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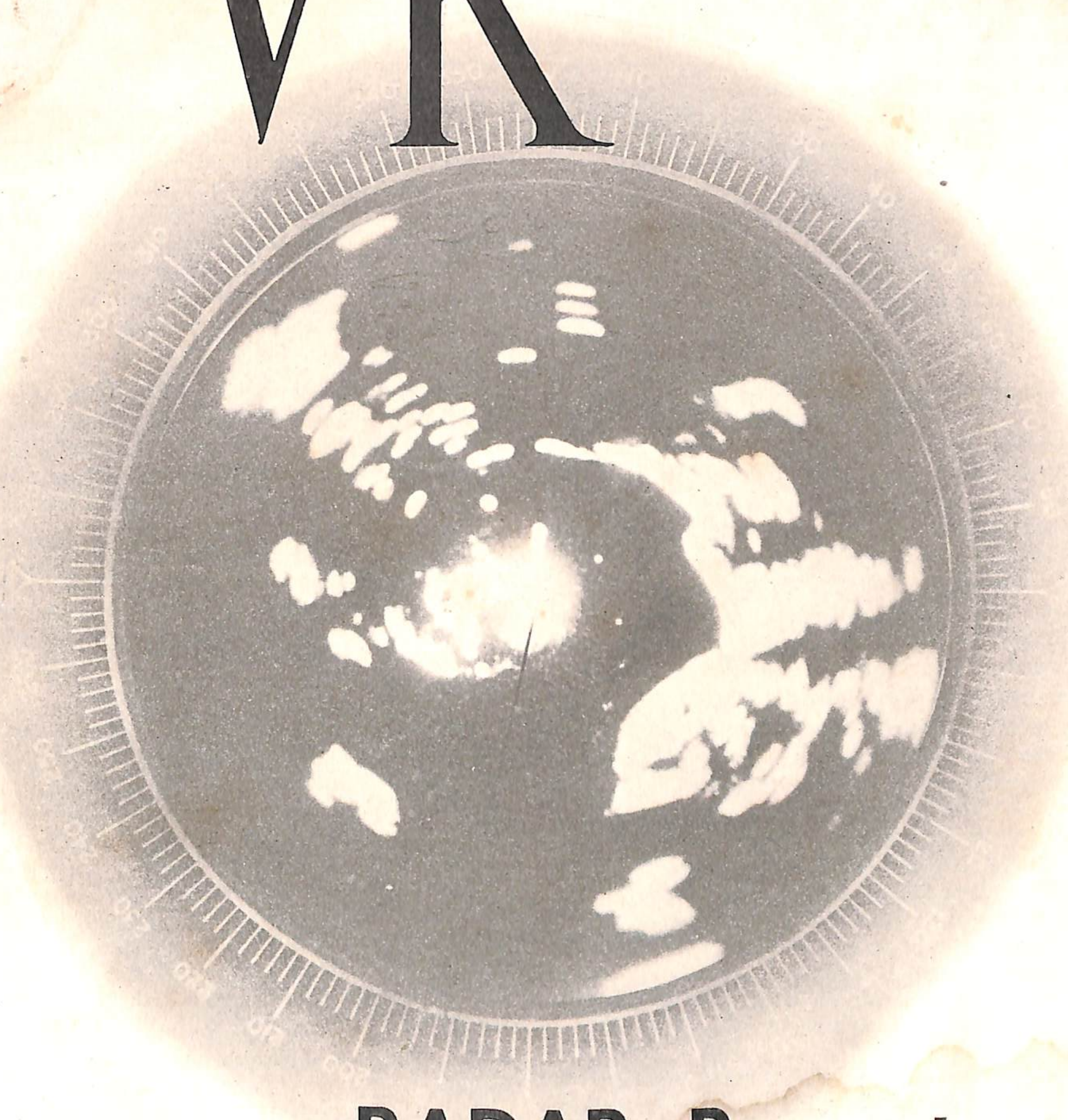
BUREAU OF SHIPS — NAVY DEPARTMENT

the VK



RADAR Repeater

By E. V. Perry, *Electronics Engineer, Bureau of Ships*

Soon to appear in the fleet are the first models of a new type radar repeater, the VK. This repeater is a single-package unit designed for compactness, measuring approximately 51″ x 18″ x 23″. These measurements include base shock mounts and a 14″ viewing hood. The unit is equipped with a 12″ PPI tube, utilizing magnetic deflection and focusing. A choice of six range scales, 4, 10, 20, 40, 80, or 200 miles, is provided in the equipment. For each range scale a certain length of gate is provided, to be used for gating various circuits throughout the equipment. Due to these various gate lengths, off-centering is available on the above-listed ranges in the amount of 36, 70, 60, 80, 80, and 80 miles in both the east-west and north-south directions respectively as shown in table 1. For example, if the unit is being operated on the 20-mile range the corresponding gate is 80 miles, so it is possible to off-center so that 40 miles of sweep is spread across the scope. If desired, this off-centering can be continued until the 40 miles of sweep on the scope actually is the 40-mile portion between 40 and 80 miles.

TABLE I—*Gate length and off-centering characteristics of the VK Radar Repeater.*

Range Scale	4	10	20	40	80	200
Gate Length	40	80	80	120	160	200
Max. Off-Centering	36	70	60	80	80	80
Radii Off-Centered	9	7	3	2	1	0.4
Range on Scope	8	20	40	80	160	200
Range-Marker Spacing	1	2.5	5	10	20	50

Each range scale selected makes available four range markers and a movable range ring, the range markers being equally spaced across the scale. For example, on the 4-mile sweep the markers will be at 1-mile intervals, on the 20-mile sweep at 5-mile intervals, etc. The position of the range ring is transmitted as target information by a 5G synchro up to a range of 72,000 yards. A mechanical bearing cursor is provided with its position on the scope also transmitted by a 5G synchro as bearing information to be used by external sources. An electronic cursor can be selected in place of the normal sweep and it will always have its origin at zero range and will always parallel the mechanical cursor.

The equipment is designed to permit maximum efficient use of off-centering principles and to furnish magnification without distortion. When a portion of the sweep is spread across the PPI, say from 20 to 40 miles, no distortion is present due to the expansion of the base as in a *B*-type scope, or contraction of the base as in a delayed-PPI presentation. The electronic cursor always starts from the position of the ship, so bearings of targets from ship's position can be determined during off-center operation. The range ring can also be positioned to the true range of a target even though the sweep is off-centered. Automatic off-centering from airborne early warning equipment is included so that the position of the ship can be kept at the center of the scope while the plane carrying the radar moves its position. Automatic operation from dead reckoning analyzer equipment offsets the effects of own ship's motion so that targets move relative to the center of the scope face at only their own motion.

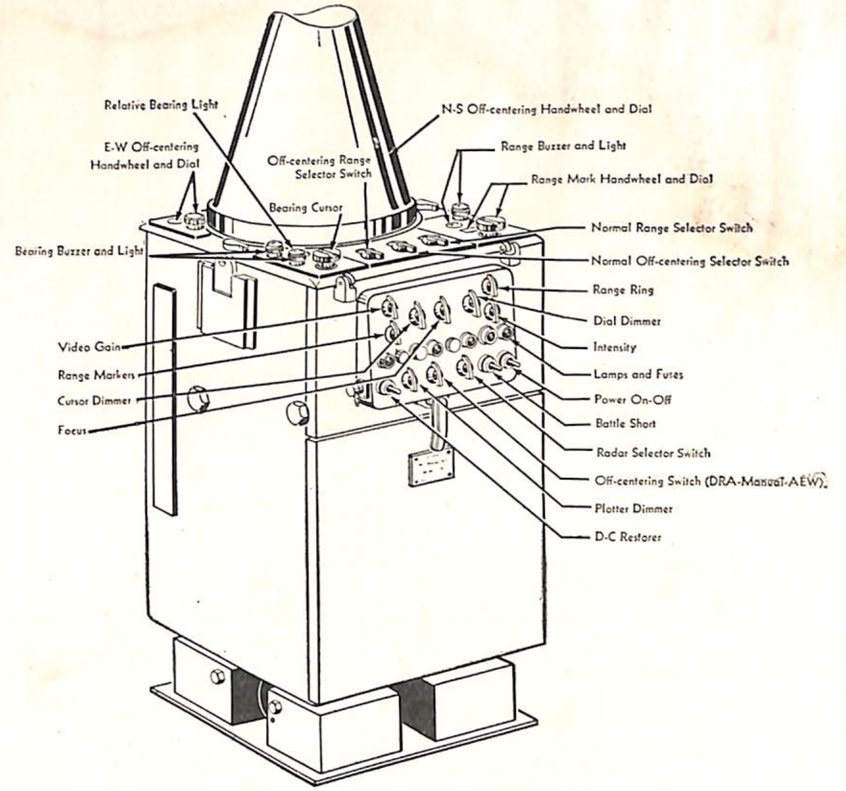
Figure 1 is a functional block diagram of the VK showing the major electrical circuits. The equipment consists of nine component circuits, trigger-amplifier and gating circuit, sweep generator, N-S and E-W sweep and off-center d-c voltage amplifier circuits, range-markers generator, range-ring generator, video amplifier, intensity compensation and blanking circuit, servo amplifier, and power supply. In addition to these circuits, the unit contains range and bearing transmitting components and circuit indicating systems.

The radar which is connected to the repeater, either through a switchboard or adapter unit, must furnish three input voltages, a trigger voltage, a video voltage, and a 1-speed synchro antenna reference voltage. All inputs and outputs of the VK are shown in figure 2. The incoming trigger from the selected radar is the initiating pulse for all sweep and gating circuits in the VK. This pulse triggers off the gating multivibrator which furnishes five outputs to various circuits including the sweep generator, range-markers generator, range-ring generator, N-S and E-W sweep circuit clamps, and the intensifier and intensity compensation circuit.

The sweep generator produces the range-sweep component for eventual application to the deflection coils of the PPI tube. This sweep is amplitude modulated by a voltage developed between the rotor and stator windings of a 2-phase resolver, the rotor being positioned by the movements of the radar antenna. The outputs are taken off the two stator windings of this resolver, one for the E-W sweep component and the other for the N-S sweep component. Each of these voltages is then amplified, clamped to a reference point, mixed with a d-c off-centering voltage, amplified in a push-pull amplifier and applied to the sweep coil of the PPI assembly.

The range-markers generator circuit produces fixed range marks to be applied to the PPI scope for estimating range of targets. This circuit receives its initiating impulse from the gating circuit and its output is delivered to the video amplifier strip for eventual application to the CR tube.

The range-ring generator produces a variable-position range mark which is used for accurate measurement of range to targets which appear on the scope face. The output of this stage is also delivered to the video amplifier strip. The video amplifier is a conventional broad-bandwidth amplifier and in addition acts as a mixer for the range markers, range ring, and video voltages, as mentioned above.



Artist's drawing of the VK Radar Repeater showing various controls and adjustments available to the operator.

The intensifier (CR tube unblanking) and intensity-compensation circuit is used to blank the scope during the return-trace period and to provide even intensity of the sweep at all times, regardless of the length of sweep being used or the repetition rate of the incoming radar trigger. This circuit is controlled by a gate from the gating circuit.

Bearing indication is afforded by an azimuth scale around the periphery of the PPI scope tube face. A mechanical cursor is attached to the unit for indicating bearing and for transmitting target bearing information to external locations through a 5G synchro. In addition to the mechanical cursor, an electronic cursor is available, if desired, which, while in use, also transmits bearing information from the unit through the 5G synchro.

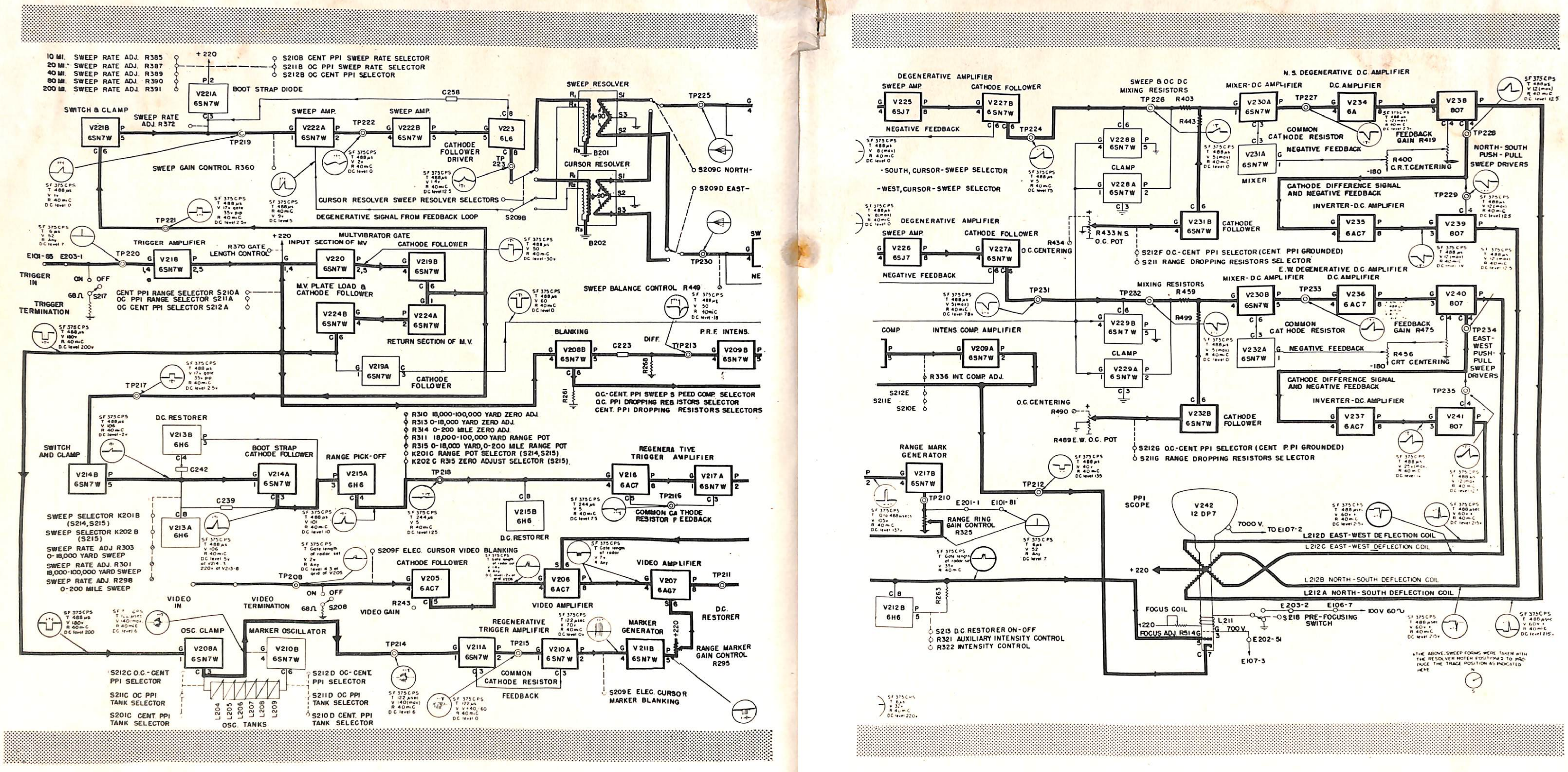
The above paragraphs have been devoted to a general description of the overall operation of the equipment. The following is a more detailed description of the operation of the individual circuits throughout the unit.

TRIGGER-AMPLIFIER AND GATING CIRCUIT

The input trigger from the selected radar is coupled to the trigger-amplifier gating circuit. This circuit is nothing more than a conventional amplifier driving a one-kick multivibrator gating circuit. The several positive and negative square-wave outputs from this multivibrator (shown in figure 3) are used to gate the sweep generator, the range-markers generator, the range-ring generator, the clamps in the N-S and E-W sweep circuits, and the intensifier (CR tube unblanking) and intensity-compensation circuit. An arrangement of switching is provided to vary the amount of capacity in the charging circuit in order to obtain the different gate lengths required with changes in range scale and changes between the centered PPI and the off-center PPI type of presentation.

SWEEP GENERATOR CIRCUITS

The sweep generator is a bootstrap type of circuit with switching provided to obtain different values of charging voltages for the different sweep lengths for each of the six ranges. One of the positive outputs from the gating circuit is used to turn on the sweep generator whose output, a positive voltage sweep, is coupled to a degenerative amplifier. The output of this stage is coupled to either the rotor of the PPI 2-phase resolver or the rotor of the electronic cursor 2-phase resolver. The resolver to be used is selected by S-209A in figure



Stage-by-stage servicing block diagram of the VK Radar Repeater. Heavy lines indicate main circuits, light lines indicate auxiliary circuits or controls.

1. The rotor of the PPI 2-phase resolver rotates in synchronism with the radar antenna, producing a voltage waveform at the secondaries similar to that shown in figure 4. The frequency of modulation is the rotation frequency of the antenna. Except for this amplitude modulation, the output sweep wave-shape is identical to that of the sweep input from the degenerative amplifier.

As a result of the positioning of the resolver rotor in relation to the stator windings, the modulation envelope of the sweep which feeds the N-S sweep amplifier lags by 90° the modulation envelope of the sweep which feeds the E-W sweep amplifier. In both the N-S and E-W circuits, each sweep voltage is amplified, clamped to ground for a reference voltage, mixed with the d-c off-centering signal, and fed through directly-coupled push-pull amplifiers to the deflection coils. The d-c off-centering voltage is taken from the variable tap of a precision potentiometer. This tap is positioned manually by a control knob, or automatically by a 1F synchro motor. This synchro is driven by a signal from either the AEW or DRA systems. Separate dials coupled to the N-S and E-W potentiometers are calibrated to indicate in miles the amount the center is displaced. It is

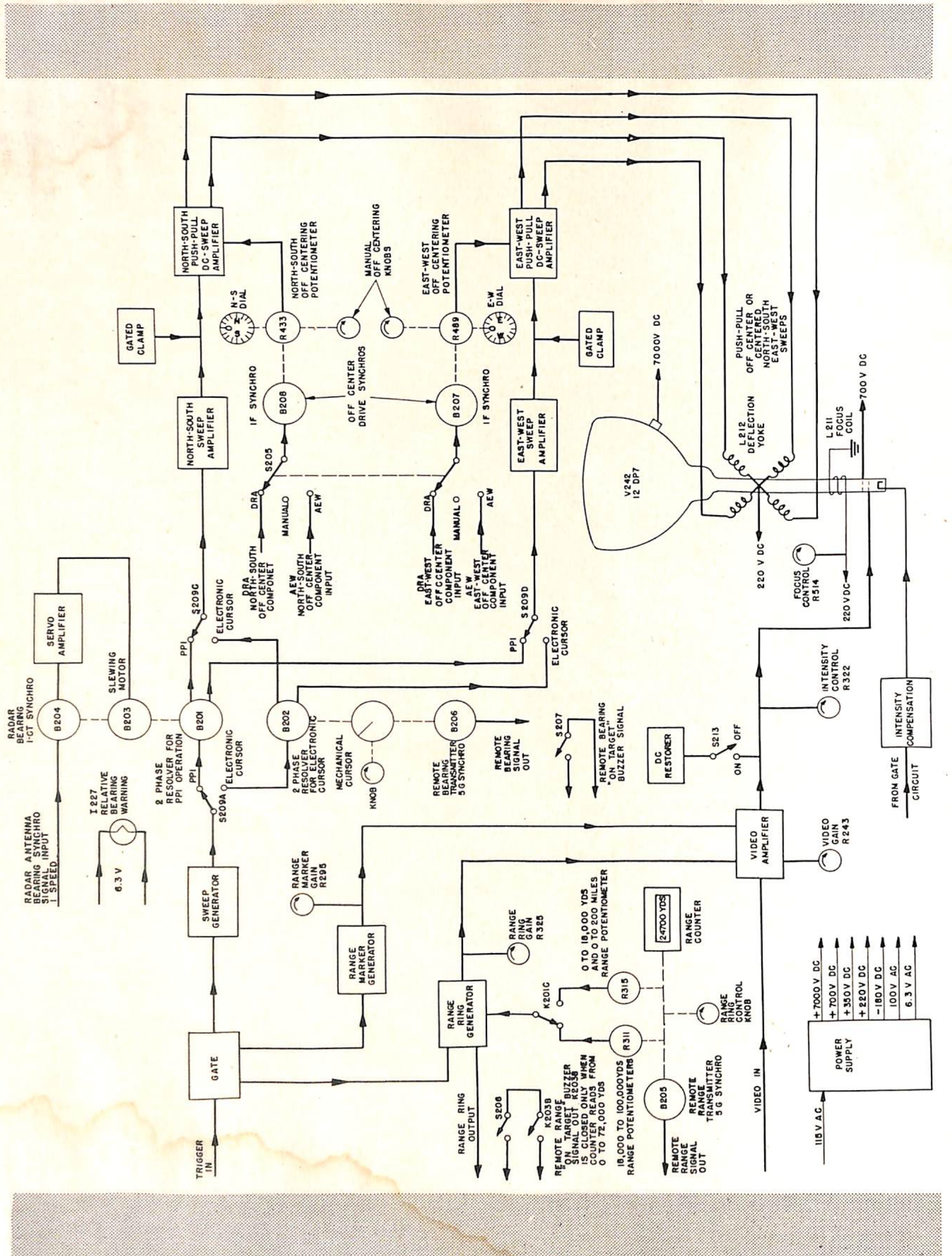


Figure 1—*Functional block diagram of the VK Radar Repeater showing sweep, ranging, and servo control channels.*

pointed out that in the VK, the deflection yoke is of the fixed type which permits a greater rpm of the sweep than if a mechanical rotation system were used.

The range-markers generator utilizes a gated Hartley-type oscillator to effect changes in range scales. The frequency of oscillation of this circuit is made variable in steps by the use of separate oscillator tank circuits whose components determine the actual frequency. The circuit is so arranged that the oscillator and its associated circuits will produce sufficient oscillations that range markers will appear at equally spaced intervals for the duration of the gated period. That is, if the 20-mile range scale were in use and off-centering were employed, range markers would appear at 5-mile intervals for the full 80 miles. Thus with selected range scales of 4, 10, 20, 40, 80, or 200 miles, range markers will represent 1-, 2.5-, 5-, 10-, 20- or 50-mile intervals respectively. The output from the oscillator, in the shape of damped oscillations, is coupled to a regenerative amplifier which produces signals with severe leading edges. The signals are transformer coupled to a blocking oscillator. When this blocking oscillator is triggered by one of the pulses from the transformer, a sharp pip is produced in the circuit, which is fed to the screen grid of the second video amplifier. In this amplifier they are mixed with the video signals and applied to the cathode ray tube.

The range-ring generator employs three sweeps to secure varying degrees of accuracy, from ±100 yards for the first 18,000 yards to ±5% of the actual range on the 0 to 200-mile scale. The three sweeps are from zero to 18,000 yards, 100,000 yards, and 200 miles. The unit automatically switches from the first to the second at 18,000 yards, and from the second to the third at 100,000 yards. When the scale shifts from the second to the third sweep, the counter goes back to 0 and starts indicating miles. The range-ring marker unit consists essentially of a sweep generator, operated by a gate from the gating circuit, a range pick-off circuit, and a marker generator. The sweep generator produces a sweep which starts simultaneously with the initiation of the main PPI sweep since it is triggered by a voltage which is identical in time phase with that which triggers the main sweep circuits. This sweep is applied to the plate of a pick-off diode which has as its cathode resistor the ranging potentiometer. This ranging potentiometer is mechanically coupled to a Veeder counter, and as the value of cathode voltage is varied the mechanical coupling to the Veeder counter will change the range-dial reading correspondingly. When the sweep voltage is applied to the plate, and its value reaches and starts to exceed that on the cathode, the diode will conduct. At this point a sweep will be formed across the cathode resistor identical to that on the plate from the point of conduction. The rise of this cathode-resistor sweep voltage quickly saturates the next stage, a regenerative amplifier, which acts as a limiter due to saturation. The output of the regenerative amplifier triggers a blocking oscillator. The output of the blocking oscillator is a sharply defined pip which is added to the first video amplifier and mixed with the incoming video.

The video amplifier receives positive input video signals from 1 to 2.5 volts in amplitude and is capable of amplifying them to a value in excess of 35 volts. The frequency response of the amplifier is relatively flat from 40 cycles to well over 6 Mc. In addition to its function as a broad-band amplifier, the video amplifier also acts as a mixer of the range markers, the range ring, and the video signal voltages. A gain control is made available for regulating the amplitude of the video signal input. When the electronic cursor is selected by the operator, a switch (S-209F) automatically blanks the video signal to prevent confusing displays on the scope.

The amplifier utilizes two 6AC7's and one 6AG7 to accomplish the various functions required of it. The first stage, a 6AC7, is operated as a cathode follower to match the incoming video (through coaxial cable) to the rest of the system. The output from this cathode follower is coupled to the control grid of the second stage which is actually the first video amplifier. Coupled to the screen grid of this stage is the range-ring voltage. Thus, this stage acts as a mixer for the video and range-ring voltages, with the resultant output fed to the 6AG7 which is the second video amplifier. The range marker voltages are coupled to the screen grid of this stage and consequently mixed with the range-ring and signal voltages from the preceding stage. Since the signal voltages (range ring, video, and range marker) are negative, the bias required on the stage is low and the cathode biasing resistor is small. The final mixed output, positive in polarity, is fed to the control grid of the cathode ray tube.

When the electronic cursor is employed it becomes necessary to blank the video, since the video signal, without bearing, has no significance and only muddles the scope pattern. When the bearing cursor knob is lifted, a negative bias of nearly 8 volts is applied to the grid of the 6AC7 which acts as the cathode follower input stage of the video amplifier. This negative bias on the grid is, for all practical purposes, sufficient to cut the tube off since the grid is normally only positive by about 4 volts.

It is necessary to blank the scope at all times except during the sweep period to prevent undesirable displays on the scope during the sweep retrace. One half of a 6SN7W (V108B) is used as the blanking tube as

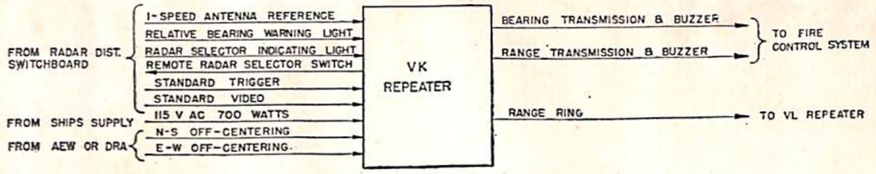


FIGURE 2—*Input and output requirements of the VK Radar Repeater.*

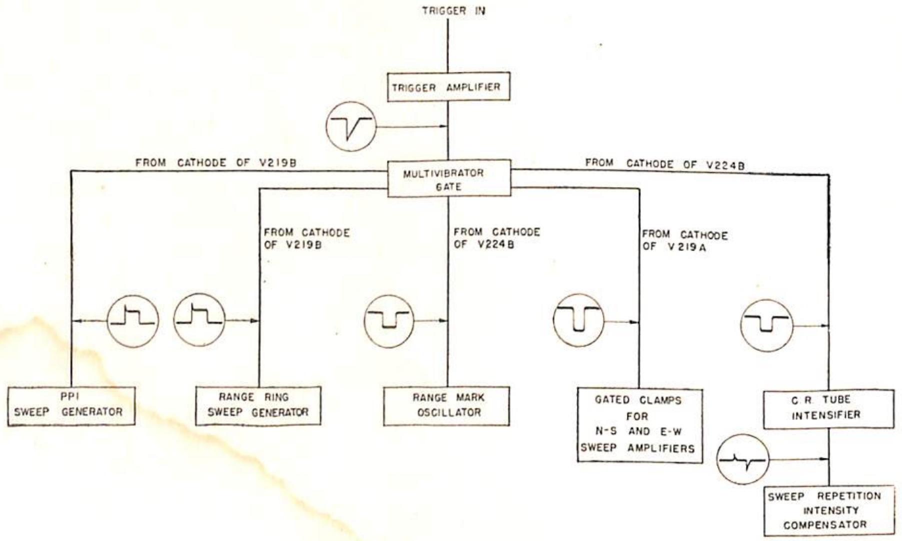
shown in figure 5. Normally V108B is conducting heavily since its grid is tied to a positive voltage source. The cathodes of the cathode ray tube and V108B have a common cathode resistor which places about 90 volts at each cathode. This condition exists at all times except when a gate is applied to the control grid of V208B. When the negative gate from the gating circuit (see figure 2) is applied to the grid of V208C this stage is cut off. This results in a decreased current flow through the common cathode resistor thus making the cathode of the CR tube swing in a negative direction, and allowing the tube to conduct. The control-grid potential of the cathode ray tube can be varied from −43 to −180 volts by the variable intensity control. During the blanking period (period between gates) the average bias voltage from grid to cathode of the cathode ray tube will be near −200 volts. Since the maximum signal from the video amplifier output will never be more than 40 volts, these signals will not be of sufficient amplitude to make the cathode ray tube conduct during the blanking period because about −150 volts will keep the tube at cutoff. Thus the retrace can be blanked regardless of the signal voltage at the grid of the cathode ray tube. As stated above, during the trace period V208B is cut off by the negative gate and a large *R-C* time constant is provided in conjunction with this stage to prevent the grid of the tube from rising to a conduction point during this period.

The brilliancy, or intensity, of every point along the entire trace is determined by the number of electrons striking the fluorescent coating of the cathode ray tube at that point. Therefore, the intensity of trace at any given point depends primarily upon three factors: 1—the speed at which the electron beam passes the point, 2—the number of times the beam sweeps across the spot before the relatively slow rotary movement of the trace moves the beam beyond this area, and 3—the rate at which the electrons in the beam are propagated; i.e., the number of electrons striking a point on the screen in a given instant.

The speed at which the beam passes a point varies inversely with the length of sweep being used. The repetition rate of the selected radar equipment largely determines the number of sweeps across the point before the rotary motion of the sweep carries the beam beyond this point. The rate of electron flow or propagation in the cathode ray tube is controlled primarily by the grid-to-cathode bias potential. Under normal conditions the plate current is constant, and may be varied only by changing the setting of the intensity control. Thus it is apparent that the trace would be less brilliant at the shorter ranges or low repetition rates and brighter at longer ranges or higher repetition rates, if the grid-to-cathode bias potential remained fixed.

Since it is not practicable to increase or decrease the trace intensity manually in accordance with unpredictable variables, the VK is provided with an automatic intensity-compensation circuit. In figure 5 the incoming negative gate from the gating circuit is applied to the first stage V208B whose cathode circuit functions as the unblanker for the CR tube. However, in the

FIGURE 3—*Trigger-amplifier gating block showing five outputs used as initiating voltages for various components of the equipment. All gates are identical in width and start at the same time.*



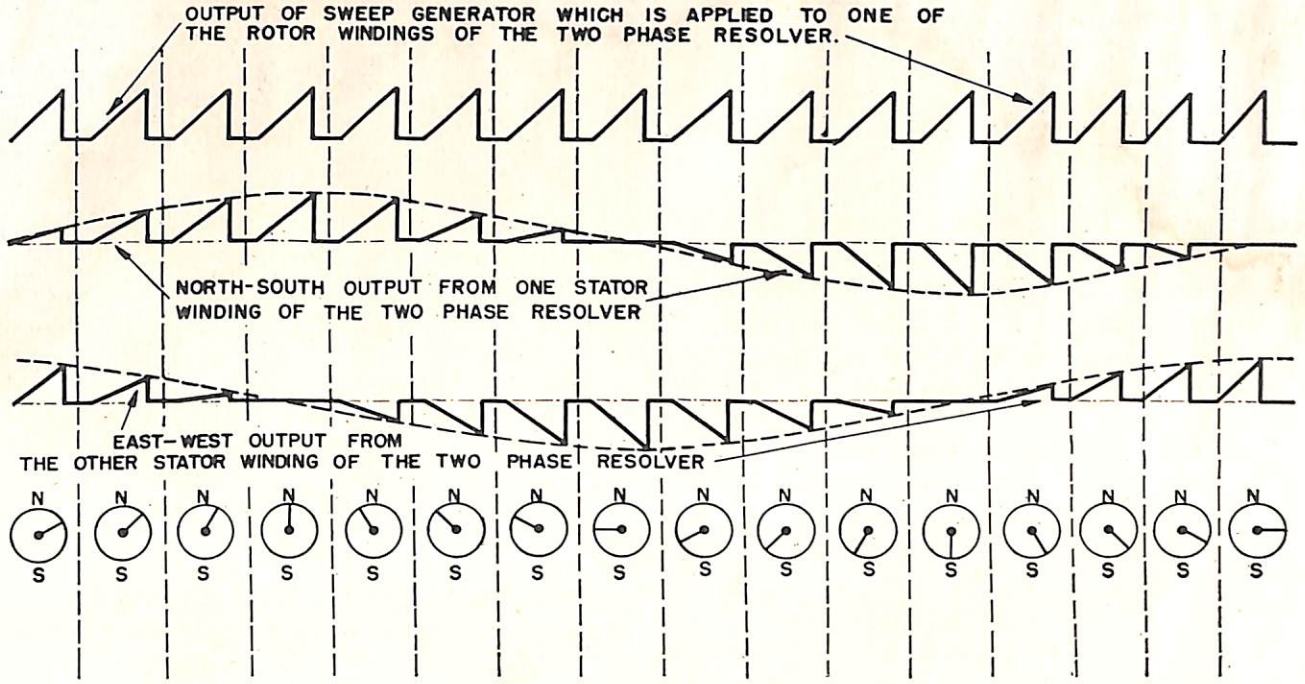
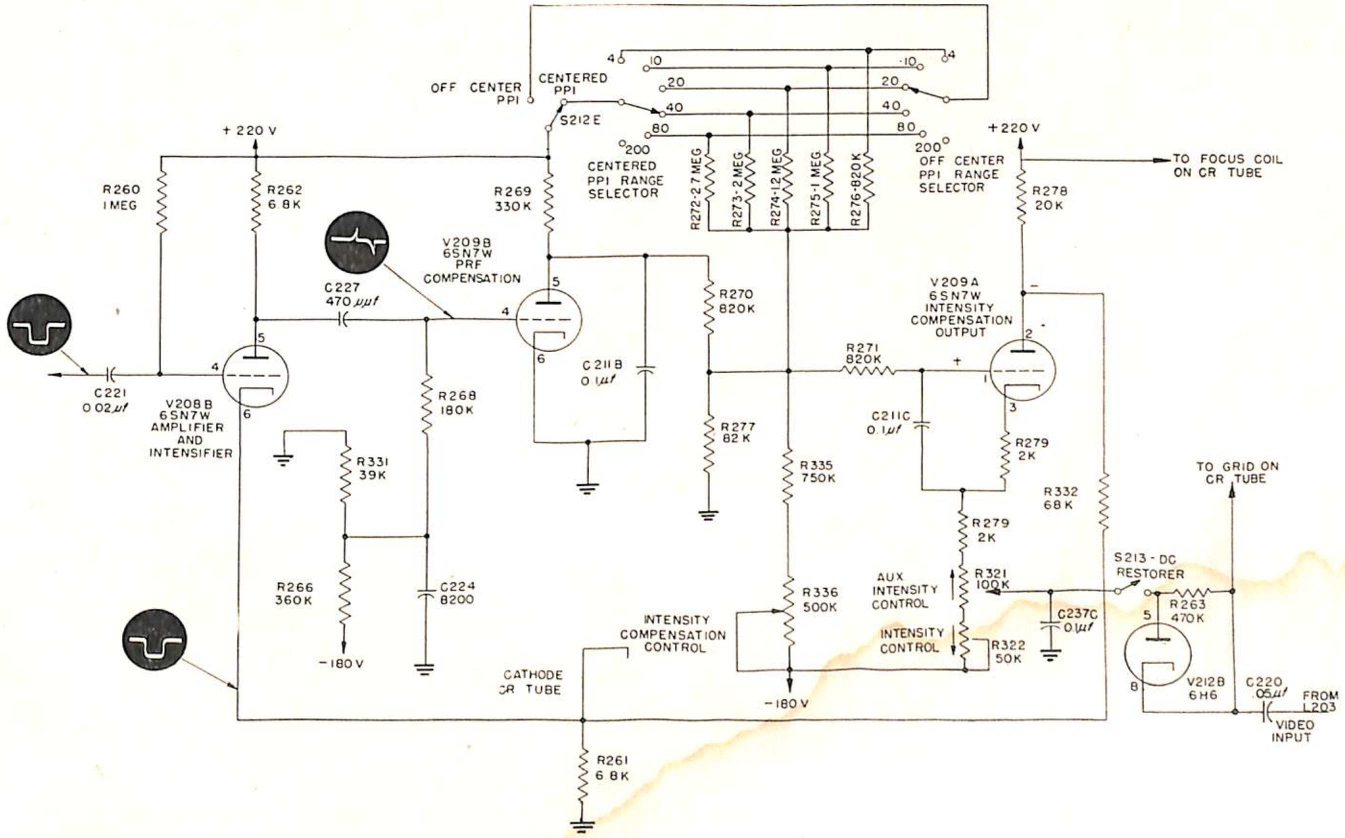


FIGURE 4—*The output of the 2-phase resolver used in the VK. This diagram shows how the output across the stator windings and the position of the PPI trace vary as the rotor winding is revolved. As the dotted envelope lines show, the amplitude of the N-S and E-W stator winding outputs vary sinusoidally. For purposes of illustration, 16 sweep cycles are shown for one rotation of the resolver rotor. Actually there are (even at the faster rotor speeds) over 1000 sweep cycles for each rotation of the antenna, rotor, or PPI trace. This gives a visually smooth rotation of the trace.*

FIGURE 5—*Intensifier (CR-tube unblanking) and intensity-compensation circuit schematic diagram with pertinent waveforms illustrated.*



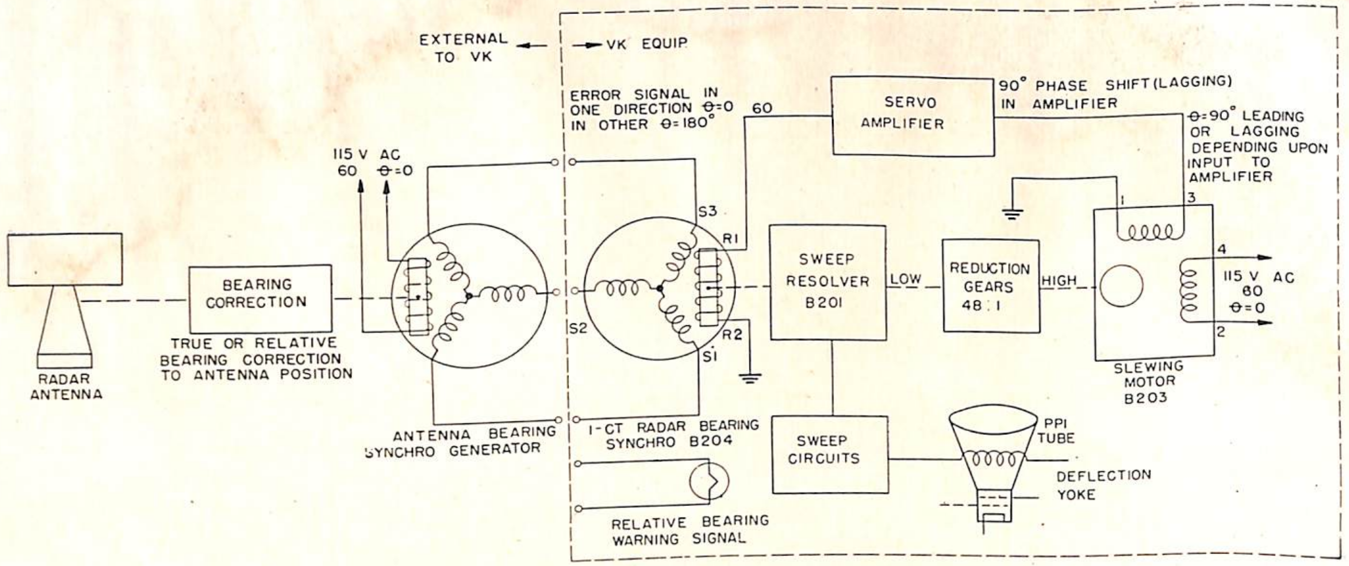


FIGURE 6—*Simplified schematic diagram of the antenna follow-up system. All phase angles (φ) are in reference to the 115-v a-c synchro-excitation line. The rotor of the antenna-bearing synchro generator and one phase of the slewing-motor field are energized from this source and therefore have a phase angle of zero (φ = 0).*

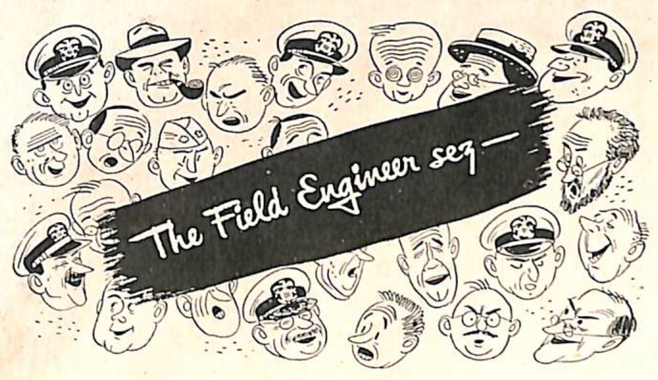
plate circuit of V208B is a differentiating circuit which develops a positive and negative pulse. The positive pulse, when impressed on the grid of V209B, causes that tube to conduct for the duration of the pulse. This quickly discharges capacitor C211B, which then charges slowly after V209B returns to cutoff (end of the positive pulse). The average d-c voltage value of this capacitor depends on the repetition rate, increasing in value as the repetition rate increases. This average d-c voltage value adds to a plus or minus reference d-c voltage whose value depends on the range switch position and which alone would compensate for the change in intensity due to change in range sweeps. The resultant d-c voltage is amplified and applied to the cathode of the CR tube, thereby adjusting the grid-to-cathode voltage differential to maintain even intensity on the screen of the tube.

Thus it is seen that we have a circuit which automatically varies the bias on the cathode ray tube according to changes in range scales and/or repetition rate. By automatically decreasing the negative bias on the CR tube the intensity is compensated for short ranges or low repetition rates. Conversely, increasing the bias on the CR tube automatically compensates for longer ranges or higher repetition rates.

The synchro amplifier system in the VK is composed of an external synchro generator coupled to the motor-driven antenna or to some device or system indicating antenna position, a synchro control transformer mechanically coupled to the two-phase resolver, a small two-phase slewing motor which drives the sweep resolver and synchro control transformer, and a servo amplifier which controls the rotation of the slewing motor. As the antenna rotates, the rotation is transmitted through the servo system to the rotor of the 2-phase resolver which positions itself accordingly. Rotation of this 2-phase resolver rotor and the application of sweep voltages to a rotor winding from the sweep generator result in the modulated sweep voltages which appear at each of the stator windings of this resolver.

A transparent plate, engraved with a cursor mark, is positioned over the face of the CR tube. This is the mechanical cursor and is rotated by the bearing-cursor handwheel which makes feasible the reading of bearing directly on the azimuth scale affixed to the periphery of the PPI. By lifting the bearing-cursor knob, several effects are noted. First an electrical cursor line appears on the scope and parallels the movements of the engraved pointer, the video presentation is cut off the tube by biasing the video amplifier beyond cutoff, and the bearing servo system is disconnected. Instead of utilizing a servo system to cause the rotor of the resolver to follow the rotations of the mechanical cursor, both are geared mechanically to the cursor handwheel. Therefore movements of the mechanical cursor cause similar movements of the cursor resolver. With the exception of the method of positioning the rotors, the action of the cursor resolver in the sweep circuit is the same as that of the PPI sweep resolver. Off-centering, range changing, and other functions are performed identically.

The power supply for the VK consists of four rectifier circuits, a high-voltage oscillator, two voltage-regulating circuits, and miscellaneous a-c power distributing systems such as tube-filament circuits, indicator-light circuits, relay circuits, etc. The various voltages delivered by the power supply unit are shown in figure 1.



OKA TROUBLE

Various difficulties were encountered with the OKA range resolving equipment aboard a DE.

The DDE standby relay K-312 was not pulling in sufficiently to actuate the range resolving relay K-311. K-312 was replaced from the spares. It is suspected that there are shorted turns in the relay that was replaced, as the trouble cleared up when the replacement was made.

The Rq rheostat R-302 was opening in certain spots, and was replaced from spares. The replacement had about 16 hours' service when it developed the same trouble. Investigation showed that one side of the contact arm had become un-anchored. Another spare was not immediately available, so the Helipot was repaired by soldering a piece of pressed powdered bronze contact metal to the original spring contact. The material was dressed down and no further trouble was experienced. It was necessary to repair the Helipot in this manner because attempts to re-anchor the contact proved unsuccessful. These failures appear to be due to errors in manufacturing.

Difficulty was experienced with the Rq-Rhq calibration drifting. The unit was pulled for re-zeroing and to check R-302. It was found that the friction clutch that drives R-302 was slipping. The clutch was tightened and slippage was no longer apparent. After two days of service, however, the slippage reappeared. Further investigation showed the clutch could not be tightened further and that the fibre washers had glazed. These washers were replaced with rubber ones and no further difficulties were experienced.

During the process of calibrating the OKA, it was noted that the Rq-Rhq dial assembly was loose. The unit was pulled from the chassis and it was found that the dial set screw and the set screw securing the gear to the dial assembly were loose. In future assemblies the shafts should be drilled so as to insure positive locking action of the set screws.

To obtain proper resolution it was found that the Rq-Rhq, the Eq, and the Eqr units had to be re-zeroed. It is suspected that these units were out of adjustment due to mechanical slippage.

During operation at sea, it was observed that the heat developed in the resolver and slant-range recorder was such that the ambient temperature was excessive (about 150° F). Therefore some form of forced-draft ventilation should be installed.

—*E.F.S.G.*

●

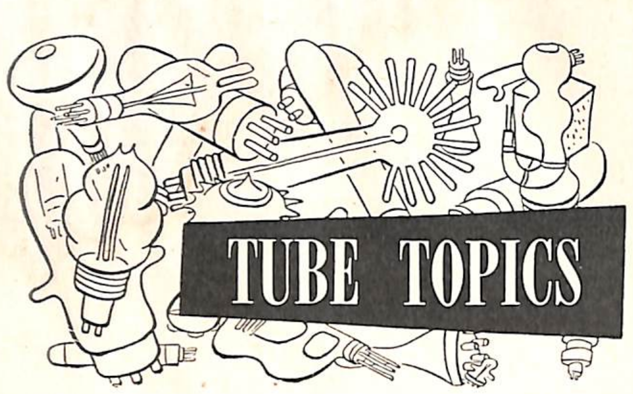
IMPROPER PRESENTATION ON TACU

In the initial adjustments of the TACU Mark 2 Mod 2, some difficulty may be experienced in obtaining a satisfactory presentation because of excessive phase shift between the antenna movement (nodding) and the vertical displacement of the indicator sweep. The result of such excessive phase shift is that the presentation from a given target may appear at a different elevation on the indicator on the *downward* displacement of the sweep from that occupied on the *upward* displacement. In an extreme case the presentation may appear as two echoes at identical ranges but at two different elevations.

The TACU is equipped with fixed phase-shift correction networks located in the output of the nodding amplifiers. The time constants of the networks have been established by precision components at the design center of 0.9 cps at high nod, and 1.8 cps at low nod. In the event of phase-shift trouble being encountered, it is suggested that the following be determined before looking for trouble(s) in the TACU: 1—that the antenna is actually nodding ±15 degrees in HIGH nod and ±5 degrees in LOW nod, as determined by a protractor mounted on the antenna. If such is not the case, first adjust HIGH nod by the PRESET NOD control, then adjust LOW nod with the 5 degree nod control, R-116 and, 2—that the nodding frequency is 1.8 cps at LOW nod, and 0.9 cps at HIGH nod, ±10%. A stopwatch is necessary for this test. The cycling frequency should be within 97 to 119 cycles per minute on low nod and 49 to 59 cycles per minute on high nod.

After the nod angle has been established as in (1) above, the nodding frequency is determined by the functions of the hydraulic drive on the antenna mount Mark 25 Mod 0. Assuming that the oil pressure is correct, no field adjustment is provided for changing the cycling rate other than changing the angle of nod. Such deviation from the adjustment in (1) above should not exceed 10 percent for satisfactory operation of the unit.

—*Western Electric.*



Preferred List of Army-Navy Electron Tubes—28 January 1947

This Preferred List supersedes the Army-Navy list of classified and unclassified Electron Tubes dated 1 November 1945.

To those concerned with the design and manufacture of Army or Navy equipment utilizing Electron Tubes:

1. The following Army-Navy Preferred List of Electron Tubes sets up a group of preferred tubes selected jointly by the Army and the Navy. The purpose of this list is to effect an eventual reduction in the variety of tubes used in Service equipment.

2. It is mandatory that all tubes to be used in all future design of new equipments under the jurisdiction of the Army laboratories or the Navy department be chosen from this list. Exceptions to this rule are hereinafter noted.

3. The term "new equipment", as mentioned in paragraph 2 above, is taken to include:

   a. Equipments basically new in electrical design, with no similar prototypes.

   b. Equipments having a similar prototype but completely redesigned as to electrical characteristics.

   c. New test equipment for operational field use.

4. The term "new equipments", as mentioned in paragraph 2 above, does *not* include:

   a. Equipments either basically new or redesigned, that are likely to be manufactured in very small quantity, such as laboratory measuring instruments.

   b. Equipments that are solely mechanical redesigns of existing prototypes.

   c. Equipments that are reorders without change of existing models.

   d. Equipments in the design stage before the effective date of adoption of this Preferred List.

NOTE: The foregoing statements in paragraphs 3 and 4 above are explanatory in nature and are not intended to be all-inclusive.

5. In the event that is is believed that a tube other than one of those included in this Preferred List should be used in the design of new equipments for either the Army or the Navy, specific approval of the Service concerned must be obtained. Such approval, when Army equipment is concerned, is to be requested from the Army Laboratory concerned with such equipment; the said Laboratory will then make known its recommendation in the matter to the Army-Navy Electronic and Electrical Standards Agency where the final decision will be made and returned to the Laboratory for transmittal to the party requesting the exception. When Navy equipment is concerned, the request for exception shall be addressed to the Electronics Division, Bureau of Ships, Code 930A, Navy Department.

6. The publication of this list is in no way intended to hamper or restrict development work in the field of electron tubes and electron tube applications.

7. This list is to take effect immediately.

Joint Army-Navy Electron Tube Committee,
Secretariat—Fort Monmouth, N. J.

Receiving Types:

Filament Voltage	Diodes	Diode-Triodes	Triodes	Twin Triodes	Pentodes		Converters	Klystrons	Power Output	Tuning Indicators	Rectifiers	Miscellaneous	
					Remote	Sharp						Cathode Ray	Crystals
1.4	1A3			3A5	1T4	1S5 1U4	1R5		3A4 3S4 3V4		1Z2 1B3GT/8016	2AP1A 3DP1A 3JP1 3JP7 3JP12 5CP1A 5CP7A 5CP12 5FP7A 5FP14 5JP1 7BP7A 12DP7A	1N21B 1N23B 1N25 1N26 1N31 1N32
5.0											5U4G 5Y3GT		
6.3	2B22 6AL5	6AT6 6BF6 6SQ7* 6SR7*	2C40 6C4 6F4 6J4 6N4	2C51 6AS7G 6J6 6N7GT 6SL7W 6SN7W 12AU7	6BA6 6BD6 6SG7* 6SK7*	6AC7W 6AG5 6AG7 6AH6 6AK5 6AN5 6AS6 6AU6 6SH7* 6SJ7*	6BE6 6SA7* 6SB7Y	2K22 2K26 2K29 2K41 2K45 2K48 2K50 2K54 2K55 6BL6	6AK6 6AQ5 6B4G 6L6GA 6V6GT 6Y6G	6E5	0Z4A 6X4 6X5GT 1005 1013		**Phototubes** 1P30 1P37 1P39 1P40 927
25 or over									25L6GT		25Z6GT	**Voltage Regulators** OA2 OB2 OA3/VR75 OC3/VR105 OD3/VR150	
Only types for 28 volts anode supply operation		26C6				26A6	26D6		26A7GT				

Transmitting Types:

Triodes		Tetrodes	Twin Tetrodes	Pentrodes	Pulse Modulation	Magnetrons		Rectifiers			Clipper Tubes	Gas Switching	
								Vacuum	Gas	Grid Control		ATR	TR
2C39 2C43 6C22 6C24 7C24 9C21 9C22 100TH	250TH 450TH 811 880 889RA 893A 893AR	4D21 5D22 807	8D21 829B 832A	2E30	3D21A 3C45 3E29 4C35 5C22 6C21 715C	2J30-34 2J41 2J48 2J51 2J58 2J60 2J61A-62A 3J21 4J50	4J51 4J57-59 4J78 5J26 5J29 5J32 5J33 6J21 HK7-T (Series)	2X2A 3B24W 5R4GY 836 1616 8020	3B28 4B26 6C 16B 857B 869B 872A 1006	2D21 C5B 6D4 393A 394A 884	3B26 4B31 719A	1B35 1B36 1B37 1B44 1B51 1B52 1B53 1B56 1B57	1B23 1B24 1B26 1B27 1B32 1B50 1B55 1B58 1B62 1B63A

* Where direct interchangeability with prototype listed above is assured and its JAN-1A Specification has been issued, a counterpart of the prototype indicated by suffix letter(s) GT, Y, W, A, B etc. may be used.

NUMERICAL LISTING

0A2
0A3/VR75
0B2
0C3/VR105
0D3/VR150
0Z4A
1A3
1B3GT/8016
1B23
1B24
1B26
1B27
1B32
1B35
1B36
1B37
1B44
1B50
1B51
1B52
1B53
1B55
1B56
1B57
1B58
1B62
1B63A
1N21B
1N23B
1N25
1N26
1N31
1N32
1P30
1P37
1P39
1P40
1R5
1S5
1T4
1U4
1Z2
2AP1A
2B22
2C39
2C40
2C43
2C51
2D21
2E30
2J30-34
2J41
2J48
2J51
2J58
2J60
2J61A-62A
2K22
2K26
2K29
2K41
2K45
2K48
2K50
2K54
2K55
2X2A
3A4
3A5
3B24W
3B26
3B28
3C45
3D21A
3DP1A
3E29
3J21
3JP1
3JP7
3JP12
3S4
3V4
4B26
4B31
4C35
4D21
4J50
4J51
4J57-59
4J78
C5B
5C22
5CP1A
5CP7A
5CP12
5D22
5FP7A
5FP14
5J26
5J29
5J32
5J33
5JP1
5R4GY
5U4G
5Y3GT
6AC7W
6AG5
6AG7
6AH6
6AK5
6AK6
6AL5
6AN5
6AQ5
6AS6
6AS7G
6AT6
6AU6
6B4G
6BA6
6BD6
6BE6
6BF6
6BL6
6C
6C4
6C21
6C22
6C24
6D4
6E5
6F4
6J4
6J6
6J21
6L6GA
6N4
6N7GT
6SA7
6SB7Y
6SG7
6SH7
6SJ7
6SK7
6SL7W
6SN7W
6SQ7
6SR7
6V6GT
6X4
6X5GT
6Y6G
HK7-T (Series)
7BP7A
7C24
8D21
9C21
9C22
12AU7
12DP7A
16B
25L6GT
25Z6GT
26A6
26A7GT
26C6
26D6
100TH
250TH
393A
394A
450TH
715C
719A
807
811
829B
832A
836
857B
869B
872A
880
884
889RA
893A
893AR
927
1005
1006
1013
1616
8020

Although not a part of the A-N Preferred List, this list of recommended subminiature tubes has been prepared for the guidance of equipment designers by the Joint Army-Navy Electron Tube Committee.

Ef Volts	Triodes	Pentodes		Diode Pentode	Audio Pentodes Video and Power	Converters	Rectifiers	Thyratrons	Voltage Regulators
		Remote	Sharp						
0.625					CK-512AX				SN-948
1.25	CK-568AX CK-556AX		1W5 CK-569AX	1Q6	1V5	1C8	VX-21 SN-956A		
6.3	CK-619CX CK-608CX SN-957A	SN-944	SD-828E		SN-947 SD-828A SN-953A		SN-954 CK-606BX	SN-949	

The Failure Report at Work Ashore

■ In the past the failure report form NBS-383 has been the topic of many articles in our Navy publications. They have covered the form pretty thoroughly, but mostly concerning its use in the fleet. The conditions under which Navy electronic equipment is handled and maintained at shore activities are also very complex, and require a system such as that associated with the NBS-383 form. It is high time that we bring the shore personnel up to date on this important system, so we will go over the NBS-383 again,—not to explain the form itself but to describe the associated system and point out the factors which make its use important for all personnel assigned to the maintenance of Navy electronic equipment, whether afloat or ashore.

The primary purpose of any reporting system of this type is to provide the cognizant organization with data whereby necessary procurement of spare parts may be initiated, design defects located, and a basis for improvement formed. In the case at hand the Bureau of Ships is the cognizant organization and the subject of the reporting system is all the electronic equipment for which the Bureau is responsible. This responsibility includes material cognizance of all radio, radar, sonar and special devices used by the Navy with the exception of that solely applying to aeronautics or ordnance. That is a large order and the Bureau needs help from the field activities if this equipment is to be kept in good operating condition. Incidentally, when we say "field activities" we mean all those activities that use BuShips equipment, and by "help" we mean strict use of the NBS-383 form. In addition to the equipment at coastal and ship installations, there is a lot of equipment located at Naval or Marine air stations, Coast Guard facilities, Civil Aeronautics installations, schools, and laboratories, which is operated and maintained by the station personnel. These equipments will be neglected unless all technicians, regardless of Bureau or agency affiliation, give their full cooperation to the Bureau of Ships by submitting the NBS-383 failure report form.

The use of this form is very important at this time because a lot of the equipments operating on shore today are either "special" and unlike anything found on board ship, or are war-time "stop-gap" equipments. Among the special equipments are the AN/MPN-1A (GCA) and AN/GPN-2. Stop-gap equipments range in size from the Army SCR-522 radio to the Army AN/CPS-1 (MEW) radar. These equipments are still serving their purpose well and we expect to be saddled with them for some time. For example, the AN/CPS-1 radar, which cost a quarter of a million dollars per unit during the war, is an excellent equipment for training purposes. The Navy has five of these equipments and obviously is not going to throw them away when a little reporting of failures and shuffling of available spare parts will keep them on the air. So if you have a piece of radio, radar, or sonar gear inoperative due to a defective component part or tube, fill out an NBS-383 Failure Report form in as much detail as you can manage and send it to the Bureau. It will be greatly appreciated.

Incidentally, the card should be mailed directly to the Bureau of Ships (Code 980) without any additional routing or "vias". Part of the efficiency of the system depends on cutting down the time between the occurrence of a fault and its transcription into the records at the Bureau of Ships. Individual commands may require additional copies of the reports and it may be advantageous that Electronics Officers who are responsible for the gear in the field also receive such reports, but nevertheless this procedure should not delay the mailing of the original to the Bureau.

Here is what happens to the reports after they reach the Bureau of Ships. As soon as they are received they are forwarded to the cognizant maintenance engineers for a quick analysis. Then they are summarized in detail to include all the information requested on the NBS-383 form. The sheets containing this summary also contain the number of failures for each component and the totals of all previous failures. This information enables the Naval Inspector and the cognizant engineers in the Bureau to constantly keep their fingers on the pulse of the equipments for which they are responsible. If they need more information at any time they can always refer back to the NBS-383 cards which are kept permanently on file. It is a very good system, but much of its success depends upon the cooperation the Bureau receives from the technical personnel in the field.

Well, we have passed the word, and you technicians will have to carry on from here. We would like to recommend that you acquire the failure-report habit immediately. It is very little trouble. To get started, fill out a form requisition and mail it to the nearest District Publications and Printing Office. In a short time you will receive a supply of the NBS-383 Failure Report forms together with addressed envelopes (NBS-383A). The rest is easy; just fill out a form for each failure and drop it in the mail. The Bureau will do the rest.

MODIFICATION OF THE TDH FOR FSK

The master oscillator circuit of the TDH radio transmitter is designed for a frequency range of 1000 to 1510 kilocycles. However, there are certain frequencies that cannot be covered when frequency-shift keying is used because with this type of keying the master oscillator frequency must be set 200 kilocycles below the frequency normally employed with on-off keying.

To alleviate this condition the Naval Radio Station at Annapolis modified their TDH transmitter to the extent of inserting an additional capacity of .0013 microfarads across the grid tuning inductors of the oscillator assembly. This capacity was connected in parallel with the master-oscillator grid tuning capacitor through a toggle switch in order to connect or disconnect it as desired. The frequency range of the master oscillator was found to be from 800 to 1210 kilocycles with the additional capacity connected. With this arrangement any frequency within the range of the transmitter can be set up for either FSK or on-off keying.

Any activity experiencing similar difficulty with the TDH-series of equipments is authorized to make the above modification. When the change is made appropriate records should be entered in the instruction book for the equipment.

REPLACEMENT OSCILLATORS FOR TDO-TDH

The Bureau of Ships is preparing to issue a field change kit providing for the replacement of the master oscillator assemblies of the Models TDO and TDH transmitters. Physically, the replacement unit is similar to the original unit, the only major change being the redesign of the tuning assembly. The new assemblies will have an improved lead-screw assembly in the permeability-tuned oscillator. While it is expected that stability will be slightly improved, the major advantage of the new unit is the improved resetability of the oscillator when used in conjunction with the *Auto-tune* mechanism.

Of the total quantity of oscillator assemblies being provided, 139 units are of the sealed variety, and are replacements for similar sealed units supplied only with the Model TDH-4 transmitters procured under Contract N5sr-55667. The Bureau has arranged for shipment of all replacement assemblies directly to the Supply Officer of each Naval shipyard, marked for the attention of the Electronics Officer. In this connection, all activities are cautioned to make sure that the sealed replacement units are used only for replacement of sealed units in Model TDH-4 transmitters.

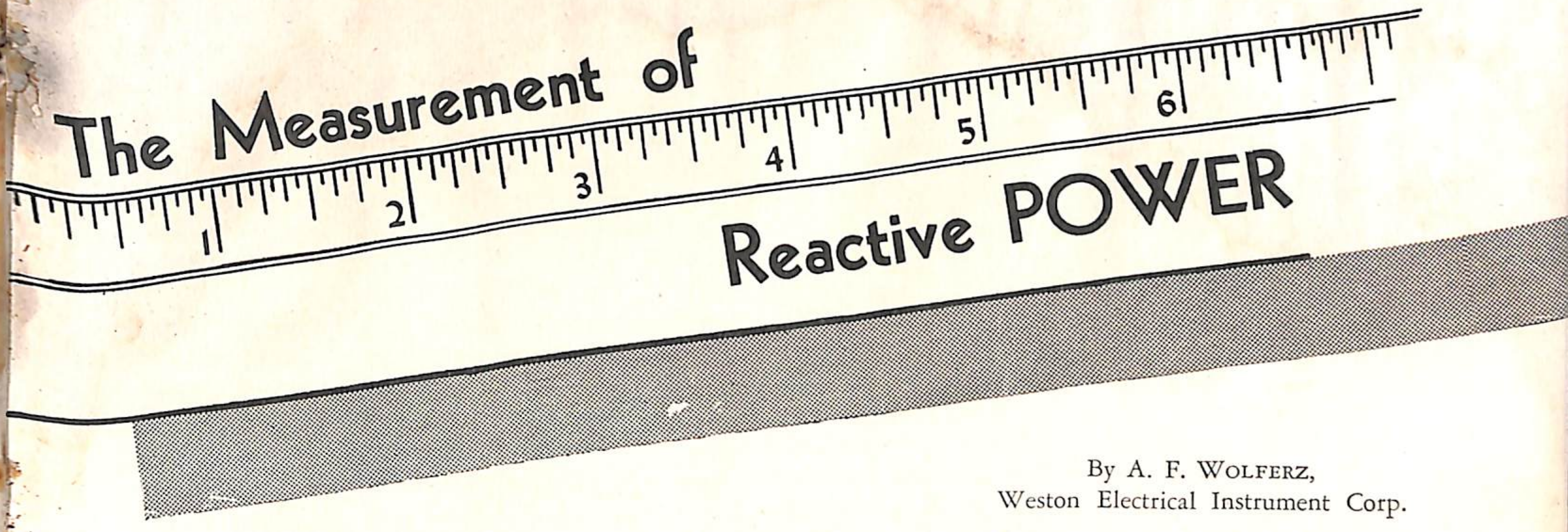
False Echoes on Mark 34 and Mark 8

During tests with a duty-cycle meter on the Mark 34 Mod 2 radar equipment the modulation network overheated and a false echo appeared between 1000 and 1350 yards. These troubles developed when the duty cycle adjustment was normally set to bring the duty-cycle meter pointer opposite the red mark and cleared when the meter indicated a lower value. It developed that a combination of tolerances in an undesired direction caused double firing of the magnetron and the consequent appearance of the false echo.

In two cases this false echo has been eliminated by the following methods: 1—By greatly reducing the duty cycle in the unit through the medium of setting the pulse rate at 1900, the high voltage at 1200 volts, and the high-voltage current at 175 milliamperes. Then, if necessary, reduce the current by adjusting the duty-cycle adjustment until the false echo disappears. The position of the duty-cycle meter pointer should then be marked for future reference. 2—By replacing both the magnetron and the pulse network. When this method was tried the duty-cycle current could be increased to 200 milliamperes without the reappearance of the false echo.

The D-169300 pulse network was designed to operate with 725A magnetron which has an operating impedance of 1080 ohms. The first production of the 2J50 magnetrons were of similar impedance, hence no difficulty was observed on the first trials of the 2J50 tubes in Mark-34 radars. Later production of 2J50 magnetrons, however, have an average impedance of 1020 ohms. When a magnetron having an impedance near the low tolerance limit is paired with a pulse network whose impedance is high, a mismatch occurs causing double firing of the magnetron, and the false echo appears. In order to use the existing network with these new 2J50 magnetrons Navy Field Change No. 22 "Elimination of Double Pulse" was designed to drive this false echo away. It consists of a 100-ohm, 40-watt, non-inductive resistor placed in series with the discharge path of the duty-cycle current. This permits the restoration of the original value of duty-cycle current to avoid the second pulse.

Since the Mark 8 Mod 3 uses the same transmitter unit as the Mark 34 Mod 2, the question was raised as to whether this false echo condition also exists in the Mark 8 Mod 3 equipment. Production of Mark 8 Mod 3 conversion kits was completed some time ago and the magnetrons supplied with these equipments and their associated spares were either 725A or 2J50 types with impedances of 1080 ohms. Since the difficulty with double pulsing showed up in the Mark 34 Mod 2 radar equipment using later design of 2J50 magnetrons, it is reasonable to expect that the same difficulty will appear in the Mark 8 Mod 3 equipments when the new magnetrons are installed. It is not likely to appear so long as spare magnetrons of high impedance are used. If and when this false echo does appear, it is recommended that the instructions in sub-paragraph (1) above be followed and the findings reported to the Bureau.



The Measurement of Reactive POWER

By A. F. Wolferz,
Weston Electrical Instrument Corp.

■ Power measurements of alternating current systems while generally concerned with the inphase components of the apparent power (volt amperes) must evaluate the quadrature power component in order to completely analyze the power demands of the system.

The power resulting from the applied potential and the component of the current in phase with it, termed the active power, is measured in terms of watts, kilowatts or megawatts and the methods for determining this quantity are well known and in general use. This is the power dissipated in the resistance or equivalent resistance of the circuit, and in a single phase circuit, is equivalent to I^2R or $EI \cos \phi$ for sine wave form where

E = Voltage, volts rms
I = Current, amperes rms
ϕ = Phase angle between E and I
R = Equivalent resistance ohms
X = Reactance, ohms.

The power resulting from the applied potential and the component of the current in quadrature with it, equal to I^2X or $EI \sin \phi$ for sine wave form, while of considerable importance in the operation of power generating equipment is not so well known as the active power. Although this power does not produce work, it is essential in producing the conditions which bring about work. In order for a transformer to function, or a motor to run, it is necessary to magnetize the core or field. The component of the current which produces the magnetic field is in quadrature or 90 degrees out of phase with the applied potential and in time phase, lagging.

This quadrature power has been termed the wattless power, wattless component, reactive power, reactive volt amperes, volt amperes reactive and is expressed in terms of the unit, the VAR. This terminology was adopted at the International Electrical Convention at Stockholm in 1930. The word VAR is the abbreviation for volt amperes reactive. The measurement of this quantity is not difficult and there are various methods for determining the quadrature power.

METHODS OF MEASURING QUADRATURE POWER

One method consists of measuring the potential, current and the phase angle: the quadrature power is then calculated from the equation $EI \sin \phi$ for a single phase circuit having a sine wave form. It is essential that these measurements be made simultaneously, requiring three instruments and three observers for single phase measurements. It must be remembered that phase angle meters such as power factor meters for use on single phase circuits are critical with respect to frequency and that the usual polyphase meters are correct only on balanced loads.

A second method of measuring the quadrature power requires the measurement of the potential, current, and the active power. Quadrature power for sinusoidal wave form can then be calculated from the relation,

$$\text{Vars} = \sqrt{(\text{Volt Amperes})^2 - \text{Watts}^2}.$$

The active power is very conveniently measured by means of an electrodynamometer wattmeter. The electrodynamometer in its best form consists of a stationary coil system which produces a magnetic field and a movable coil mounted to a pivoted staff which also carries a pointer. The movable coil rotates in the magnetic field of the stationary coils and the torque producing the angular deflection is proportional to the product of

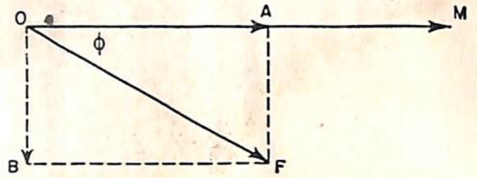


FIGURE 1—*Typical vector diagram of voltage and current relations in single phase circuits.*

the components of the ampere turns of the movable coil and the ampere turns of the field coils which are in phase with each other. The movable coil, together with the necessary series resistance, is connected across the line and its current is proportional to and substantially in phase with the potential applied and the instrument indicates the in-phase product of current and potential or active power. Figure 1 is a vector diagram of the voltage and current conditions for a single phase circuit wherein *OM* represents the current in the movable coil which is in phase with the applied potential and *OF* the current in the field coil. *OA* is the component of the field coil current in phase with the movable coil current and is equal to $OF \cos \phi$. It is this current which causes the movable system of the electrodynamometer to deflect when connected to measure watts.

The quadrature power can be directly and conveniently measured with the electrodynamometer by shifting the phase of the current in its movable coil 90 degrees so as to bring it into phase with the quadrature component of the current in its field coils. Referring to figure 1, the magnetizing or quadrature component of the current which must be considered when measuring vars is represented by the vector *OB* which is equal to $OF \sin \phi$.

The methods for bringing about this phase shift are described in the paragraphs which follow.

SINGLE PHASE CIRCUITS

The current in the potential circuit of the electrodynamometer is practically in phase with the potential applied.

We can shift this current nearly 90 degrees by substituting a series reactance for the series resistance in the movable coil circuit. By using a tapped reactance and an auxiliary shunt resistance, as shown in figure 2, we can obtain a true 90 degree relation.

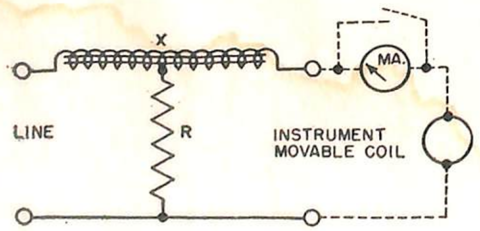


FIGURE 2—*Circuit of reactor for single phase varmeter.*

In order to adjust the instrument, an adjustable resistance is inserted in series with its potential circuit. It is then connected, as for measuring watts, to a lamp bank load at the potential, current and frequency desired.

The resistance is adjusted to give full scale reading when the potential current and frequency are as desired for full scale watts. A low resistance milliammeter is connected in series in the potential circuit. The most satisfactory milliammeter for this purpose is a thermocouple type. The potential circuit current for full scale is then recorded. The series resistance is then replaced by an adjustable reactor and a shunt resistor connected to a suitable tap on the reactor as shown in Figure 2. The reactor *X* and the resistor *R* are adjusted so that with the above potential, load current and frequency, the potential circuit current is restored to the recorded value and with the milliammeter shorted the instrument under adjustment reads zero. The current of the potential circuit has now been made to lag 90 degrees behind the applied potential and becomes in-phase with the quadrature or magnetizing current described. The instrument is now correctly adjusted to measure vars.

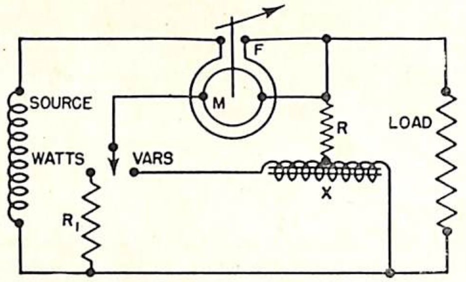


FIGURE 3—*Diagram showing connection of instrument for measuring watts or vars in single phase circuit.*

From the above it is quite evident that correct indications will be obtained only when the frequency is the same as that used in the adjustment. Any deviation in frequency will result in an error.

The same instrument may be used to measure either watts or vars by connecting as shown in figure 3. A series resistance and a series reactance are each adjusted so that with the former in its potential circuit the instrument measures watts, and with the latter in circuit it measures vars. R_1 represents the series resistance used when measuring watts.

TWO PHASE CIRCUITS

A two phase circuit is a combination of circuits energized by alternating electromotive forces which differ in phase by 90 degrees. The two sources of potential may be insulated or may have a common terminal, the former is known as two phase four-wire circuit and the latter as two phase three-wire circuit.

Either circuit may be treated as two single phase circuits utilizing instruments and measurements as described under single phase circuits. The total active or reactive power will be the algebraic sum of the respective powers measured for the two circuits.

In order to reduce the number of instruments and still obtain the correct indication of power, it is more convenient to use an electrodynamometer having two elements. This instrument essentially combines two single element instruments with the movable potential coils of each element mounted to a common pivoted staff carrying a pointer which moves over a common scale. The total torque developed is the algebraic sum of the torques produced in the elements. The scale may be graduated, and the indications of the pointer in reference to this scale will be in terms of the total power.

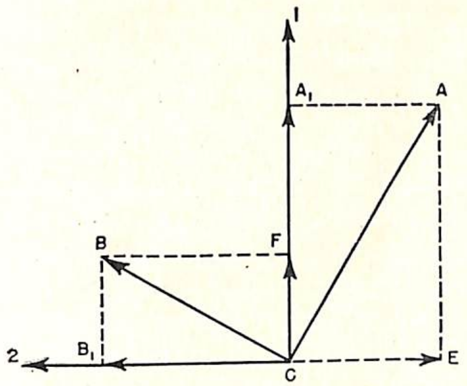


FIGURE 4—*Typical vector diagram of current and voltage relations of a two phase system.*

The current and voltage distribution of a two phase system may be represented by vectors as shown in figure 4. *C1* represents the voltage in one phase and *C2*, the voltage in the second phase. These potentials are considered as balanced when they are equal and displaced by 90 degrees.

If *CA* represents the current as measured for phase 1, the component of this current in phase with its potential will be CA_1. This component of the total current produces torque in the element of the electrodynamometer when measuring watts. The component of the total current which is in quadrature with its potential will be *CE,* and it is this component of the current which produces torque in the element of the electrodynamometer when measuring vars. Likewise, the component of the current *CB* which is in phase with its potential will be CB_1 and the component in quadrature will be *CF*.

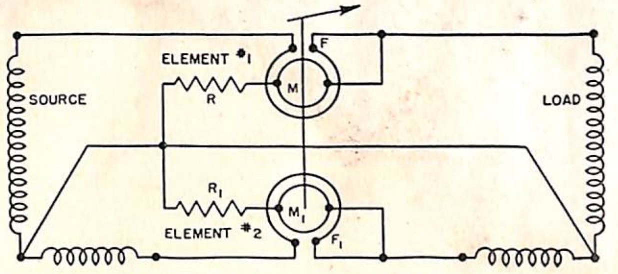


FIGURE 5—*Diagram of connections for a two-element electrodynamometer for measuring watts in a two phase three-wire circuit.*

If we connect element 1 of a two-element electrodynamometer to phase 1 and element 2 to phase 2 as shown in figure 5, the torques developed in each element will be in proportion to the potential applied to the movable coil of each element and the component of the current, in the stationary, or field coil, which is in phase with its potential.

Referring to figure 4, these components will be CA_1 for element 1 in phase with *C1,* and CB_1 for element 2 in phase with *C2*. The indication of the common pointer on the scale will therefore be in terms of the active power or watts.

When connected, as shown in figure 5, the quadrature component of the current in the field of element 1, represented by *CE* in figure 4, will develop no torque with the movable coil. Likewise, the quadrature component of the current in the field of element 2, represented by *CF* in figure 4, will develop no torque with its movable coil.

In order to measure the reactive power of phase 1, element 1 must be connected to a potential which is in phase with the quadrature component of the current in the field coil associated with that element. This con-

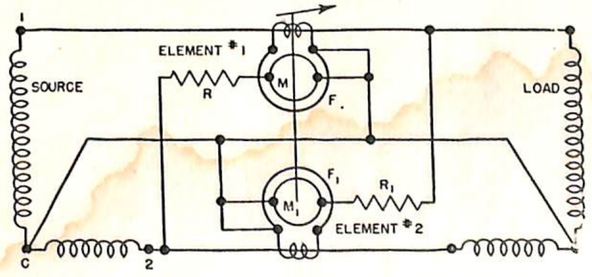


FIGURE 6—*Diagram of connections for a two-element electrodynamometer for measuring vars in a two phase three-wire circuit.*

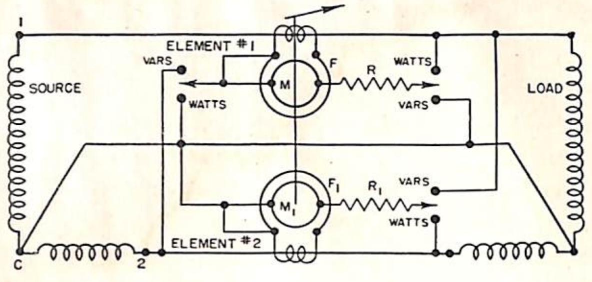


FIGURE 7—*Diagram of connections for a two-element electrodynamometer for measuring watts or vars in a two phase three-wire circuit.*

dition may be readily obtained by using potential *C2* which is in phase opposition with the quadrature current component *CE*. It will be necessary when making this transposition to reverse either the potential connection to the moving coil or the current connection to the field coil to preserve the direction of indication, that is, up scale indication of lagging power factor.

Similarly the reactive power of phase 2 may be determined by connecting element 2 to the potential *C1* which is in phase with the quadrature current component *CF*. Note that vectors *C1* and *CF* are in the same direction, indicating that it is not necessary to reverse connections to obtain an up-scale indication. These connections are shown in figure 6 in which the potential connections for element 1 are transferred to *C2* and reversed. The use of current transformers in the field circuits is suggested in order that the field and movable coils of each element may be connected together to avoid electrostatic effects.

By virtue of the balanced potentials of the circuit, there is no change in magnitude when the voltage connections are shifted and the instrument can be used to measure watts or vars simply by transposition of the proper connections. See figure 7.

Two phase four-wire circuits may be treated similar to two phase three-wire circuits except that the insulation between the phases must be preserved. If the potential coils of the wattmeter are connected together and brought out to three binding posts, it is necessary to use two potential transformers as shown in figure 8. Current transformers are suggested so that ground connections may be made to relieve electrostatic effects and protect the instrument.

Instrument manufacturers generally find it more satisfactory to insulate the potential circuits of varmeters, bringing the connections to the potential coils to four binding posts. The potential transformers are then unnecessary except when the line potentials are higher than the self-contained ranges provided.

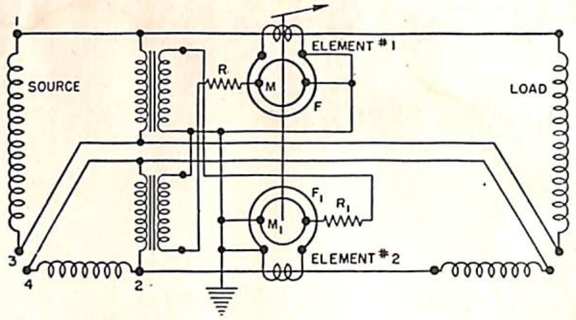


FIGURE 8—*Diagram of connections for a two-element electrodynamometer for measuring vars in a two phase four-wire circuit.*

NON-INTERCHANGEABILITY OF SYNCHROS

When ordering replacement synchros from supply it is mandatory that both the Mark and Mod number are clear and distinct in the order. The differences among Mod numbers are in the external dimensions, notably in the size and shape of the end bells. Occasionally a larger end bell will interfere with adjacent apparatus and prevent the use of a synchro to replace one of a different Mod.

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"Hi, Chief. Mind if I take Miss Klutz up to see the new SR-6 radar?"

RADCM Allowances and Equipment

The RADCM allowance for large combat ships, as originally planned and promulgated in the Electronic Equipment Type Allowance Book (NavShips 900,115), consisted of the following equipments:

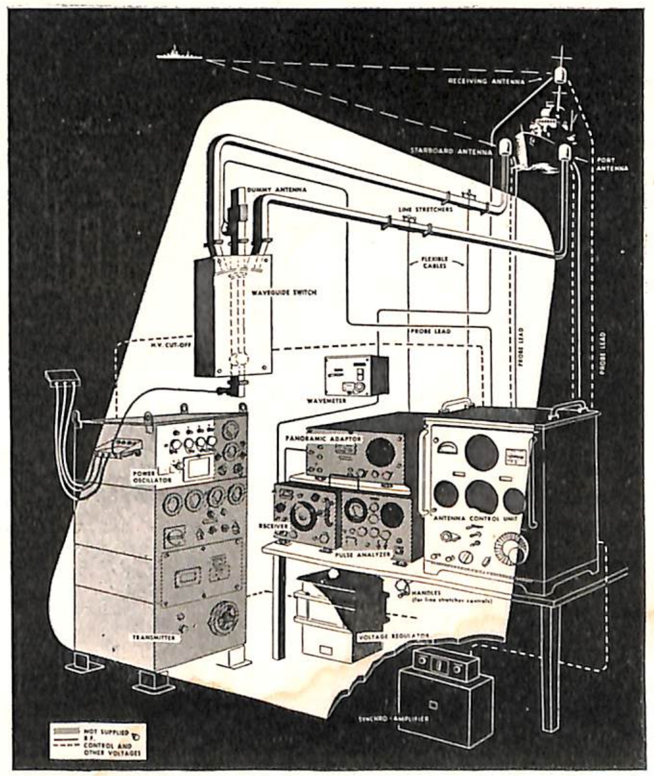
Model TDY-1 transmitter
High-frequency transmitter
Model RDO-series receiver
Model AN/SPR-2 receiver
Model RDJ pulse analyzer
Model RDP panoramic adapter
Model DBM-1 direction-finding equipment

A pictorial system diagram for this equipment is shown in the accompanying illustration, and a limited description of its operation was given on p. 9, ELECTRON for December 1945. The high-frequency (*S*-band) phase of RADCM operations was to be taken care of by the high-frequency transmitter and the AN/SPR-2 receiver. The high-frequency transmitter that the Bureau had in mind for this application was the Model MBT or MBR. Since these transmitters have not been forthcoming, however, due to the cancellation of contracts with the consequent curtailment of production, it was considered necessary to substitute the TDYa/TDY-1a high-frequency modification kit in the space designated for the high-frequency transmitter, thus permitting the partial coverage of the *S*-band range. In this connection it should be pointed out that both the Models TDYa/TDY-1a and DBM-1 are available only for new construction at the present time, so that only advance planning should be contemplated, and the running of cables, fabrication of foundations, etc., should be held in abeyance pending availability of the equipment.

The changeover from the Model TDY/-1 to the TDYa/-1a is based on the assumption that the ship receiving the installation is already equipped with a Model TDY or TDY-1 equipment in good working order. If this is not the case, and the TDY/-1 equipment is to be installed at the same time as the modification equipment, the TDY/-1 installation should be completed and placed in operation before attempting to make the modification. This is important to insure successful low-frequency operation and subsequent satisfactory reconversion to Model TDY/-1 when a high-frequency transmitter becomes available. There is no reason, however, why the installation of field-change kits containing modifications such as antennas (and waveguides), waveguide switches, line stretchers, dummy antennas, antenna control units, synchro amplifiers, wavemeters and voltage regulators, should not be made concurrently with the TDY/-1 installation.

The modification of Model TDY/-1 equipment to Model TDYa/-1a merely changes the frequency coverage of the original equipment. On the accompanying illustration, the original TDY units needed for low-frequency (*L*-band) operation are shown shaded, while the light units are those needed to convert to the higher frequency. The modification consists of alteration of the modulator and transmitter power supply, replacement of the power oscillator and its associated r-f and antenna system, installation of a wavemeter, an antenna control unit to provide a means of controlling the transmitting antennas, and a waveguide switch to permit automatic switching of the power output to either transmitting antenna.

Particular attention is invited to the receiving antenna shown in the accompanying illustration. If your ship has a Model DBM-1 on board, the TDY-a or TDY-1a antenna is removed and the Model DBM-1 antenna and associated equipment replaces it, as explained fully on p. 18, ELECTRON for March 1947. Of course, if there is no Model DBM-1 on board, the receiving antenna of the Model TDYa/-1a is not removed, but remains as indicated in the illustration.



Pictorial representation of a RADCM system using the TDYa/-1a transmitter. The type of receiving antenna shown here is removed from ships that have a Model DBM-1 direction-finding equipment aboard.

Shipboard Radio-Teletype Panel

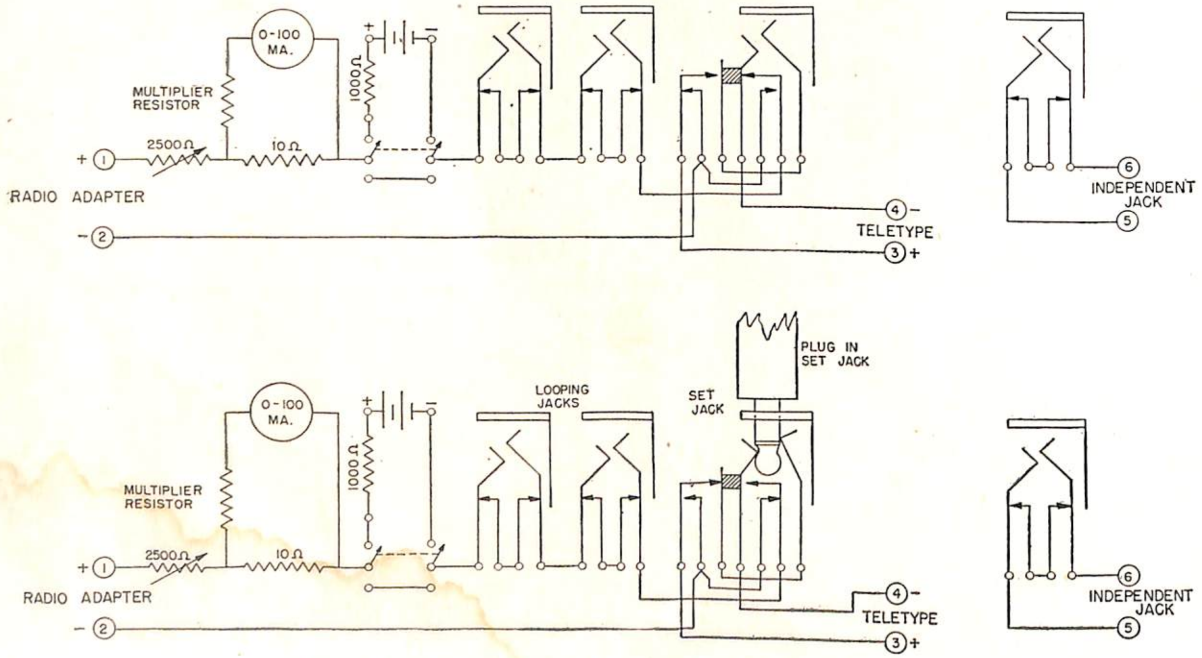
The Bureau of Ships has recently completed design on a radio teletype transfer panel which is believed to contain all the features necessary and desirable for shipboard installations. This panel, designated Type TT-23/SG, has been designed to provide flexibility, simplicity and practicability in the process of removing or transferring of a teletype machine from one channel to another.

The panel has a capacity of six independent channels. A meter (0-100 ma) and selector switch enable the checking of line current in any channel without interrupting the signal on that channel. During normal operation, when only one machine is being used, no patchcords are required. However, if the situation warrants, two additional teletypewriters may be connected into any one channel by the use of patchcords.

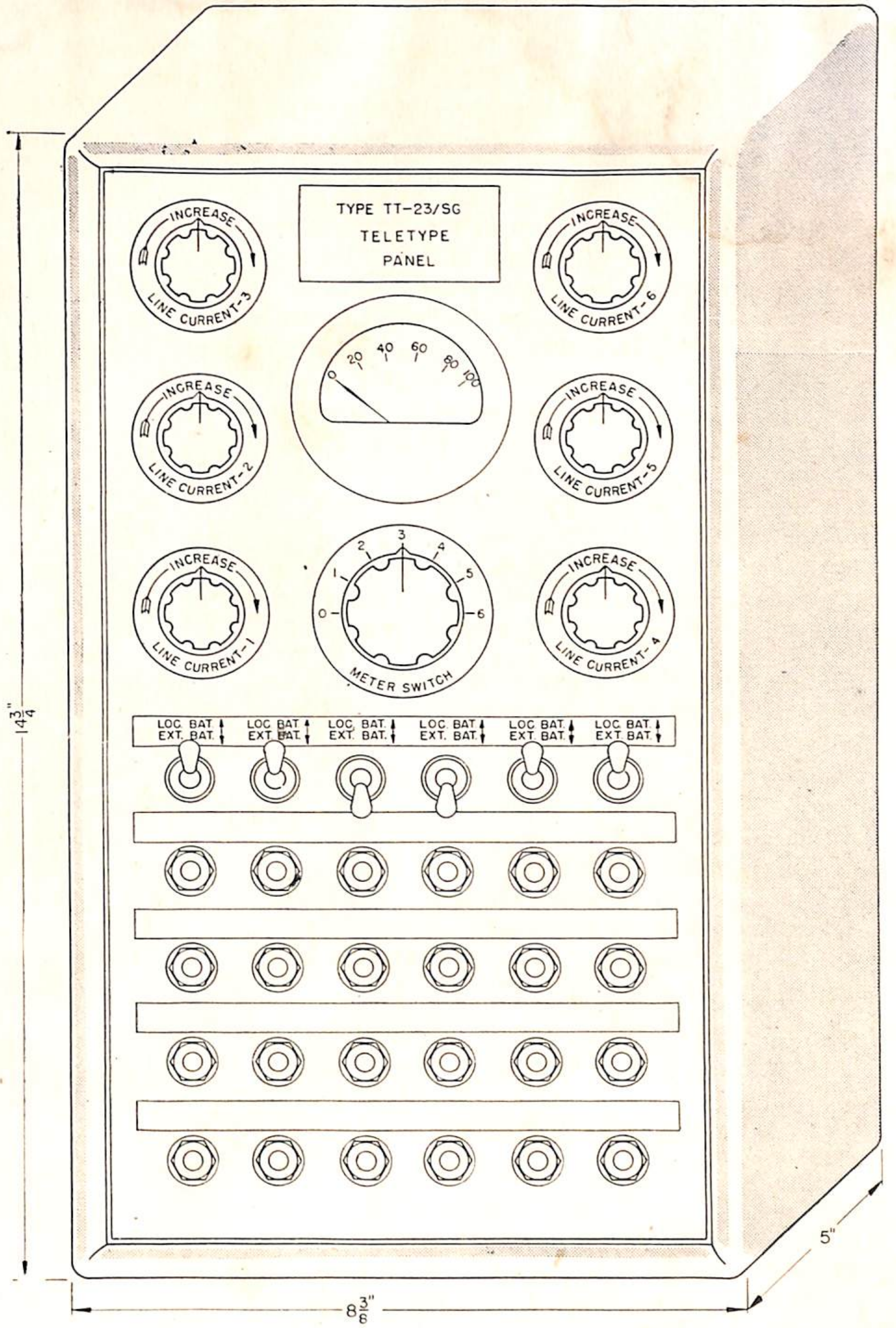
To those familiar with the Signal Corps patch panel 6C31, this new panel will not present any unusual features. In each channel are two *looping* jacks, a *set* jack, and an independent jack which is tied directly to terminals 5 and 6 on the terminal block inside the panel. There is also a battery switch and rheostat in each channel to provide and control line current. The local battery supply is connected to terminals 7 and 9 of the terminal block. With no plug inserted in the set jack, there is a straight series circuit between the radio adapter, connected to terminals 1 and 2, through the looping jacks and then to the teletype machine connected to terminals 3 and 4 of the terminal block.

The action of the springs in the set jacks is such that, when a plug is inserted, the plug sleeve and tip are connected to the teletype machine through terminals 3 and 4 respectively, the machine being removed from terminals 1 and 2.

Procurement of these panels is now being initiated. No definite delivery date can be established, although it is believed that a quantity will be available by November of this year.



Channel schematic. Note in upper diagram the unbroken circuit between radio adapter and teletype. A plug, when inserted in the set jack (lower diagram), isolates the radio adapter from the teletype machines.



General appearance and dimensions of the new TT-23/SG teletype transfer panel.

ERRORS IN NAVSHIPS 900,926

NavShips 900,926, the final instruction book for Target Acquisition Unit Mark 2 Mod 2, has been found to contain several errors which should be corrected. These errors appear in Section IV, which outlines operational procedure.

In paragraph 6 (Search procedure for designated target), it is stated under (5), "Turn ELEVATION knob to set the elevation index at approximately +8 degrees. This allows search of a sector from the horizon to about 17 degrees in elevation". This information would apply to TACU Mark 2 Mod 1, but not to TACU Mark 2 Mod 2. The foregoing quote should be changed to read: "Turn ELEVATION knob to set the elevation index at approximately +15 degrees. This allows search of a sector from the horizon to about 30 degrees in elevation." Under (6) of the same paragraph "—advance the elevation index to approximately 20 degrees to search—" should be changed to read: "—advance the elevation index to about 40 degrees to search—".

Under paragraph 7 (procedure for sector scanning) on page 4-2, under (e) "—the TARGET ELEVATION dial to eight degrees. (This provides the scanning of a sector from the horizon to about 17 degrees in elevation)." This should be changed to read: "—the TARGET ELEVATION dial to 15 degrees. (This provides the scanning of a sector from the horizon to about 30 degrees in elevation)". Under (g) of paragraph 7, "—the ELEVATION knob to approximately 23 degrees". Change to read "—the ELEVATION knob to approximately 40 degrees".

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CRYSTAL OVEN EXTRACTORS

A previous article appearing in the ELECTRON, CEMB, and RIB, stated that crystal-oven extractors for models TDZ, RDZ, MAR and RDR equipments are being shipped with those equipments and that a sufficient quantity would be stocked at a naval activity on each coast to take care of the equipments that were shipped before the extractors became available.

This statement is not entirely correct. The extractors were not procured for and are not being shipped with models MAR and RDR as they are not necessary. The crystal ovens in these equipments can be extracted with little difficulty.

Crystal-oven extractors are now being shipped with models TDZ and RDZ equipments only, and those now available in stock shall be issued exclusively to activities having the model TDZ and RDZ equipments that were shipped before the extractors became available.

LUBRICATION OF NUTATING DRIVE

The nutating drive assembly "AS", part of SP/SP-1M Field Change No. 43, has been shipped from the contractor's plant in a non-lubricated or "dry" condition.

It is imperative that, prior to the first use of the antenna, the gears in the nutating drive assembly "AS" be lubricated with about five pounds of grease, Navy type 14L3 Grade II. (General store stock No. 14L90-15 for 1 lb., 14L120 for 5 lbs.)

The gears may be greased through inspection hole "AA". The grease level should be up to the center of nutator shaft when all grease has been scraped from the sides of the case and the gears. Failure to properly lubricate these gears will result in the nutator drive motor burning out from the overload.

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DESIGN CHANGE IN MARK-34 RADARS

A minor circuit design change has been introduced into later production of Radar Indicator (Control) Mark 2 Mod 0 (a unit of Radar Equipment Mark 34 Mods 2, 3, and 4) to permit a sharper focus on precision sweep. This change was the result of trouble experienced in production when certain approved cathode ray tubes were used in the indicator. It was found that in many cases a careful selection of tubes was required to obtain correct operation and adjustment of this unit.

The circuit modification consists of replacing the ½-watt, 0.15-megohm resistor R-369 with a ½-watt, 75,000-ohm resistor. The new resistor shall still be designated as R-369. The parts and spare parts list, drawings, and all circuit schematics of the subject equipment should be modified accordingly.

The Bureau of Ordnance does not contemplate a field change to modify indicators which were delivered to the Navy without this design change. In order to assure proper operation of these units when cathode ray tubes within JAN limits are used, fleet personnel should examine the Radar Indicator (Control) Mark 2 Mod 0 of subject equipments to determine if the circuit modification described above has been incorporated in the unit. If the modification has not been made it should be introduced at once.

Failure report cards NBS-383 are now to be submitted for failures of all items and tubes regardless of age or status of guarantee. This directive will be made a part of Chapter 67 of the Bureau of Ships Manual.

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