IMPROVED BEACON RECEPTION FOR AN/APS-6, 6A RADAR

A marked improvement in X-band beacon reception by AN/APS-6, 6A radar equipments has been achieved with a simple antenna design change. Previous night fighter radars using the spiral scan were limited in reception at extreme azimuth angles. With improved equipment, it is possible to receive beacon signals over a much larger area.

Although ranges of 80 to 100 miles could be obtained at 0° azimuth with present equipment, performance falls off sharply beginning at plus or minus 5° until, at plus or minus 60°, ranges of less than 20 miles were obtained. The principal reason for this deterioration in performance at large angles is cross-polarization between beacon and radar antennas. As each sweep of the spiral scan crosses the horizon where the beacon is located, polarization of the scan is 90° out of phase with the beacon antenna.

Numerous experiments have been conducted to improve this condition. The most effective solution discovered is to twist the antenna feed 90° and thereby change the polarization of the antenna from tangential to the path of the spiral scan, to radial to the path. With this change, as the projected beam passes the location of the beacon, which is horizontally polarized, the radar antenna is polarized in the same plane as the beacon antenna.



Comprehensive tests were conducted to insure that this change in polarization would not adversely affect normal radar performance by reducing ranges or by increasing sea return. Results of recent tests at Radiation Laboratory, Cambridge, Mass., and NAS Patuxent River, Maryland, indicate that beacon performance is greatly improved without any deterioration of radar performance. AN/APS-6A, with the new twisted antenna feed, regularly obtains beacon ranges over 80 to 100 miles at all azimuth angles. Sea return is the same with twisted and straight antenna feeds.

As a result of these tests, all future AN/APS-6 and -6A radars will be equipped with the twisted feed antenna, beginning late in November. A sufficient quantity of feeds have been ordered to allow retroactive fitting of all AN/APS-6 and -6A's now in the field.

Due to their delicate balance, it may be necessary to rebalance the scanners after the twisted antenna feed is installed. Therefore, it will be advisable to change feeds only when there is a spinner balancer, CGJ-10 AEH, available.

BLOWER MOTOR FILTER KITS AVAILABLE FOR AN/APS-2 SERIES

Blower Motor filter kits for suppressing electrical interference radiation from the d-c blower motor of the AN/APS-2 series of equipment are now available and are being distributed as follows:

Destination	*Quantity*
ASA, Oakland	1300
NASD, Norfolk	800
NASD, Philadelphia	500

The use of this filter kit is retroactive to the first unit of AN/APS-2 equipment. Complete instructions for installing the kit are included in the ARMB for AN/APS-2, supplement number 19, page I-11.

IMPROVED CONTROL UNIT FOR AN/ARC-5 VHF

BuAer Technical Note No. 93-44 announces an improved control unit for the AN/ARC-5 VHF Radio due to troubles with the present unit, C-30/ARC-5, which included loss of the phenolic push buttons and breakage of the shafts.

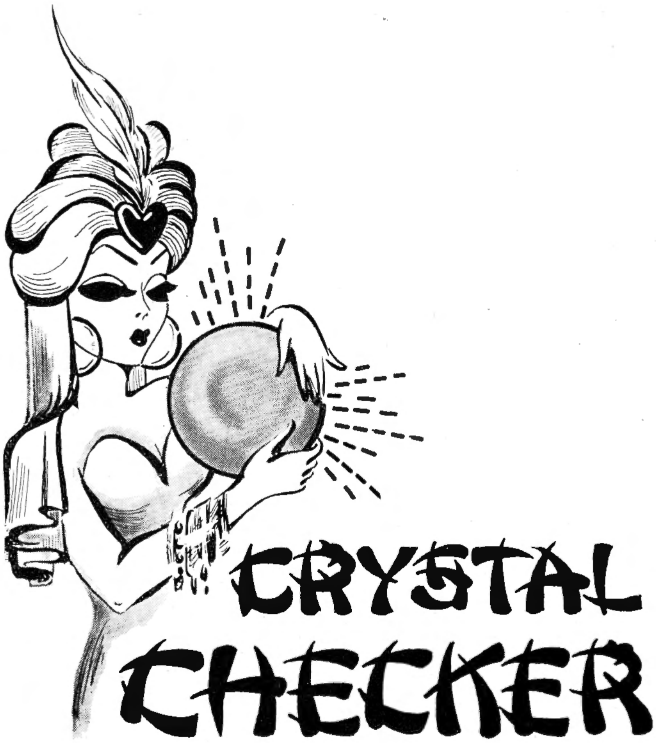
The new-type control box is designated C-30A/ARC-5 and should overcome all the difficulties heretofor experienced. Electrically the two control boxes are identical and mechanically they are interchangeable except that the C-30A/ARC-5 requires 5/16" greater clearance above the top and weighs 0.6 pound less.

The new control box is now available at ASA Oakland, California and NASD Norfolk, Virginia.

NOISE IN COMMUNICATION GEAR CAUSED BY AN/APS-4

Another aid in eliminating noise from communication equipment caused by the AN/APS-4 has been reported by an installation base.

They found that cleaning the paint and anodizing from under the 27 contact AN/APS-4 separable wing plug, and from under the 800-1C alternator (mounting bolts, etc.) eliminated the noise. It is suggested that all activities using AN/APS-4 check for the above condition, eliminating any poor condition found.



CRYSTAL CHECKER

DEVELOPED AT THE RADIATION LABORATORIES

A new crystal checker for field use has been developed by the Radiation Laboratory at M.I.T., which by two simple D.C. checks indicates whether a crystal is good or bad.

The first test is to apply a standard voltage (1 volt) across the crystal and measure the back current. Various currents are given below for the different types of crystals. If the back current is greater than the quoted value, the crystal is bad. If less, the crystal is good. This is nicely indicated on the checker by a "good-bad" scale on the meter face.

The second test is to measure the front to back resistance of the crystal. If the front resistance is greater than 500 ohms, or if the front to back ratio is less than 9 to 1, the crystal is bad and should be rejected. If the front resistance is less than 500 ohms and the front to back ratio is greater than 9 to 1, the crystal is good. However, the crystal must pass both tests (current and resistance) before it can be accepted as a good crystal.

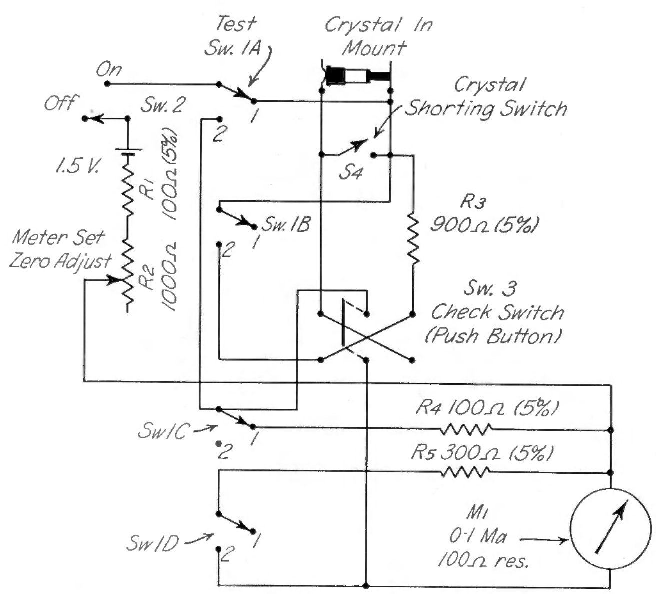
Almost a thousand crystals have been checked at the Radiation Laboratory with this checker. The crystals were first checked by the precision methods employed by the laboratory and then were checked by this crystal checker. The results obtained compared favorably with the regular laboratory method.

These checkers are being ordered by the Navy but will not be available for a few months. However, the checkers are simple to build and may be easily produced in the field.

The schematic diagram shown herewith should be self-explanatory. A photograph is shown of the model built by the boys at M.I.T., as well as a photograph of the meter scale. It is suggested that this scale might be cut out and used by anyone desiring to build one of these crystal checkers. (The photograph shows two of these scales for the convenience of the builder.)

The following are operating instructions for using this crystal checker:

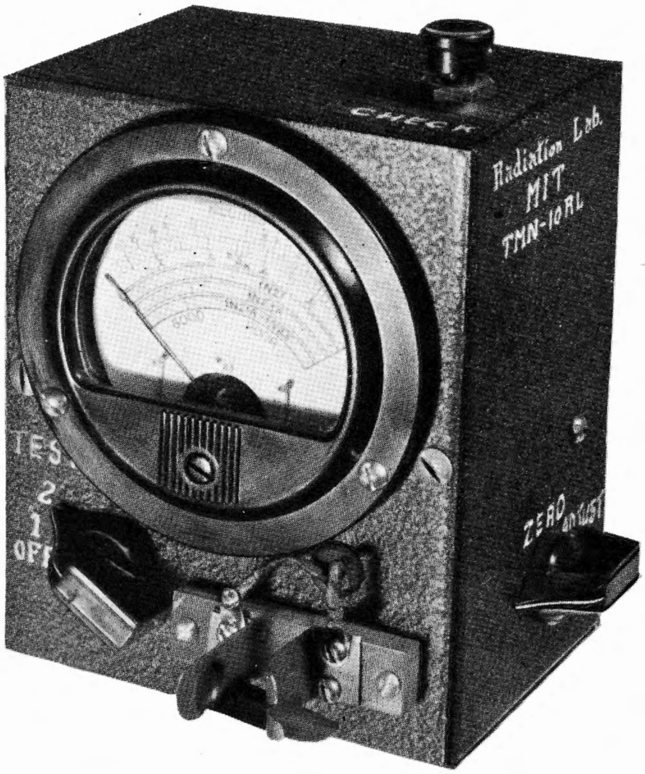
1. Turn on switch #2.
   (This switch may easily be incorporated with the "test" switch, as was done by M.I.T. Or a separate switch may be used for this purpose.)
2. Insert crystal in mounting.
3. Switch to "Test" #1.
4. Adjust meter to full scale.
5. Press check button.
6. *Discard if meter indicates "poor" crystal*
(Consult chart showing currents for the various types of crystals)
7. If good crystal, switch to "Test" #2.
8. Short crystal and adjust meter to full scale.
9. Release short, meter will now read the front resistance of the crystal.
10. *Discard crystal if resistance is greater than 500 ohms.*
11. Press "Check Button". Meter will read back resistance.
12. *Discard if ratio of resistance is less than 9 to 1.*

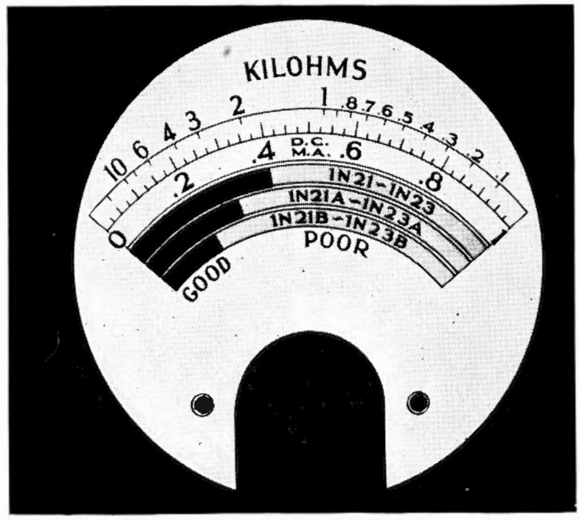


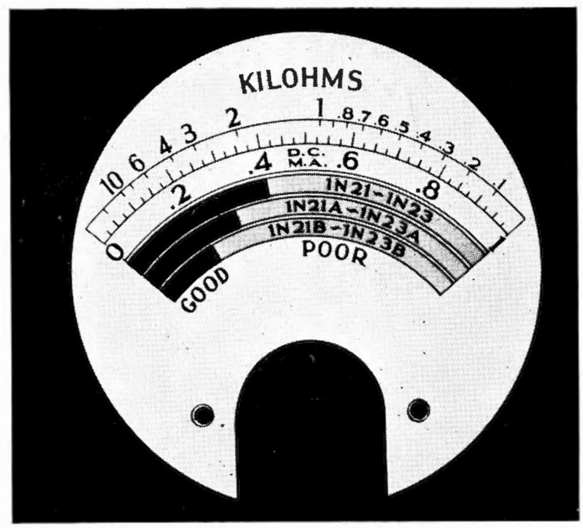
This schematic shows the wiring arrangement of the crystal checker described in this article

Chart showing proper currents for various types of crystals.

1N21	.4 ma.
1N21A	.3 ma.
1N21B	.2 ma.
1N23	.4 ma.
1N23A	.3 ma.
1N23B	.2 ma.







WOODEN GUARDS ON YAGI ANTENNAS MAY CAUSE DISTORTION

It has been reported that the wooden guards used on Yagi antennas sometimes cause quite a bit of trouble because the holes in the wood are drilled without sufficient clearance to allow for warpage, which may occur if the wood gets damp. This happens more often if the guards are unpainted. It is recommended that slightly larger holes be drilled in the guards and that they be dip-painted to lessen moisture absorption.

In some cases it has been reported that the guards are placed on the antennas before the glyptol applied to the tuning caps has dried, and are actually cemented to the tuning caps. In removing the guards the antennas can easily be damaged to such an extent as to require rake replacement. While the use of wooden guards has proved a valuable safety precaution in most instances, care must be observed to prevent damaging the antennas with them.

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Kits Now Available for AN/APS-2G Modification of Local Oscillator

At Serial No. 24 in the AN/APS-2G equipments, a 56,000-ohm, 1-watt resistor, symbolized R-933, was connected in series with the plate circuit of the 2K28 local oscillator tube. This change was made in production to prevent power supply surges and interruptions from blocking the local oscillator.

A quantity of 23 kits (Philco Part No. 453-3222) have been procured and are available for modifying AN/APS-2G equipments with serial numbers below 24. The kits may be procured from NASD, Philadelphia.

Complete instructions for installing the resistor and relocating capacitor C-938 are found on page 1-38 of the ARMB for AN/APS-2.


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