INCORRECT METHOD OF RANGING

Some radar operators have been instructed to range the SG equipments on the edge of the pip. This method introduces an error.

The SG Technical Manual recommends that "The range crank should be rotated until the exact center of the signal is bisected by the offset." Operators are cautioned to follow the procedure given in the technical manual.

HEINTZ AND KAUFMAN TUBE TYPE 304TH

Performance of the type 304TH tube manufactured by Heintz and Kaufman, Ltd., prior to January 1945 has been reported as very poor. Special tests conducted in accordance with JAN specifications on sample tubes selected at random from various navy yard stocks have proved that this type tube is unsuitable for use in shipboard radar equipment.

It is recommended that vessels check the spare 304TH type tubes on hand, replacing those made by Heintz and Kaufman with those of other manufacturers at the first opportunity. If other manufactured types are not on hand check the tubes for operation in the equipment. Although the tubes are unsatisfactory for normal operation they will give limited service.

SPECIAL TYPE 721A AND 721B TR TUBES

An improved type duplexing tube has been developed by the Raytheon Manufacturing Co. A total of 1,000 of the improved tubes will be sent to the field engineers of the Raytheon Manufacturing Co., for installation in SGa and SG-1 radar equipments. To date several hundred of these have been shipped out as type 721A with a date-code mark stamped on the bulb. The date-code mark consists of a month and the last digit of the year, 11-4 being the eleventh month of 1944 and 1-5 representing January 1945, JAN (Joint Army and Navy) Specifications have authorized the type number 721B to be applied to the improved tube. Several hundred of the improved type will therefore be marked 721B. This will help to differentiate between the old and new types in use.

These tubes have operated satisfactorily in factory tests for more than 1,000 hours. Bases on these tests, it is expected that the new type duplexing tube will yield better than 1,000 hours life in actual shipboard operation.

The Bureau authorizes the use of the special tubes in SGa and SG-1 radar equipments. They may be operated beyond the established 300 hours life limit. In order that no delay occurs in receiving this information, it is requested ships submit a special report as soon as tube data becomes available on these special tubes. This information should include the following:

a. Date tube installed.
b. Date of removal.
c. Date-code mark of tube (date of manufacture of 721A tubes).
d. Hours of operation (see note 1).
e. Comments regarding performance (see note 2).

NOTES: (1) In SG equipment the operation time should be determined from the instant the STANDBY switch (S-907) is first thrown on. The keep-alive voltage goes on with this switch. Cases have occured when only the RADIATION switch has been turned to the OFF position in order to place the equipment on "standby." The RADIATION switch (S-908) should be thrown to the OFF position and the STANDBY switch (S-907) should be thrown to the STANDBY position for this equipment to be on "standby."

(2) Check the performance on close-in targets very closely; as the tube nears the end of its life the clear-up time (deionization time) lengthens, resulting in poor echoes from close-in targets.

Technician's Checkoff List (SGa, SG–1)

The maintenance procedures outlined in this checkoff list were collected from data submitted by vessels, navy yards and manufacturers' radar field service engineers. This checkoff list is to be used by the ship's radar technician or other radar personnel equally qualified. This checkoff list should be made effective immediately upon receipt of this information. A copy of this checkoff list (preferably typewritten) should be made for future use.

NOTE: After completion of each item check (✓) in appropriate blank space.

	Year___											
	Month_											
	Week__	1	2	3	4	1	2	3	4	1	2	3	4
MAIN FRAME													
1. Clean or replace air filter.													
2. Clean driver and transmitter compartments thoroughly and wipe insulators with dry clean cloth.													
3. Check main blower motor and lubricate every 3d month. See Lubrication Chart.			X X	X X	X X		X X	X X	X X		X X	X X	X X
4. Remove lower panel and check tightness of all terminals and condition of interlock.			X X	X X	X X		X X	X X	X X		X X	X X	X X
5. Check condition of interlocks on modulator doors.			X		X		X		X		X		X
6. Check auxiliary blower motor for noise. Check bearing temperature.													
7. Disassemble auxiliary blower motor, clean commutator and bearings. Replace brushes if necessary and lubricate bearings. See Lubrication Chart.			X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X
8. Replace TR and anti-TR tubes V–112 and V–113 each 300 hours of operation. Record total operating hours when changed.			X X	X X	X X		X X	X X	X X		X X	X X	X X
9. Check transmitter and total direct current. Record and compare with previous values.													
10. Clean tube prongs and grid and plate caps on 304TH and 705A tubes.			X	X	X		X	X	X		X	X	X
11. Check and record power voltage and operating time.			X	X	X		X	X	X		X	X	X
12. Check and record driver current and compare with previous values.			X	X	X		X	X	X		X	X	X
13. Check alinement of TRF assembly with wave guide extension—should be within one-eighth inch horizontal and vertical and not separated by more than one-fourth inch. Shutter should operate freely. See Lubrication Chart.													
14. Check mixer crystal for ratio (resistance). Front to back resistance ratio should be about 10:1.													
15. Check mixer adaptor coaxial line for tightness of center conductor and coaxial plugs.			X X	X X	X X		X X	X X	X X		X X	X X	X X
16. Check oscillation control and record crystal current as read on meter marked oscillation indicator after tuning oscillator cavity.													
17. Tune receiver and record tuning indicator reading.													
18. Check operation of r-f monitor and record wave meter reading.			X	X	X		X	X	X		X	X	X

Technician's Checkoff List (SGa, SG–1)—Continued

	Year											
	Month											
	Week	1	2	3	4	1	2	3	4	1	2	3	4
MAIN FRAME—continued													
19. Lubricate wavemeter barrel (Z–104) quarterly. See Lubrication Chart.			X	X	X	X	X	X	X	X	X	X	X
20. Check clamping rings of TR boxes and local oscillator for tightness.													
21. Check operation of all controls on modulation generator.													
22. Check range mark oscillator for proper operation (this will show up in range inaccuracy) withdraw crystal—if marks move, oscillator is not operating properly.													
23. Check all tubes in receiver—all 6AC7's should be tested in 1st i-f stage V–303; tap each tube lightly—replace any noisy or weak tubes.													
24. Check 24. Check action of all relays in modulation generator. Burnish contacts where necessary.			X X	X X	X X		X X	X X	X X		X X	X X	X X
INDICATOR													
1. Check transmitter current reading at indicator and compare with reading obtained at transmitter.													
2. Record line voltage at indicator and compare with value at transmitter.													
3. Check operation of transmitter power control.													
4. Check for double moding on range tube.													
5. Check reading of transmitter current meter in normal, tune, and monitor positions.													
6. Check bearing accuracy on known target by comparing with pelorus (use a pelorus near base of antenna).			X X	X X	X X		X X	X X	X X		X X	X X	X X
7. Check relative bearing dial with gyro repeater. Have gyro processed and check rotation of dial.			X X	X X	X X		X X	X X	X X		X X	X X	X X
8. Check range and PPI tubes for focus, intensity, and centering.													
9. Check long and short range counters for proper reading. See Lubrication Chart.													
10. Check operation of receiver gain control.													
11. Check operation of receiver tune control.													
12. Check calibrating resistors.													
13. Check operation of ranging crank. See Lubrication Chart.													
14. Check operation of slewing switch on all speeds in both directions.													
15. Check operation of hand bearing crank. See Lubrication Chart.													

Technician's Checkoff List (SGa, SG–1)—Continued

	Year											
	Month											
	Week	1	2	3	4	1	2	3	4	1	3	4	2
INDICATOR—continued													
16. Check slewing motor—clean commutator and replace brushes if necessary.													
17. Check clutch for slipping and oil on surfaces.													
18. Lubricate the shaft connecting motor (B–901) to the yoke of PPI rotating deflection coil quarterly. See Lubrication Chart.			X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X
19. Clean and lubricate slip rings, rotating deflection coil (L–904) quarterly. See Lubrication Chart.			X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X
20. Blow out indicator—wipe insulators with dry clean rag.													
21. Check condition of interlocks.													
22. Check signal-mark switch and long-short range switch, several times back and forth, observe results on both range and PPI tubes.													
23. Check alignment of markers on long and short range.													
24. Check range reading at each 5,000 yards, marker on both ranges (report errors).													
25. Withdraw all tubes few times to remove possible oxide on tube prongs.			X	X	X		X	X	X		X	X	X
AMPLIDYNE AND ANTENNA													
1. Check amplidyne brushes and clean commutator, replace brushes if necessary. See Lubrication Chart.			X X	X X	X X		X X	X X	X X		X X	X X	X X
2. Check antenna motor brushes and commutator. See Lubrication Chart.			X	X	X		X	X	X		X	X	X
3. Check rotation of antenna in both directions at all speeds—check for noise and smooth operation.			X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X
4. Check antenna heater and thermostat operation.			X	X	X	X	X	X	X	X	X	X	X
GENERAL													
1. Check cabling and all connections.			X	X	X		X	X	X		X	X	X
2. Check wave guide run for loose flange bolts, hot spots, dents, etc. Use neon bulb to check for leakage at flanges.			X X	X X	X X		X X	X X	X X		X X	X X	X X
3. Check resistor clips and fuse clips for tightness and cleanliness.			X	X	X		X	X	X		X	X	X
4. Personnel checking equipment should initial and date.	Date Initial												

LUBRICATION CHART (SGa, SG—1)

Proper maintenance requires periodic lubrication of the various components. This chart is intended to reference the units involved, time serviced, and to give the Navy type number if available. Reference must also be made to the instruction book for location of lubrication points and the quantity of lubricant required.

Equipment			Service					Lubrication data						
Unit involved	Name of component	Circuit symbol	Hours	Daily	Weekly	Monthly	Annual	Oil	Grease	Instruction book type	Commercial type	Navy type	Nearest Navy equivalent	Comments
Antenna assembly							X		X	Beaconlube M-285, Royco No. 8.			O. S. 1350	See Note No. 1.
Motor dynamo amplifier	Ball bearings					X	X		X	Beaconlube M-285			O. S. 1350	See Note No. 2.
Transmitter	Blower motor, main	B-101					Q	X		Light machine oil	SAE-20	N. S. 3050	N. S. 9250 or N. S. 9110.	
	Blower motor, auxiliary	B-102					Q	X		Light machine oil	SAE-20	N. S. 3050	N. S. 9250 or N. S. 9110.	See Note No. 3.
	Wavemeter shutter	Z-104					Q		X	Thin coat of grease			O. S. 1350	
	Wave guide shutter	E-107					Q	X		Light machine oil	SAE-20	N. S. 3050	N. S. 9250 or N. S. 9110.	
Indicator	Veeder root counters						S	X		Nyes' external low temperature clock oil.			O. S. 1362	See Note No. 4.
	Worm gears, range crank assembly.						Q		X	Petroleum jelly			14P1	
	Shaft bearings, range crank assembly.							Q	X	Light machine oil	SAE-20	N. S. 3050	N. S. 9250 or N. S. 9110.	
	Shaft connecting motor (B-901) to the yoke of PPI rotating deflection coil.						Q	X		Light machine oil			N. S. 9250 or N. S. 9110.	See Note No. 5.
	Bearing crankshaft bearings and universal joint.						Q	X		Light oil	SAE-20	N. S. 3050	N. S. 9250 or N. S. 9110.	
	Sliprings, rotating deflection coil	L-904					Q		X	Petroleum jelly			14P1	See Note No. 6.

Q = Quarterly.

S = Semiannually.

NOTE No. 1.—See Instruction Book for annual overhaul and lubricating instructions. In addition, lubricate the wing screws securing the antenna pedestal doors.

NOTE No. 2.—On amplidynes using grease cups, give each grease cup ½ turn *each month*. On all type amplidynes, if operation extends beyond the annual overhaul period, a few drops of lightweight oil such as N. S. 3050 (or N. S. 9250) may be added to the old grease. For annual overhaul see *Raytheon Engineers Service and Installation Bulletins* (NAVSHIPS 900,635) Bulletin No. 59.

IMPORTANT.—Overhaul must be made more frequently when the amplidyne is in a poorly ventilated or dirty location and when it is used over long continuous periods of time.

NOTE No. 3.—It is necessary to disassemble motor to oil bearings.

NOTE No. 4.—Normally requires no lubrication. See instruction book for lubrication under abnormal conditions.

NOTE No. 5.—Should be checked quarterly, lubricated only if binding occurs.

NOTE No. 6.—See instruction book for proper method. Do not use graphite.

METHOD TO REDUCE FAILURES OF THE RF SIGNAL MONITOR FOR SG-1 SERIES

Operational reliability of the RF signal monitor in the SG-1 series is improved by use of a suggestion proposed by the Boston Naval Shipyard. The RF signal monitor is needed to tune transmitter and receiver circuits in the SG-1 series and to monitor reliably their frequency accuracies. Monitor failure has frequently occured in the RF-103 tuning cavity due to insulating cup breakage of the Y-101 crystal. Tightening P-109 firmly presses crystal Y-101 into its insulating cup socket. But too much pressure has often crumbled the delicate insulating support cup, thus shorting Y-101 crystal to ground and making the RF signal monitor inoperative. The suggestion is to insert the crystal into a one-fourth-inch long by 0.208-inch diameter phenolic tubing before placing the crystal in its holder. This insulates the crystal sufficiently for proper operation at the frequencies encountered and provides a rugged, unbreakable support.

TUNING

CAUTION: Personnel lacking experience and complete knowledge of the purpose, action, effect and interaction of controls should not make adjustments excpet in cases of extreme emergency. In any case a note or marking of the position of the control should be made in order that the control may be returned to its previous position if no improvement is noted. Cavities, vanes, and plugs are precision units and should be handled with care to prevent damage. Do not force adjustments and clamps.

Faulty duplexer action may be due to faulty assembly, bad tubes, or detuning. Any one of these can cause burned or insensitive crystals. Following is a simple tuning procedure:

a. Check the transmitter frequency, then set the local oscillator at the same frequency.

b. Couple the McNally (local oscillator) into the crystal mixer in the normal manner.

c. Tune the mixer for maximum crystal current, backing off the oscillator input by adjustment of coupling loop in Z-301 if the crystal current goes over 0.6 ma.

d. Tune the TR box for minimum crystal current.

e. Tune the anti-TR box for maximum crystal current.

NOTE: If the cavities do not tune, follow the procedure outlined in Raytheon Field Engineers' Service and Installation Bulletins (NAVSHIPS 900,635), Bulletin No. 42.

f. Retune the McNally oscillator to proper beat frequency (30 mc/s away from the magnetron).

Numerous erroneous tuning items have been reported. Some of the worst will be itemized here.

a. **Do not** adjust L-304 to anything except a resonant condition; resonance gives the highest load impedance possible in the plate of V-303. Any tuning in the plate circuit of V-303 cannot have any desirable effect on the tuning of the local oscillator and will only reduce the sensitivity of the receiver.

b. **Do not** change the coupling of T-303. This transformer is purposely overcoupled at the factory to give the best signal to noise ratio. Any adjustment will only increase the minimum signal strength necessary for detection; this effect may be as much as 2 to 1 or more. Undercoupling rapidly decreases signal strength while leaving the noise at the same level. In cases where T-303 has been so damaged it should be replaced with an undamaged unit.

c. **Do not** attempt to adjust local oscillator coupling to its load at any place except at RF-303 and RF-301. This oscillator is designed to have far more than enough power so that loose coupling and increased oscillator stability may be had.

MOUNTING PLATES FOR SLEWING MOTORS

Two types of slewing motors for SG, SGa, and SG-1 equipments have been supplied which are not physcially interchangeable due to variations in their base dimensions. Bodine motors have been used almost exclusively in equipments shipped while EMC motors have been used extensively in spares. A different type of mounting plate is required with each of these motors. The motors in spares were not always equipped with a mounting plate. Cases have occurred where it was impossible to install a slewing motor obtained from spares.

Mounting plates for both EMC and Bodine motors may be obtained through the supply system. When a mounting plate is replaced, the old mounting plate should be placed in the engineers' stock of spare mounting plates so as to be available for future use.

If it becomes necessary to order additional plates, the part numbers are as follows:

Bodine Motor Mounting Plate part 24-5148 Pl.
EMC Motor Mounting Plate 24-5345 Pl.

NOTE: Mounting plates are the same for each type of motor regardless of gear reduction. Therefore, if an EMC 40:1 motor is to replace an EMC 23:1 motor, a new mounting plate will not be necessary.

It will be noticed that the angle of the low-speed shaft on the 40:1 motor is different from that on the 23:1 motor. The 40:1 motor shaft is not perpendicular to the mounting base. This is necessary since the low speed shaft is displaced more with the higher gear ratio and must be at the proper angle so that its projection passes through the center line of the large bevel gear which it drives.

ANTENNA HEATER OPERATION

Numerous failures of the antenna heaters, R-701, R-702, and R-703, have been reported. In several cases, rust and corrosion have set in and mold has formed on the wiring.

In tropical areas, these heaters have not been in operation as the thermostat, S-701, is set at approximately 70° F.

It is recommended that all antenna pedestals be inspected periodically for open heater resistors, rust, and mold. The heater circuit should also be checked for grounds and defective fuses.

For operation in tropical areas, the thermostat should be reset to operate at 122° F. as outlined below. It must be remembered that this is an emergency measure and that proper notation as such should be made in the vessel's Radar Log.

Procedure for adjusting thermostat: Since this adjustment cannot conveniently be made at the antenna, the thermostat should be temporarily removed and taken to a location where the proper facilities are available for this work.

a. Temporarily remove both heater circuit fuses F-801 and F-802 in the control amplifier. Remove from the antenna pedestal, as one unit, the thermostat cartridge and C-701 together with its associated leads to the two lower terminals 106 and 107 and E-701 and the leads to the heater element terminals. This method will thus make any unsoldering operations unnecessary. To remove C-701, it will be more convenient to temporarily remove the E-701 mounting brackets from the pedestal casting in order to obtain access to the condenser mounting nuts.

b. Obtain a small metal container and thermometer. The Weston Testing Thermometer Model 226L 0-100° C. used for testing the v-f oven temperature will be adequate. (These thermometers have been shipped to all bases.) Fill the metal container with water to a depth of about 2 inches and heat it to a temperature of 50° C. (122° F.). Allow the thermometer to remain in the water and try to maintain the temperature constant.

c. Attach an ohmmeter across the thermostat leads. A continuity may or may not be obtained, depending upon temperature and present adjustment. If no reading is obtained, turn out on the adjusting screw on the end of the cartridge until the internal contacts close as shown by a continuity reading.

d. If sufficient heat is now applied to the thermostat the contacts will open. Immerse the thermostat vertically in the heated water and turn the adjusting screw so that the circuit opens at this temperature and closes when the thermostat is withdrawn for a short period of tiem.

(CAUTION: Do not allow the adjustment end of the cartridge to become wet.) Recheck this series of operations for positive thermostat contact action.

e. Apply glyptal to the adjusting screw threads for sealing purposes. Attach a label to the center portion of the cartridge on which is inscribed "Adjusted to 50° C." Cover the label with a transparent (Scotch) tape to secure it in place.

f. Reinstall the thermostat in the inverse order of the steps outlined in paragraph a.

TROUBLES IN ANTENNA PEDESTAL HEATING UNIT CIRCUIT

A service report stated that the 115-volt heater line to the antenna pedestal was not functioning due to improper wiring during original installation. In this particular case, the heater circuit at terminals 86 and 87 on E-803 in the control amplifier assembly was connected to terminals 86 and 87 on E-908 in the indicator unit. As a result, it was necessary for the engineer to have the ships' personnel run a 115-volt powerline to terminals 86 and 87 on E-803 in the control amplifier assembly, which should be normal practice at the time of installation.

A second service report received mentions a case where the antenna pedestal heater was inoperative due to the fuses F-801 and F-802 not being placed in the amplifier when equipment was originally installed.

To avoid trouble it is suggested that during cold-weather operations all antenna heating circuits be checked, making sure that the voltage not only leaves the control amplifier but arrives in the antenna pedestal on the correct lug. Count 106 and 107 on terminal strip E-701; also check the operation of thermostat S-701.

BEARING AND RANGE CALIBRATION

In the initial calibration of the SG and SG-1 rqdar for optimum range accuracy:

a. Allow the equipment to heat up for a period in excess of 1 hour (MAIN SWITCH—ON; STANDBY SWITCH in OPERATE position; RADIATION SWITCH—ON).

b. Calibrate the range markers as outlined in the SG Instruction Book, NavShips 900,531.

c. Locate three or more fixed targets, such as lighthouses, from which a steady echo will be received. These should not have the same bearing but should be approximately 90° apart.

d. Obtain an accurate reading of the range and bearing of these fixed targets, using either the perlorus or director.

e. The antenna should have been calibrated previously on electrical zero. The echoes should be ranged on one at a time. In each case, check the radar bearing readings against the known bearings, likewise the range.

(1) If the antenna was not correctly aligned when the equipment was installed, the bearings on the three or more targets will be consistently out the same amount. This error, if 1° or greater, may be compensated by opening the doors in the antenna pedestal, loosening the 5CT (B-701) synchro case, and slowly rotating the 5CT synchro housing to compensate for this error.

(2) If the ranges on the three or more targets are out a consistent amount, let us say by 20 yards or more, this may be corrected as follows:

Pull out the modulation generator, at the same time jumpering the interlock. Knowing the range inaccuracy, it is merely necessary to adjust C-453, thus shifting the markers to the left or right, the amount that the equipment is out of calibration. In detail, when the range error is found, the SIGNAL MARKER switch is in SIGNALS position. Throw the SIGNAL MARKERS switch to MARKERS position and shift the markers the amount of inaccuracy by adjusting C-453. Having accomplished this, once more recalibrate the range marks as outlined in the SG Instruction Book, and the error will be corrected.

NOTE: Earlier in these instructions, it was suggested that the echoes used should cover an approximate quadrant of 180°. The reason for this is that the range error on two targets may be in the vicinity of 50 yards, while a third target will have an error of 90 yards. When this error dif-

ference comes up, it will usually be found that the navigator is plotting his pelorus reading from the anchorage point instead of from the exact location of the ship's bridge, which is in close proximity of the mast supporting the SG radar antenna. This should be borne in mind at all times and range readings figured from as near to the SG supporting mast as possible.

INTERLOCKS JUMPING METHOD

Some difficulty has been experienced with momentary opening of interlock switches under the extreme shock of gunfire. When loss of use of the equipment occurs, or is expected from interlock failure, the procedure outlined below may be followed until repairs can be affected. Interlocks are a necessity for the protection of personnel, and should not be removed or shunted unless absolutely necessary.

Apparently most of the trouble is caused by interlocks S-104, S-105, and S-116. Momentary opening of any of these would cause the time delay relay, K-101, to open, causing a one minute delay while recycling. These switches may be easily shunted but in some equipments the transmitter could be started with the modulator power supply short circuited by S-103 causing damage to the equipment. Before jumpering interlocks, it is necessary to determine whether S-106 is wired as in drawing DWG2-5060 or as in DXG2-5169.

This may be checked quickly as follows: Remove wires from terminal "K" on the driver rectifier chassis. Check continuity between these wires and the primary lead of T-104 that is common to K-101. Open and close door handle switch S-103, S-106 and if continuity is broken, the wiring is as shown in drawing DXG2-5169 and will not have to be altered.

If continuity is not broken, the wiring will have to be changed as follows: Make up a small 2 wire cable. Remove the leads from S-106 and connect one lead of the new cable to terminal "K" of the driver rectifier unit and the other end to S-106. Connect the other lead to the other side of S-106 and to the primary of T-104. Replace the wires on terminal "K".

After these changes have been made, interlocks S-103, S-104, and S-116 may be shunted simply by connecting terminal "K" of the driver rectifier unit to the load side of F-107.

NOTE: When this connection is made, the driver unit doors must be closed while operating or the modulator power supply will be short circuited by drop bar S-115. A short circuit here will almost inevitably result in failure of rectifier tubes V-101 and V-102.

Should trouble arise in the indicator interlock switches due to spring of the case or other causes, the switch S-905, S-906 may be easily shunted by connecting terminals 51 to 52 on terminal strip E-912. Again this connection would expose personnel to lethal voltages, and should be removed as soon as possible.

Momentary interlock failure in the other units of the SG are not as important as the previously mentioned ones, and usually cause a loss of patterns for only a fraction of a second. Periodic cleaning of the interlock contact surfaces will usually prevent a complete failure and would aid materially in recovery after a shock. In event of recurrent failures of these interlocks, the easiest method of shunting them would be to solder a jumper across the leads at the interlock.

EXCESSIVE VOLTAGE DROPS IN CABLES

The Bureau has received reports of reduced SG performance due to low voltage applied to the transmitter. Equipments giving underpar performance should be checked for low voltage supply and wiring drops; check the voltage drop in cable runs between indicator and main frame, conductors nos. 3, 4, 4, 6, and 7. The voltage drop should be within 1 volt in the conductors. Refer to SG Instruction Book, External Cabling Diagram.

In cases of excessive voltage drops, install Auto-Transformer, Type CRP-301250, between the main frame and the indicator. These auto-transformers are available through the supply system.

TR BOX LOCKING NUT WRENCHES

Because a standard wrench or pliers will not fit locking nuts on SG-1 TR boxes a special wrench (fig. 1) is being provided, and quantities are being shipped to all yards. One of these wrenches should be furnished each SGa or SG-1 up to equipment 717 which was the first to include it in equipment spares.

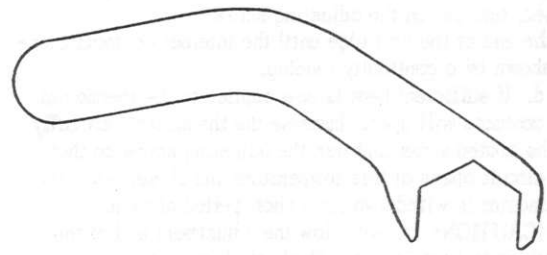


FIGURE 1.—Special wrench for TR box.

AMPLIDYNE MAINTENANCE

Reports from the field indicate failures of amplidynes in service on SGa and SG-1 equipment. A high percentage of these failures is caused by worn out brushes or dirty commutators or other causes directly traceable to poor commutation. This indicates a need for more frequent thorough inspection of the brushes and commutator.

The technicians check-off list specifies that the brushes and commutator should be inspected once each month. The amplidyne should be overhauled annualy.

Many cases of noisy bearings are directly traceable to poor commutation. If the commutator is dirty and the slots between the commutator bars become filled with carbon and metal particles, or if the brushes are making poor contact due to insufficient pressure or improper shape, an excessive amount of heat will be developed and this in turn will be transmitted to the bearing thus causing the lubricant to dry up and become ineffective. The bearing then running without lubrication will soon become damaged and will be very noisy. When this has happened the situation can seldom be rectified by forcing new grease into the bearing through the greasing hole. This procedure will usually only serve to force the decomposed grease into the bearing and also force some grease out of the bearing housing onto the commutator.

A routine monthly check of the amplidyne should be established. This check should be as follows:

a. Check the amplidyne while operating under normal load, for unusual noise and vibration. A noisy bearing can be detected by placing a light screw driver against the housing near the bearing and placing the ear against the other end of the screw driver.

b. Remove all eight brushes and inspect them for proper length and contact surface. All brushes should slide freely in the brush holders with no tendency to bind. All brushes should be at least three-quarters inch long and the surface which contacts the commutator should be smooth and shiny with no evidence of copper particles in its surface. Each pair of brush holders should have one hard and one soft brush with their relative positions alternated in successive holders so that two hard brushes and two soft brushes contact each commutator position.

c. Remove the end plate of the amplidyne on the commutator end and inspect the commutator. This should be smooth and clean with no evidence of grease. The slots between the commutator bars should be clean with deposit of grease between the bars. The surface of the commutator should be either copper colored or a light chocolate color and there should be no ridges in the area contacted by the brushes. If this area is worn slightly depressed but is still smooth, no difficulty should be experienced. If any grease is present on the commutator it can be cleaned off with a clean cloth and the slots between the commutator bars can be cleaned out with a suitable tool. If it is necessary to polish the commutator this can be done with very fine sandpaper, but under no conditions should the commutator be sanded with the brushes in place. Emery cloth or crocus cloth should never be used on a commutator.

d. Reference should be made to NavShips 900, 635 for lubrication instructions and maintenance instructions.

If inspection reveals conditions other than specified above, the amplidyne should be removed to the motor shop and overhauled.

MAIN BLOWER MOTOR B-101

Several failures of the Blower Motor B-101 have been reported. Investigation reveals that with adequate lubrication, these motors would have given many more hours of service. Personnel should make sure that this motor is included in the lubrication schedule. Refer to the lubrication chart for data.

TIME DELAY RELAY K-101

Several failures of the time delay relay K-101 have been reported. Investigation indicates that the majority of the trouble is brought about by the improper seating of the microswitch arm. An examination of the switch structure will show that the arm must make on two contacts and unless the fulcrum of the arm is properly set in the microswitch case, the arm will not come down simultaneously making on both contacts. Personnel are requested to watch this item very carefully when trouble arises with the relay.

INCREASING LIFE EXPECTANCY OF THE TYPE 2050 (V-220) TUBE

The AFC circuts of XSG-3, XSG-4, and SG-3 serials 1 through 9 utilized a limiting choke (L-229) in the plate circuit of V-220, a type 2050 tube. This choke has proven inadequate for the application. Accordingly, beginning with the SG-3 serial No. 10, a 1,000-ohm ±10 percent, 1/2-watt resistor was substituted for L-229. If you wish to increase the life of V-220, and your equipment still has limiting choke L-229 in the plate circuit of V-220, make this change and record it in the appropriate log.

SG CLUTCH PLATE TREATMENT

A suggestion by the San Francisco Naval Shipyard has been forwarded to the Bureau of Ships. The suggestion concerns a treatment for the clutch plates of the tuning section of Radar Equipment SG. Slipping of these plates can be prevented by coating them with a solution of resin and acetone. One part of resin is put into seven parts of acetone and left several hours to dissolve. Then the solution is carefully applied with a brush. It is not necessary to disassemble the clutch since the solution can be applied to the outside edges of the plates from which position it will seep inward. This will save replacing many clutch plates of this unit, for they usually are not worn but merely become glazed, so that application of this solution will make them usable again.

This method is satisfactory for emergency shipboard use, but shipyards should overhaul these clutches when necessary, rather than coat them as recommended in this emergency procedure.

INCREASING LIFE EXPECTANCY OF TYPE 1B54 PRE-T-R TUBES

It has been found that two types of construction have been used in the manufacture of 1B54 tubes supplied to the fleet in SG-3 and SX radar equipments. The original 1B54 had a shell made of brass; however, this was later changed to steel when it was found that the brass shell tubes failed due to temperature cycling. The two types may be identified by using a magnet since only the later steel shells will be attracted by the magnet.

It has also been found that the life of the 1B54's can also be increased by using only 4 of the original 10 mounting holes. The proper holes are shown on the accompanying illustration.

It isrecommended that any brass shell 1B54's now on hand be removed from active stock and reserved for emergency use only.

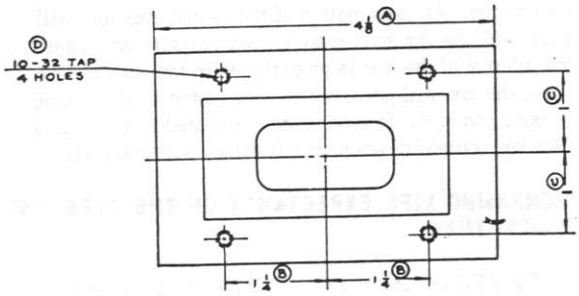


FIGURE 1.—Proper mounting holes.

LOSS OF ECHOES IN SG-6 RADAR ANTENNA GEARS

A very unusual failure in the SG-6 has been reported. Operators observed a complete loss of echoes over two sectors symmetrically located. Close examination of transmitted pulse on PPI showed a rounded extension of the normally circular pulse pattern, with two symetrical extensions reaching a maximum of about twice the length of the transmitted pulse at bearings of 095 and 275 relative. The loss of echoes coincided with the increased pulse length. Measurement of the standing wave ratio indicated almost complete reflection in the guide twice during each revolution of the antenna. The transmitter would not stay in operation on long pulse, and the magnetron current would fluctuate widely and arcing was indicated in the magnetron or waveguide. The transmitter would stay in operation on short pulse with the effects described above. Fuse F-109 blew occasionally.

It was suspected that the trouble lay in the waveguide rotating joint in the antenna. Upon arrival in port when the SG-6 could be secured and work begun, a wooden staging was constructed on the mast to allow disassembly of the pedestal. It was found necessary to remove the rotating joint, both reflectors, and the selector valve assembly to accomplish repairs.

It was found that a small piece of the waveguide rotating joint assembly immediately above the lower bearing had broken loose where it was brazed to the guide, although it was still in place. The lower bearing in the rotating joint had jammed completely, with the ball race broken, balls jammed, bits of the broken race and about a cubic centimeter of iron dust in the guide below the joint. It is presumed that the bearing failed due to energy leakage from the cracked guide getting into the bearing and causing arcing and pitting, although there is a possibility that it was caused by lack of lubrication since there is no provision for lubrication of this bearing. The jamming of the lower rotating joint bearing caused the rotating joint and the center waveguide to stop, shearing off the lower halves of P-1301, the plastic coupling that rransmits the torque to turn the rotating joint. As a result the center waveguide remained stationary while the selector valve assembly waveguide rotated above it, with a complete mismatch reflected back to the transmitter when the two waveguides were at right angles. The coupling P-1301 and the lower bearing were taken from maintenance parts, and the piece of waveguide that had come loose was brazed in place.

Difficulty has been experienced in identification of gears and gear assemblies used in Model SG-6 antenna assembly, type CRP-66AMQ, as outlined by illustrations and parts lists in Technical Manual NAVSHIPS 900,861A and NAVSHIPS 900,861A.1.

Figure 7-48 in both technical manuals illustrates the main gears of the antenna gear train mechanism. These gears are numbered 1 through 6 and are not carried in the supply system as individual repair parts but are supplied as parts of complete replacement assemblies. It is recommended that complete assemblies be ordered through normal supply channels and installed if replacement of these gears becomes necessary.

To facilitate the identity of the complete assemblies in connection with the gears as illustrated in figure 7-48, the following information is given:

a. Antenna Subassembly: symbol 0-1301, contractor's drawing No. 12-5260G1, contains gear No. 5, tag No. 1366, Stock No. N5840-309-2400.

b. Antenna Subassembly: symbol 0-1302, contractor's drawing No. 12-5236G1 contains gear No. 1, tag No. 1367, Stock No. N5985-387-2392.

c. Antenna Subassembly: symbol 0-1303, contractor's drawing No. 12-5261G1 contains gear No. 4, tag No. 1368, Stock No. N5985-694-2801.

d. Antenna Subassembly: symbol 0-1304, contractor's drawing No. 12-5259G1, contains gear No. 2, tag No. 1369, Stock No. N5840-321-6885.

e. Antenna Subassembly: symbol 0-1316, contractors drawing No. 12-5258G1, contains gear No. 3, tag No. 1382, Stock No. N5985-387-2392.

f. Antenna Subassembly: symbol none, contractor's drawing No. 102-5405G1, contains gear No. 6, tag No. 1385, Stock No. N5840-305-6856.

EXCESSIVE FAILURE OF MAGNETRONS IN SG-6 RADAR

A cause of short magnetron life in the SG-6 radar is reported as due to a defective pulse cable. A review of the electronic history cards indicated that the magnetrons (4J47, 4J48 or 4J59) used in the SG-6 radar aboard this vessel averaged about 300 hours of life. It also revealed that 30 percent of the magnetrons received for spares failed to operate with the equipment, that 40 percent could be used on short pulse only, and that the remaining 30 percent could be used on short or long pulse with a maximum life of about 600 hours. All magnetrons were baked for at least forty-eight (48) hours prior to installation; failure indication would be one or more of the following:

(a) Constant and excessive arcing of the magnetron.

(b) Low power output-low ringtime.

(c) Low magnetron current reading.

(d) Poor frequency spectrum.

(e) Poor target definition.

The pulse cable (RG-74/U, length 103") was checked and appeared normal, but disassembly of the connector (UG-36/U) revealed a loose connection between the center conductor of the pulse cable and the pin of the connector at the transmitter end of the cable. Arcing between the connector pin and the coaxial conductor had caused the Dow-Corning compound in the connector to turn black and lumpy. A new pulse cable was installed and the following results obtained:

(a) Resonance indication previously reading 20 dial divisions went to maximum on the meter.

(b) Ringtime increased slightly over the maximum previously recorded.

(c) Magnetron current remained normal, with a minimum of arcing.

(d) Small target indications were much sharper and maximum range 40 percent greater.

(e) Only 1 magnetron had failed in operation since replacement of the pulse cable, a period of about 7 months. The life of this magnetron was over 1,500 hours. Most of the magnetrons which formerly failed to operate in the radar, or which operated on short pulse only, now operated properly.

This maintenance problem solution is published as an aid to the correction of similar causes of high failure rates among SG-6B RF components, and to encourage the submission of similar material for fleet publication.

SG-6B RADAR ANTENNA PROBLEM

A solution to a SG-6B radar antenna malfunctioning problem has been reported:

Antenna trouble was first noticed by intermittent rotation of the antenna. The antenna appeared to be dragging on the half cycle into the wind with complete stoppage at times. Investigation revealed the brushes were nearly worn to the minimum 1/4 inch after 1,087 hours of operation. The brushes would not remain seated properly, causing the intermittent rotation and complete stoppage in a relative wind of 40 knots. One commutator bar being burred and raised higher than the others was found to be the cause of the excessive brush wear and of the brushes jumping out of position, catching the brush holder spring on the brush holder assembly. To hold the brushes against the commutator, the commutator was turned down and the brush springs tightened. After reinstallation of the motor the intermittent operation continued, so that the spare was drawn and installed in the antenna.

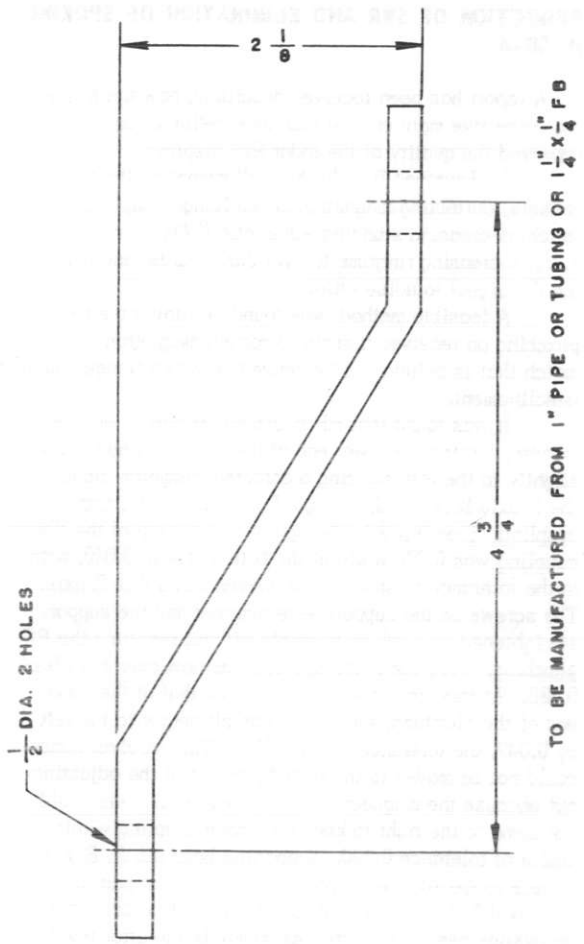
The new drive motor operated satisfactorily for only 128 hours before the same type of intermittent operation was noticed. The brushes would not hold proper contact against the commutators even after tightening the brush springs in the new motor. Though the brushes were not excessively worn, the brush holder springs would catch against the side of the brush holder assembly, removing the spring pressure needed to make contact between the brushes and the commutator. Vibration was believed to be causing the spring to catch against the square corner of the brush holder and then at times jar it back to the holder. This proved to be the source of the trouble.

The corners of the brush holder guide have been rounded off so that the spring can guide itself back into the holder. The antenna has rotated continuously at 15 r. p. m. with no indication of dragging.

This information is published as a suggestive cure for possible similar difficulties encountered on other SG-6B radar antennas.

ANTENNA-TO-PEDESTAL LOCKING DEVICE FOR SG SO SERIES RADARS

A suggestion proposing a new locking device for securing SG series or SO series radar antenna for repair on active vessels or preservation on reserve fleet vessels has submitted. Formerly, angle iron with flanges welded on each end was used. This type of bracket was expensive to construct as it required the services of two crafts to manufacture.



The suggested bracket may be manufactured (see sketch) from either 1-inch or 1 1/2-inch pipe or 1 1/4-inch strap iron. Preventing rotation of the reflector while work is in process or the equipment is in "mothballs" the bracket may be unbolted, turned over, and the antenna rotated with the locking device still attached, precluding the possibility of loss of the locking device while checking out the radar. The illustration shows the proposed locking device in place.

NO MAGNETRON CURRENT

An inspection of the equipment disclosed no magnetron current. Since ships force had explored normal sources of trouble, the pulse cable between modulator and transmitter/receiver units was suspected. The cable was disconnected at both ends and meggered. Resistance reading was 250 K. The plug at the transmitter end (P & J 1520) was disassembled, showing the cable to be shorted and charred at that point. The cable was cut back about 6 inches and the plug remade—normal operation was then observed. Equipment operation was observed for 2 hours during the seasoning of the new magnetron and minor tuning adjustments were made. T/R tube V1504 (1B50) was replaced because of consistent blowing of crystal Y202.

REDUCTION OF SWR AND ELIMINATION OF SPOKING IN SG-6

A report has been received describing how the following corrective maintenance increased reliable range and improved the quality of the radar PPI display:

1. Improved RF plumbing alignment on the receiver chassis, correcting magnetron choke flange coupling mismatch, decreasing standing wave ratio (SWR) from 1.5:1 to 1.2:1, increasing ringtime to over 2,000 yards, and improving the signal to noise ratio.

A feasible method was found of alining the RF plumbing on receiver chassis to correct magnetron mismatch that is believed to be caused by choke flange coupling misalinement.

It was found that RF plumbing support D was bent inboard, forcing the lower end of the RF plumbing to move slightly to the left inducing a cantered mismatch along the X axis between the maggie flange and choke flange coupling. (See fig. 2.) The spacing at the top of the flange coupling was 0.070 while at the bottom it was 0.040, within the tolerance of spacing but uneven along this Z axis. The screws on the support were removed and the support straightened as much as possible without removing the RF plumbing. This done, the spacing was now even but about 0.080. At this time it was also noticed that at the other end of the plumbing, the flange was off center to the left by 0.047, the tolerance being 0.020 . The receiver chassis could not be moved to the right by means of the adjusting nut because the magnetron and transmitter chassis could not come to the right to keep the choke coupling within limits of tolerance 0.100. Supporting brackets A, B and C were loosened, then support "A" (fig. 1) at positions 1, 2, and 3 shimmed with 0.050 metal stock to bring the waveguide over to the left approximately the error involved, 0.047. This gave a good match along the X and Y axis. Then it was noticed there was still a mismatch along the Z axis at this point. The spacing was 0.090 at the top and 0.030 at the bottom. The only way to correct this without fouling up the RF plumbing was to remove bracket A again and file 0.060 (0.090"-0.030") from the forward corners of the supporting bracket, as shown in the diagram, to bring the wave guide forward 0.060, the error involved. This done, the spacing to 0.030" was evened up by alignment of the lower supporting bracket at C. After tightening down all bolts everything was in alignment within the tolerances. No extra twists or bends were induced in the waveguide run by the corrections. Before alignment the SWR was 1.5:1; it is now 1.2:1. The ring time is over 2,000 yards and significantly the signal to noise ratio has improved.

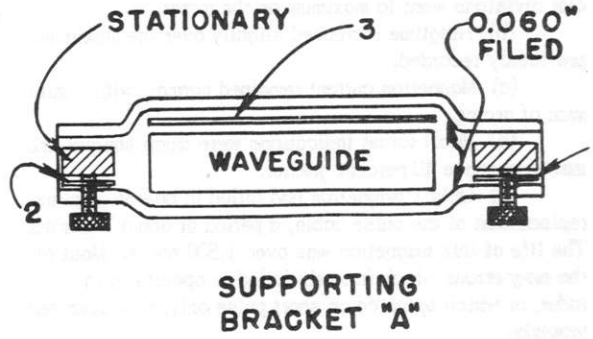


FIGURE 1.

2. Tigntened the transmitter chassis mounting on its runners, eliminating spoking:

During the last couple of days it was noticed that a few instances of spoking occurred. Upon investigation it was found that the transmitter chassis was considerably loose on its runners. When the ship was going through high speed maneuvers this chassis would vibrate from left to right causing the spacing between the maggie flange and the RF plumbing choke flange coupling to vary, sometimes touching. This caused an impedance mismatch and possibly standing waves to be set up at this coupling. There was evidence of light arcing. The chassis was removed from the cabinet and the right-hand runner shimmed to the left about 0.110 by using (2) 0.055 flat steel washers behind the braces on the runner on each of the (4) securing bolts. This took up all the slack in the chassis movement and eliminated this cause spoking.

The radar is now in excellent operating condition.

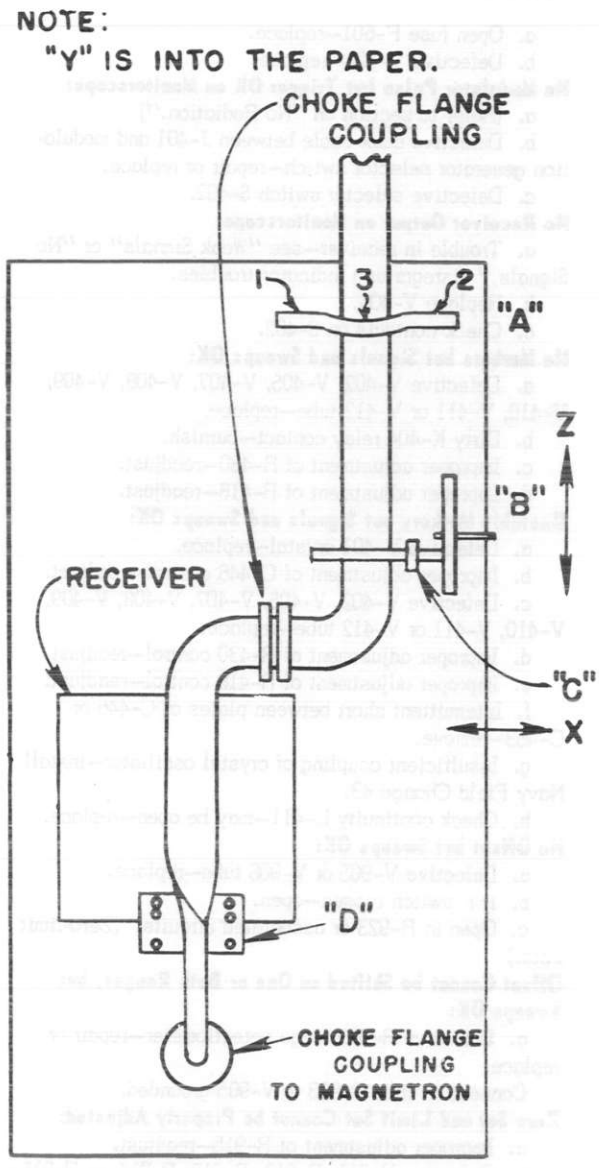


FIGURE 2.—Right side view of SG-6 transmitter.

MODEL SG SERIES TROUBLESHOOTING NOTES

TROUBLESHOOTING HINTS

No Radiation:

a. Defective V-401 or repetition rate oscillator circuit. Check for operation on MARKS. If trace appears, trouble is in transmitter.

b. Defective magnetron V-110. Replace.

c. Defective modulator tubes V-108 and V-109. Replace.

d. Defective 829 driver tube V-107. Replace.

e. Defective C-109, C-110, C-112, C-126, C-117, C-111 or C-101. Replace.

f. Dirty or defective S-104, S-105, S-106, or S-116 (interlock switches). Clean or replace as necessary.

g. Open fuses. Replace.

h. Defective C-118 through C-123. Replace.

i. Defective K-101 relay fails to close. Check microswitch (does not close).

j. Waveguide shutter not opening—free or replace E-107.

k. V-106 shorts.

l. C-116 shorts and burns out R-129. Replace.

Intermittent Radiation:

a. Dirty or defective S-104, S-105, S-106, or S-116 (interlock switches). Clean or replace.

b. Defective tube V-110, V-109, V-108, V-107, V-106, or V-105. Replace.

c. Dirty or pitted time-delay K-101. Clean or replace contacts.

d. Dirty or loose modulators V-108 and V-109, filament socket contacts, or leads. Clean with crocus cloth, tighten, solder as needed.

e. Check for cracked porcelain feed—through insulators at "R and S" on driver bracket.

f. Water in waveguide. Remove and clean.

Overload Relay Will Not Stay In:

a. Defective or gassy V-110 tubes—reset several times. If gas won't "cook off," replace.

b. Defective V-108 or V-109. Replace.

c. Defective C-102. Replace.

d. Check that relay is adjusted to approximately 100 ma as indicated on its scale (some have been found set too low).

Unstable Radiation:

a. Magnetron V-110 double moding. Readjust variac slightly. Replace magnetron in persistent cases.

b. Arcing in waveguide. Foreign matter or scale—remove waveguide section and clean thoroughly.

c. Improperly adjusted V-106 bias control R-129—adjust.

d. Weak magnetron magnet assembly—replace.

Low Output:

a. Weak magnetron V-110 or modulator tubes V-108 and V-109—replace.

b. Weak rectifier tube V-101, V-102, V-103, or V-104—replace.

c. Resistor R-142, R-143, R-118, or R-119 increased in value—replace.

d. Weak V-105, V-106, V-107 tube—replace.

e. Defective C-118 through C-123—replace.

f. Low line voltage—check.

g. Dirty or loose modulator tubes V-108 and V-109, filament socket contacts, or leads. Clean with crocus cloth, tighten, solder as needed.

h. Weak magnet E-103 (an indication of this is high V-110 current as read on TRANSMITTER CURRENT meter).

No Indicator Sweeps:

a. Defective V-403, V-404, V-909 tube—replace.

b. J-101 or coax cable #3 shorted or open—repair or replace.

c. Open fuse F-902, F-903—replace.

d. Defective cathode-ray tubes V-914 and V-915—replace.

e. Improper adjustment of R-418—readjust.

f. No trigger pulse from S-103—check, especially cabling.

g. V-903 or V-904 removed from socket—reinsert.

No Range Sweep but PPI OK:
a. Defective F-904—replace.
b. Defective V-902—replace.
c. Defective V-913—replace.
d. Defective V-915—replace.
e. Shorter C-925.

No PPI Sweep but Range Sweep OK:
a. V-907, V-908 defective—replace.
b. V-910 defective—replace.
c. Defective V-914—replace.
d. Focus coil grounds—replace.
e. Deflection coil opens—replace.
f. Make sure anode clip is on tube.

Short PPI Sweep:
a. Defective V-910—replace.
b. Defective L-903A-B—replace.
c. Defective R-954—replace.
d. Defective V-907 or V-908—replace.

Unstable Sweeps:
a. Improper adjustment of R-418—readjust.
b. Defective V-403, V-404, V-902, V-900, or V-910—replace.
c. Dirty slip rings on deflection coil—clean.
d. Improper adjustment of R-129—readjust.

Weak Signals: (Refer to paragraph on "Low Output.")
a. Weak tubes in receiver or video stages of indicator—replace.
b. Detuned r-f system—retune and lock (SG equips. only).
c. Defective mixer coax cable—replace.
d. (1) Defective mixer tube V-302—on SG—replace. (2) Defective mixer crystal Y-301—on SGa/SG-1—replace.
e. Defective V-112 or V-113 or poor contact of TR tube in cavity—replace or clean.
f. I-f regeneration (1) tighten or clean receiver tube shields, swap i-f tubes, or replace offending tube. (2) tighten shield mounting screws. (3) poor soldered ground connections in receiver chassis.
g. Poor waveguide joints—repair.
h. Foreign material or water in waveguid. Remove section and clean. Drill 1/8-inch hole if water accumulates in low spot.
i. Insufficient local oscillator coupling—adjust coupling until oscillation indicator reads 20. (Never over 30.)
j. Excessive frequency drift due to overheating—clean or replace blower input filters. Check auxiliary blower.
k. Detuned i-f stages—retune.
l. Waveguide shutter not completely open.

No Signals at Close In Ranges:
a. Defective TR and Anti TR tubes—replace.

No Signals but Sweep OK: (Refer to paragraph on "Weak Signals.")
a. Throw SIG-MARKS Switch to MARKS. If marks appear, trouble is in receiver or transmitter.
b. Defective receiver tubes—replace.
c. Defective video tubes—replace.
d. Defective No. IV video cable between transmitter and indicator—repair or replace. Also check other cabling.

No Trigger on Monitorscope:
a. Open fuse F-601—replace.
b. Defective V-406—replace.

No Modulator Pulse but Trigger OK on Monitorscope:
a. (Refer to section on "No Radiation.")
b. Defective coax cable between J-401 and modulation generator selector switch—repair or replace.
c. Defective selector switch S-402.

No Receiver Output on Monitorscope:
a. Trouble in receiver—see "Weak Signals" or "No Signals," disregarding indicator troubles.
b. Replace V-406.
c. Check contacts on S-402.

No Markers but Signals and Sweeps OK:
a. Defective V-402, V-405, V-407, V-408, V-409, V-410, V-411 or V-412 tube—replace.
b. Dirty K-404 relay contact—burnish.
c. Improper adjustment of R-430—readjust.
d. Improper adjustment of R-418—readjust.

Unstable Markers but Signals and Sweeps OK:
a. Defective Y-401 crystal—replace.
b. Improper adjustment of C-446 control—readjust.
c. Defective V-402, V-405, V-407, V-408, V-409, V-410, V-411 or V-412 tube—replace.
d. Improper adjustment of R-430 control—readjust.
e. Improper adjustment of R-418 control—readjust.
f. Intermittent short between plates of C-446 or C-453—remove.
g. Insufficient coupling of crystal oscillator—install Navy Field Change 43.
h. Check continuity L-411—may be open—replace.

No Offset but Sweeps OK:
a. Defective V-905 or V-906 tube—replace.
b. IFF switch closed—open.
c. Open in R-923 or associated circuits. (Zero-limit sets.)

Offset Cannot be Shifted on One or Both Ranges, but Sweeps OK:
a. Defective R-923 range potentiometer—repair or replace.
Connection from R-923 to V-905 grounded.

Zero Set and Limit Set Cannot be Properly Adjusted:
a. Improper adjustment of R-915—readjust.
b. Defective R-911, R-912, R-913, R-914, or R-915—replace or shunt a high value resistor across R-913 and R-914.
c. R-923 arm slipped on shaft—readjust so R-923 resistance at zero range is approximately 1000 ohms.

Unstable Signals Due to Vibration:
a. Loose tube elements—replace tube.
b. Loose terminals—tighten.
c. Loose PPI focusing or deflection coil—tighten.
d. Dirty relay contacts—clean and burnish.
e. Dirty interlock switches—clean and polish.
f. Dirty or loose fuse or resistor—clean and tighten.

Antenna Fails to Rotate:
a. No power from synchro excitation bus—throw switch to emergency position (relative bearing).
b. Open F-901 or defective fuse holder—replace.
c. Defective motor-dynamo amplifier—repair.
d. Defective V-801 or V-802 tube—replace.

e. Defective drive motor or fouled commutator—repair.

f. Defective wiring to antenna—correct.

g. No field voltage on antenna motor. The armature may burn out if voltage is applied to it under this condition.

h. Antenna safety switch may be in OFF position, switch ON outside of antenna pedestal door. (Not on all equipment.)

Antenna Hunts:

a. Improper adjustment of R-801—readjust.

b. Weak V-801 or V-802 tube—replace.

c. Poor voltage regulation—check and remedy.

d. Reversed polarity at terminals 99 and 100 on E-805.

e. Reset lead B on T-801 to one tap more or less as needed.

f. Defective 1801 neon bulb in control amplifier—replace.

g. Backlash in antenna synchro coupling. Replace or tighten coupling.

Antenna Rotates Continuously:

a. Defective V-801 or V-802—replace.

b. Open conductors in antenna cable.

c. Antenna synchro coupling disengaged.

Incorrect Bearings:

a. Synchro system out of adjustment—readjust.

b. Loose or defective couplings on synchros.

c. Worn keyways, gears, or loose setscrews in antenna pedestal—repair.

d. Incorrect wiring or open conductors in synchro system.

e. Poor contact on K-901 relay—affects true bearings only—clean or adjust.

Signal Monitor Does Not Indicate:

a. Defective V-201, V-203, or V-204—replace.

b. Defective wavemeter crystal—replace.

c. Wavemeter improperly tuned or pickup coupling too loose—adjust.

d. Defective wavemeter coaxial cable—repair or replace.

e. Dirty RECEIVER-TRANSMIT switch on monitor—clean.

Signal Monitor Gives Erratic Indications, but Transmitter OK:

a. Dirty or loose wavemeter plugs—clean.

b. Defective V-201, V-202, V-203, or V-204—replace.

c. Defective wavemeter crystal—replace.

d. R-f leakage in transmitter—check grounding and alignment of r-f system—replace V-110.

Range Counters Inoperative:

a. Jammed with dirt—clean in carbon tetrachloride or replace if counter is worn.

b. Fail to turn with range crank because of bent shaft or stripped gears—repair or replace.

Excessive Standing-Wave Ratio:

a. Foreign material in waveguide—remove and clean guide.

b. Loose or damaged waveguide joints—inspect and repair.

c. If an expansion joint is used, check alignment and realign if necessary. The spacing of the expansion joint should not exceed 1/2-inch.

d. Refer to paragraph on "Low Output."

e. Poor waveguide run with excessive number of bends, twists and elbows—rerun waveguides.

SUBSTITUTE SAFETY STOP BRACKETS FOR RANGE AND TRAIN INDICATORS OF SG AND SG-1 SERIES

A suggestion for the replacement of faulty, safety stop brackets with brackets of new design, on Range and Train Indicator of SG and SG-1 series equipments has been suggested. Shipboard and maintenance activity personnel should check SG and SG-1 series equipments to determine if the recommended change is needed. Only faulty brackets should be replaced. The suggested brackets are approved for use.

This suggestion involves using two metal arms 3/16-inch thick, 1-inch wide and 2-inches long, and drilling and tapping two 1/4-inch holes. The range and train indicator, which weighs approximately 870 pounds, has two guide rails, one on each side of the chassis on which the unit is pulled out for servicing. The chassis has two small stops which slide into and clamp against the rollers of the guide rails to lock the chassis. These present locks or stops are unsafe since on several occasions in this yard they have sprung and the chassis (870 pounds) has tilted or fallen.

The suggestion is to have the two arms drilled and tapped onto the framework of the chassis, one on the upper right rear corner and the other on the lower left rear corner, figure 1. When the chassis is pulled out to the limits, the two arms will lock against the cabinet and prevent any further travel.

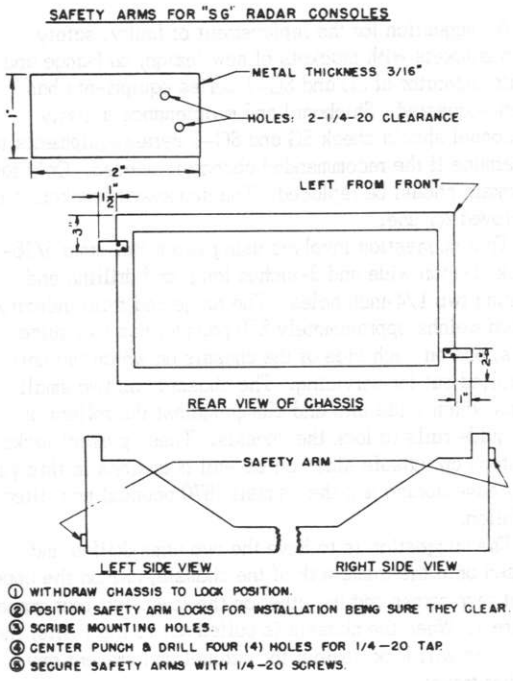


Figure I

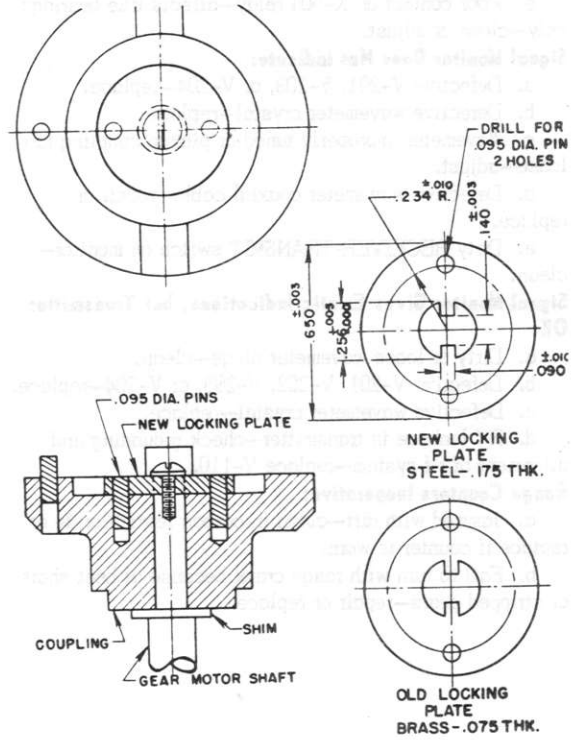
SG-1B REPORT ON FAILURE OF AMPLIDYNE GENERATOR

The following information is published as a maintenance aid to fleet activities:

"For the past two years, vessels have been troubled with an extremely erratic rotary motion of the SG antenna. in March of 1954, an antenna was lifted at the New York Naval Shipyard in an unsuccessful attempt to correct the 'hunting' action. It was again lifted by the tender but the cause of the trouble was never located. Recently, the subject generator failed and was dismantled for inspection. It was found that loose brush wires had been rubbing on the armature for a long period of time, and had broken the armature winding in many places. While the generator continued to operate after some wiring had been cut, the signal produced was erratic, and apparently caused poor operation of the antenna drive. Upon replacement of the generator, the antenna operated perfectly."

SG-1b REPLACEMENT OF COUPLING IN ANTENNA

A suggestion has resulted in the approval of an improved coupling (between synchro unit and gear box



in the antenna) for replacing couplings which have failed.

The original coupling is taken apart and the locking plate removed and replaced by a new locking plate. (See figure 1). The coupling is reassembled and connected in position between the synchro and the gear box. The antenna is then given a complete lubrication in accordance with the lubrication chart (to prevent excessive torque from shearing the synchro-to-gear-box coupling) and returned to normal operation.

The new locking plate is made of untempered steel instead of brass and is 0.175-inch instead of 0.078-inch in thickness. It is silver soldered to the coupling instead of being attached by a small screw.

MODEL SG-6 ANTENNA GEARS

Difficulty has been experienced in identification of gears and gear assemblies used in SG-6 antenna assembly, type CRP-66AMQ, as outlined by illustrations and parts lists in technical manual NAVSHIPS 900,861A and NAVSHIPS 900, 861A.1.

Figure 7-48 in both technical manual illustrates the main gears of the antenna gear-train mechanism. These gears are numbered 1 through 6 and are not carried in the supply system as individual repair parts but are supplied as parts of complete replacement assemblies. It is recommended that complete assemblies be ordered through normal supply channels and installed if replacement of these gears becomes necessary.

To facilitate the identification of the complete assemblies in connection with the gears as illustrated in figure 7-48, the following information is given:

a. Antenna Subassembly: symbol 0-1301, contractor's drawing No. 12-5260G1, contains gear no. 5, tag no. 1366, stock No. N5840-309-2400.

b. Antenna Subassembly: symbol 0-1302, contractor's drawing No. 12-5262G1, contains gear no. 1, tag No. 1367, stock No. N5840-387-2392.

c. Antenna Subassembly: symbol 0- 1303, contractor's drawing No. 12-5261G1, contains gear no. 4, tag No. 1368, stock No. N3010-694-2801.

d. Antenna Subassembly: symbol 0-1304, contractor's drawing No. 12-5259G1, contains gear no. 2, tag No. 1369, stock No. N5840-321-6885.

e. Antenna Subassembly: symbol 0-1316, contractor's drawing No. 12-5258G1, contains gear no. 3, tag No. 1382, stock No. N5985-387-2392. (Incorrectly identified as symbol No. 0-1305 in figure 7-48, 7-57, and 7-58 in technical book NAVSHIPS 900, 861A.1.) (This item is presently BuShips controlled; however, action is being taken to transfer control of Antenna Subassembly N5985-387-2392 to the Electronic Supply Office.)

f. Antenna Subassembly: symbol none, contractor's drawing No. 102-5405G1, contains gear No. 6, tag No. 1385, stock No. N5840-305-6856. (Incorrectly identified as symbol No. 0-1306 in figures 7-48 and 7-61, in technical manual NAVSHIPS 900,861A.1 and was deflected from the spare parts list.)

TEST SET FOR CHECK OUT OF ANTENNA IN SG-6, SG-6B

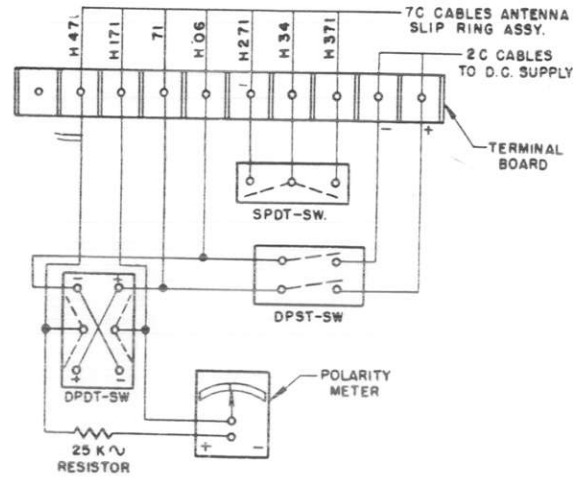
A test set has been designed to be used for testing antanna circuits in SG-6 and SG-6B equipments.

The purpose of the suggested test equipment is to check for correct wiring, open circuits, or short circuits in the antenna selector valve assembly and all associated component parts. It enables speedy checking, trouble-shooting, and repair of antennas. This test set aids in finding defective wiring, checking all switches, and continuity through slip rings, and for checking dc drive motor and motor circuit included in selector valve assembly and antenna.

The disadvantage of the present testing method is that the appearance of a simple defect in the antenna often necessitates removing the antenna from the ship for disassembly in the shop to locate and correct the trouble.

The wiring and outline drawing shows necessary details for fabricating the test set, figure 1. The "Surface-Zenith" switch in the test set provides a means of reversing polarity of the input voltage to the drive motor; the meter provides a visual means of checking the polarity.

The suggested device, by changing polarity on the input voltage, also permits a reversal of the rotation of the Geneva Wheel within the selector valve assembly. This test equipment also changes position of cams and switches to allow a change form Surface Search to Zenith Watch and to permit proper alignment of the waveguide in either position. Use of the suggested test set at yards and repair facilities may be locally authorized.



SCHEMATIC WIRING

Figure 1

SG-6B SHORT RANGE FALSE RINGING

A Raytheon representative reports encountering false ringing extending up to 800 yards on several installations with long (approximately 100 feet) waveguide runs. Minimum range was improved to 200 yards by replacing the RG-49/U (1" X 2") waveguide with its transition flanges and mode suppressor with RG-50/U (3/4" X 1-1/2") waveguide.

SIGNAL GENERATOR SG-31/U RF VIDEO LEVEL

Field activities have reported that in many cases it is impossible to adjust the Video RF level of the Signal Generator SG-31/U to simulate a saturated signal radar return.

Pending the completion of an investigation of this condition and issuance of an official field change, the Bureau authorizes the replacement of R-268 (1K1/2W) with a 390-ohm, 1/2-watt resistor as an interim solution.

Notes on Recurrent Failures (SGa, SG–1)

Antenna

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Intermittent operation of antenna.	Connector lugs coming into the control amplifier were just wide enough so that they rested on the Jones connector strips instead of making good contact with their respective contacts. This caused an intermittent operation of the antenna, because at times there wasn't any current supplied to the unit.
SGa developed erratic hunting of the antenna.	Changing 6L6 tubes no help. Fuses at gyro repeater switch board O. K. Discovered neutralizing control R–811 had insufficient range for eliminating the "hunt." Stable operation was obtained by moving lead "B" on T–801 in the control amplifier assembly from tap No. 6 to No. 7.
Antenna rotating intermittently on automatic and hard to turn by hand crank.	Guide wheel on pinion gear binding. Loosened guide wheel and cleaned slip rings and brushes.
Antenna stopped revolving.	Found 6L6 (V–802) to have a dirty contact at socket. Cleared.
Antenna tended to "hunt."	Adjusted potentiometer R–811 in motor-amplifier unit to overcome this condition.
Continuous rotation of antenna.	V–801 (6L6 tube) found defective. Replaced.
The antenna was not able to keep up with the slewing motor when rotated at high speed.	About every fourth revolution the antenna would drop back to get in step. Replacement of the tubes V–801, V–802 (6L6) in the control amplifier returned things to normal. The abnormal indication at the control amplifier was the constant glow of the neon indicator bulb V–803.
Antenna would no rotate. Echoes on range scope remained in same place. Echoes on PPI dragged around in circular movement.	Fuse blown in gyro bus. Replaced. Operation normal.
Bearings read low, about 1½°.	Rotated synchro in pedestal in clockwise direction and locked. Bearings normal.
Difference of 3° to 5° in bearing of fixed echoes when direction of antenna rotation was reversed.	The Antenna Assembly (CRP–66ABJ) was removed from the mast of the ship. The top plate of the antenna pedestal (of gear case) was slid to one side and then removed to facilitate work. It was found that the key that fits into the keyway of the small gear and the gear motor B–701 was too small, also the Allen setscrew had lossened up. These conditions caused a "slap" or back lash between the two gears. A larger key was inserted, the Allen set-screw was tightened—the antenna was reassembled and placed back on the mast.
Normal operation of antenna at low speeds of slewing motor. At higher speeds, antenna would reverse direction without signal several times per single revolution. Trouble got worse rapidly until antenna refused to answer to train signal except for slight hunting.	Cleaned amplidyne of grease and carbon which was the result of overlubrication. Took turn off commutator on lathe. Cleaned carbon from between segments of commutator.
After antenna was operated CCW for an hour it would begin to hunt intermittently in a 60 degree arc.	Replaced one 6L6 in the control amplifier.

Transmission Line

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Range performance poor. Severe arcing heard.	Shut down immediately. Dried out wave guide with clean rags on plumber's tape. Removed about 2 cups full of water in horizontal section of wave guide 4 feet long. Performance normal. Drilled several ¼-inch holes at the lowest point of the horizontal run to allow drainage. (Care must be taken to smooth out rough edges around the hole, both inside and outside.)

Transmitter

Bad keyer pulse.	1 tube type 829 (V–107) defective. Replaced.
Time delay relay K–101 did not always make good contact.	Contacts were cleaned with crocus cloth and carbon tetrachloride.
Instability in transmitter.	Front pole of magnetron magnet found weak compared to rear pole. Replaced magnet and found operation stable.
Transmitter current read between 1 and 2 mils.	One of the modulators, 304TH (V–108) had a grid to filament short. Replaced.
Only two sections of each 304TH (V–108, 109) lighted.	Found one leg of filament circuit grounded. Cleared.
Magnetron current low 9 ma with Variac turned to maximum voltage and line voltage 115. Operation fair to normal otherwise.	Replaced both 304TH keyer tubes—magnetron current then increased from 9 to 15 ma.
Unit became inoperative.	Located trouble due to shorted section of the H. V. filter and doubling condenser C–101. Replaced unit.
No output at transmitter.	Defective V–107 (829)—replaced.
Intermittent and subnormal operation.	Magnetron current 10 ma. Cleaned 304TH tube to socket contact.
Excessive frequency drift.	Air filter clogged, causing temperature of transmitter to rise excessively. This caused frequency to drift almost continuously. Cleaned air filter on transmitter.
With the Variac in the full "on" position the high voltage overload relay chattered while the reset button was held depressed. With the Variac set at 50 the high voltage overload relay held but no magnetron current was flowing. The total transmitter current was 25 milliamperes and the modulator tubes, type 304TH became very hot in a few seconds. When the driver tube, type 829, was removed, the modulator tubes did not heat.	After a prolonged search, the coupling condenser, part No. C–116, between the gas tube, type 2050, and the driver tube, type 829, was found to have been shorted. This threw a positive bias on the driver tube, type 829, which then drew so much plate current the bias voltage available to the modulator tubes type 304TH, was reduced to a very low value causing the tubes to heat excessively.
Overheated transmitter.	Dust stop packed with dust.
Fluctuating (V–110) oscillator plate current.	(V–110) oscillator filament lead at terminal connection on T–105, magnetron filament transformer, tightened. (Connection was very loose.) Keyer tube filament lead shorted to ground where sharp edge of modulator chassis had rubbed through insulation. Ran new filament lines, using 10,000 volt test wire and running clear of sharp edges.

Transmitter—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Transmitter output insufficient to keep duplexer tube lighted.	Keyer tube filament lead shorted to ground where sharp edge of modulator chassis had rubbed through insulation. Ran new filament lines, using 10,000-volt test wire and running clear of sharp edges.
Low transmitter plate current.	The heater leads from the modulator tubes are connected to a fiber terminal board. The board was charred at the terminals apparently due to heat developed by loose contact. This caused the transmitter plate current to become very low and also manifested itself by the indication of high driver current. The filament leads were replaced with heavy copper braid conductor insulated with glass tape covering and the fiber board terminals were replaced by three porcelain terminals mounted on a metal bracket. The plate current immediately increased and the power output of the transmitter was greater than at any time.
V–110 current only 0.002 ampere.	Tightened down V–108 and V–109 filament terminals on driver panel. Cleaned up filament prongs on V–108 and V–109 tubes. Upon completion of work V–110 current up to 0.020 ampere. Signal strength was normal.
The transmitter current meter M–103 read about 2 ma. and the 304TH modulator heated excessively.	The driver unit was removed and examined for defective parts. C–111 was replaced. Normal operation was obtained.
Driver current crept to 5 ma.	40,000 ohms measured across C–126 when disconnected. Replaced.
Transmitter current low.	Filament leads going to the modulator tubes V–108/9 304TH type, were tightened and the bias on the buffer amplifier tube 829 increased slightly.
Transmitter could not be turned on by radiation switch.	Interlock in transmitter panel failed to make proper contact. Repaired. Operation normal.
No magnetron current.	Tested circuits and found shorted coupling and leaky timing condenser (C–117 and 118) in driver circuit. Replaced condenser and again tested equipment. Equipment operated satisfactorily.
Overload relay would not reset. No transmitter output (1 mil magnetron current). Replaced 705A. Check was made for pulses. Modulator pulse was not quite normal. Replaced resistor F–129. Operation now normal. Later the magnetron current dropped to 5 mils and signals faded; one hour later the current rose to 17 mils and signals reappeared.	The equipment operated normally for a short time then the current dropped down again. It was found that the condenser C–123 was breaking down intermittently. This was replaced and operation was normal. (NOTE: Any one of the delay line condensers, C–118 through C–123, can cause these symptoms.) See Field Change 24.
C–118 and C–122 with high leakage values cause the square wave transmission network not to work. The trigger pulse was not "loaded" and there was no modulator pulse or transmitter current reading.	New capacitors put the equipment back into operation. (NOTE: Any one of the delay line condensers, C–118 through C–123, can cause these symptoms.) See Field Change 24.

Transmitter—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
While set was operating at optimum efficiency, all echoes disappeared; there occurred a higher duplexer sing; arcing was heard in transmitter; all sweeps disappeared. Examination disclosed broken glass collar of plate lead on magnetron. Fuses 103, 104, 105, and 108 were blown. K–103 chattered when overload relay pressed—would not remain closed.	Attempted to isolate trouble by substituting tubes in transmitter while eliminating single circuits. Tubes could now be successfuly checked and it was found that one 2050 (V–106) would not pass a signal. After sweeps were obtained, removed one 705A (V–101) rectifier, using the other as a half-wave rectifier, cutting down average d-c current output. This enabled relay to close but resulted in excess transmitter current (30 to 40 mils). This was unsuccessful as K–103 continued to cut in and out in chattering manner. By alternately removing and replacing V–101 and cutting out different parts of the circuit by pulling tubes, resistors, etc., trouble was tracked down to C–102. This condenser had been previously checked and was found to be all right. By closely watching C–102 with C–101 in, arcing could be seen between rubberized lead coming from C–103 and passing close alongside of C–102 providing a short between the two condensers. This arcing was not discernible except with difficulty with the left panel removed and only if one was looking for it. Removed lead from vicinity of C–102 and reinsulated. It is believed that probable rubbing from vibration and deterioration of rubber caused H. V. breakdown.
Very poor echoes for first several thousand yards.	Remedied by placing V–112 (721A) and returning for maximum response.
Magnetron current was observed to be gradually dropping.	R–142 and R–143 in driver were checked. R–142 measured 60,000 ohms, and R–143, 125 ohms. R–142 was replaced with single spare. Magnetron current returned to 16 ma.
Intermittent dropping of V–110 current 3 ma. and total current increasing 10 ma. Keyer tubes, V–108 and V–109 simultaenously getting red.	Replaced R–121 and R–122 which had changed from 62,000 ohms apiece to 26,000 and 1 megohm, respectively.
V–110 current 15 ma. with line voltage of 116 volts.	R–142 and R–143 had changed from 50 ohms apiece to 20,000 ohns and 100,000 ohms, respectively. These were replaced.
The magnetron current was varying erratically from 15 to 18 mils with the Variac full on.	Pulse line condenser C–119 had leakage resistance of 2 megohms and condenser C–123 had varying leakage resistance from 0.8 to 5 megohms. When these condensers were replaced magnetron current was steady at 23 mils.
705A (V–101) tube not free to vibrate in shock mount.	Lead to tube too short.
Trigger pulse unsteady and monitor scope showed double trace.	Cleared trouble by replacing V–105—6X5GT.
Fuzzy modulator pulse.	Replaced C–121 condenser in pulse forming network.

Receiver

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Receiver tuning drifted excessively and sensitivity decreased after several hours of operation.	McNally tube, first oscillator was replaced in receiver, correcting trouble.
No receiver grass.	Replaced defective 6H6 (V–309) second detector.
Poor gain in receiver.	Found that by replacing 6AC7/1852 (V–304) and (V–305) with new tubes, a substantial gain in signals was secured.
Tuning meter on new receiver read a steady current of 7 ma. instead of peaking.	The 1853 (V–312) was defective. Replaced.
Off scale readings on the tuning indicator, M–902.	The voltmeter tube 6SN7GT (V–313) was replaced.
Sensitivity of unit tapered off rather abruptly beyond about 5,000 yards.	This condition was corrected by changing around the tubes in the i-f section of the receiver until the height of the grass on the range tube was uniform along its entire length.
Low sensitivity of equipment.	Found loose tuning plug on Z–301, tightened.
Grass low.	Retuned final i-f stage to restore grass to normal. (L–309).
Noise being picked up in i-f and appearing as thin grass with a definite peculiar waveform.	The thin grass disappeared when the loose link in F–105 was tightened.
Grass poor.	Interchanged V–305 and V–306—grass returned to normal.
No gating on receiver.	Receiver gating multivibrator not operating. 430 adjustment found set at edge of operating point. Readjusted.
Low receiver sensitivity.	Retuned L–306 and L–304 as these controls were loose and glyptol seals were broken. Tightened locking springs on L–306 and L–304 and applied glyptol to all i-f tuning controls.
Poor gain on receiver.	Changed tubes V–303, V–305 (i-f stages), V–310 (1st video) in receiver and gain returned to normal.
Slight regeneration of receiver.	The operation of the receiver gain control gave the receiver a chance to regenerate slightly making signals on long range erratic. Several of the i-f tubes were swapped around and the regeneration stopped. Locking rings around all tubes were tightened.
Bad condition of "sloping grass" in receiver.	Uneven grass on V–915 (5BP1) range tube. Proper selection of V–304—V–305 tubes is an important factor in securing even grass in receiver.
With equipment operating on long range there was little or no receiver gain with the pulse frequency switch (S–119). On either the B or C position the gain was normal.	Adjusted bias controls R–418 on the square wave multivibrator and R–430 on the receiver gating multivibrator.

Receiver—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Instability of receiver tuning required constant resetting of oscillation control, R–302 and tuning control (resonant cavity).	This was found to be caused by an unstable McNally oscillator, V–301. Upon replacement of this tube receiver sensitivity was very low. This condition was corrected by replacing V–512, 6SN7–GT, regulator tube in the power supply, which was found to have a shorted element.
Receiver would not stay in tune with very small line voltage fluctuations.	A change of line voltage from 118 volts to 120 volts changed repeller voltage from −520 volts to −540 volts, a change of 20 volts. Adjusting R–515 made repeller voltage variation only about 5 volts when line voltage was varied. Receiver tune is now steady between line voltage of 115 volts to 120 volts.
707A tubes had creeping plate current, rising from 15 ma. to 40 ma. during a time period of two to ten minutes. Oscillator cathode voltage dropped from −230 volts d-c to −150 volts d-c. Oscillator repeller voltage dropped from −460 volts d-c to −390 volts d-c.	Receiver power supply was immediately checked (V–508). 6AB7 tube in the voltage regulator circuit feeding the oscillator cathode voltage was cold. Tube was checked and found to have an open or burned out filament. V–508 was replaced.
Raytheon engineer in routine inspection found loss in receiver sensitivity. Also a slightly unstable McNally oscillator.	Peaked up McNally oscillator and duplexing cavities. Also unstaggered i-f stages to get more signal strength. Instability of McNally tube found to be caused by inner conductor in coupling unit to crystal mixer to be touching outer conductor under slight pressure. Inner conductor straightened out which brought back stability to the local oscillator.
In adjusting tuning of Z–301 cavity an intermittent condition was observed on the received signals.	It was found that the pickup loop coupling output from the oscillator to the crystal mixer was causing this condition. In forcing the coupling sleeve into the adapter coax, the inner conductor is pressed back toward the loop, thus expanding the loop, and causing the side of the loop to ground against the outer conductor of the sleeve. The correction for this is to loosen the clamps holding the oscillator coax. line on the mixed adapter and forcing the entire line forward away from the Z–301 cavity. This will then permit the inner conductor of the sleeve to enter the female section of the coax in the adapter far enough to permit proper adjustment.
Excessive grass and blanking out of PPI tube V–914 with receiver gain control R–906 advanced to maximum.	Physically relocated C–331 from its position at the grid of V–312 to the plate of V–305.
Meters M–301 oscillation indicator and M–302 tuning meter in receiver were very erratic when attempting to time equipment.	Adjusted shutter on solenoid E–107 in main frame.
Small magnetron blower motor commutator radiating r-f which was being picked up by receiver at crystal mixer assembly.	0.0002 μf condenser was shunted across 110v line to blower motor at motor frame.
Local oscillator had been operating at two distinct modes. Cleaning fins and locking contact rings made no difference. Ship's personnel had experienced abnormal drift, and short life from the 707's.	This was traced to the fact that R–515 was set at a position applying very high repeller voltage. This was adjusted to give reduced normal operating potential.

Modulation Generator

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Intermittent monitorscope operation.	Defective modulation generator 3AP1 tube (V–413). Replaced.
Pulse at modulator found erratic.	Corrected by replacing V–401A and by adjusting bias resistor R–129 on V–106.
Double trace on monitor scope.	See Navy Field Change 41.
Trace on monitor scope jumped erratically horizontally.	Replaced 6SN7GT (V–401). Adjusted square wave multivibrator bias (R–148).
V–413 would not focus.	Found R–474 focus control open. Replaced.
Double trace on V–413 monitor scope.	Changed position of K–407 relay. Position of K–407 affecting traces on V–413.
No sweep on monitor scope.	Tightened shorted sweep condenser C–436.
No sweeps on range or PPI tubes with pulse rates on B or C. Operation normal on pulse rate A.	Primary resistance of transformer T–401 found to be 7 ohms indicating a short in its winding. A new transformer was installed which cleared the trouble.
K–401 and K–402 in base frequency oscillator were found to contain dirt between the contacts causing jittery output.	The K–401 and K–402 had evidently been cleaned with crocus cloth or similar abrasive, a part of which had remained between the contacts. K–401 and K–402 were cleaned with a burnishing tool. All other relays in the equipment were similarly cleaned.
Trigger would cut off if R–407 potentiometer on modulation generator was turned clockwise past its midposition. Equipment would then not function.	Replaced R–407.
It was noticed that there was a multiple trace on the monitor scope, also that receiving gating pulse was not normal.	This was corrected by adjusting bias on receiver gate multivibrator with potentiometer R–430 to prevent multivibrator oscillating without first being keyed.

Range and Train Indicator

Loss of sweep on indicator unit.	Tube type 6SN7–GT burned out in modulation generator. Replaced tube.
The limit set control did not have sufficient range to pull the 15,000-yard marker down when the counter was set at 15,000 yards.	R–911 and R–912 were changed which cleared this trouble.
No traces on either scope in indicator, main frame scope and meter readings normal.	Cable 3 coax grounded in plug J–101 and at main frame.
Double trace, 75,000-yard range.	2050 (V–106) bias adjusted. Cleared.
The range counter was binding on occasion.	Discovered the faulty condition was due to dirt that had filtered into one of the range counters. Corrected the above condition by bathing both short and long range counters in carbon-tetrachloride, and lubricating with vaseline.
No grass on the range tube (V–915) when operation on long range with the gain control at maximum.	The first i-f tube 6AC7/1852 (V–303), was replaced.
Range marks for calibrating had slight double trace and fuzzy outline, at times no markers.	Tube type 6SN7GT in synchronizer socket (V–408A) and (V–408B) caused faulty operation.

Range and Train Indicator—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Range marks failed to hold calibration.	Traced trouble to defective range marks oscillator (V–407).
Double and erratic markers on 15,000 yards.	R–418, R–430, C–446 and C–435 (locked controls in modulation generator) out of adjustment. Remedied by adjusting modulation generator controls.
Grass on 75,000-yard range was slightly below normal.	Replaced, interchanged some of the 6AC7/1852 tubes in receiver i-f stages and brought grass up to normal.
No sweeps on V–914 and V–915.	Fuse F–903 opened. Replaced, obtaining sweeps.
Range marks on PPI (V–914) enlarged, very bright and out of focus.	Found grounded lead in wiring harness between PPI and R–971, caused by cable clamp cutting insulation. Operation satisfactory after servicing.
No range marks.	Found relay K–408 defective and replaced.
Intermittent sweep on range tube.	Trouble traced to a poor ground connection in the filter of the modulation generator power supply.
Slewing motor (B–901) not operating properly; clutch slipping.	Tightened packing gland on slow-speed shaft of slewing motor. Packing gland dragging against gear on slow-speed shaft of slewing motor, caused motor to stick, and clutch to slip.
No echoes or range-marks on PPI tubes; echoes and range marks visible on range tube (V–915), but compressed due to a short sweep.	Installed new RKR–72 rectifier (V–901). Poor RKR–72 (V–901) caused loss of voltage to PPI tube (V–914), and range tube (V–915) sweep circuit.
Echoes and grass would occasionally drop to zero and then slowly reappear. The monitor scope was observed to show two straight horizontal traces spaced approximately 1/16 inch apart.	A poor ground connection between the chassis and pins No. 2 and No. 7 of X–311 was found. Secure ground connection on X–311.
Double trace in PPI tube V–914 ZP–455.	Primary leads of T–905 reversed.
Traces on PPI were jumpy when ship vibrated.	The PPI retaining ring was loose so that tube could vibrate causing sweep position to change. PPI retaining ring was tightened so that tube could not move.
When S–907 was thrown to standby position some chattering of K–901 relay was noticed, which caused slight disturbance to gyro repeaters.	Adjusting spring tension alleviated this condition.
No trace on range tube. Also affected operation of PPI tube.	Open filament on the range tube (5–BPI). Replaced tube.
No transmitter current; signals on indicator fading and also very weak at times.	Filament supply lead of modulator tubes was arcing and was burned at lug, where it is connected to filament metal strips on tube sockets. Also found metalized and burned bakelite separator. Removed separator having no spares, which did not affect operation, also cut off burned portion of filament lead and replaced burned lug. Operation normal. Transmitter current meter reading up to 15 mils.
Range marker pips blurred.	Adjusted condenser C–446 in modulation generator.
No targets.	Interlock on lower panel of main frame out of position. Not making contact. Bent interlock back in position to clear.

Range and Train Indicator—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Bunching of the 75,000 yards markers on V–914 from the thirteenth marker on.	Setting the pulse frequency at the lowest rate cleared this condition.
No sweeps on V–914 and V–915.	Radiation switch S–906 placed in LOCK position and sweeps appeared at V–914 and V–915.
Double trace on markers.	Replaced crystal oscillator in modulation generator.
5DG selsyn reading 4° high.	Zeroized 5–DG selsyn in range and train indicator.
Occasional double moding evident on range tube.	Re-tuned Z–301 (local oscillator).
Range counter not working properly mechanically. Backlash noted in gear movement.	Tightened down loose set screw in insulated coupling on range counter potentiometer shaft.
Echoes on PPI V–914 not clear.	Reversed primary leads to T–905. The field of T–905 was causing diffusion of images appearing on V–914.
Lack of gain (grass) on long range.	The last two i-f stages were peaked so as to bring up the gain.
Equipment operating normally except for slight error in range calibration.	Adjusted C–453 in modulation generator.
Sloping grass saturated at start of sweep, no grass two inches from beginning of sweep. (Severe at 75,000.)	Bonded socket terminals 1, 2, 3, and 5 of V–312. Slight improvement in sloping grass resulted from bonding of terminals to ground.
15,000- and 75,000-yard markers did not coincide.	Readjusted C–953 and R–915 to make 15,000- and 75,000-yard markers coincide.
Grass not normal, amplitude greater at beginning than end of sweep on range tube, especially noted on long range.	Replaced first three i-f tubes (V–303, 4, 5) 1852's.
Some play was found in gearing between PPI sweep yoke L–904 and 5DG selsyn B–903.	A shim was removed from under jack shaft gearing assembly. Wear in fibre gears on PPI yoke—5–DG jack shaft caused slight amount of play. Removing shim reduced the tendency for echoes appearing on V–914 to be out of agreement, depending on whether clockwise or counterclockwise rotation was used. Slight amount of displacement still noted and the degree of this condition was concluded to be normal.
Frequency drift.	Air filters clogged. Replaced.
Unable to bring PPI tube into perfect focus.	Replaced R–965, PPI focus control.
V–914 focus poor (broad).	Reversed primary connections to T–905. Magnetic field from T–905 causing poor focus on V–914.
No markers on V–914, PPI on long range position.	Readjusted R–968, PPI anode No. 2.
No sweep on V–914 on RECEIVER TUNE position of S–910.	Replaced V–403 and readjusted R–418.
R–967, PPI focus just focusing at maximum clock wise position.	Replaced R–965, 25,000 ohm 2 watt, with 15,000-ohm 2-watt resistor. Too high a value of the parallel resistors R–965 and R–966 would not allow R–967 to focus the PPI tube, V–914.
Sweep on V–915 range tube unsteady when operating R–923 range potentiometer.	Cleaned contacting surfaces of R–923 range potentiometer.

Range and Train Indicator—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Pulse frequency below normal.	Replaced V–401 6SN7–GT repetition rate oscillator tube from equipment spares.
Markers very unstable.	Removed small pieces of solder from plates C–446 phasing capacitor.
Signals and markers erratic on short range band. Sweep line continued on, even with echoes on range tube. The indication was that double moding was occurring, but after tuning the transmitter and receiver this idea was discarded.	R–418, the bias for the square wave multivibrator was adjusted until the sweep on the range tube was normal. This adjustment cleared up this trouble.
No signal on range scope, PPI scope operating normally.	Replaced C–925, 1.7 kv. filter for range scope power supply. It shorted during normal operation.
Over a period of approximately 50 to 60 hours of operation the "grass" on the range scope would decrease from normal maximum to 30 percent or less. This decrease would continue proportionately until it was impossible to see any grass on the range scope.	Location of trouble: By replacing all of the i-f tubes (type 6AC7) in the receiver, and aligning the i-f stages, normal grass was restored temporarily. However, the same gradual loss of sensitivity followed as before. It was found that careful tuning of the reflection type oscillator in the receiver about 20 to 30 minutes after the radiator switch is turned on in conjunction with a careful tuning of the transmitter for maximum echoes and at the same time maximum rise of the tuning indicator meter and maximum dip of oscillation meter has corrected the trouble. This procedure is followed each time the radiation switch is turned on.
Sweep and signals dim on range tube (V–915) with pulse frequency switch S–911 on "A" position.	Brought up intensity on range tube by adjusting intensity control R–990.
Plate supply circuit for indicator blows fuse during 5-inch gunfire.	Replaced mounting of 2X2 with a more flexible rubber mounting. Have had no more trouble with fuse.
Stray trace on V–914 tube with receiver gain control off and PPI intensity controls set normally.	Made complete investigation of this condition. Decided it was caused by some stray pickup at S–912C as when S–912C is in the signals position the coax to V–914 G1 is open at S–9120. Placing a small (0.0001 μf) bypass condenser from the "S" position of S–912C cleared up the stray trace on V–914, without any noticeable abnormal effects to operation of the equipment.
Short sweeps on range and PPI tubes; sweeps appeared to double back on themselves. K–101 chattered.	Line voltage dropped to about 90 volts. Motor generator had lost speed as a result of carbon dust between contact points on speed regulator. Governor unit of motor generator was thoroughly cleaned and contact points were polished with crocus cloth.
PPI and range scope inoperative except when indicator chassis placed in certain position on slides.	Intermittent condition traced to broken coaxial lead to terminal 101 at terminal strip on side of indicator. Visual examination failed to disclose source of trouble due to fact the subject lead had been wrapped in rubber tape and affixed with same to the terminal strip for support at the time of original installation.

Range and Train Indicator—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Antenna revolved at slower speeds clockwise than counterclockwise, especially at the lower speed.	On the slewing motor, B–901, dirty brushes and an oil commutator were found. In addition, the grease lubricant in the gear box for the slewing motor had been overheated, causing it to liquefy and leak over other parts of the control unit, including the slewing motor. All parts were disassembled and cleaned with carbon-tetrachloride.
Gyro repeater causes overload on ship's gyro circuit.	Traced trouble to a loose piece of solder in K–901B. (This solder had been present since the equipment was built.)
Discrepancy in range tube marks. Long and short range sweep length not equal on range tube.	Adjusted R–915 and C–935 for equal sweep length on both long and short ranges on range tube.
Double range mark dots on PPI. Double dots appearing on PPI tube in operate position due to magnetic field of T–905.	Reversed primary leads on T–905 to correct double dot condition on PPI marks position.
Markers unsteady.	Adjusted C–935 to change sweep time so last marker would pull down. After resetting arm and adjusting C–935, range marks could be calibrated in normal manner.
Interference pattern on range scope had appearance of broad signal covering about 5,000 yards on the sweep.	Examination of the wave shape of the output of the amplidyne d-c generator indicated a sparking commutator. Examination of the amplidyne commutator disclosed that at least one section was raised slightly causing the brushes to jump. Apparently the sparking on the commutator generated high frequency energy approximately that of our i-f frequency. The arrangement of the antenna amplidyne cables and wave guide was such as to resonate at this frequency, thus the energy fed to the receiver from the wave guide which was not grounded at the lower end was sufficient to cause interference.
Offset on range tube short.	Bumper which holds V–915 in place had not been set up, this caused a poor connection. After setting bumper up tight, offset was normal.
The PPI tube V–914 showed range marks that were other than constant as to position upon rotation of the deflection coil assembly.	The brush contacts of L–904A were not making good electrical connection with the slip rings of the L–904 deflection coil. This trouble was corrected by reshaping the brush contact surfaces.
Antenna nearing stall at 150° on slow speed.	Bent synchro shield on 5F which stopped binding.
Inverted markers on G. E. remote PPI.	The clue to finding this trouble was that the markers on V–915 could not be brought down to zero magnitude by R–959, range mark amplitude control. This isolated the trouble to excessive range mark output from the modulation generator. With C–453 shorted the C bias was removed from V–412 (6V6GT) cathode followed, giving excess output which overloaded V–1006 (6SN7GT) limiter tube in the remote adaptor. This overload gave inverted markers.
Flashes (not double-moding) across "A" scope and PPI and monitor scope extending to about 1/3 the radius of short range scale, making accurate calibrations within this limit difficult. A blurry "Main Bang" noticeable.	Changing V–110 eliminated the condition. When current on V–110 dropped, the flashing reappeared.

Range and Train Indicator—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Meter M–902 in range and train indicator was reading 50 ma. in normal position of switch 8910 with Variac T–901 on full. A vibrating double trace on range scope V–915.	The double trace on V–915 disappeared after installing shield around 5F synchro B–902.
Intermittent bearing error when antenna was rotated automatically by means of slewing motor.	Tightened loose 5CT selsyn coupling on end of antenna drive motor shaft with help of material man.
Unable to adjust limit marker on short range scale.	Adjusted R–915 voltage control in range and train indicator so limit marker could be calibrated.
Sweep on range scope went out on 15,000 yards scale. Markers normal on both range scales and PPI normal on both scales.	Changed condensers—C–426 and C–429, 0.1 μf 600-v. which were leaking oil and trouble disappeared.
Step trace intermittent and unstable.	Located and replaced coupling condenser, C–908, which had an intermittent high resistance short. Locating this defect was a little difficult due to the erratic and, at times, normal operation. The quickest check is to clip a voltmeter between grid and ground of offset shaping amplifier V–906–A. Normal grid voltage (on long range) is approximately 7 to 9 volts negative with respect to ground. Voltage below this and particularly when grid swings positive can be an indication of leakage through C–908. Other conditions of course could give the same result, such as a shorted V–906.
A bearing error of 1° was observed when changing antenna rotation from one direction to the other.	Caused by a loose coupling on the 5DG synchro B–903. This synchro was removed and the coupling was tightened.
Range markers developed fuzzy tops showing improper oscillations.	Cleaned modulation generator crystal contacts and trouble cleared.
No sweep on range tube or PPI at indicator.	Checked wiring. Found video and sync coaxial cables reversed at remote adaptor. Clearing this reversal cleared all trouble.
Last low range marker not properly aligned with last long range marker.	Adjusted C–935 short range sweep length control and R–9109 low range linearity control.
Range and Train Indicator (SGb/SG–1b)	
Range step on maximum range (at end of sweep) causes jumping or jittery sweep.	VR150's (V–903, V–904) intermittently conducting, or VR150's in by mistake. R–916 (3 meg.) has changed value.
Range step at zero yards causing jittery sweep.	R–917–50 (0.5 meg.) has changed in value.
PPI sweep short and markers bunched at the end of the sweep.	R–9118 (0.5 meg.) has increased in value, or opened.
PPI sweep shows center expansion.	R–934 has increased in value. R–934 original resistor not replaced by 1750 ohm unit. R–990 is "full on" causing grid No. 10 (pin) to draw current, thus shifting the timing of PPI sawtooth sweep tube V–910 Check setting of R–418. Check value of R–9118.
Sweep unstable and markers flutter; square wave leading edge distorted.	Change V–404 (6V6GT).

Range and Train Indicator—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Range offset cranked to left and range mark cannot be pulled down to baseline.	V-918A has low amplification. (The induced pip in the tertiary winding of T-909 is extremely sharp and fast. If amplification of V-918 is down, the range offset amplitude will be lowered. This causes a variation in the spot at which the top of the range mark comes to rest when the offset has supposedly brought the marker to its lowest point.)
Unable to get offset below 7A. zero yards.	Shorten leads from Pin 2 of V-906A to the "C" section of K-906. Also shorten the lead from C-932-50 to K-906C. Check R-418 setting which is *very critical* and *nearly full on* (CW). Check C-453 setting.
VR tubes (V-903, V-904) glow at all times in 15K position, when 75K appears normal.	Check K-405 relay in mod. gen. Failure to contact in 15K position causes this trouble.
Failure of R-959-50 range mark intensity pot. to reduce range mark intensity.	Check for 115v across Terminal No. 4 (or Terminal No. 139 on the newer schematics) and No. 189 on E-928. Clean contacts or replace K-905.
No video or range marks on range tube V-915.	Open L-914 (on range tube panel).
Overintensity on PPI tube in SIGNALS position.	Check for ground—No. 172 on E-936 (video chassis) to SIGNALS position on S-912C.
PPI tube glows in marker position with S-907 in STANDBY.	R-9166 of wrong value.
Base line of "A" scope hops above "zero" line instead of below zero line on 15K range.	Check value of C-936-50. It should be 200 $\mu\mu$f (V-905 cathode circuit).
Jittery range marks *and* offset.	Check clearance of wiring near K-906 relay. It may be jamming the relay action.
Jumpy and unsteady range marks.	Check crystal in mod. gen.
Excessive intensity of 7BP7 (PPI) tube, V-914 in SIGNALS or MARKS position.	R-9164 arm grounded.

Signal Monitor

R-f monitor meter needle reading more than full scale. R-f probe in waveguide was picking up too much r. f. from waveguide coupler.	Readjusted r-f probe in waveguide so as to indicate half scale reading.
R-f monitor meter erratic.	Tightened probe in waveguide. Secured set screws in probe. Probe was not tightly assembled nor was it properly secured in waveguide.
M-201 the indicating meter on the signal monitor giving small erratic indications.	The crystal rectifier in the wavemeter was defective showing a resistance of only 10 ohms in either direction. Replaced crystal rectifier. Coupling of wavemeter probe in waveguide reduced.
For some time the signal monitor circuit had given us trouble. Touching any part of the circuit connected with the signal monitor circuit would cause a deflection of the meter. Waving a hand in front of the coupling to the crystal cavity would have a similar effect. There was no sharply defined point of resonance as indicated by a maximum deflection of the indicating meter.	It was found that there was a cold soldered connection between the spring connection and the crystal wavemeter. The electrical and mechanical contact was very poor. When resoldered, this point made good contact and monitor operation was normal in all respects.

LOBE SWITCH INDEX MAGNET CONTACTS

Failure of the lobe switch motor to operate or to index correctly has been traced to improper adjustment of the index magnet contacts in a number of cases. Following are the conditions necessary for proper operation of the spring pile-up assembly—refer to ANTENNA ASSEMBLY for numbering of contacts:

With index magnet armature fully operated:

a. The preliminary-make contacts 1-2 shall be fully closed.

b. Contacts 4-5 and 7-8 shall be fully closed.

c. Contacts 3-4 and 6-7 shall be separated.

With the pawl riding on the large periphery of the cam:

a. Contacts 1-2 shall be fully made.

b. There shall be no clearance between the stud and spring 2 and between the stud and spring 7.

c. Both transfer armature springs 4 and 7 shall be just about to leave springs 3 and 6.

With the pawl half way into the notch:

a. Contacts 1-2 shall be closed.

b. Spring 2 shall be just about lifted off the card.

With the pawl in the bottom of the notch:

a. Contacts 1-2 shall be open.

b. Contacts 3-4 and 6-7 shall be closed.

c. Contacts 4-5 and 7-8 shall be open.

Antenna Assembly Service Notes

Avoiding Icing of Window and Reflector: In frigid climates there is a strong tendency for ice to form on the polystyrene window and on the parabola. Since a heavy layer of ice will cause the system to lose greatly in sensitivity, some crews have been coating windows and parabolas with oil.

Any organic or inorganic oil will severely damage a polystyrene surface in a short time. For this reason, no oil of any sort should be used on the window or on the projector housing near the window.

Oil may be used on the reflector surface only. It should be removed whenever the ship is not actually operating under icing conditions.

Glycerine may be used on the window and on the projector housing below it. The glycerine will not damage the window or its rubber gasket, as would oil.

Unfortunately, however, glycerine softens the paint used on the housing. For this reason it, too, should be removed when not needed, and it may be necessary to repaint the housing more often in cases where glycerine must be used.

Water Leakage: A new type drip pan has been designed by the Navy to prevent water leakage from getting on the collector rings and contact fingers in the antenna feeder unit. An improvement in the packing gland around the torque tube has also been made which should help alleviate this condition. It should be made certain on all installations that gaskets are properly in place to prevent further possibility of water leakage. In order to prevent an accumulation of condensation water, the drains in the dipole casting should be left open.

Water leakage is reduced materially by keeping the packing gland around the torque tube well filled with grease. Fiske's Mineral Lubricating Grease Medium Grade 11, Navy Spec. 14-G-1h (used for lubricating periscopes), or the equivalent may be used. The drip pan above the collector rings should be examined periodically to see that grease from the gland has not clogged the drain hole.

Emergency Waveguide Valves: The emergency waveguide valve has become jammed in a number of installations. In order to prevent this from happening on later equipments, a new type valve stem spring washer has been used which allows greater spring deflection and reduces the spring load. Approximately 20 of the earlier installations were furnished with a valve having a small angle taper on the valve stem which makes the valve tend to stick. The latest type spring washer should be installed when possible. Valves that stick should be lubricated with No. 15520A stopcock grease made by the Central Scientific Co., or an equivalent grease. If this does not remedy the difficulty, the valve should be replaced.

Sealing of Feeder Unit Nuts: The four large nuts are to be adjusted to make the upper casting tube flush with the wave guide surface in the lower casting. In several cases these nuts have been drawn up tightly by crew members who noted they were loose. This results in destruction of gasket No. 10 when the antenna is rotated. The nuts should be tightened only in case of heavy damage which results in water entering the waveguide, since the gasket is an emergency seal only.

To prevent tampering with the adjustment, copper wire should be passed through the holes in the four nuts provided for that purpose and soldered, after adjustment. This will discourage tampering but will not interfere with emergency action. Crews should be instructed in this matter.

Cleaning Collector Rings: If the collector rings have become very dirty or corroded because of leakage or improper maintenance, the assembly must be removed in order that the rings and insulators be thoroughly cleaned. Ships' personnel should be instructed to wipe the rings daily with a cloth moistened with fresh water, then thoroughly dry them with a cloth or hot air blower, if any salt water leakage is present. This of course should be done with power off.

Hanger Stud Alignment: A varying degree of misalignment of the hanger studs which support the feeder unit lower casting has been noted in several installations. This causes severe wear to take place between the upper casting tube and the lower casting, especially under motor train.

Stud alinement should be checked carefully on all new equipments during assembly by noting whether the tube slips easily into the casting without the necessity of applying horizontal force.

On all service calls on motor train equipments, engineers should check for wear between the tube and casting by removing the antenna tuning plungers and looking inside to note whether brass shavings are present in the lower casting. If shavings are found, the lower castings should be removed and cleaned. If excessive wear is noted, it may be replaced. Steps should be taken to align the hanger studs properly with the aid of yard of crew mechanics.

It will be observed that one terminal assembly is a double conductor of the coaxial type. This terminal assembly should not be dismantled beyond removing the fiber washer, terminal, lockwasher and nut unless absolutely necessary, because it is rather difficult when reassembling to maintain the necessary insulation between the inner and outer conductors. An oil seal must also be maintained between the inner and outer conductors.

a. Withdraw the inner ceramics and the associated gaskets.

b. Clean all the parts thus removed and the surface of the can which makes contact with the insulators, with carbon tetrachloride.

If any of the gaskets are broken or torn, new gaskets should be cut from neoprene, corprene, or similar oil-resisting material.

a. Before reassembling the parts, it should be ascertained that a short does not exist between the inner and and outer conductors of the coaxial terminal assembly.

b. When reassembling, coat the contacting surfaces of the parts and the can with a liberal amount of glyptal cement.

c. Reassemble the insulators. (Keep in mind that the oil seal is maintained on the inside end of the terminals rather than on the outside.)

d. Resolder the leads to the terminals and fasten the chassis to the cover plate.

e. Mount the assembly in the can, put the self tapping screws in place and resolder them.

f. Solder the lid to the can. Keep in mind that an oil seal must be maintained.

g. Refill the can with oil. The oil level should be no higher than 1/4 inch from the top of the can to allow for expansion. In the event that additional oil is required, "Nujol" is recommended. "Fractol A" obtained from Standard Oil Co., of N.J., or "Mervsol" obtained from Standard Oil Co., of Indiana are commercial trade names for "Nujol."

h. Resolder the cap on the filling hole.

i. Test the repaired modulation network in the transmitter.

TRANSMITTER-RECEIVER CW-43AAF-1 SERVICE NOTES

Double Trace on Indicator Upon Application of HV: It has been reported that in several installations a double or jittery trace has appeared on the indicator screen upon the application of the high voltage to the transmitter. The analysis of this difficulty indicates that under certain conditions, the bias generating circuit using the 807 tube V-13 and the 6X5GT tube V-6 does not supply sufficient current to maintain ionization in the VR150/30 regulator regulator tubes V-7 and V-8. Under these conditions the VR150/30 tubes may be unstable in their operation.

It may be possible to eliminate this double trace on the indicator screen in many cases by connecting a 0.01 μfd condenser from terminal 29 on the modulation generator to ground. In cases where this procedure fails to eliminate the trouble, replacement of the VR150/30 tube is recommended.

Shorted Magnetron: A filament-to-anode short in the magnetron places 300 volts across resistors R-14, R-51.1, and R-51.2 causing them to burn out or become badly scorched.

Since metallic contact is not necessary, the surfaces in contact may be rubbed with a thin film of Andoc "C" grease, as supplied for blower motor lubrication, to reduce the tendency for wear at this point.

MODULATION NETWORK LEAKING OIL

Several reports indicate that oil has been leaking around the insulators on the D-164472 Modulation Network. The normal procedure under such circumstances is to replace the modulation network. However, in cases of emergency and when the loss of oil has not caused breakdown of the insulation, the modulation network may be repaired in the field using the following procedure:

a. Turn the D-164472 Modulation Network right side up (insulators on top) and unsolder the seal on the filling hole which is located between or near the two large insulators.

b. By tilting the network, drain the oil from the can into a clean container through a funnel.

c. By applying a torch or soldering iron, unsolder and remove the self-tapping screws from around the sides of the can near the top.

d. Play a torch on a small section of the solder seal which is around the edge of the cover and wipe off the molten solder with a cloth. This is done to prevent the solder from running down inside the unit. Progress in a similar manner around the entire cover seam, taking care not to damage the terminals.

e. Suspend the unit above the work bench by anchoring a toggle bolt or some similar piece of hardware in the filling hole. When doing this, be careful not to damage the components inside the can.

f. Apply heat all around the top edge of the unit while it is suspended and pull the can down away from the cover and chassis whenever the solder has reached the melting point.

To apply the necessary heat to all sides of the can, the Lab has rigged up a special burner for this purpose. The burner is made of a section of 1/4-inch iron pipe which has been bent to form a rectangle of such dimensions that it will fit down over the top of the can with about 1/2-inch clearance all around. On the inside of the pipe rectangle there are numerous small holes so placed that when the burner is connected to a gas line, all sides of the can will be heated at the same time.

a. Remove solder or any other foreign material which may have entered the can.

b. After making reference to the wiring code, disconnect the five low potential leads from the five small terminals.

c. Remove the screws that hold the chassis to the cover.

d. Disconnect the leads from the large insulator terminals.

e. Remove the hardware from the top of the two large insulators.

f. Remove the outer ceramics and gaskets and push the terminal assemblies free.

short may only occur when the magnetron filament is hot.

In any case, when a shorted magnetron is found, R-14, R-51.1 and R-51.2 should be checked carefully.

Intermittent Transmitter Failures: A number of cases of transmitter failure have been traced to shorts or opens in the three coaxial cables from J-6, J-7, and J-8 on knocker chassis to various parts of the transmitter. The trouble usually does not occur until after the transmitter has become quite warm from operation for 30 minutes or more.

Warbling Pulse Rate: A warbling of the pulse rate which can be heard audibly can be caused by incipient failure of C-2 (2 μfd) in the high voltage rectifier.

Operation of VR150/30: When the performance of V( )7 and V( )8, VR150/30 tubes is subnormal, the regulation of the -300 volt bias supply can be poor enough to make it possible to change the pulse repetition rate merely by tuning the receiver. When the transmitter tone changes as the receiver is tuned, these tubes should be examined.

Condenser C-28: When condenser C-28 is low in capacity, the transmitter fires raggedly and can cause sounds and HV meter fluctuations similar to a leaky pulser box acting up.

Failure of Inductor L(1)1—Navy Type 47474: We have received several reports of failure of the KS-9196 inductor L(1)1 per ES-697734 in the plate circuit of the 807 tube V(1)13 in the D-150960 Transmitter-Receiver. These reports indicate that the coil opens as a result of arcing to ground.

An investigation as to the possible cause of failure of L(1)1 revealed that the factory was instructed to place a 1/4-inch spacer in under the isolantite coil form in order to raise the winding away from the chassis. It is felt, however, that this practice was not carried out in the assembling of the early units which were delivered to the field.

In order to prevent further failures of L(1)1, it is necessary to inspect all D-150960 Transmitter-Receivers which are in the field at the present time, in order to ascertain that a spacer has been installed. In the event a coil is found to be without a spacer, the coil form should be raised about 1/4 inch by inserting an insulating washer between the coil form and the chassis. It is suggested that 1/4-inch-thick bakelite is used.

Suitable washers have been installed on the transmitters associated with Mark 2 systems which have systems serial Nos. 5, 6, 14, 63, and 64.

Improper Converter Injection Voltage: Converter injection voltage should be 2.8 volts for the best signal-to-noise ratio, since this value gives optimum converter performance. If this voltage, measured from terminal 7 on the converter chassis to ground, is not 2.8 ±0.3 volts, some correction must be made or the system performance will be poor.

The coax line from the TR cavity to the converter filament stub contains standing waves, since the TR circuit is tuned to a compromise between the best tuning for transmitting and that for receiving (this is done automatically when the equipment is tuned for maximum signals). In order for the proper injection voltage to be applied, it is necessary that the line be of the right electrical length to match the converter tube filament stub at the proper impedance point.

If the injection voltage is more than about 10 percent below 2.8 volts, a check should be made to see whether the antenna is bleeding more of the oscillator output than it should. This may be done by simply removing the Holmdel jack, J-10, from the TR cavity and noting whether an increase of over about 0.3 volt occurs. If this condition exists, it is imperative that the line length be adjusted, since the antenna is bleeding the oscillator and serious signal loss will be observed.

If the injection voltage is too high, noise level will be higher than is desirable, and signal-to-noise ratio lower, but the condition is not as serious as it would be if the voltage were too low.

The method of adjustment is to shorten the line in about 1/4-inch steps until the proper injection voltage (and no more than moderate antenna bleeding) is noted. Usually one or two cuts will be enough. In cases where cutting the first 1/4 inch changes the injection voltage further away from normal, a new line one inch longer should be made up and the cutting process repeated.

Preventing Converter Plug Jamming: Plating on the threads of converter cavities and plugs has caused numerous cases of jamming. In some cases it has been necessary to replace cavities because plugs become immovable.

Plating should be removed and threads cleaned by using taps and dies on all cavity holes and plugs. It is very important that no metal shavings be left inside cavities after tapping. This should be done as soon as is convenient on all equipments, to avoid future troubles from plugs jamming.

The proper tap and die sets have been distributed.

Tuning of Beating Oscillator Cavity: In the event that it becomes necessary to replace the 707A tube it will probably be necessary to retune the cavity. If the cavity is so far out of tune that signals will not be received for any position of the repeller voltage tuning control a cut-and-try method of adjusting the tuning plugs must be used. As soon as signals are received the following procedure should be used for final tuning. Rotate the repeller voltage control to each side of the point of optimum signal response. If the received signals drop off smoothly as this is done the cavity is correctly tuned. If, however, the signals drop off suddenly as the repeller voltage control is moved to one side of the optimum point the cavity is slightly detuned. If the repeller voltage control to each side of the point of optimum signals drop off abruptly the plugs are too far out in the oscillator cavity and vice versa.

Low I-F Amplifier Gain: If the i-f amplifier appears to have low gain, as evidenced by lower than normal "grass" on the indicator and replacement of tubes does not remedy the trouble, check condenser C-201 in the D-150412 i-f amplifier. In some cases, a 100-μμf condenser will be found in this position. It should be replaced by a 7.5μμf condenser per item 27 Maintenance Parts List, Issue 3. It may be necessary to trim the input transformer FL-201 afterward. The adjustment will be found to be quite broad.

INSUFFICIENT VERTICAL DEFLECTION ON RANGE INDICATOR SCREEN

The height at which pips on the range indicator screen saturate is determined largely by the characteristics of the last i-f tube V-206. Certain 6AC7 tubes will give a much higher saturation level than others.

In some cases the supply end of R-44, the screen dropping resistor for V-6 in the range indicator, has been strapped to the 300-volt supply lead instead of being connected to regulated 150 volts at the plate of V-11 the VR150/30. This error causes V-6, the final deflection video stage, to draw abnormal screen and plate currents. The resulting low plate voltage causes reduction of saturation signal amplitude at high settings of P-8, the NOISE SUPP potentiometer.

If the circuit is normal, the saturation level should increase continuously with clockwise rotation, of the NOISE SUPP control. With a properly chosen 6AC7 tube in the V-206 position this should give at least 1 1/2-inch saturation height at full clockwise rotation of the control.

If the saturation amplitude reaches a maximum and then decreases somewhat as the NOISE SUPP is rotated to the full clockwise position, the screen voltage on V-6 should be checked. It whould be slightly less than 150 volts. If it approaches 300 volts when the control is turned full counterclockwise, the screen wiring of V-6 is wrong and should be corrected.

INTERMITTENT STEP AND PRECISION SWEEP

This trouble occurring at certain ranges may be due to a broken lead to the movable crystal in the range tank.

If the step and precision sweep disappear at a certain range and are missing for all greater range settings, the trouble may be due to loss of liquid from the range tank. This may be checked from the outside by noting whether the loss of sweep is intermittent when the range is set just at the critical value and the range unit is shaken.

If the step and precision sweep are not present at any range setting, go through the routine listed in the next article to locate the fault.

LOSS OF PRECISION SWEEP AND STEP

This symptom indicates that there is trouble in the range indicator step generator panel, the trans-rec. knocker or the range unit.

It is possible to locate such troubles in a systematic manner, and the following procedure is suggested:

a. With the sweep switch in the PREC position, ground test point E-2 in the range unit. This reduction in fixed bias for V-4 causes the crystal knocker multivibrator to oscillate without a sync pulse applied. If the prec sweep and step now appear, the trouble lies in the trans.-rec. knocker, the connecting coax cable, or in T-2, the sync pulse input transformer in the range unit. The trans.-rec. knocker may be checked with test scope and handbook oscillograms, and the cable and transformer checked for shorts and opens with the ohmmeter.

b. If the sync pulse input is satisfactory and the precision sweep and step do not appear in test a, check the range pulse input at the grid of V-12 in the range indicator. If this is satisfactory, the trouble lies in the precision sweep generator or step generator circuits, and these should be checked systematically with the test scope and oscillograms.

c. If there is not proper range pulse at the grid of V-12, the range pulse output from the range unit should be checked. If proper output pulse is observed, the trouble lies in the coax cable or in the input network to V-12.

d. If there is not proper output pulse from the range unit check the scope pattern at V-1 grid. If this is satisfactory, the trouble lies in the circuits of V-1, V-2, V-3 and these should be checked throughout with the scope and oscillograms.

e. If test d shows that, with proper sync pulse input to V-4, the pattern at the grid of V-1 is not correct, the trouble lies in the knocker crystal tank or amplifier circuits of the range unit. Check the scope patterns in the V-4, V-5 knocker circuit.

f. If the knocker output, at input crystal jack, J-2, is satisfactory, the trouble lies either in the range tank circuit or in the amplifier. To check the amplifier circuits the crystal tank circuit may be replaced by an equivalent network with an attenuation of 86 db. as follows:

(1) Connect a 20 $\mu\mu$f and a 0.1 μf condenser in series, the junction of the two to J-1 with a Jones plug soldered as close to the terminals as possible, the free terminal of the 0.1 μf condenser to ground with a clip soldered directly to the condenser terminal and the free terminal of the 20 $\mu\mu$f condenser to J-2 with a short piece of coax cable. This network may be made up as a test unit and kept on hand for checking purposes.

If, with proper input to the test network, proper output from V-8 to the grid of V-1 does not occur, the trouble is in the amplifier.

If, when the network is connected in place of the crystal tank, the proper pattern appears at the grid of V-1, the trouble is in the crystal tank circuit. Checks should be made for opens and shorts in the crystal leads, damaged or misaligned crystals, or low liquid level.

RANGE INDICATOR SERVICE NOTES

Regulator Lamps: The characteristics of the regulator lamps LP-1, LP-2, LP-3, and LP-4 tend to change after being in service several hundred hours. The change in characteristics results in a higher than normal voltage drop across the lamps. The voltage should normally read about 225 volts and if it rises about 10 percent, the receiver tuning control may not be able to tune the receiver properly. A periodic check of this voltage is recommended and, if it is found high, the faulty lamp or lamps should be replaced.

Low Bias on 1st Video Tube V-6: The first video tube V-6 of the range indicator may draw grid current as the i-f output is increased and cause a vertical jitter of the pattern on the indicator screen when lobe switching. The value of grid bias which allows this effect to occur is

about-4 volts. This condition can be remedied by increasing the negative bias on the control grid of V-6 to about -6 volts by adjusting noise suppressor potentiometer P-8.

Centering Trace on Screen: Insufficient control of horizontal positioning of the CR tube trace is usually due to aging of glow lamp LP-4. When its voltage drop, which increases with use, rises above 63 volts, it may be impossible to center the sweep, which will be too far to the right-hand side of the screen. Replacing LP-4 is the cure for this cause of improper centering.

Another cause of off-center sweep, which may force the sweep to either side of the screen, is unbalance between V-3 and V-4, the push-pull sweep amplifier tubes which have their plates connected directly to the CR tube horizontal deflection plates. Any considerable unbalance in tube currents will unbalance their plate voltages and, consequently, the positioning of the trace. If this is the cause of off-center sweeps, it will be necessary to interchange 6AG7 tubes V-3 and V-4, or possibly to replace one or both.

It is also possible that the 6SN7GT sweep cathode follower, V-2, may have to be replaced.

If none of these four tubes is the cause of the trouble, it may be necessary to check the resistance network connected to sections D-1.5 and D-1.6 of D-1, the sweep switch. P-2 and P2A, R-14, R-15, R-16, R-17, R-18, and R-21 should be checked, special care being taken to note whether proper and smooth variation of both P-2 and P-2A is had.

Adjustment of Return Trace Blanking, Focus, Dynamic Focus and Intensity Controls: Turn the IF GAIN control to minimum. Operate the SWEEP SWITCH to MAIN SWEEP position and the PULSE RATE SWITCH in the transmitter-receiver to HIGH. Turn the RETURN TRACE BLANKING toward maximum (clockwise) position and see that the return trace is extinguished. Adjust the INTENSITY control a little brighter than minimum. Adjust the FOCUS control for minimum width of sweep line. Now operate the SWEEP switch to PREC position. Increase the RETURN TRACE BLANKING until the return trace just disappears. Adjust the DYNAMIC FOCUS control to restore good focus. Change the SWEEP switch to MAIN position. Adjust the FOCUS control and repeat the cycle of adjustment. When the four controls, RETURN TRACE BLANKING, INTENSITY, FOCUS, and DYNAMIC FOCUS, have been correctly set, the change in brightness and focus should be small when transferring from one sweep to another. Main sweep should be slightly dimmer than the others so small echoes will not be lost in the grass.

Measurement of CR Tube Supply Voltages: Voltages in the range indicator CR tube power supply may be checked on the 1,000-volt scale of the 1200F volt-ohm-milliammeters by measuring individual drops across the series resistors in the 2X2 circuit. Voltages should be fairly close to the following values, if the circuit is in good condition:

a. Across R-62, from 2X2 plate to terminal 1 of P-11, 300 volts.

b. Across R-63, from terminal 3 of P-11 to terminal 3 of P-10, 400 volts.

c. Across R-64, from terminal 1 of P-10 to terminal 3 of P-9, 860 volts.

CHECKING FLUID IN THE CRYSTAL TANK

This tank is a device for securing a time delay for use in measuring the range of the target. The tank is and should be kept completely filled (up to the back cover plate with the sylphon bellows collapsed) with the solution of ethylene glycol and distilled water. The composition of the solution is:

15.8 volumes of ethylene glycol.
100 volumes of distilled water.

The correct solution has a specific gravity of 1.016 at 77° F.

This solution should be kept reasonably close to the correct proportions as incorrect amounts will introduce an error in the range unit. If fluid is spilled or lost, the solution in the correct proportions should be added. If some of the fluid is boiled away due to a defective thermostat, distilled water only should be added.

A check of the fluid level can be made by setting the unit for maximum range and observing the step. If the fluid tank is not full, the step will disappear for maximum range setting. When the unit is set for maximum range the crystals are at extreme ends of the tank and the one at the upper end will be in the air if the unit is not completely filled; this will make the time delay unit inoperative.

It may be necessary to add or change the solution in the tank, or to disassemble it to inspect it or change crystals. The solution may be added by opening the small ports near the front of the unit and using a small funnel.

RANGE TANK HEATER BURNOUTS AND LIQUID LEAKS

Several cases of range tank heater failures have been reported without mention of tank leaks, and there have been reports of tank leaks without mention of heater trouble. The tank liquid is highly corrosive to hot nichrome wire. It is usually only a short time after a leak at the Garlock Klozures starts that the liquid begins to soak into the insulating blanket. When this happens, failure of the 275-ohm heater winding is to be expected shortly in almost every case.

Since these two troubles often occur together, the equipment should be carefully checked for the companion trouble whenever one of them is noted.

Leaks at the Klozures have been due to improper finish on the shaft which passes through this packing. This should be corrected in all equipments in the field by installing the field change kit which includes a new, properly polished shaft and associated fittings, and a pair of Klozures from the field stocks which have been shipped to all submarine repair locations. See SJ Field Change No. 7, page 2-5.

Heater failures should be repaired in all cases by ordering a new insulated tank, per drawing ESO-686220, since rewinding in the field does not usually result in correct heat distribution.

MECHANICAL JAMMING IN RANGE UNITS

There have been reports of mechanical jamming caused by loose bearing rollers which slip out of place, improperly positioned gears and rough shafts. Correct Garlock Klozures cannot cause jamming. Care should be taken to correct causes of mechanical jamming rather than to remove symptoms, as has sometimes been done by crew technicians. Under no conditions should it be necessary to lock the clutch except as an emergency measure. Mechanical jamming in new range units is sometimes due to insufficient clearances in the Oldham coupling between the fiber and metal sections. This may be checked by loosening or removing the three screws holding the gear housing to the bronze casting; if this frees the mechanism, the binding is in the coupling.

Cure of this trouble consists of filing the fiber wafer slightly, smoothing its surface with crocus cloth, and lubricating-preferably with a grease stick and powdered graphite.

There should be 0.005-inch end play in the shaft which passes through the Garlock Klozure. If this clearance is not proper, it should be corrected by installing a new shaft assembly. In some cases allowing correct end play at this point may be enough to free a jammed Oldham coupling.

Range Units Clutch: The range unit is provided with a clutch to protect the mechanism when the crank is turned to either limit of motion.

MAINTENANCE OF KS-5589 MOTOR GENERATOR SETS

The single-phase, 60-cycle, a-c generator (alternator) is rated at 115 volts, 1.5 kva. (1.35 kw.). Inherent regulation, regulation of the motor speed and temperature compensating equipment reached by removing the cover plate on the side of the alternator, are depended on to hold input voltage at 100 to 120 volts ac. Voltage setting is made by a rheostat connected in the exciter shunt field circuit and located in the control cabinet.

The speed regulator control dial is reached by removing the small end plate on the motor end of the set; that is, the end opposite to the blower. The dial is marked for the initial setting but changes are required in service to compensate for contact wear. Clockwise rotation of the dial decreases speed.

The speed should be maintained as close to 3,600 rpm (60 cycles) as required by the equipment with which it is used but very infrequent adjustments are recommended, not only because adjusting is likely to decrease contact life but also because speed may be less stable just after adjustment. The set is designed to maintain a speed of 3,600 ±18 rpm which corresponds to 60 cycles ±1/2 percent.

Speed (frequency) readings may be taken with a contact type tachometer applied to the end of the shaft after removing the plate on the alternator end or with a strobocopic type tachometer such as a "Strobotac" viewing the shaft at alternator end. Frequency meters attached to the machine output are also satisfactory. A very good method to check speed is to compare the readings of an accurate watch (or clock) with the readings of a synchronous clock driven by this set.

One-half minute gain or loss by the electric clock in each 100 minutes as read on the watch indicates a gain or loss, respectively, of 18 rpm or 1/2 of 1 percent.

The control field resistor and the resistor in parallel with the speed regulator contacts are set at the factory and should require no adjustment in service. They are reached by removing the cover plate on the side of the motor.

Speed regulator brushes, if dirty, should be cleaned with petroleum spirits. Burs can be removed from the rotating contact by holding a carborundum pencil or the equivalent against the contact while the machine is running. Burs can be removed from the stationary contact with a fine file; or, if the contact has been removed from the set, burs can be removed with a carborundum pencil rotated between the fingers. Contacts should be replaced when the contact material is worn down to base metal. The stationary contact has the shorter life and the screw and contact assembly are readily replaceable. The entire rotating element, including springs and weights, are replaced as an assembly whenever the rotating contact requires replacement. After replacement, run set at no load and if possible, at maximum battery voltage to wear in contacts.

The output voltage is expected to remain between 100 and 120 volts if machine is not overloaded. Voltage is raised or lowered by operation of the exciter field rheostat located in the control cabinet. Optimum performance is obtained if no load voltage is set at 119-120 volts when speed is 3,600-3,618 rpm.

Load and capacity need not be checked unless the set fails to perform the functions for which it is intended and a source of trouble in the set cannot be found.

With voltage and speed within the above limits, a rough check of load is to see that nameplate a-c amperes output from the alternator is not being exceeded. For greater accuracy, continue to see that the volt-amperes do not exceed 1,500 and the output watts do not exceed 1,350.

Brushes should be replaced when 1/4-inch long measured to the spring. The pressure is considered satisfactory if 1/8-inch or more of the spring extends out of the holder when the brush holder screw cap is removed and the end of the brush is touching the commutator or collector ring. New brushes should be sanded in to fit the commutator or collector ring surface and the set then run for 2 hours at no load to complete the fitting. Blow out dust after sanding. When brushes are removed for any reason they should be replaced in the same holder and the same position.

A brush aligning nameplate on the motor end shows the position in which the end bell should be returned after removal in order that the brushes may be returned to the neutral position.

The overload relay in left end of control cabinet is set at the factory for 120 percent of the associated motor nameplate rated full load current and should require no adjustment. If required, however, adjustment is made by moving the pointer on the relay. Note that the percentages

shown on the dial of the TC-121 overload relay are percent of relay rating, not percent of motor rating.

The two line contactors (LE-1 and LE-2) and the associated accelerating relay (1A) are satisfactory if they operate positively on lowest rated battery voltage, 175 volts for the list 01 motor and 85 volts for the list 02 motor. They are set at the factory for 80 percent of these values. Operation of the LE-2 line contactor releases the 1A accelerating relay. The 1A accelerating relay is set to release long enough after the LE-2 contactor operates to give approximately equal starting current increments when list 01 set is connected to 260-volt battery or list 02 set is connected to 128-volt battery. Adjustment of the 1A accelerating relay contactors is by changes in armature spring tension.

The normally closed relay (AVR) is across the armature of the exciter to give over speed protection. With the set operating at normal speed and with the generator output set at 120 volts by operation of the exciter field rheostat, increase the speed of the set by turning the speed regulator dial. The (AVR1) relay should operate before the generator output voltage reaches 140 v. Adjustment is by changing the tension of the armature spring and in extreme cases by changing the shim to give a different armature gap.

Contact pressures should be sufficient to give firm contact even when mechanical shock is present. Contact pressures are increased by moving the contacts closer together and decreased by moving them farther apart.

Burs on contact surfaces should be removed with a fine file and dirt should be removed with petroleum spirits. Pole faces should be cleaned with petroleum spirits and in severe cases with sandpaper. Remove as little of the finish as possible. After sanding apply a light coat of oil to the pole faces and wipe nearly dry. If pole faces tend to rust apply a light coat of oil and wipe nearly dry.

Additional Suggestions: Be sure + battery is connected to L1 + and thence to XS1 of motor. Q axis (short circuiting) brushes are particularly sensitive to poor seating. If the field adjustment of the AVR relay does not give satisfactory operation try to shop setting which is operating on 190-195 volts d-c across relay coil at room temperature and relay cold. If satisfactory operation of the set cannot be obtained in accordance with the above instructions and a field circuit open cannot be found, refer to the Electronics officer at the next Navy Yard availability for additional instructions or for a replacement depending upon the availability.

LUBRICATION OF EXHAUST AND BLOWER MOTORS

Lubrication of Motor: Many reports have been received regarding frozen bearings on exhaust and blower motors in SJ equipments. Field engineers have been instructed to lubricate these motors. The operation is considered within the scope of forces afloat and should be made when necessary to prevent further motor failures.

TOOLS REQUIRED: 3 1/2-inch cabinet screwdriver. Wrench for 1/8-inch Allen set screw. Small spatula of knife. Small center punch.

Remove motor from mounting.

If motor is connected to blower loosen Allen set screws on blower fan hub and remove blower fan from shaft. Wrench can be inserted through blower outlet. Remove two screws holding blower housing to motor.

If motor does not drive blower it will have a coupling. Remove taper pin from coupling half by tapping small end of pin with punch. Remove coupling.

Remove motor brushes as otherwise they may slide through the brush holders and into the housing. They might then be difficult to remove.

Remove two screws in end shield (shaft end) of motor. Remove this shield. It may be necessary to tap side of end shield with a screwdriver handle or to use a knife between end shield and housing to loosen the end shield. It is preferable not to remove commutator end shield as this may pull the leads out of place and make assembling difficult. It is also desirable not to put any tension on the external leads, for the same reason.

The armature may or may not come out with the end shield, and if it does not, the bearings can be lubricated without removing it.

Remove the two screws holding the nameplate on and remove the nameplate, being careful not to lose the small washers sometimes used between the bearing outer race and the nameplate for reducing end play.

With the small spatula or with knife blade spread grease (Standard Oil Co. type Andok "C" grease) on bearings even with the top of the ball races for two-thirds or three-fourths of the way around. Put armature back into frame if it was removed.

Replace end-shield (shaft end) taking care that the notch in the end-shield registers with the pin in the motor housing. Insert the long screws and tighten them. It may assist, in getting the screw started, to look through the screw holes on the commutator end end-shield in good light.

Place the end play washers on the outer race of the small bearing and put the nameplate on and screw it in place. The letter "G" should be stamped on the nameplate at the right of the lower mounting screw to indicate that the motor has been greased. Try the motor shaft by hand to see that it turns freely and evenly.

If the shaft appears to bind, tap the end-shield (shaft end) and tighten screws to be sure that it is completely in place.

Replace the brushes and run the motor before reassembling fan or putting on coupling. Make sure that the brush marked + is in brush holder with the + mark near it and that the side of the brush with the + mark on it is toward the + on the end-shield. The same applies to the minus mark on the end-shield. If the motor speed appears constant, the motor can be put back into service. If the sound indicates that the motor speed varies widely, the shaft end or the middle of the nameplate can be tapped gently to make the motor run evenly.

FALSE ECHOES

A "ghost" or false echo at a range of about 65,000 yards, appearing with main sweep when using MED pulse

rate, is usually caused by too abrupt application of positive voltage to the grid of the 813, V-1. This may be caused by a defective 6H6, V-8, in the knocker. The false echo will be at a range of about 75,000 or 80,000 yards if it appears while using LOW pulse rate.

FLICKERING OF NEON LAMPS (991)

If the neon lamps (991's) V-10 and V-11 do not light, or if they flicker, examine R-43 for being high in value or open. This is characterized by no sweep or flickering sweep on the PPI. If replacement of R-43 is made, it should be with an Allen Bradley 1 watt resistor instead of a one-half watt. In addition, check R-25 to see if it has been damaged by high current due to lack of bias on V-4.

LOCKNUT ON TR BOX CAVITY

In some cases, the locknuts on the TR box cavity have vibrated loose and allowed the tuning screw to turn and detune the cavity. A periodic check of the lock nuts is recommended.

TECHNICIANS' CHECKOFF LIST (SJ, SJa, SJ-1)

Daily Checkoff:

a. Check and log load voltage with all units operating.
b. Check and log low voltage with all units operating.
c. Check and log high voltage rectifier voltage.
d. Check and log high voltage rectifier current.
e. Check and log voltage of regulated rectifiers.
f. Check and log converter current.
g. Check tuning and sensitivity of receiver.
h. Check operation of blower motor.
i. Check picture on indicators for brightness, focus, sweep length, centering, etc.
j. Check zero setting of range unit.
k. Check rotation of antenna.
l. Log briefly any equipment failures of difficulty experienced and the corrective measures effected.

Weekly Checkoff:

a. Inspect the modulation network in the D-150960 Transmitter-Receiver for oil leakage.
b. Wiggle interconnecting cables at point of entry to units to check for loose connections.
c. With the equipment in operation, shock test all units.
d. While observing the picture on the range indicator, check range unit by rotating range dial from 0 to 40,000 yards.
e. Check waveguide emergency shutoff valve for freedom of movement.
f. Inspect and clean feeder unit rings.
g. Inspect and clean motor generator set.
h. Log approximate hours of operation for the week
i. List number of hours radar was inoperative due to equipment failure.

Monthly Checkoff:

a. Inspect waveguide for dents, corrosion, etc.
b. Inspect antenna exterior for alignment, rust, corrosion, etc.
c. Inspect antenna window exterior for cracks, foreign substance, etc.
d. Inspect antenna feeder unit for evidence of antenna water leakage.
e. For lubrication refer to the lubrication chart.

Quarterly Checkoff:

a. Clean relay contacts.
b. Inspect lobing motor. (See lubrication chart.)
c. Check motor generator speed.
d. Pressure test antenna assembly and torque tube, inspect for leakage.
e. Carefully clean the interior of all units.
f. For lubrication refer to the lubrication chart.

Yearly Checkoff:

a. Inspect zinc electrode in antenna.
b. Inspect lobe switch unit. Examine lobing pins, switch contacts, gears, resistor cards, etc.
c. Refer to lubrication chart.

DISCONNECTING C-22A IN TYPE CW-43AAF-1 TRANSMITTER

Because of the numerous failures of capacitor C-22A in the D-150960 transmitter, which is evidently caused by an excessive surge of voltage when the transmitter is turned on, it has been decided to disconnect this capacitor.

The capacitor is in the middle bypass of a three-section R-C smoothing filter in the bias generator circuit. C-22A and B capacitor is built as one unit, and only the A side is to be disconnected. The change applies to all D-150960 transmitters.

MODEL SJ SERIES TROUBLESHOOTING NOTES

CW–66AAP Antenna (SJ)

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
The packing gland around antenna mast leaked.	This difficulty was remedied by repacking gland with leather cup packing. Continual soaking of unit at base of shaft due to leaky gland caused the bakelite insulators between the rings to give a reading of 50,000 ohms to ground. This makes the lobe switching faulty in operation. It is expected that this inoperation of the lobe switching will be remedied with the installation of a new set of collector rings and ceramic insulators.
Unable to get the lobe switcher to run.	It was found that the switch assembly on lobe switcher unit was bent out of shape, with the top pair of contacts not opening when the lobe switcher backed up with the arm against the stop on the cam. Thus the motor would run backward to the stop on the cam, but the circuit did not open and the motor continued to draw current through the speed-reducing resistors shunted across one-half on the ANTENNA CONTROL switch.
Lobing could not be used with the system, because the lines to the lobing motor were shorted. As a result of these shorts, fuse F–12 had been blown and resistor R–3.1 was burned out. (The system operating normally without lobing, good ranges being obtainable.)	The trouble was traced to the collector rings of the antenna feeder unit. Salt water had leaked through the packing box through which the 4-inch pipe enters the hull, and had wet the rings and the spacing insulators, shorting together all of the rings. There was considerable corrosion on the rings. All of the spacing insulators were washed, and polished with fine steel wool. After completing reassembly and connecting the wires, the system operated properly.
As with other SJ installations, difficulty was experienced with leakage around the packing.	Moisture collected on the collector rings causing the lobing motor to become inoperative and burning out the resistors shunted around 1 side of the antenna switch, by taking up on the packing and installing a larger drip pan the moisture problem was solved.
The lobe switching motor would not operate due to the indexing magnet contacts not closing.	The antenna access cover was removed and the spring contacts of the index magnet bent so that they made positive connection when the magnet operated.
Antenna feeder unit in bad shape. All moving contacts arcing and dirty.	Antenna feeder unit and collector rings cleaned and finger springs adjusted for proper contact.
The lobe switching system did not operate properly. When the motor was running operation was normal, but the rotating fingers did not stop in the same cavity each time the lobing switch was turned off.	An effort was made to repair the trouble by working through the opening in the antenna assembly, but it was found that repairs could be made only by removing the antenna. It was necessary to bend the cam follower and to adjust the relay contacts. After reassembly the equipment operated properly.
Arcing and smoke from collector rings on antenna assembly when turned on.	Packing gland was leaking. Greased and tightened gland.

CW–66AAP Antenna (SJ)—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
The training motor began smoking.	The points on the centrifugal switch that cuts out the starting winding when the motor comes up to speed were found to be out of adjustment.
3° loose play in manual antenna training mechanism.	Moving the worm gear closer to the ring gear, thereby causing a closer mesh, eliminated most of the loose play of the antenna bearing mechanism. This was accomplished by loosening the nuts on the worm gear housing stud bolts and moving the housing a fraction of an inch closer to the ring gear.
Improper alignment between antenna and periscope beating.	"Bore Sighting" was a simple operation. A target, range 6,000 to 8,000 yards, was selected. The hair line of the periscope was placed on the center of the target and when the radar antenna was so trained that identical pips were seen on the CRT screen, using lobing and precision sweep, a mark was given and the 2 relative bearings compared. The slight disagreement in relative bearing was corrected by disconnecting the antenna from the antenna training shaft and resetting the dial to agree with the periscope bearing.
Lobe motor not stopping in same position every time.	Cleaned and adjusted contacts on relay in antenna head.
The beam was not being shifted sufficiently to produce normal lobing. Upon removal of the polystyrene window, the left pip disappeared before the right pip was visible when training through a target. With the window fastened in position, lobing was normal unless the window frame was screwed tight against the antenna head casting. A thin paper insulating gasket placed between the window frame and antenna head casting improved lobing to almost normal action. This indicated that the electrical bond between the frame and head casting interfered with the normal passage of waves through the window.	The damaged polystyrene window was replaced.
Lobing motor noisy when stopping and starting.	Adjusted lobing motor relay contacts.

Control Unit (SJ)

120v supply became low.	Traced trouble to potentiometer (T1 Variac 5 amp-current rating) in control unit. The arm was not making contact.

Power Supply (SJ)

Set cut out momentarily when ship rolled.	Loose interlock in main control unit. Interlock shorted out.
Load voltage (120v a-c) operated 20–30 volts below the normal level. The immediate effect of this condition was apparent in the horizontal jitter of the pulse and sweep.	Raised the resistance of R–3 by resetting transformer (T–2).
Output voltage of regulated rectifier "A" was high and could not be regulated.	Replaced the VR105/30 tube.

Range Indicator (SJ)

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
The return trace blanking control P–7 was turned to the limit as is usual, with hardly sufficient return trace blanking voltage being developed.	In order to insure that sufficient blanking voltage was available, a condenser of 25 $\mu\mu$f was added in parallel to condenser C–29 in the range indicator unit and the return blanking control set for correct return trace blanking on precision sweep. With this adjustment the control was found to be advanced about two-thirds of the way clockwise, leaving considerable control to allow for variation in cathode-ray characteristics.
Cathode-ray tube V–9 flared up, indicating loss of control by the cathode-ray tube grid.	The cathode-ray tube was replaced with one from the spares which in turn gave poor results, as the trace would dim with received signals. This tube in turn was replaced with a tube from the spare parts, after which operation was normal.
Jittery sweep on the range indicator and failure of the transmitter to operate when the high voltage control was increased.	Continuity measurements in the knocker circuit disclosed an open circuit in L–4 of the grid return of V–9. A new coil L–4 was obtained from the tender spares at the subbase and installed in the place of the bad coil.
Multiple step showing on the range indicator.	Capacitor C–14 in the knocker circuit of the range unit had broken down, upsetting the frequency of this multivibrator circuit. This condenser was replaced, curing trouble completely.
Loss of precision sweep after warmup period.	The coax patch cord from J–2 to J–2A in the range indicator was shorting out the output of the precision sweep generator. A new piece of cord was installed which cleared the trouble.
Double step on range indicator scope as the result of no AVC action in the range unit.	This was due to open resistor R–29 in the range unit. Replaced.
Poor ranges.	Located trouble in the coupling between the 706 tube and the TR box. The outside sleeve had become unclipped from the TR box and slipped back toward the 706 tube, causing a partially open circuit in the TR box. This coupling was put in place and the equipment retuned.
Faulty blanking.	Changed VS (6AG7) grid video tube in range unit to correct.
The main and expanded sweeps were pulled over to the right side of the screen.	The VR 150/30 voltage regulator tube in V–11 was found to have a cracked envelope. Replaced.
Intermittent sweep.	Caused by J–101 shorting to ground—excessive heat. Removal of heater unit and reinsulation of leads to J–101 cleared up this trouble.
Voltages on screen and plate of V–8 in range indicator were abnormally high.	Replacement with new 6AG7 (Item 220) brought these voltages very close to indicated values. This produced nearly uniform intensity of beam on all sweeps. Previously the intensity was considerably higher on precision sweep than on main and expand. V–206 (6AC7) in the i-f amplifier.
Return trace blanking action, poor, also poor correlation of intensity. Focus, return trace blanking and dynamic focus controls.	Changes LP–1, regulator tube (991) item 227S, which brought voltage as measured across 4 No. 991 regulator tubes LP–1 to LP–4 down from 235 volts to 227 volts.

Range Indicator (SJ)—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Lobing indication useless due to leakage at feeder unit.	The feeder unit tuning assembly was badly burned requiring sanding, polishing and retensioning of the flexible fingers.
During installation tests "grass" and echoes dropped to approximately half their normal height.	This was intermittent and finally cleared by replacing V–206 (6AC7) in the i-f amplifier.
Sweep became broad and return trace appeared.	Changed 6AG7 focus video and 6AG7 grid video and adjusted dynamic focus and return trace blanking. This helped but did not entirely clear up situation. Changed the cathode-ray tube and readjusted the dynamic focus and return trace blanking. This entirely cleared up the situation noted above.
Sweep on cathode-ray tube too far to the right and unable to center properly with HORIZONTAL CENTERING control. Also receiver tuning control at one limit of rotation for response to signals.	Voltage across the four neon lamps designated LP–1, LP–2, LP–3, and LP–4 in range indicator schematic found to be 245 volts instead of normal 225. Replacing LP–4 brought sweep on cathode ray back to center with the HORIZONTAL CENTERING control at midscale. Replacing the three remaining lamps, LP–1, LP–2 and LP–3 brought the receiver turning control back to its normal position. The voltage across the four lamps then measured 220 volts.
Double step on indicator screen.	Caused by misadjustment of the AVC threshold setting of P–1 in the range unit.
After a few minutes of operation the return trace on CRT would disappear.	CRT–5HP1 (V–9) found loose in its base and was replaced
The sweep on the range indicator screen was too far to the right.	A bad 991 neon glow lamp LP–4 in this unit. The voltage drop across this tube was 65 instead of 57 volts resulting in a higher than normal voltage across the sweep positioning divider composed of P–2, R–14, R–15, R–16, R–17, R–18, and R–21 replaced lamp.
Precision range sweep, flickered.	Worn range pulse coaxial cable. Repaired cable.
Intermittent loss of sensitivity was experienced, both signals and grass disappearing on the indicator screen.	Traced to one i-f stage. Replacement of C–201 and C–203 corrected this trouble permanently.
Intensity not the same on all sweeps.	Focus was not at the same for all the sweeps. Replaced V–8 and V–5 and adjusted dynamic focus control.
Grass disappeared.	Replaced two i-f tubes (6AC7) and the v-f tube (6AG7). Grass became normal.
The receiver tuning drifted as unit was operating.	Replaced 991's. Tuning returned to normal.
Erratic trace on precision sweep. The trace on precision sweep was found to vary in length as the equipment warmed up, sometimes becoming as short as one and a half inches in length, with the step to extreme left of the sweep. Main and expanded sweeps were normal.	Replacing the step generator condenser, C–51, remedied the trouble. Evidently the capacity of the condenser changed with heat, enough to cause a reduction in amplitude in precision sweep voltage, resulting in a shorter trace; also, in checking with the test scope, the voltage wave form of precision sweep was found to be non-linear on forward trace, probably explaining why the step appeared off to the left of the trace.
No step, no precision sweep.	Renewed crystals. 535 hours in service.
Echoes jumped when range indicator unit vibrated.	Resoldered six poor joints in i-f receiver. Broken lug at terminal strip.

Range Indicator (SJ)—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
The three oscilloscope sweeps did not focus in the same position of the focus control. Echoes from known targets were not up to usual values.	The dynamic focus control, P–6, was adjusted for proper focus control on all three sweeps.
The horizontal positioning control on the RI would not properly center the pattern on the screen of the CRO.	The voltage across the regulator lamps, LP–1 to 4, was checked and found to be much higher than the normal 225 volts. All four of the 991's were replaced and normal voltage obtained also allowing correct sweep positioning. The receiver tuning could now be properly adjusted to a smooth point.
Noticed decrease in "grass" and pip height after a few minutes operation.	Checked all intermediate frequency tubes in the tube tester and found all tested "Good." One 6AC7 tube's emission was found to drop off after warmup. This type of tube failure must be kept in mind when troubles arise.
Bad step on CR tube trace.	Swapped position of V–16 and V–15 in range indicator unit. Step OK.
No precision sweep, no step in sweep.	No connection on terminal strip of resistors in step generator unit. This was jumper wire connection between resistor R–74 and plate resistors R–85.1, 85.2, and R–91. There was therefore no plate voltage in V–14.1 and 14.2. This jumper also feeds the step generator plate voltage. Wire was replaced.
Bad shape on range step.	Exchange positions of V–15 and V–16 (range indicator) to fix shape of step.
Insufficient horizontal positioning control in range indicator to bring trace to left edge of CR tube.	Ionizing voltage of LP–4 range indicator too high for proper positioning control. Exchanged LP–4 and LP–2 range indicator. Positioning of sweep OK.
Disappearing step: Receiver indicator on precision scale registered green dot; on main and expansion scales, as straight line minus step.	Synchronous and range pulse leads from transmitter receiver to range unit were open. Repairs made.
Lost the range step on main and expanded sweep. Precision sweep gone.	Renewed a faulty condenser (C–9) in the trimmer-buffer-shaper circuit in the range unit.
The sweep on the range indicator was found to jitter horizontally on one lobe of the lobe switching.	This was traced to 60 cycle leakage in the antenna projector assembly. The wiring was rearranged in the antenna projector assembly and the terminal strip was cleaned. This cured the trouble.
The sweep on the range indicator jittered vertically with the i-f gain control turned up.	This was traced to an open potentiometer (P–8) in the range indicator. The potentiometer (P–8) was replaced, curing the jitter in the sweep.
There was no trace on the cathode-ray tube screen.	It was found that loose fuse clips on fuses F–5 and F–6 on the power control unit prevented any voltage from being applied to the cathode ray power supply in the range indicator. The fuse clips were tightened and the equipment functioned normally.
Intensity of CR tube low on main sweep as reported. Also down about 6 db.	Turned up intensity control on CR tube. Retuned stubs slightly to improve signals.

Range Indicator (SJ)—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Precision sweep line extended approximately ¼ inch each side of the step.	Tubes were checked and found to be normal. The cause of the trouble was finally traced to a defective condenser, C–52, in the step generator unit (part of the D–150314 range indicator). This condenser was replaced from the ship's equipment maintenance parts.
Fringes from the sweep began to cover practically all the screen.	Found the guide pin in the grid video loose; renewed the tube and the trouble was remedied.
Trace on scope moved to right to start at center of scope. Rolling of ship and engine vibration then caused trace to disappear entirely, leaving a spot at left of scope only.	Loose i-f coaxial cable from oscillator converter. I-f amplifier circuit checked back to coaxial cable connection from oscillator converter. The plug was seemingly tight but proved to be about ⅛-inch out from its connected position. The spring clamp was made tighter and the connection made good.
Jittery sweep and occasional multiple sweep.	V–4 in the C–150315 range unit was found to be defective and was replaced. P–1 in the range unit was adjusted for proper operation.
A fast lateral jitter of the step and pulse was apparent on the range indicator screen.	The voltages at the output of the regulated rectifier unit were properly adjusted and condition was remedied.
Very poor ranges were being attained. The pulse and signals were about 40 percent of normal height. There was no stop on the sweep selector switch. It could be rotated 360° and was intermittent in the main and expanded sweep positions.	The sweep selector switch on the range indicator was removed and repaired, remedying condition.
The trace on the range indicator screen was all to the left of center and the horizontal control would not return it any nearer to the proper position.	The regulator lamp LP–4 in the range indicator did not function and the voltage at terminal No. 36 in the range indicator was 83 volts. The lamp was changed and condition was remedied.
Sweep line too far to the right and unable to correct with HOR positioning control.	Replaced neon lamps in range indicator from ship's spares.
Sweep intensity was found to be erratic.	Traced trouble to V–8 (6AG7) in range indicator; replaced defective tube.
Sweep shortened to half length.	Traced trouble to V–4 (6AG7) in range indicator; replaced tube with spare.
Unable to get ranges greater than 4,000 yards.	Tuned LCU–103 and wave guide tuners. Operation again normal.
Insufficient horizontal centering control.	Range indicator LP–4 and LP–2 exchanged. Horizontal positioning OK.
The trace rose too steeply to the right of the range marker step.	Tube V–15 was replaced, bringing the step back to normal shape.
Range Unit (SJ)	
Disappearing step.	This difficulty was first experienced during otherwise normal operation. Upon investigation it was discovered that two of the jacks in the range unit were grounding to their metallic shield through the securing cap. This was remedied by cutting the metallic shield away from the securing cap. No further trouble of this nature was experienced.

Range Indicator (SJ)—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
When the range unit was jarred, the precision sweep as well as the stops on the other sweeps disappeared.	The 4,000-ohm resistor R–65, in the range unit, was found to be internally intermittent.
Receiver Indicator (SJ)	
A double trace appeared as if lobing with the lobing motor not running.	This was traced to the continuous operation of equipment with lobe separation potentiometer in an advanced position.
Regulated Rectifiers (SJ)	
No trace; no blower motor noise; no voltage regulation.	Loose fuse (F–4) in main control unit. Checked regulated rectifier and a-c source OK. Checked load and found loose fuze. Tightened clamp.
Transmitter-Receiver (SJ)	
The receiver tuning shifted considerably as the equipment warmed up.	The drift in receiver tuning was caused by a defective heating unit in the beating oscillator assembly.
During operations at sea excessive fan rattling was discovered.	Upon returning to port the transmitter receiver unit was disassembled and the retaining rings on ball bearings in magnetron blower motor were found broken. When this condition was remedied, the rattling noise disappeared.
The sensitivity of the equipment was quite low. The sleeve which is a part of the outside of the coaxial line from the magnetron was not in place and there was arcing on the coaxial-to-waveguide transformer on the transmitter. In addition there was considerable dirt in the antenna feeder unit.	The coaxial-to-waveguide transformer on the transmitter was removed, cleaned with crocus cloth and replaced; the antenna feeder unit was disassembled and cleaned and the sleeve on the magnetron coaxial line was put in place.
The equipment was found to have very poor sensitivity although both the transmitter and the receiver seemed to be operating normally.	The trouble was traced to the RT cavity where it was found that the output loop was turned about 90° from its normal position. The loop in the TR cavity was returned to its normal position and the equipment was retuned. It was then found to be working with normal sensitivity.
706A would only operate at 625 volts.	Installed new 706A.
A fluctuation of the step was noted. Step shifted rapidly over a range of about 2,500 yards at times rendering accurate ranging impossible.	Reduction of high voltage (from 800 to 700) helped slightly Replaced tubes in range unit (V–1, V–2, V–6, V–7). Trouble corrected.
Magnetron blower motor stopped.	Secured and oiled by means of oiling rings after which operation was normal.
When the equipment was placed in operation, the transmitted pulse and echoes were at a range of approximately 10,000 yards.	This condition was found to be caused by P–5A and P–4A, modulation generator in the D–150960 transmitter, being plugged into wrong jacks. This caused a neg. sync. pulse to be fed to the range indicator and range unit.
The gain in the receiver did not seem to be high enough, as evidenced by a shortened main pulse on the cathode-ray tube.	Tube V–206, the last intermediate frequency stage was replaced, giving normal gain.

Technician's Checkoff List (SL, SLa, SL–1)

The maintenance procedures outlined in this checkoff list were collected from data submitted by vessels, Navy Yards and manufacturers' radar field service engineers. This checkoff list is to be used by the ship's radar technician or other radar personnel equally qualified. The checkoff list should be made effective immediately upon receipt of this information. A copy of this checkoff list (preferably typewritten) should be made for future use.

NOTE: After completion of each item check (√) in appropriate blank space.

	Year___														
	Month_														
	Week__	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
ANTENNA																	
1. Check oil level in oil cup.																	
2. Check oil level in gear box.																	
3. Check azimuth mark switch for clear sweep.																	
4. Check antenna disabling switch for smoothness of operation.																	
5. Tighten cover bolts and mounting bolts.																	
6. Clean polystyrene window.																	
7. Check wires and lugs on terminal strips.																	
8. Check all cable fittings.																	
9. Check bearing accuracy (± 1.5°).																	
10. Check to see that the antenna drive motor is operating normally.	S																
	M																
	T																
	W																
	T																
	F																
	S																
TRANSMITTER CONVERTER																	
1. Check condition of rubberboot and Belden braid.																	
2. Observe TR box to make certain tube is firing properly.																	
3. Replace TR tube (721A) V–703 every 300 hours.																	
4. Tighten mounting hardware (lubricate any bolts showing corrosion).																	

Technician's Checkoff List—Continued

	Year___											
	Month_											
	Week__	1	2	3	4	1	2	3	4	1	2	3	4
TRANSMITTER CONVERTER—continued													
5. Tighten cover screws (wing bolts) and entrance plugs.													
6. Inspect cables for sharp bends or damage.													
7. Check wires and lugs on terminal strips. (Wires to transformers.)													
8. Check all cable fittings.													
9. Check to see that heater (R–703) is operating properly.													
10. Clean all dirt and dust from chassis; wipe chassis, tubes, transformers, etc., with cloth.													
11. Check operation of blower motor B–701.													
12. Check alignment of magnetron coupling to wave guide.													
13. Check alignment of air gap coupling.													
14. Check for the tightness of crystal converter.													
15. Check for smoothness of operation of S–702.													
16. Check solenoid and gate (butterfly valve).													
17. Oscillator amplifier: (*a*) Check wires and lugs on terminal strips. (*b*) Check all cable fittings. (*c*) Clean dirt and dust from chassis; wipe chassis, tubes, transformers, etc., with cloth.													
18. Check spring tension on waveguide butterfly valve. Check for full opening.													
INDICATOR-MODULATOR													
1. Check wires and lugs on terminal strips.													
2. Check all cable fittings.													
3. Inspect cables for sharp bends or damage.													
4. Tighten mounting hardware.													
5. Tighten cover screws and entrance plugs.													
6. Check interlock (S–801).													
7. Check resistor and fuse clips.													
8. Clean all dirt and dust from chassis; wipe chassis, tubes, transformers, etc., with clean cloth.													

Technician's Checkoff List--Continued

		Year___											
		Month_											
		Week__	1	2	3	4	1	2	3	4	1	2	3	4
INDICATOR-MODULATOR—continued														
9. Check dial and pilot lamps.	S													
	M													
	T													
	W													
	T													
	F													
	S													
10. Tighten Allen head screws.														
11. Check smoothness of operation of T–501 and T–502.	S													
	M													
	T													
	W													
	T													
	F													
	S													
12. Check all voltages: (*a*) Terminal 10, 300 Volts (Adjust by R–416) (*b*) Terminal 15, 110 Volts (Adjust by R–418) (*c*) Line voltage 115 A. C.	S													
	M													
	T													
	W													
	T													
	F													
	S													
13. Check to see that potentiometers R–416 and R–418 properly control the reg. rectifiers.	S													
	M													
	T													
	W													
	T													
	F													
	S													

Technician's Checkoff List—Continued

		Year___											
		Month_											
		Week__	1	2	3	4	1	2	3	4	1	2	3	4
INDICATOR-MODULATOR—continued														
14. Check tuning of equipment with wavemeter.														
15. Check pulse network (Z–501) for oil leaks.														
16. Check cable terminations in junction box.														
17. Clean telltale switch contacts with crocus cloth every 6 months.		Semiannually												
18. Check switches for proper operation—S–452, S–451, S–458, S–453, S–461, S–462, S–454, S–455, S–457, and S–460.	S													
	M													
	T													
	W													
	T													
	F													
	S													
19. Clean soot and dust from L–517.														
20. Check tension of brushes on spark wheel.														
21. Clean spark wheel and electrodes thoroughly.														
22. Rotate stationary electrode 90° every 500 hours.														
23. Check proper seating of all tubes.														
24. Check operation of R–462, R–453, and R–467.	S													
	M													
	T													
	W													
	T													
	F													
	S													
25. Check condition of scope drive motor, differential idler gear, synchro or step-by-step motor and deflection coil assembly.														
26. Check pulse cable termination.														

Technician's Checkoff List—Continued

		Year											
		Month											
		Week	1	2	3	4	1	2	3	4	1	2	3	4
INDICATOR-MODULATOR—continued														
27. Clean bearing cursor face.	S													
	M													
	T													
	W													
	T													
	F													
	S													
28. Check to see that maximum signal and maximum converter current coincide.	S													
	M													
	T													
	W													
	T													
	F													
	S													
29. Crystal current should not be more than 0.8 ma.	S													
	M													
	T													
	W													
	T													
	F													
	S													
30. Check standoff insulators for cracks, chips, etc. (Clean and replace if necessary.)														
31. Check operation of heater.														

Technician's Checkoff List—Continued

		Year___											
		Month_											
		Week__	1	2	3	4	1	2	3	4	1	2	3	4
INDICATOR-MODULATOR—continued														
32. Check operation of time delay relay (if any)—1 min.	S													
	M													
	T													
	W													
	T													
	F													
	S													
33. Check "GO"—"NO—GO" spacing of spark wheel electrodes at pin marked "G."														
RANGE UNIT														
1. Check calibration of range unit.	S													
	M													
	T													
	W													
	T													
	F													
	S													
2. Check the 300v regulated rectifier in range unit.														
3. Check switches for proper operation.	S													
	M													
	T													
	W													
	T													
	F													
	S													

Technician's Checkoff List—Continued

	Year												
	Month												
	Week	1	2	3	4	1	2	3	4	1	2	3	4
RANGE UNIT—continued													
4. Check wires and lugs on terminal strips.													
5. Rotate range dial through 6 complete revolutions as rapidly as possible.													
6. Tighten mounting hardware, cover screws, etc.													
7. Check resistor and fuse clips.													
8. Check all cable fittings.													
9. Clean all dirt and dust from chassis, wipe chassis, tubes, transformers, etc., with cloth.													
AFC UNIT													
1. Check to see that AFC is working properly.	S												
	M												
	T												
	W												
	T												
	F												
	S												
HEATER LINE FILTER													
1. Tighten mounting hardware.													
2. Tighten cover screws.													
3. Check cable fittings.													
4. Inspect cables for sharp bends or damage.													

LUBRICATION CHART (SL, SLa, SL–1)

Proper maintenance requires periodic lubrication of the various components. This chart is intended to reference the units involved, time serviced, and to give the Navy type number if available Reference must also be made to the instruction book for location of lubrication points and the quantity of lubricant required.

Equipment			Service					Lubrication date						
Unit involved	Name of component	Circuit symbol	Hours	Daily	Weekly	Monthly	Annual	Oil	Grease	Instruction book type	Commercial type	Navy type	Nearest Navy equivalent	Comments
Antenna	Drive motor	B–101												See Note 1.
	Synchro worm gear drive						S		X	AN–G–3–A			14L3—Grade II	
	Upper sleeve bearing					X		X		Univis No. 54			O. S. 1113	
	Gear box					X		X		Univis No. 54			O. S. 1113	See Note 2.
	Oil cup					X		X		Univis No. 54			O. S. 1113	See Note 3.
Indicator	Sweep coil drive motor	B–451					X		X	Andok C			14L3 Grade III	
	Sweep differential gears						S		X	Andok C			14L3 Grade III	
	Sweep deflection coil assembly						S	X		Univis No. 54			O. S. 1113	
	Deflection coil worm gear									Spermiceti wax (per RM 641504).			14–P–2	See Note 4.
	True-relative bearing motor	B–452						X		Univis No. 48 (or mineral oil).			O. S. 1113	See Note 5.
	True bearing motor drive gears							X		Univis No. 40			2075	See Note 4.
	Hub of shoulder screw item No. 8								X	Norma-Hoffman C–66 or Beacon M–285.			ANG–3	See Note 4.
	Bearing cursor bevel gears						S		X	AN–G–3–A			14L3 Grade II	
	Bearing cursor shaft						S		X	AN–G–3–A			14L3 Grade II	
Range	Potentiometer	R–1018					S			Bayol D			14K1b	See Note 6.
Modulator	Spark wheel motor	B–501					X		X	Andok C			14L3 Grade III	See Note 7.
Transmitter-converter	Blower motor	B–701					X		X	Andok C			14L3 Grade III	

NOTE No. 1.—Bearings lubricated for the life of the motor and should require no attention for 20,000 hours.

NOTE No. 2.—Oil level should be checked once per week.

NOTE No. 3.—Oil level should be checked once per week.

NOTE No. 4.—After assembly or when installed.

NOTE No. 5.—Synchro motors need no further lubrication. Step-by-step motors should be lubricated after 250 hours of operation or once every three months, whichever is completed first.

NOTE No. 6.—(*a*) Rotate range dial once per week through 6 complete revolutions as rapidly as possible to distribute the lubricating oil. (*b*) Change oil every six months—refill with 2 ounces.

NOTE No. 7.—Centrifugal cutout assembly will require no attention for several years.

ANTENNA LUBRICATION AND MAINTENANCE

a. The antenna gear box housing should contain 6 to 7 ounces of No. 54 Univis Oil. Standard Oil Company of New Jersey, per Navy Specification Bureau of Ships, OS-113. The housing should be filled with oil, through the Gits oil fitting designated Item 20 on ES-687515, until the oil level is flush with the top of the fitting. The upper oil cup should be filled with the above oil and inspected at sufficiently frequent intervals to insure an adequate supply at all times.

b. The contact plunger should have a travel of minimum 0.025 and a maximum of 0.030 inch. The actuating cam should be in contact with the inside of the collar groove at all times with a minimum of 20 and a maximum of 40 grams. The azimuth contact spring should have a contact follow of minimum 0.005 and a maximum of 0.010 inch.

c. The plywood hood covering the antenna parabola should be painted when necessary with either of the following haze gray air dry enamels:

No. 236-40438-Arco Co., Cleveland, Ohio
No. NU7878-Murphy Varnish Co., Newark, N.J.

d. The large diameter threaded plugs designated Item 28 on ES-687515 and located under the covers Item 1 are tuning adjustments for the antenna which should not be disturbed.

Procedure for Draining and Flushing Antenna Gear Case: A life run now being made on a factory-rebuilt antenna (Field Change 46) indicates the necessity for thoroughly draining and flushing the gear case at the first 500 hours of operation to remove any metal particles resulting from the wearing-in of the drive worm and worm wheel. (See Field Changes 25 and 46.)

After the first 500 hours of operation, drain the gear case. Then for flushing, pour 5 or 6 ounces of oil into the filler cup and allow the antenna to run for a few minutes. Drain the gear case again. Finally refill the gear case with OS-1113 oil, revisions D and E. NOTE: If the old type OS-1113 oil without rust preventative is only on hand, add 3 percent (by volume) of anti-rust compound Navy Specification 52C18 Grade 2. This should be carefully blended by shaking or stirring the anti-rust compound before adding it to the oil and then vigorously shaking or stirring the solution until the mixture is thoroughly blended.

After in initial 500-hour flushing, a small sample of the gear case oil should be drawn off every three months when the oil level is checked. If the sample is dirty, then drain, flush, and refill the gear case.

Antenna Drive Motor: The only moving parts are the squirrel cage rotor and the bearings. They are lubricated for the life of the bearing, which should be about 20,000 hours of operation. The capacitors are oil filled and should require no attention or replacement over a period of years.

ANTENNA VIBRATION DUE TO MOTOR MISALINEMENT

The bolts holding the lower portion of the antenna to its mounting plate, Item 84 on ES-687515 Antenna Assembly, protrude slightly through the mounting plate. If the antenna is mounted on a very heavy ship's bolting circle and tightened, warping of antenna mounting plate can occur, causing misalinement of the antenna motor drive. This situtation can be eliminated by adding washers under the heads of item 84 bolts so that this interference does not exist.

STEP-BY-STEP REPEATERS

Some difficulty has been experienced with the step-by-step repeater in the indicator not following the gyro compass accurately when using true bearing indication. At present there is no method for clearing this trouble and the system should be operated with relative bearing indication until a further investigation can be made.

SYNCHRO COMPASS REPEATER CIRCUITS

The compass repeater in the SL D-150610 Indicator is designed to operate from a 36 to 1 type compass repeater circuit. Some SL systems have been installed on ships equipped with the Mark 14 Mod. 6, 1 to 1 speed gyro equipment by using a 1 to 36 speed converter system.

This matter has been referred to the Bureau and wherever possible, priorities have been shifted to avoid this condition. However, where this type of installation is ordered, it will be completed to provide the relative bearing indication only.

Since the SL radar compass repeater is designed to be operated with a 36-to-1 repeater system, it is necessary that the leads by properly connected. In one installation it was found that as the compass was rotated by hand, the angular rotation of the bearing mark line equalled 1/36th the annular rotation of the compass, indicating that the SL system repeater was connected to the 1 to 1 speed synchro generator rather than to the 36 to 1 synchro generator. The synchro terminal blocks should be connected as follows:

COMPASS TERMINALS	COLOR CODE	CONNECTIONS	SL TERMINALS
1	Black	Rotors	35
2	White	Rotors	36
3			
4		1 to 1 speed stators	—
5			
6	Red		37
7	Green	36 to 1 speed stators	38
8	Orange		39

Transposing leads 37 and 39 on the SL terminal strip will reverse the direction of rotation. Rotating the compass by hand will verify correct operation of the synchro.

BO TUNE ADJUSTMENT

When best echoes do not coincide with maximum converter current, the BO TUNE CAVITY adjustment is incorrect and must be readjusted. A procedure is suggested for adjusting the BO TUNE control that is quicker than the method given in the SL Technical Manual, SHIPS 255

(Sec. E, par. 3.59) and SL-1 Technical Manual, SHIPS 249 (sec. E, par. 3.59).

If the equipment has no AFC unit, adjust REC TUNE for best echoes. Then note the direction and the amount that REC TUNE has to be turned in order to obtain maximum crystal current. Turn the BO TUNE control in the same direction and amount. Repeat this procedure until best echoes coincide with maximum crystal current. (One can always predict the direction but not the amount that the BO TUNE control will have to be turned. The amount depends upon the particular 726B tube being used and upon the frequency of the magnetron.)

If the AFC unit can be used, let the AFC hold the 726B tube on correct frequency. Adjust BO TUNE for maximum crystal current as read on the wavemeter.

MAINTENANCE OF SPARK WHEEL

Stationary Spark Electrode: The stationary spark electrode deteriorates with use. Its life can be extended by turning it through an angle of 90° at the end of approximately 500 hours of operation, thus giving it a total life of about 2,000 hours. The electrode should then be replaced with a new one. The cathode should be inspected once each month when in constant use.

If it should be necessary to make adjustments of the spark wheel, the spark electrode spacing should be checked. A set of pass-no pass gages are supplied with the maintenance repair parts. Each of these gages should be slipped over an anode of the wheel and the stationary electrode (cathode) should be moved until one of the gages passes and the other gage does not.

Spark Wheel Brushes: Western Electric Field Modification No. 30 will replace all spark wheel brushes with an improved type having a much stronger spring. Until this modification is made, the brushes should be frequently inspected and the springs kept stretched so as to get sufficient brush pressure on the spark wheel. The spring should be stretched until the pigtail is held taut. If the spring is overstretched, it will coil up and will be difficult to install. Unused brushes are 1/2 inch long. They should be replaced when they wear to a length of 3/8 inch. Be sure the brushes are free in holders and that all burrs are removed. The holder should be adjusted to allow a clearance of 1/16 inch between it and the spark wheel. It may be necessary to bend the brush holder bracket to accomplish this.

In case the slip ring on the wheel has become pitted because of weak brush springs, the only satisfactory remedy is to replace the wheel with a new one. When a new wheel is unavailable, temporary repairs can be made by polishing the ring or by reversing it. Care must be taken when reversing the ring as it may unbalance the wheel to such an extent that the motor bearings will be damaged.

Spark Wheel Motor: The ball bearings are packed with Standard Oil Co. of New Jersey Andoc C grease. The motor should require no lubrication or maintenance for at least a year. To relubricate, remove the cover plate held by four screws, take out felt washer and retainer, also spacing and thrust washers, if any, retaining these washers in proper order to facilitate replacement. This will expose the unshielded side of the bearing. Clean out old grease with a stiff brush dipped in lubricating oil to soften the grease. Add fresh grease, filling the ball bearing space nearly full but avoiding overpacking since fully packed bearings will increase heating. Reassemble in reverse order and repeat for the bearing on the other end. The centrifugal cut-out assembly, Bodine part No. N-612X, is expected to give service for many years without attention.

INDICATOR-MODULATOR SERVICE NOTES

Sweep Coil Drive Motor: The only moving parts are the squirrel cage rotor and the bearings. The bearings are packed with Andoc C grease and this motor should require no lubrication for at least a year. To relubricate, remove the two frame through-bolts and rest the motor on a flat surface, supporting it on the end opposite to the shaft extension. Lift up the main part of the frame separating it at the edge of the outer end bracket, if necessary using a small screwdriver in the pry holes. The rotor complete with bearings on the shaft will remain in one end bracket and may be lifted out, exposing the unshielded sides of the bearings. Clean the old grease out of each bearing with a stiff brush dipped in lubricating oil to soften the grease. Add fresh grease, filling the ball bearing space nearly full, but avoiding overpacking. Reassemble in proper order. The separately mounted capacitors should require no attention or replacement over a period of years.

Tune and Relative Bearing Motor: The precision type ball bearings are lubricated to prevent rusting and keep out foreign material. In use, it is not expected that lubrication or other maintenance will be required or will be practicable. If the motor fails to operate properly, it should be replaced.

Blower Motor: The ball bearings are packed with Andoc C grease and the motor should require no lubrication for at least a year. To relubricate, follow the procedure outlined in the preceding article under "Spark Wheel Motor." The centrifugal cut-out assembly, Bodine part No. N-615X, is expected to give service for many years without attention. If it should fail, change the motor and repair or replace the assembly.

Erratic PPI Indication: This may occur if the 110 or 300 volt d-c supplies to the indicator increase in value due to poor voltage regulation. Measure the voltage as outlined on page 46 of Model SL Instruction Book (ENG. 193). If adjustment of potentiometers P-416 and P-418 does not lower the voltage, the 6Y6G V-402 or V-403 is probably defective.

Hole in Center of PPI Screen Too Large: This indicates the sweep is not being returned to the center of the screen and the 6L6 tube V-304 is not being completely cut off. Replacement of V-304 will usually remedy the condition.

Elimination of False Echoes: False echoes of about 1/4 mile range, which appear as two crossed figure eights at the center of the screen when using the 5-mile sweep, may be cured by adjustment of the antenna tuning plugs. These are the large diameter plugs designated Item 28 on ES-687515 and are located under the covers item 1. First screw the top plug out until the distance between the top of the locknut (item 30) and the top of the plug (not including the grasping tongues) is 1-1/8 inch. If adjustment of

the upper plug does not eliminate the interfering pattern, adjust the bottom plug in a similar manner. Some distant target should be observed when the plugs are changed in order to note any serious changes in sensitivity of the equipment.

Inspection of Variac: Inspect all Variacs for an insecure solder connection on the apparatus side of the terminal. This poor connection is not easily detected visually and becomes apparent when the solder on the connection is drawn off by melting. The Variac is T-502 (115v.-5a) in the SL Modulator Unit D-150611, item 32T of the maintenance part list.

TUNING THE TR (721A) CAVITY

There seems to be an assumption by a number of technicians that the TR cavity is tuned at the factory and that once tuned, it does not have to be tuned again. This is erroneous because the sensitivity of the 721A tube, which forms a part of the tune-up cavity, changes continually. As the plates of the tube ionize, the sensitivity drops and thus the sensitivity of the cavity drops. Aso, the sensitivity of new 721A tubes is never the same.

In many cases, the technician merely tunes the beat oscillator, neglecting the TR cavity, whereby the true efficiency of the system is greatly diminished. Upon the replacement of a 721A tube every 300 hours, it is necessary to tune the cavity.

The tuning process as outlined on pages 44 and 45 and in figure 15 of the Technical Manual (ENG. 193) should be followed.

LUBRICATION INSTRUCTIONS FOR THE OSCILLOSCOPE (INDICATOR) TUBE ASSEMBLY

Due to the temperature under which the SL/SLa/SL-1 indicator units have been operating, the lubrication instructions given in SL Technical Manuals are inadequate. The following bulletin (No. GF 2.3944 dated 13 April 1945) was prepared by the Western Electric Co. at the Bureau's request to supplement the lubrication data in the instruction books. Field Change 49 SL, "Addition of Console Ventilation," will aid in reducing the number of gear assembly failures by preventing the hardening and drying of the lubricant. Additional maintenance repair gear assemblies and parts are being stocked at navy yards and radio pools to take care of necessary replacements.

The lubrication procedure is divided into two step:

a. To be completed by qualified ship radar technicians after every 1,500 hours of operation or every 6 months, whichever occurs first.

b. To be completed by navy yards and repair ships after every 6,000 hours of operation or every 2 years, whichever occurs first.

Purpose of Instructions: The purpose of these instructions is to explain in detail the lubrication and maintenance of the oscilloscope (indicator) tube assembly and the associated flexible shaft assembly used in the SL series of radar systems.

General Comments on Lubrication and Maintenance: The lubrication and maintenance program for the oscilloscope tube assembly is divided into two procedures which are referred to as the "1,500-hour lubrication procedure" and the 6,000-hour lubrication procedure".

1,500-HOUR LUBRICATION PROCEDURE. This procedure is the simpler of the two and may be carried out by the ship's technician after he has been properly instructed. In this procedure, a few easily dismounted components of the oscilloscope tube assembly are temporarily removed to provide access to the lubrication points without taking the whole assembly from the indicator unit. The points lubricated by this procedure are:

a. Deflection coil ball bearing.
b. Deflection coil worm and wheel.
c. Differential gear case.
d. True bearing gear train.
e. Bearing cursor assembly.
f. Flexible shaft assembly.

This procedure shall be carried out after each 1,500 hours of operation or 6-month period, whichever comes first and with the exceptions noted in the second paragraph below. All the points lubricated in the 1,500-hour procedure are lubricated in the 6,000-hour procedure.

6,000-HOUR LUBRICATION PROCEDURE. This procedure involves the removal of the entire oscilloscope tube assembly from the indicator unit to make all lubrication points accessible.

Furthermore, it may involve the replacement of worn parts and only a person who has had considerable experience with the assembly is qualified to juge whether a certain parts should be replaced or not. Because considerable skill and experience is required to carry out the 6,000-hour lubrication procedure, it is suggested that this procedure be carried out by supply ships, tender ships and at Navy Yards.

This procedure shall be carried out as described on page SL Series 2-19 after each 6,000 hours of operation or 2-year period, whichever comes first and with the exceptions stated in the paragraph below.

EXCEPTIONS TO LUBRICATION TIME INTERVALS. Rigid adherence to the intervals prescribed above is not intended if the individual equipments are used under exceptionally severe or corrosive conditions or where excessive heat or dirt is present. Under such conditions, it may be necessary to apply these procedures either completely or in part more frequently. Similarly, if the tube assembly is removed from the indicator unit for other reasons it may be advantageous to then apply the 6,000-hour lubrication procedure.

MAINTENANCE OF TRUE BEARING MOTORS. Whenever a synchro motor is in need of lubrication or replacement, consult the RMO because the Navy has a definite policy regarding the maintenance of synchro motors.

CAUTION ABOUT MAGNETIZED TOOLS. It is essential that all tools used in connection with the procedures described below shall be nonmagnetic or free from magnetism. This precaution is necessary because the magnetization of any of the steel parts of either the deflection coil assembly or differential and worm shaft assembly may introduce spoking on the CRO tube.

CAUTION ABOUT THE USE OF VASELINE. Vaseline

has a low melting point and when it melts it loses practically all of its value as a lubricant. Because of the low melting point of vaseline and the comparatively high temperatures encountered in the oscilloscope tube assembly, vaseline should never (except in case of emergency) be used as a substitue for OS1350 grease.

CAKED GREASE.

a. The grease used in the oscilloscope tube assembly is essentially a mixture of soap and oil. Excessive heat separates the oil from the grease and leaves a residue of soap or caked grease which has little or no lubricating value.

b. Caked grease is the most frequent cause of stiff ball bearings in the oscilloscope tube assembly. The usual remedy, except for the ball bearing of the deflection coil, is to work OS1113 oil into the ball bearing through the clearance opening between the raceway and shield. The deflection coil ball bearing involves procedures that are somewhat different because it is practicable to remove the shield from this bearing.

CHECKING LUBRICATION OF A REPLACEMENT PART. Whenever a wearing component is replaced with a new maintenance repair part, the lubrication of the new item should be checked and not taken for granted. This applies also to complete units. Remove the shield from the deflection coil ball bearing and relubricate if necessary. If a sealed ball bearing feels stiff or sounds dry, apply OS1113 oil. Remove the cover from the differential or telltale gear box and if in doubt relubricate with OS1113 oil or OS1350 grease or both.

1,500-Hour Lubrication Procedure:

ACCESS TO LUBRICATION POINTS. To gain access to the points requiring lubrication, the following part of the oscilloscope tube assembly shall be removed:

a. Bearing cursor assembly.
b. CRO tube.
c. CRO tube shield.
d. CRO tube centering washer.

LUBRICATION OF DEFLECTION COIL BALL BEARING.

a. Removal of the CRO tube centering washer expose the deflection coil bearing. Remove the bearing shield to gain access to the ball races as shown in figure 1. This shield need not be replaced as it is not essential in this application.

b. Wipe the area surrounding the exposed bearing clean, being careful not to get any dirt or grit into bearing.

c. Examine bearing carefully while rotating it first in one direction and then in the opposite direction. If bearing is free and smooth in operation and there is no evidence of caked grease adhering to the balls and races it may be assumed that the bearing is in good condition. Bearings in good operating condition merely require packing with OS1350 (Beacon M-285) grease. After packing, rotate bearing several times and remove excess grease.

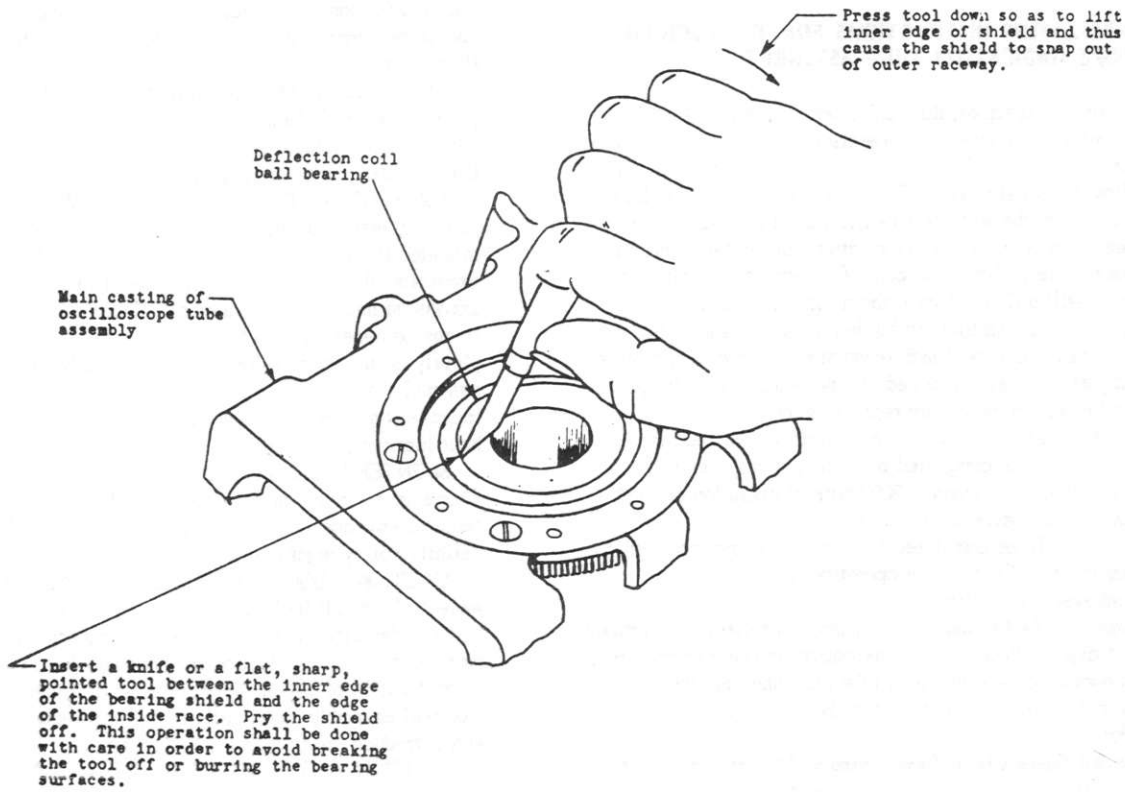


FIGURE 1.—Method of removing shield from deflection coil ball bearing.

d. Replace CRO tube centering washer after first wiping clean the surface adjacent to the bearing.

e. If the bearing does not turn freely, the trouble is most likely due to caked grease. Apply a few drops of OS1113 (antenna) oil to the bearing while rotating it several times in both directions. This procedure should loosen the caked grease sufficiently to permit its removal. With an orange stick and a lint-free cloth, remove as much possible of the old grease or soap. If this procedure result in restoring the bearing to good operating condition, it should be repacked with OS1350 grease as described in the preceding paragraph. If not, it will be necessary to remove the deflection coil assembly and submerge the bearing in a grease solvent as called for in the 6,000-hour procedure, and under "Lubrication of Deflection Coil Assembly."

LUBRICATION OF DEFLECTION COIL WORM AND GEAR.

a. The worm gear can be observed by looking into the openings in the front part of the indicator tube assembly main casting just above the terminal strip as indicated in figure 2. At the first time that the "6,000-hour procedure" is applied, this opening will be enlarged by cutting away a part of the deflection coil shield assembly. If an opening has been cut in shield, dismount the terminal block without disconnecting the wires and push the terminal block to one side.

b. To the visible portion of the worm gear, apply some OS1350 grease with the aid of a stiff wire having a short hooked end or with a small short-bristled paint brush. Rotate the gear by hand and apply grease to several places on the gear. Avoid applying excessive quantities of grease and the smearing of the slip rings. Rotate gear several times to evenly distribute grease over both the gear and the worm.

c. If shield has been cut away, the slip rings will be accessible for cleaning. Wipe the rings with a clean cloth dampened with a cleaning fluid such as carbon tetrachloride or equivalent.

LUBRICATION OF DIFFERENTIAL GEAR CASE.

a. Make a reference mark on the differential housing cover so that this cover may later be replaced in its original position. Loosen the two recessed screws and remove the cover to permit inspection.

b. If the grease appears caked or dirty, remove as much as possible of the old grease with the aid of an orange stick and a lint-free cloth. Do not flush with a solvent as flushing may wash foreign matter into the ball bearings.

c. Add OS1350 grease until housing is approximately one-third full. Replace cover in its original position.

LUBRICATION OF TRUE BEARING GEAR TRAIN.

a. Clean gears of dirt and caked lubricant with a rag and a small quantity of OS1113 oil.

b. Apply a small amount of OS1350 grease to the teeth of all the gears in the train including the gear on the differential housing. Run gears by hand to distribute grease over all the teeth and carefully wipe off the excess.

c. Apply a few drops of OS1113 oil to the sleeve bearing of the idler gear located next to the differential housing gear as indicated in figure 2. If true bearing motor is a step-by-step motor, apply oil to idler gear sleeve bearing on step motor as indicated on figure 2.

LUBRICATION OF BEARING CURSOR ASSEMBLY.

a. Remove the cover plate from the top of the bearing cursor assembly. See figure 3 for lubrication points.

b. Apply a few drops of OS1113 oil to the oilite sleeve bearings of the dial rollers and the oilite sleeve bearings of the miter gear shafts. Wipe off any excess oil.

c. Wipe the upper and lower edges of the driven cursor ring with a clean cloth and a little OS1113 oil. The under side of this ring may be reached by removing the spring loaded roller assembly.

d. Before reinstalling the spring loaded roller assembly, apply some OS1113 oil to the surface on which this assembly slides.

e. Reinstall the spring loaded roller assembly and the cover plate.

f. After cleaning the miter gears, apply a small amount of OS1350 grease to their teeth.

LUBRICATION OF FLEXIBLE SHAFT ASSEMBLY. Lubricate the flexible shaft assembly as indicated in figure 4.

RESTORATION OF OSCILLOSCOPE TUBE ASSEMBLY TO NORMAL. Reinstall the parts removed from the oscilloscope tube assembly. Adjust the spring tension on the loaded roller so that it is just sufficient to prevent the sideways displacement of the cursor dial when the handwheel is rocked back and forth. Turn the high voltage on. Readjust the horizontal and vertical centering. Check the oscilloscope tube assembly for normal operation.

6,000-Hour Lubrication Procedure:

REMOVAL OF OSCILLOSCOPE TUBE ASSEMBLY FROM INDICATOR UNIT.

a. Remove the bearing cursor assembly, CRO tube and CRO tube shield.

b. Dismount true bearing motor (synchro or step-by-step motor) from oscilloscope tube assembly casting. The true bearing motor should be moved aside without disconnecting its wiring to permit removal of tube assembly.

c. Disconnect wires between oscilloscope tube assembly and indicator unit. The wires involved appear on sweep chassis terminals 314, 315, 316 and 317; indicator tube terminals 401 to 412 inclusive; telltale marker terminals 1 and 3 and telltale marker switch S-463. Access to S463 can be obtained by withdrawing the range unit from its case.

d. Dismount and remove the oscilloscope tube assembly from the indicator unit. The casting of the oscilloscope tube assembly is fastened to the indicator unit chassis with four hex cap screws in front and three larger hex cap screws in the rear. The telltale marker gear box is fastened to a bracket with one round head machine screw. To provide additional working clearance, it may be helpful to unbolt and slide the sweep chassis to the left.

REMOVAL OF COMPONENTS FROM MAIN CASTING OF OSCILLOSCOPE TUBE ASSEMBLY.

a. Remove telltale marker assembly and associated motor condenser. The deflection coil drive motor mounting plate is fastened to the main casting with four hex cap screws. In certain SL type equipments, two pins are used to index the assembly of the motor to the main casting.

If these pins are loose and cannot be staked tight, they should be removed and discarded.

b. Remove the square cover plate from the deflection coil shield by removing six screws and nuts. Allow the subassembly consisting of the focus-centering coil and CRO tube socket to remain attached to this plate. There is a 2-conductor and a 9-conductor cable between this subassembly and the 12-conductor terminal strip. If these cables interfere with the work to be done, unfasten them from the main casting.

c. Remove the rectangular shield that encloses the deflection coil assembly and be careful not to damage the attached spring contacts.

d. To remove the deflection coil assembly, remove the four flat head screws that hold the two ball bearing clamping plates to the casting. Do not remove the CRO tube centering washer.

e. If the ball bearing shield of the deflection coil is still on the bearing, pry the shield off as shown in figure 1. Place the deflection coil assembly, bearing end down, in a shallow vessel and fill with Stoddard solvent, or equivalent, until ball bearing is submerged. Allow to soak and occasionally spin the bearing to aid the removal of the grease. Repeat this process as required until bearing is entirely free of grease and foreign matter.

f. Remove the differential and worm shaft assembly as indicated in figure 5.

g. Remove the idler shaft and idler gear. An exploded view of the idler gear assembly is shown in figure 7. First remove the locknut and lock-washer. Then screw the elastic stop nut back and push the clamping cup back in order to expose the hexagonal portion of the stud shaft. Finally screw the stud shaft out of the main casting.

INSPECTION AND CLEANING OF MAIN CASTING.

a. If any difficuly was experienced in removing the differential and worm assembly, examine the bearing mounting bosses for burrs and scratches. Burnish the bearing seating surface of the bosses with crocus cloth if necessary.

b. Thoroughly clean the casting with a cloth or brush and Stoddard solvent or equivalent. Set casting aside for later.

MAINTENANCE OF DIFFERENTIAL AND WORM ASSEMBLY.

a. Wipe the exterior clean with a dry cloth.

b. Carefully examine the worm and the three ball bearings that are external to the differential housing. If the worm shows excessive wear, it should be replaced. The bearings should also be replaced if they cannot be made to turn freely after the application of OS1113 oil to the balls and races. Application of the oil may be done by submerging the bearings for a few minutes or by working oil into the bearing through the clearance opening between race and shield. Occasionally rotate bearing during application of

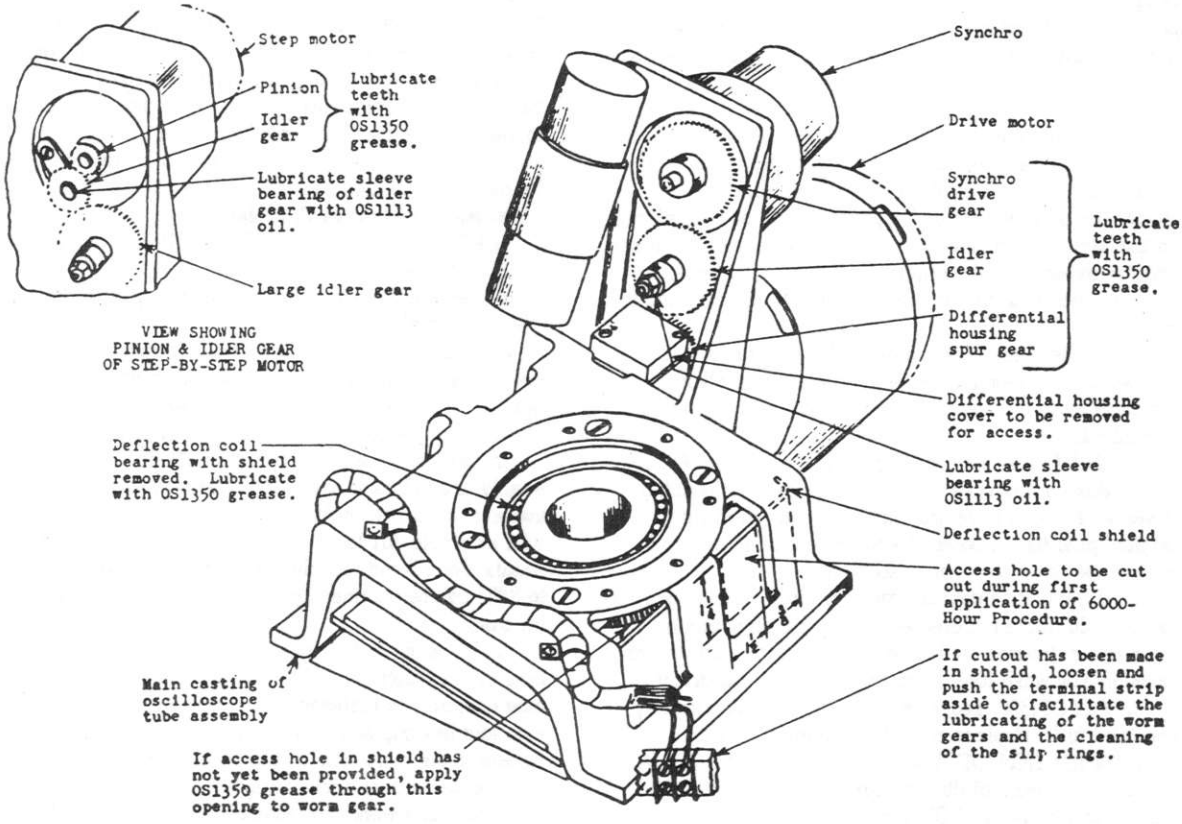


FIGURE 2.—Location of 1,500-hour lubrication points and access hole in shield.

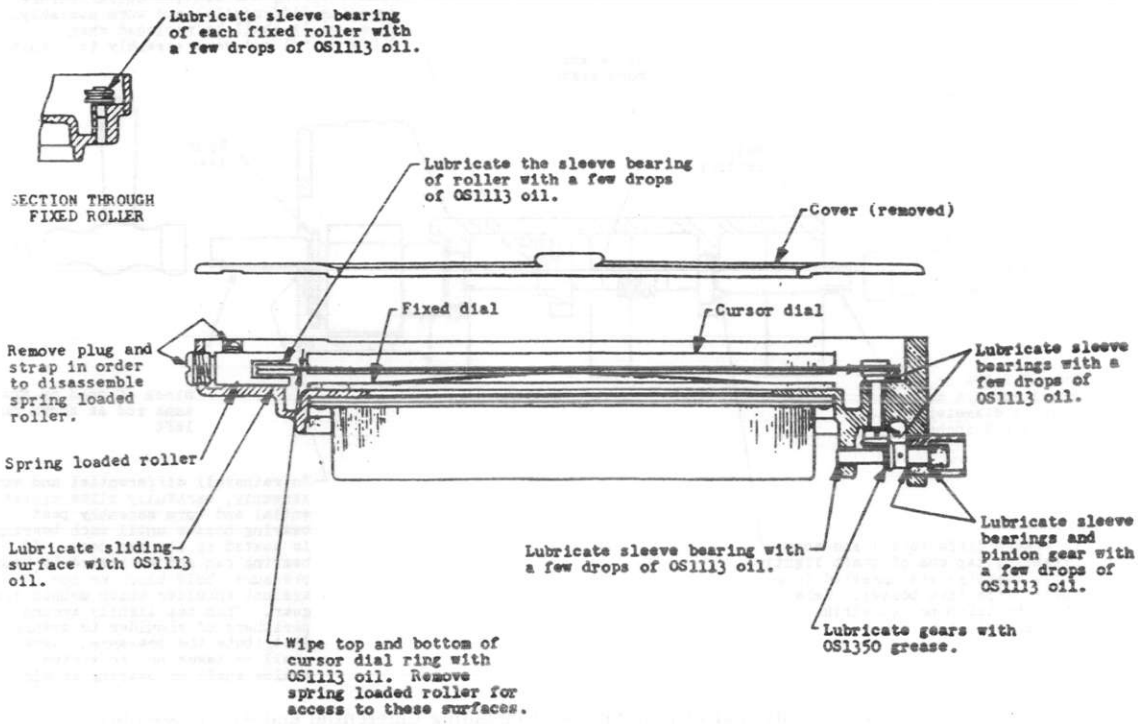


FIGURE 3.—Lubrication of bearing cursor assembly.

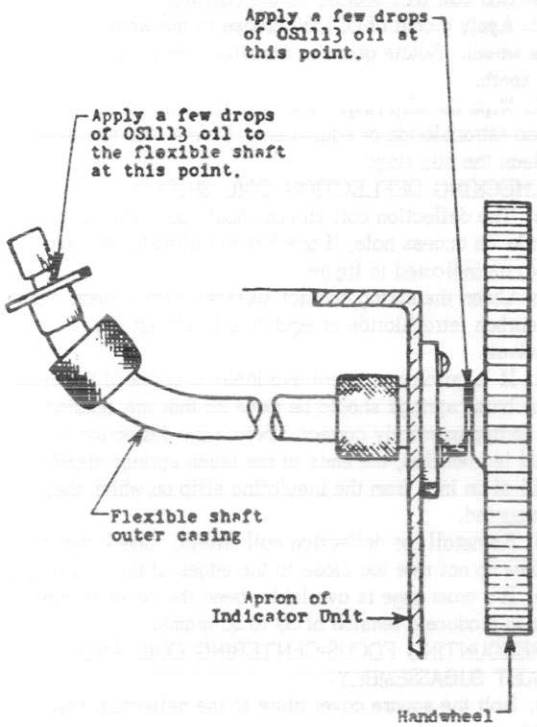


FIGURE 4.—Lubrication of flexible shaft assembly.

oil. Allow excess oil to drain from bearing and wipe with a clean cloth.

c. Make a reference mark on the differential housing cover so that this cover may later be replaced in its original position. Loosen the two recessed screws and remove the cover.

d. Remove as much as possible of the old grease with the aid of an orange stick and a lintfree cloth. Do not flush with a solvent as flushing may wash foreign matter into the ball bearings.

e. If the ball bearings can not be made to rotate freely by the application of OS1113 oil or if the condition of the miter gears is bad, replace the entire differential and worm assembly.

f. When the differential and worm assembly is in good condition, add OS1350 grease until the housing is approximately one-third full. Replace the cover in its original position.

g. Remount the differential and worm assembly in the main casting as indicated in figure 5.

LUBRICATION OF TELLTALE MARKER GEAR BOX.

a. Remove end plate as indicated in figure 6. Remove the grease, as much as possible, with a cloth and orange stick. Exercise care to avoid working dirt or foreign matter into ball bearings. Do not flush the gear box with a solvent as flushing may wash foreign matter into ball bearings.

b. Apply a few drops of OS1113 oil to balls and races of ball bearings in order to loosen up any caked grease that may be present.

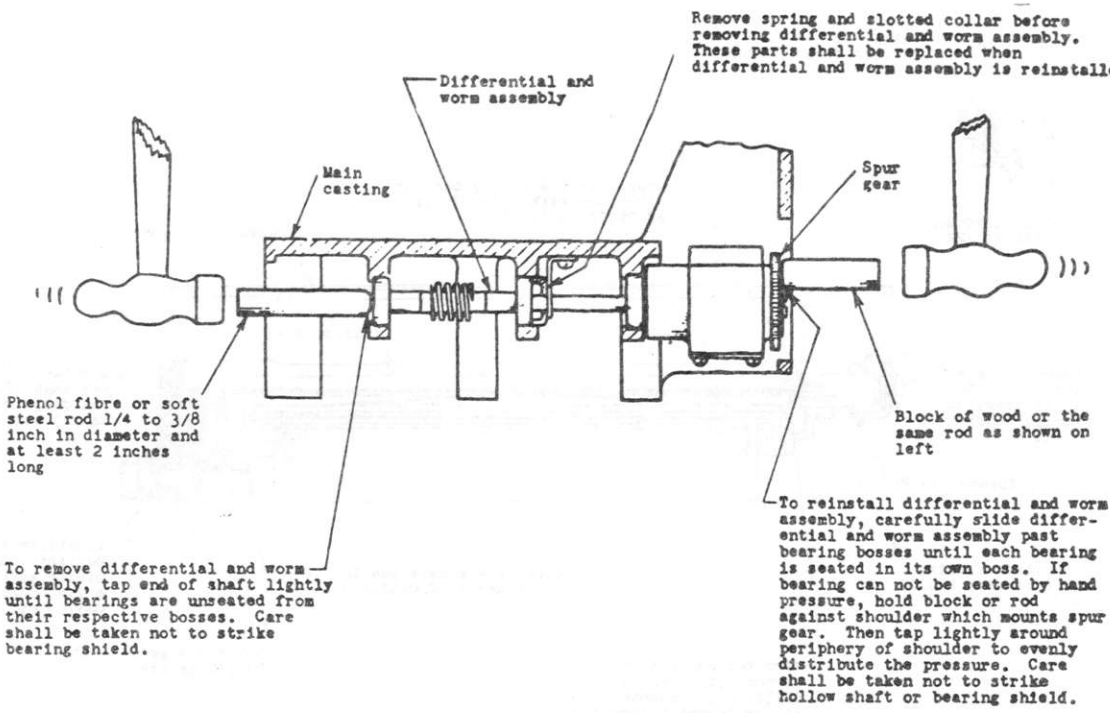


FIGURE 5.—Method of removing and installing differential and worm assembly.

c. Apply a liberal coat of OS1350 grease to the worms and worm gears.

d. Apply OS1113 oil to all points indicated in figure 6. Reinstall the end plate.

MAINTENANCE OF DEFLECTION COIL DRIVE MOTOR.

a. In one of the shaft extensions of the KS-5995 motor there is a projecting pin which has been forced into a hole in the shaft and set very accurately. It is not considered practicable to remove and replace this pin in the field. Therefore the end shield should not be removed to regrease the bearing at that end.

b. To lubricate the motor, remove the countersunk flush screw in each bearing chamber. Add two or three drops of OS1113 oil. Replace the two screws.

c. When a motor bearing fails, substitute a new motor.

LUBRICATION OF IDLER GEAR.

a. Clean the components of the idler gear assembly with a cloth and Stoddard solvent.

b. Apply OS1350 grease to the hub bearing of the idler gear and reassemble to main casting as indicated on figure 7.

c. After assembly to casting, apply OS1350 grease to teeth of idler gear. Rotate gears to distribute the grease over teeth of the idler gear and the differential spur gear.

LUBRICATION OF DEFLECTION COIL ASSEMBLY.

a. Remove the deflection coil assembly from the solvent and allow excess solvent to drip off. With a clean cloth in one hand, and deflection coil assembly in the other, tap the deflection coil sharply against cloth to remove excess solvent. After the solvent has entirely evaporated and the bearing has been thoroughly cleaned, inspect and repack the bearing.

b. Remount the deflection coil assembly to the main casting.

(CAUTION: The CRO tube centering washer must be mounted in place and each of its four mounting screws must be equipped with a lockwasher to avoid the screws from extending through the casting and thus preventing the proper seating of the clamp plates which secure the deflection coil ball bearing to the casting.)

c. Apply a coat of OS1350 grease to the worm and worm wheel. Rotate gears to distribute grease over the gear teeth.

d. Wipe the slip rings clean with a clean cloth and carbon tetrachloride or equivalent. Do not use abrasives to clean the slip rings.

CHECKING DEFLECTION COIL SHIELD.

a. The deflection coil shield should be modified to provide an access hole, if one has not already been provided, as indicated in figure 2.

b. Clean the spring contact surfaces with a clean cloth and carbon tetrachloride or equivalent. Do not use abrasives.

c. If a gram gage is not available, a check of the angle of the brush springs should be made so that the tension will be approximately correct. Before the deflection coil shield is installed, the ends of the brush springs should be 11/16 of an inch from the insulating strip on which they are mounted.

d. Reinstall the deflection coil shield. Check that the brushes do not ride too close to the edges of the slip rings.

e. If a gram gage is available, bend the brush springs so as to produce a tension of 30 to 35 grams.

REMOUNTING FOCUS-CENTERING COIL AND SOCKET SUBASSEMBLY.

a. Bolt the square cover plate to the deflection coil shield.

b. If the 9-conductor cable was removed from the casting, put the cable back in place.

c. Taper or cover the 2-conductor cable with a suitable insulating material. Thread this cable through the front left-hand opening of the main casting. In rearranging the 2-conductor cable, it will be noted that this cable is long

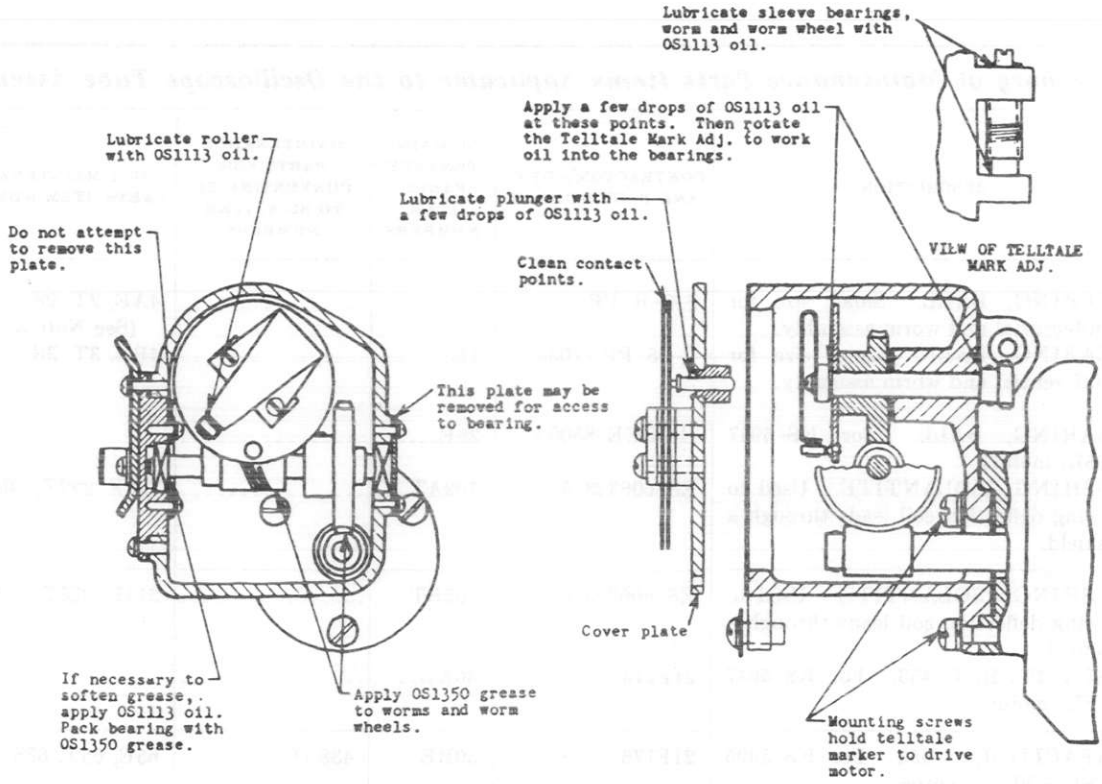


FIGURE 6.—Lubrication of telltale marker gear box.

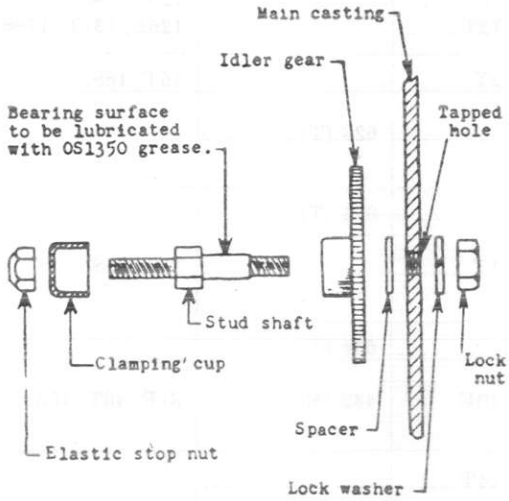


FIGURE 7.—Exploded view of large idler gear assembly

enough to be connected directly to terminals 314 and 315 of the sweep chassis instead of terminals 401 and 402 of the tube assembly. This change will eliminate the two strap wires between the sweep chassis and tube assembly in order to facilitate subsequent servicing of this unit.

REMOUNTING TELLTALE MARKER ASSEMBLY. The pin on the shaft of the deflection coil drive motor must engage the two slots in the differential shaft. Remount the drive motor plate to the main casting. Remount the drive motor condenser on the rear surface of the main casting.

TEST-RUN OF DEFLECTION COIL DRIVE.

a. Apply 115 v. 60 cycles a-c to terminals 1 and 3 of the telltale marker terminal strip in order to run the deflection coil drive motor.

b. Hold the differential housing lightly with one finger in order to determine that the torque developed is uniform. Variations in torque usually indicate irregularities in operation of bearings or gearing on both. Such irregularities should be corrected before the oscilloscope tube assembly is reinstalled in the indicator unit.

REINSTALLATION OF OSCILLOSCOPE TUBE ASSEMBLY IN INDICATOR UNIT. Reinstall the oscilloscope tube assembly in the indicator unit in reverse order of procedure outlined under "Removal of Oscilloscope Tube Assembly from Indicator Unit," but omit the reinstallation of the bearing cursor assembly. Connect the white wire of the 2-conductor cable to sweep chassis terminal 314 and the white-red wire to terminal 315.

LUBRICATION OF BEARING CURSOR AND FLEXIBLE SHAFT ASSEMBLIES. The 6,000-hour and 1,500-hour lubrication procedures are identical for the bearing cursor and flexible shaft assemblies. Apply the procedure given in "Lubrication of Bearing Cursor Assembly" and "Lubrication of Flexible Shaft Assembly."

RESTORATION OF OSCILLOSCOPE TUBE ASSEMBLY TO NORMAL. Replace the CRO tube and bearing cursor assembly. Adjust the spring tension on the loaded roller so that it is just sufficient to prevent the sideways displacement of the cursor dial when the handwheel is rotated back and forth. Turn on the high voltage. Readjust the horizontal and vertical centering. Reset the zero adjustment on the telltale. Check oscilloscope tube assembly for normal operation.

Summary of Maintenance Parts Items Applicable to the Oscilloscope Tube Assembly

DESCRIPTION	CONTRACTOR'S DWG. AND PART NUMBER	SL MAINTENANCE PARTS, ITEM NUMBERS	MAINTENANCE PARTS FOR CONVERTING SL TO SL-A, ITEM NUMBERS	SL-1 MAINTENANCE PARTS, ITEM NUMBERS
BEARING, BALL. Small size for differential and worm assembly.	S-3-R-PP			4AE, 2T, 2S. (See Note *a*.)
BEARING, BALL. Large size for differential and worm assembly.	C-95-PP 77035	1E		4BE, 3T, 3S.
BEARING, BALL. For KS-5947 (SL) motor.	ENDEE-8500	28E		
BUSHING, ISOLANTITE. Used to bring deflection coil leads through a shield.	ES-606323-5	102AT		213E, 222T, 204S.
BUSHING, ISOLANTITE. Used to bring deflection coil leads through a shield.	ES-606323-6	102BT		214E, 223T, 205S.
CAPACITOR, C-453. For KS-5947 (SL) motor.	21F213	30AE		
CAPACITOR, C-453. For KS-5995 (SL-a/SL-1) motor.	21F176	30BE	438 (E)	65E, 65T, 63S.
CAPACITOR, C-454. 1 μf $\pm$ 10%, 600 V d-c.	ES-682063-5	(69E)	439 (E)	136E, 147T, 129S.
COIL, DEFLECTION, ASSEMBLY	ES-692545-1	73T		129E, 140T, 122S.
COIL, FOCUSING & CENTERING	D-163194	72T		126E, 137T, 119S.
DIFFERENTIAL & WORM ASSEMBLY.	BO-29023-1	2T		16T, 16S.
GASKET. Used between switch assembly and telltale marker gear box.	B-13358-4		623 (T)	
GASKET. Used between small cover plate and telltale marker gear box.	B-13360-3		624 (T)	
GEAR, SPUR. Large idler gear. G-147.	BO-29000-3	1T		15T, 15S.
JACK, J-457. Carries current to panel lamps.	PC2M		654 (T)	
LAMP, PANEL. 3 volts, I-453 to I-460, inc.	71A-900	10E	432 (E)	31E, 46T, 46S.
MOTOR, DEFLECTION COIL DRIVE, B-451. Used prior to Field Change No. 27.	KS-5947	14T		
MOTOR, DEFLECTION COIL DRIVE, B-451. Used with telltale marker and replaces KS-5947.	KS-5995-LO2 or LO3.	14T	625 (T)	53E, 53T, 53S. (See Note *a*.)
MOTOR, STEP-BY-STEP, B-452, 70-volt.	D-150962	19S		54T, 54S.
MOTOR, SYNCHRO, B-452	D-150948	20S		54T, 54S.

Summary of Maintenance Parts Items Applicable to the Oscilloscope Tube Assembly—Continued

DESCRIPTION	CONTRACTOR'S DWG. AND PART NUMBER	SL MAINTENANCE PARTS, ITEM NUMBERS	MAINTENANCE PARTS FOR CONVERTING SL TO SL-A, ITEM NUMBERS	SL-1 MAINTENANCE PARTS, ITEM NUMBERS
OSCILLOSCOPE TUBE ASSEMBLY. Does not have bearing cursor or telltale marker.	D-150946	15S		
OSCILLOSCOPE TUBE ASSEMBLY. Equipped with bearing cursor and telltale marker.	D-151901	23S		382S.
PLUG, P-457. Carries current to panel lamps.	MC2F1		653 (T)	
RESISTOR, R-488. 0.47 meg. ±10%, 1 watt.	ES-682064-19	(182E)	440 (E)	341E, 340T, 321S.
SET OF PARTS FOR MOUNTING KS-5995 MOTOR. See Note *b*.	BR-29861	14AT		
SOCKET, X-451. For CRO tube	ES-692539-6	89T		198E, 206T, 188S.
SPRING ASSEMBLY. Part of S-463	B-13357-1		436 (E), 621 (T)	37E, 47T, 47AS.
SPRING ASSEMBLY. Part of S-463	B-13357-2		437 (E), 622 (T)	38E, 48T, 48S.
STEERABLE AZIMUTH DIAL. Bearing cursor assembly with flexible shaft and handwheel.	D-151662		708 (S)	387S.
SWITCH ASSEMBLY. S-463 complete.	B-13361-1		625A (T)	75AE, 75AT, 78AS.
TELLTALE MARKER. Includes KS-5995 motor.	D-151663		709 (S)	388S.
TUBE, CATHODE RAY, V-451	7BP7/1813-P7	53E, 64T		114E, 123T.
WASHER, FELT. For KS-5947 (SL) motor.	5852918AA1	29E		
WINDOW DIAL ASSEMBLY. Used prior to the addition of the bearing cursor assembly.	ES-692548-1	15E		

NOTES.—*a*. SL-1 equipment maintenance parts, items 4A and 53, are added to the maintenance parts box by Field Change 47.

b. When a KS-5947 (SL) deflection coil drive motor is replaced by a KS-5995 (SL-a/SL-1) motor, a set of parts per BR-29816 are required unless Field Change 27 can be applied instead. The set of parts per BR-29816 contains complete instructions.

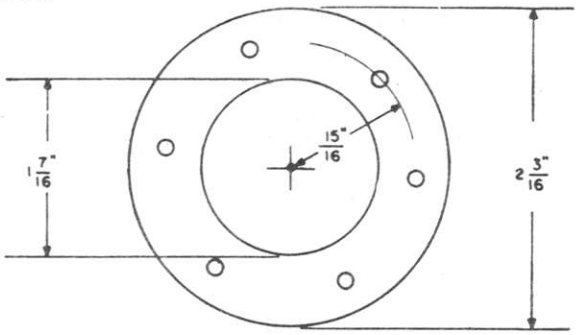
REPLACING CRO TUBE CENTERING WASHERS

During the 3,500-and 6,000-hour lubrication procedures the rubber (or neoprene) CRO tube centering washers should be checked for deterioration and replaced if necessary.

Since they are not included in any maintenance parts, washers can be made locally as shown in figure 8.

INSTALLING ANTENNA DRIVE MOTOR

Care should be taken to align the motor properly. The KS-5986 Motor on the CW-66AEP-2 Antenna assembly is coupled to the antenna drive by the 252CC Morse Flexible Coupling. Place the motor on the base with the shaft slipped into the motor half of the coupling but with the coupling setscrew loose. Install the four mounting bolts with sufficient sleak to permit free movement of the motor on the base. Shims such as those generally used with the present assembly should be available to slip under the motor feet as required. Connect white or green motor lead to terminal No. 3 on the terminal strip. Connect black motor lead to terminal No. 4 and red motor lead to terminal No. 5. Prepare to apply 115 volts, 60-cycle power to terminals 3 and 4 of the terminal strip for the purpose of running the motor. Start the motor. Slide the motor sideways until quitest operation is attained. This condition is determined by observing the position resulting in a minimum noise level. The mounting bolts may now be fastened down more snugly but not entirely tight. Lift the motor slightly at each foot by prying with a heavy screwdriver used as a lever. During each operation again observe the noise level and insert or remove shims to attain the minimum noise. Finally, tighten the four mounting bolts and the coupling setscrew.



MATERIAL

A.S.T.M. NEOPRENE 8003 OR RUBBER NAVY SPEC 33R1 (INT)
3/32-IN. THICK, WITH 6 EQUALLY SPACED HOLES, 1/8 IN. DIA.

FIGURE 8.

REPLACING SPARK WHEEL ASSEMBLY

a. Be sure all power to the radar is turned off. There are two sources of power, i.e., main power and heater power. The main power is controlled by the POWER switch on the Indicator Unit. The heater power is controlled by a switch external to the radar.

b. Remove the two front covers, i.e., the front cover of the console and the front cover of the Modulator Unit.

c. Disconnect the high-voltage pulse cable.

d. Remove the phenol fibre guard plate from the front of the spark wheel enclosure.

e. Remove the brush holder assembly.

f. Remove the stationary electrode assembly.

g. Remove the old spark wheel from the motor shaft.

h. Install the new spark wheel on the motor shaft.

i. Reinstall the stationary electrode assembly and set the spark gap clearance with the GO and NO-GO gauges.

j. Reinstall the brush holder assembly.

k. Reinstall the phenol fibre guard plate on the front of the spark wheel enclosure.

l. Reconnect the high-voltage pulse cable.

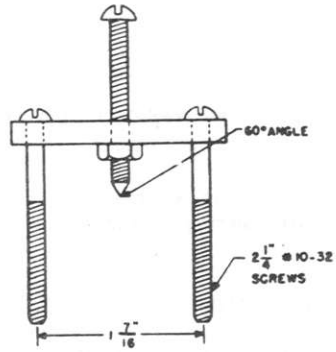
m. Test-run the radar and check the operation of the spark wheel for normal.

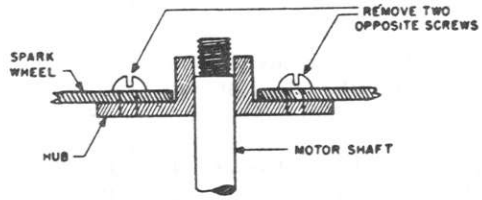
n. Replace the two front covers that were removed per direction b.

SPARK WHEEL REMOVAL ON SL

Reports from the field indicate that considerable trouble has been encountered by inexperienced personnel in attempting to remove the spark wheel from the SL radar equipments. In order to avoid unnecessary work and possible damage to the equipment when removing and replacing this component, it is suggested that technicians follow this procedure:

To loosen the motor shaft nut it is necessary that the spark wheel assembly be prevented from turning. To prevent this natural tendency to turn requires patience and the correct method of blocking the assembly. Do not block on the spark wheel pins because they are very brittle and will snap off when pressure is applied to the nut. Use a double open-end wrench with 5/16" and 13/32" openings. Place the larger openings of the wrench on one of the round bars that support the stationary electrode assembly. Engage the smaller opening of the wrench with one of the hex nuts in the outer row on the spark wheel.





Ordinary methods of applying pressure often-times fail to accomplish the removal of the wheel after the nut has been removed. To meet this situation a wheel puller has been devised (fig. 1). This consists of a piece of steel or brass approximately 1/4" thick, 1" wide, and 2-1/4" long. Three holes are drilled as shown in figure 1. The center hole is drilled and tapped for a #10-32 brass screw. An alternate method is to use a nut through which the center screw is screwed thus accomplishing the same purpose—applying pressure on the center of the motor shaft. The two outer holes are a loose fit for the #10-32 screws.

To use the wheel puller, first remove two opposite screws that hold the spark wheel to the hub. Then screw the two 2-1/4" screws of the wheel puller into these screw holes. The exact depth the screws are inserted is not critical but the puller plate should be parallel with the wheel so that the wheel will have no tendency to bind when pressure is applied. The final step is to screw in the center screw, putting pressure on the center of the motor shaft until the spark wheel is pulled off the shaft.

MODEL SL SERIES TROUBLESHOOTING NOTES

Notes on Recurrent Failures

Antenna System (SL/SL-a, SL–1)

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
The equipment was operating satisfactorily with the exception that the bearings received were 45° off.	Due to improper adjustment of BEARING MARK ADJUST. BEARING MARK ADJUST was set so that the bearings received checked with those taken by the ship's polaris.
Found the azimuth marker switch shorted.	This was due to the switch cover on the antenna being loose. Salt water fouled up the switch causing it to remain closed at all times. The switch was cleaned and readjusted, and the cover was then securely fastened to prevent recurrence of this trouble.
Azimuth contactor plunger assembly in the CW–66AEP antenna assembly leaking oil due to high oil level in gear box and worn leather gasket around plunger shaft.	Removed azimuth contactor plunger assembly and compressed leather packing.
Ship reported false signals.	Checked the antenna, found the antenna wave guide plug on top side of assembly had vibrated loose; reset by turning out 2 turns which cleared this false echo.
A second azimuth mark was encountered at times when the ship was sailing in rough seas.	This difficulty disappeared when the antenna was properly lubricated.
When the antenna drive motor was turned on, the high voltage to the transmitter would also come on.	Caused by condenser C–102 having one side shorted to ground. The condenser itself was not shorted, merely *one* side was shorted to the metal case. A new condenser was installed.
The azimuth mark had appeared intermittently at sea.	The azimuth switch box was opened and the antenna rotated until the contacts closed. The lock nut on the plunger was unscrewed so that the contacts closed with more tension. This remedied the trouble.

Modulator and Indicator (SL/SL-a/SL–1)

Two echoes, slightly displaced in range, were appearing on the PPI screen, indicating double firing of the magnetron.	The 706FY tube, V–702, in the D150608 r-f unit was replaced and the equipment returned. NOTE: Any abnormal conditions should be checked by testing all tubes and plugs leading to the point of difficulty at the first sign of the difficulty.
The sweep length on the CW–55ACV Plan Position Indicator was abnormally long.	The sweep length was adjusted to coincide with the maximum range marking by adjustment of R–329.
False echoes appearing in the form of a cross, approximately one mile long on the short scale. D–163366 crystal rectifier capsule having a front to back ratio of 2 to 1.	Tuning plug No. 28 on D–150606 Antenna Assembly, plug screwed into casting with approximately ⅝ inch of the screw threads protruding, this adjustment causing false echoes. Crystal rectifier D–163366 with poor front to back ratio. The tuning plug on the D–150606 antenna (top plug) was adjusted to eliminate the false echo. It was eliminated when the plug was unscrewed to approximately 1 inch of thread showing. At this position the equipment seemed to operate most efficiently.

Modulator and Indicator (SL/SL-a/SL-1)—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
The PPI sweep trace was not returning to zero range and was scribing a circle about coincident with the 1-mile line. Also no crystal current was registered.	Both troubles were due to failure of V–408, the 6X5GT rectifier in the d-c power supply circuit of the D–150610 Indicator Unit. V–308 failed causing improper bias on V–304 allowing residual current to flow in deflection coils. Replaced both tubes.
PPI picture did not maintain a true bearing position.	The bearing shaft for the large gear in the train of gears between the step-by-step motor and the differential in the CW–55ACU Indicator Assembly was very loose and in some positions allowed the gears to become unmeshed. This allowed one side of the differential to turn freely thereby allowing the PPI image to turn at random regardless of the setting for true or relative bearing. The bearing shaft was tightly screwed against its mounting plate. After the gear was properly mounted on its shaft there was no further trouble with out of step rotation of the PPI image.
Ship's gyro was started up and was precessed for 45° each side of zero relative and the operation of the azimuth mark observed.	It was found that the azimuth mark did not follow properly. The idler gear between the step-by-step repeater and the differential was too tight and this was loosened and then the aximuth mark was noted to follow properly.
No signal indication.	A shorted i-f coax cable. This was corrected.
CRO tube entirely blanked out.	Found azimuth potentiometer (P–462) open circuited. Replaced.
Indicator sweep coil drive motor assembly binding slightly. Operating satisfactorily with gyro voltage applied, but locking mechanically when voltage removed.	Cleared binding of indicator sweep coil assembly by backing off idler gear locking nut.
Equipment off 5° in bearing.	The azimuth mark cam adjustment was set up 5°
No received signals.	On checking voltages of d-c power supply circuit in Indicator Unit (D–150610) found 300 volt supply to focus control on indicator tube (451) was low and fluctuating. Trouble was traced to regulator tube V–407 (6L6). Replaced.
The sweep trace on the CRO in the D–150610 indicator unit was very erratic.	Caused by an intermittent trigger pulse cable connection at jack J–452. Repaired connection.
With equipment in operation there was no converter current deflection at indicator.	Absence of a converter current reading at the indicator was found to be due to an open center conductor at the r-f unit Jones plug. This was repaired.
The image on the CW–55ACV Plan Position Indicator was improperly centered.	The pattern was centered by means of the horizontal and vertical positioning controls.
Equipment operating with about 50 percent normal scope indications.	After warm-up of equipment, tightened coaxial connectors at converted unit, adjusted controls of PPI. After adjusting and tuning equipment, received satisfactory indications and signals. Left system in normal operating condition.
Targets would appear more than once, only a slight distance apart. The primary image would be normal and the secondary image splintered and offset slightly. The sweep was erratic and intermittent, varying in length.	As the controls on the indicator and modulator unit had no effect on the sweep, the circuits from the controls were traced back to the power supply. A defective rectifier tube (V–401–5U4G) was located in the sweep unit. When this was replaced, the azimuth sweep was returned to operation.

Modulator and Indicator (SL/SL-a/SL-1)—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Gyrocompass indications were not received at deflection coil drive differential in indicating unit.	Interchanged leads S1, S2, and R1, R2. Found wiring error in gyro-repeater switching panel in ship's gyrocompass room. Trouble remedied by ship's personnel and by lead shifting indicated above.
True course gyro step-by-step would not function.	After checking through gyro to synchro wiring, found that floating gear of selsyn to differential drive had been slightly displaced allowing occasional slipping of gear mesh. Reset floating gear to proper mesh with both gears of drive and resecured locking bolt with double lockwasher. Gyro action was then normal.
Ship reported sweep on CRO to be falling out of step with the antenna.	Found that rotation of the gyrocompass in one direction resulted in erratic movement of the azimuth mark—sometimes in one direction and sometimes in the other. A check of the leads from the indicator terminal strip to the selsyn motor showed an open circuit in the S–1 lead from terminal 37 to the synchro. The open was found to be in the WH–OR lead from terminal 37, having broken loose from terminal 1 on the compass switch. Removed compass switch (S–456) from mounting and soldered WH–OR lead to terminal 1.
Large bright spot near center of PPI scope, no sweep, no control of intensity or focus, and no signals.	No voltage to sweep circuit due to fuse F–456 being burned out. This was caused by a short between terminal 317 and the base of V–304. Removed short and replaced F–456.
F–456 blown.	Often caused by a shorted C–616 capacitor. C–616 is a part of the center conductor inside of BO OUTPUT jack J–603.
The sweep in the CRO failed during the early operation.	This was found to be caused by the sync pulse jack (Jones) being shorted by a clipping of wire. Repaired.
The equipment was turned on but a few minutes when sounds like a threshing machine broke loose. The sweep across screen stopped with the appearance of the noise.	Upon subsequent inspection it was discovered that the pin on the drive motor shaft that operates the deflecting coil assembly had sheared off and the gear box was revolving from friction only rather than from direct contact with the motor. The pin was replaced and the trouble was immediately eliminated.
Spark wheel face plate burned badly where the brushes bear during arcing of the spark gap. This was judged to be due to too light brush bearing pressure and too heavy current through spark gap.	Removed and lengthened slip ring brush holder springs and turned brush contact ring over as side used was badly burned. Equipment then operated normally. NOTE: To prevent pitting of the spark wheel in the SL equipments, the following checks and adjustments should be made: (1) Be sure the spark wheel is not pitted. If so, replace it at first availability. (2) Be sure the brushes are free in holders and that all burs are removed. (3) Adjust the brush holder so that clearance between it and the spark wheel is one sixteenth of an inch. It may be necessary to bend the brush holder bracket to accomplish this. (4) Stretch the brush springs so that the relaxed length is 1½ inches or if the pigtail is too short, stretch the spring to fit snugly against the pigtail washer.

Modulator and Indicator (SL/SL-a/SL-1)—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Relay K–502 failed to close.	Tune-up switch S–702 in r-f unit was in OFF position, thus preventing the K–402 relay from closing.
PPI picture did not maintain a true bearing position.	The bearing shaft for the large gear in the train of gears between the step by step motor and the differential in the CW–55ACU Indicator Assembly was very loose and in some positions allowed the gears to become unmeshed. This allowed one side of the differential to turn freely thereby allowing the PPI image to turn at random regardless of the setting for true or relative bearing. The bearing shaft was tightly screwed against its mounting plate. After the gear was properly mounted on its shaft there was no further trouble with out-of-step rotation of the PPI image.
There was no azimuth mark on the CW–55ACU Indicator Assembly because the switch S–101 in the CW–66AEP antenna failed to make contact when the antenna was rotated.	The switch S–101 was adjusted until the contacts closed properly.
An "X" image was observed on the cathode ray tube in the Indicator Unit D150610 when the switch was in the minimum range position.	The adjustable tuning plugs in the Antenna Assembly D–150610 were adjusted for minimum standing waves. This adjustment removed the "X" image from the indicator.
The rotation of the sweep in the CW–55ACV PPI lagged behind the rotation of the antenna by about 12° in each rotation.	This was caused by the lack of a pin in the worm gear which drives the sweep coil. Without the pin the worm gear rotated freely on the shaft and the sweep coil was driven only by friction between the gear and the shaft. The pin had probably been loose and had fallen out after about 200 hours of operation. A new pin was put in the sweep coil drive worm gear.
Sweep trace out of adjustment.	Incorrect voltages going into sweep circuit. Adjusted R–320, R–416, R–418.
The equipment was in good operating condition. The adjustments of brightness and video level in the CW–55ACV PPI were such that the azimuth mark was generally quite dim.	The adjustments of the brightness and video level controls (R–453 and R–347 respectively) were made to obtain proper signal level together with proper brightness of the azimuth mark.
Slippage of marker line.	Nut causing resistance to one end of differential required slight tightening. This corrected slippage of marker line.
Converter failed. Fell off to zero. Sweep failed to cross scope face; was short and out of focus.	300-volt power supply at terminal No. 10 was checked and found low. Replaced tube V–406 (5U4G). Normal operation resumed.
The sweep disappeared in the center of the PPI scope out to about half range on the 5-mile scale. No targets. Tubes VR 150–30 and VR 105–30 did not glow and the 6X5GT filament was not lighted.	The 6X5GT rectifier had an open filament.
PPI tube showed a large fuzzy spot in center of screen. No crystal current and no magnetron current.	Found crystal assembly pushed too far through TR box, that transverse slot was covered and would not allow the passage of signals into assembly. High voltage switch in r-f unit in off position. No targets or sweep on PPI.

Modulator and Indicator (SL/SL-a/SL-1)—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Long persistence of discharge on scope.	R–452 in indicator unit having too high resistance. Replaced from ship's spares and trouble cleared.
Signal intensity and background illumination on the PPI were low.	Video tubes V–307 and V–309 (both type 6AC7) were replaced. The i-f amplifier tube V–206 (type 6AC7) was replaced. (V–206 very critical.)
The sweep length would vary intermittently losing about an inch at the outer edge of the circle and leave a good sized blank circle in the center and would appear on all three positions of the range switch S–460.	This condition was corrected by replacing V–306 (6N7GT)
A strong spoke effect on the CRO screen which appeared to be a 60 cycle ripple indication.	This effect was eliminated by replacing V–601 (717A) first i-f tube in the oscillator amplifier.
The bright spot which normally appears on the CRO for a few seconds would remain there for an excessive length of time.	The high voltage bleeder resistor R–452 had opened and would not discharge the high voltage condensers. R452 was replaced.
Spokes appeared on the indicator scope on the 5-mile range and after a few minutes the whole equipment became erratic on all ranges. Spokes such as these had in a previous instance been corrected by replacing VR 150–30 (V–404). A new tube was again installed here together with the 450-volt rectifier tube 5U4 (V–401) which could be seen arcing. After these replacements spokes still appeared on the indicator, but had a somewhat different appearance.	By replacing the same VR 150–30 (V–404) with another new tube the trouble was corrected. The converter crystal and protective gas tube 721A (V–703) were also replaced and equipment tuning checked throughout, and good echoes were then received.
Sweep on ranges 1 and 2 were erratic and signals very weak.	Checked terminal No. 10 and found output voltage of regulated rectifier had increased to approximately 310 volts. (300 v. normal.) This condition indicated that V–302, the sweep generator, was self oscillating at random frequency and no longer synchronized with transmitter pulsing. Adjusting pot. R–416 to give approximately 300 volts on terminal No. 10 gave proper indications on ranges 1 and 2.
The equipment was operating intermittently with periods of normal operation and periods when the sweep length increased off the PPI screen, and a large black hole of increasing size up to the diameter of the screen appeared.	Due to an intermittent short in the sweep chassis condenser C–307. This condenser finally became dead shorted during testing. Replaced.
Sweep disappeared.	Trouble found to be small piece of lock washer which lodged between center conductor of sync pulse jack and ground thus shorting the 40 v. sync pulse to ground failing to trigger sweep unit.
It was noted that an erratic indication was occasionally obtained on the 5-mile sweep which produced "spokes" on the CW–55ACV indicator screen. Also, it was noted that the 300-volt supply could not be adjusted over its proper limits.	The erratic PPI indication on the 5-mile scale, as well as the 300 volt supply adjustment, were both remedied by simply interchanging the two 6Y6G tubes V–402 and V–403 in the CW–55ACV Plan Position Indicator.

Modulator and Indicator (SL/SL-a/SL-1)—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Radial lines or spokes appeared on scope masking echoes. Sixty spokes per 110° of rotation of sweep or in one second indicated leakage of 60-cycle voltage into sweep circuit. Brightness or intensity of spokes could be varied by receiver gain control indicating leakage occurred in i-f amplifier.	Tube check revealed filament to cathode short in V–203, third i-f amplifier stage. (Other causes are mostly of a magnetic nature as 60 cycle transformer fields or current loops of current carrying wires around console.)
The azimuth line was not appearing.	Cleaned the contacts of switch S–101 in the antenna and adjusted the movable arm of R–462 to make better contact.
Poor signals.	The poor signal condition was traced to low beat oscillator output. The 726A oscillator V–603, item 58, was replaced from ship spares. This tube was shorted internally causing R–607, item 141, to burn out. R–607 was replaced from ship spares and another 726A installed.
Sweep started quarter inch from center of scope.	Replaced 6H6, V–308, item 43 to clear hole in center of scope.
No converter current and no sweep on indicator.	A voltage check showed that there was no 450 volt supply voltage in the indicator. Trouble was traced to a bad 5U4G, V–401.
Sweep starts 1¼ inches from center and no converter current.	Replaced V–408 a 6X5GT tube. Corrected the sweep start position and brought back the converter current.
Signal indication was indistinct and erratic because of the intermittent irregularity of the sweep.	V–306 was replaced with a new 6N7GT, item 46E; the intermittent sweep was cleared.
Brilliancy of indicator CRT showed great variation.	Traced to poor 6AG7 sweep tube. This was replaced.
No sweep on indicator.	Trouble was traced to V–309 stage. An open was found in the plate circuit of this stage, the cause being a poorly soldered connection. The connection was resoldered.
It was found that the 300 d-c volts at terminal 10 of the indicator unit was about 275 volts and could be brought up to only 310 volts with potentiometer R–416.	This was corrected by replacing V–401, 5U4G rectifier tube in the power supply of the indicator.
Echoes on the PPI were split.	Receiver tuning control, R–468, on the indicator unit was turned slightly to bring the receiver into tune. This eliminated the split images.
Fuzzy ring appearing on each range sweep but most noticeable on the high range. On this range it appeared as fuzzy ring out about 2 inches of about 1 inch in extent.	Eliminated the fuzzy ring by cleaning the socket of the 6X5 tube V–408 and adjusting the video level pot. for less input. (6X5 V–408 supplies bias to 6L6; if this were intermittently removed it would make a hole appear and disappear in center giving appearance of rings.)
No control of the PPI intensity or focus. The sweep width approximately 10 times normal width. Receiver gain produced no grass.	Defective cathode-ray tube. Operation restored to normal by replacing cathode-ray tube.
Sweep length one-third of normal length, no receiver gain, no control of PPI intensity, converter current zero.	Defective 726A; defective crystal rectifier capsule; gaseous 5U4G; defective voltage regulator tube VR 105–30. Replaced above items and normal operation was restored.

Modulator and Indicator (SL/SL-a/SL-1)—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Good signals and range but receiver gain had to be in maximum position for this condition. After about 15 minutes of operation the gain suddenly jumped to normal.	Found that by moving V–205 from side to side, gain could be brought to normal. Inspected and found poor soldered connection on V–205 socket. Resoldered and operation was normal.
Sensitivity below normal in receiver and the sweep on the 60-mile range decreased in intensity from about 24 miles and out, disappearing entirely at about 48 miles. The brightness control on the PPI had to be run up above normal.	Resistor R–347 had decreased to 100 ohms. A new resistor was installed.
A crossed "figure eight" pattern appeared in the center of the PPI scope on the 5-mile scale. This pattern extended to about 1000 yards.	The top tuning plug on the antenna was backed out from ⅞ inch to 1⅛ inches.
The picture was constricted and our minimum range was about 2 miles.	Found that C–306 a 250 μf capacitor was open. Replaced and sweep signals were normal.
Ship's crew reported that severe distortion was noted on PPI scope at 0/1000 yard range, through 360° of sweep rotation.	Distortion was caused by bushing which holds and guides the antenna contact plunger having worked loose. The entire contact assembly was thrown out of adjustment and caused false azimuth marks to appear.
Trace very broad (approximately ⅜") with large spot in center of scope. Trace about ½ of normal length. Input and magnetron current normal. No converter current.	Corrected by replacing V–309 (6AC7)
Abnormal sweep, no echoes received. Voltages low in sweep circuits.	Condenser C–401 in sweep circuit power supply was shorted. This caused 5U4G to become defective. Replaced condenser.
Trouble was experienced with focus and range fluctuation.	The cause was found to be a loose connection on the cap lead of the high voltage rectifier for the 6,000-volt scope plate voltage, a 705–A.
The SL radar operated normally for approximately 30 minutes after being turned on; then all signals disappeared. After system turned off and allowed to cool it again operated normally when first turned on.	When wiring to sockets of i-f tubes in oscillator amplifier unit was checked it was found that the bare wires to socket terminals No. 7 and No. 8 of V–602 were so close that a thin piece of paper could not be passed between the wires. These wires were bent to give spacing. After this was done there was no longer any fading when equipment heated up.
Ship reported circles on scope.	V–701 type 705A diode was replaced to clear trouble.
Besides normal echoes a pattern of false echoes appeared on screen in the form of small dots at regular intervals throughout the length of the sweep. The trace was brightened by these dots at intervals of about 10° so that the screen was covered with what appeared to be false azimuth lines, each line bearing this series of spots.	Found the clip to the intensifier anode connection making poor contact. Improved contact cleared up interference pattern on indicator screen.
The short range had doubled and was jittery, the middle range was a series of dashes extending ⅜ of the normal sweep length, the long range was a series of dots extending ⅓ of the normal sweep length.	In the D150945 sweep panel condenser C–306 a 250 μμf condenser had changed value to 90 μμf. This condenser connects the plate of V–303.1 to the grid of V–303.2. C–306 was replaced to clear this trouble.

Modulator and Indicator (SL/SL-a/SL-1)—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Concentric circles on PPI scope extending as far as one mile.	Remade terminations on converter and i-f cables. Tightened plate lead on V–452.
Azimuth mark dropping back 5° or 6° per revolution.	A-c supply was too high in frequency. Slowed the motor generator to proper operating rpm. If the frequency of the motor generator is very far off, the antenna and sweep motors will no longer be synchronized because of different loads.
Sweep about ½ the proper length on 5-mile range. OK on 20- and 60-mile range.	V–306 the sweep limiter tube was defective. Replaced tube.
High voltage transformer burned out when system was turned on.	Dirty insulator for bleeder resistor causing low resistance to ground overloading the transformer. Cleaned the insulator and replaced the transformer.
Trouble in putting equipment into operation.	Magnetron would not always start firing. Contact on relay K–502 in modulator which carries 110 volt a-c feed to magnetron filament transformer and coating of what appeared to be wax. Cleaned contact. (Sometimes caused by magnetron being slow to heat—most often with Westinghouse tubes.)
Set was operating normally when suddenly without warning targets that were on the screen (PPI) were reduced to great extent. The targets were approximately 1 mile from the ship.	Tube No. V–207, type 6AC7, in the CW55ACU Indicator Modulator assembly was changed, and all trouble was remedied.
No converter nor magnetron current readings.	MAG-CON switch, S–457, was loose and 1 wire to each circuit was broken off. Repaired.
Loss of scope trace and no image of any kind on cathode ray tube.	Primary of transformer T–402 found open, replaced unit.
Error of 140 degrees in bearing accumulated during long period at sea without visual cntact.	Vibration and gun fire caused locknuts on azimuth setting control, on antenna, to come loose and cause bearing inaccuracy.
Echoes developed lines extending approximately one-half inch from their outer edge, spaced ⅛ inch apart and only visible on the 5-mile range. They resembled a picket fence.	Remedied by the replacement of V–401, a 5U4G tube.
A large hole was occurring in the center of the indicator scope tube sweep.	Prepulser tube V–305 in the sweep chassis was not functioning correctly and the sweep was not intensified at the start of the sweep. This gave a large hole in the center of the scope pattern. The tube was replaced, curing the trouble.
The synchro was overheated.	The wiring to R–2, and S–2, had been interchanged. The wiring was corrected and after sufficient test the motor ran normally.
A narrow circle was observed on the 5-mile scale at about 500 yards.	Replaced 721A TR tube which eliminated the 500 yards circle. Retuned TR plugs and checked sensitivity and range adjustment.
When REC. GAIN was advanced to the final 15° clockwise sector and sweep flashed at irregular intervals of about 3° all signals were substantially lost.	Found erratic operation of sweep due to open connection between shield of i-f cable and plug P–454. Connection appeared very well soldered on exterior of cable shield but plug shell loose and not soldered to shield. Soldered same.

Modulator and Indicator (SL/SL-a/SL-1)—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
Intermittent sweep condition that gave several different kinds of indications each time it was made to reoccur.	Corrected when condenser C–306 was replaced with item 88E and C–311 with item 91E. Also R–328 was poorly soldered at one of its terminals.
Jittery sweep on the 5-mile range which caused the targets to appear fuzzy.	Replaced tube V–302 of the sweep chassis (6AG7).
Circle as described by the sweep was elongated along the vertical diameter.	When the oscilloscope tube was properly positioned with respect to the sweep coil, the circle as described by the sweep became normal in form.
Sweeps on all ranges were short; each one commencing at the 3-mile range circle and extending beyond the outer range circle.	Adjustment of R–329 (sweep length) would not correct condition. However, the replacement of V–306 (6N7GT) returned sweep length to normal.
Lost sweep, fuzzy spot in center of scope.	Replaced shorted C–402.
No azimuth marker at times.	Adjusted azimuth marker switch on the antenna unit.
Loss of repeller voltage supply for 726B oscillator tube in D–150815 converter oscillator amplifier unit.	Trouble was breakdown of 2 μf 600 v. condenser, C–410, of indicator unit.
Excessive spoking of the sweep.	Check for loose i-f cable plugs and bad 6AC7 i-f amplifier tubes.
After equipment is shut off, a bright spot remains on the scope screen for an abnormally long time.	R–452, 7 meg bleeder resistor open.
Intermittent loss of spark at spark wheel.	This is caused by a dirty corona point. The corona point should be clean, sharp, and straight. It does not have to be microscopically sharp but should be sharp to the naked eye. 12/1/45

Transmitter-Converter

High-voltage pulse cable arcing at modulator termination.	Shortened cable and reterminated. Inner conductor rubber insulation apparently damaged by heat of soldering iron during applied heat of serving process. Pigtailed shield and grounded same. Transmitter then operated normally. (Check Field Change 20.)
This unit was found to become somewhat unstable when operated at 17 to 18 ma. magnetron current as evidenced by erratic sounding spark wheel operation and unsteady magnetron current. A new magnetron showed the same characteristics.	Some of the trouble was cleared up by adjusting the spark wheel arc gaps which were found to be spaced much too wide apart.
The tone of the D150611 modulator spark wheel was not clean, caused by a badly pitted electrode.	The D150611 modulator spark electrode was turned 90° and gauged.
No magnetron current indication on meter, yet equipment operation seemed normal with exception of intermittent received echoes.	The lack of meter indication was caused by a small piece of shield braid found under the 705A clipper tube in r-f unit, which effectively shorted the filament, putting both meter terminals at ground potential. The intermittent received echoes were caused by the beat oscillator blocking capacitor in the converter unit being shorted out completely putting the 300 volt supply to 706–B oscillator tube at ground potential. The converter unit was replaced from ship's spares.

Transmitter-Converter—Continued

NATURE OF OPERATION	TROUBLE FOUND AND REMEDY
On close range there were several evenly spaced markers on the sweep out to about 1 inch from the center. On the next range, they were more closely spaced markers.	Apparently they were picked up out of the resonant pulse circuit which was not loaded due to the 706 tube drawing no current. Tube was replaced and these markers were no longer present.
No echoes were apparent on the CRO screen due to incorrect tuning of the transmitter converter, and beat oscillator.	The ship had changed V–702 (706FY tube) in the D150608 r-f unit and the probe injector on the 706FY tube was improperly spaced in the waveguide. Tube was properly inserted.
Intermittent arcing in waveguide in r-f unit.	Found magnetron probe in waveguide badly pitted; end of magnetron output lead corroded, making poor contact with probe. Replaced magnetron probe from ship's spares, cleaned magnetron output lead. Retuned waveguide.
Low magnetron current and does not follow step-by-step gyrocompass.	The low magnetron current due to the setting of the high voltage transtat for T–503 which gave only 100 volts maximum on the primary of T–503. Adjusted the transtat to give 115 volts and the magnetron current became normal.
Noted that waveguide butterfly valve solenoid did not release properly when deenergized.	Readjusted plunger and shortened return spring and thus cured this trouble.
Ship's personnel complained of short life of crystal converter.	Investigated and found gate in waveguide jammed in open position, caused by jammed K–701 solenoid. Disassembled solenoid and cleared.
The MAG.-CONV. milliammeter had been removed from the unit by the ship's crew to locate the cause of possible trouble indicated by zero converter current and no echoes.	Replaced the meter and noted that the trouble had been caused by someone having turned the receiver tuning knob to the extreme clockwise position. Readjusted this knob and retuned the beating oscillator frequency slightly for best tuning adjustment.
No echoes.	Trouble found to be shorted capacitor C–608 (360 $\mu\mu$f), decoupling capacitor, which shorted the plate and screen voltages of the 2 WE 717A tubes to ground. Trouble remedied by replacing from spares.
Unable to keep receiver in tune. Frequency drift noted. Power supply failed due to fuse blowing.	Trouble traced to an intermittent short in base of beat oscillator tube V–603 (726B) unit. This unit, including base of tube and jack J–603 found to be shorted at point of connection of tube and coaxial line. Replaced entire unit. Normal operation resumed.
The crystal converter assembly, item 61E (old type), was broken at the sweated joint at the junction of the round probe section with the square crystal holding section.	Resweated the converter assembly using a heavy solder bead for strength.
During the progress of transmitter tune-up crystal current could not be obtained at J–703 of crystal converter assembly nor could repeller voltage be measured at terminal No. 2 of oscillator-amplifier unit.	Traced to faulty 6X5GT rectifier tube V–408 of power supply circuit of indicator unit. The replacement of V–408 restored the supply circuit to normal.