OFFICE COPY

TM 11-395

WAR DEPARTMENT TECHNICAL MANUAL

OPTIPHONE
AN/TVC-1 (XO-1)

SigO	2	
Asst	1	
CC		
A&P		
S&P	3	
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P&T	6	
CmdSec	4	
CrypO		
SigSer		
P Srv		
Repln		
AA Bn		

RESTRICTED. DISSEMINATION OF RESTRICTED MATTER. No person is entitled solely by virtue of his grade or position to knowledge or possession of classified matter. Such matter is entrusted only to those individuals whose official duties require such knowledge or possession. (See also par. 23b, AR 380-5, 15 Mar 1944.)*

WAR DEPARTMENT 27 JANUARY 1945

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WAR DEPARTMENT,

WASHINGTON 25, D. C., 27 January 1945.

TM 11-395, Optiphone AN/TVC-1(XO-1) is published for the information and guidance of all concerned.

[A. G. 300.7 (30 Dec 44).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,

Chief of Staff.

OFFICIAL:

J. A. ULIO,

Major General,

The Adjutant General.

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DESTRUCTION NOTICE

WHY - To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN - When ordered by your commander.

HOW - 1. Smash-Use sledges, axes, handaxes, pick-axes, hammers, crowbars, heavy tools.

2. Cut -Use axes, handaxes, machetes.

3. Burn -Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. Explosives-Use firearms, grenades, TNT.

5. Disposal -Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT

WHAT -1. Smash-Carrying cases, all tubes, modulator cell and lens systems of the optical unit, the optical unit, tripod, amplifier chassis, power supply chassis, cable connectors, battery and battery case, Telephone EE-8-(*), and all auxiliary equipment.

2. Cut -Connecting cables, webbed-cotton carrying straps, telephone case and carrying strap, and tripod carrying case.

3. Burn -This technical manual, all papers, and cut sections of all webbed material.

4. Bend -Optical unit, amplifier chassis, power supply chassis, and all other metal parts.

5. Bury or scatter-All of the above items after they are completely destroyed.

DESTROY EVERYTHING

SAFETY NOTICE

There is no danger of an electrical shock at any point on this equipment when it is completely assembled, interconnected, and in operation. When the control unit amplifier chassis, power supply chassis, receiver chamber cover, transmitter chamber cover, or receiver and transmitter cable assemblies are removed with the equipment in operation, be careful, as voltages exceeding 150 volts are present at many points on the above items when disassembled.

Figure 1. Aligning Optiphone AN/TVC-1 (XO-1).

PART ONE
INTRODUCTION

SECTION I

DESCRIPTION OF OPTIPHONE AN/TVC-1 (XO-1)

1. GENERAL.

Optiphone AN/TVC-1 (XO-1) is an equipment designed to provide single-channel, two-way, break-in speech communication over a narrow beam of white or dark-red light. The equipment consists of an optical unit, control unit, 6-volt storage battery, Telephone EE-8-(*) and accessories (fig. 2). The complete unit weighs approximately 145 pounds.

2. APPLICATION.

The optiphone is designed for use as telephone link equipment or for point-to-point communication where the laying of wire lines is impossible or impractical and it is necessary that radio silence be maintained. The optical range of the equipment will be up to 4 miles during the day and up to 7 miles at night with dark-red filter, depending upon atmospheric conditions. Telephone EE-8-(*) may be used directly with the equipment for point-to-point communication. When the optiphone is used as a telephone link equipment, the telephone is used for monitoring purposes.

3. TABLE OF MAJOR COMPONENTS.

		Physical Characteristics				
		Dimensions (in.)			Volume	Weight
Quan	Component	Length	Width	Height	(cu ft)	(lb)
	Package 1:					
1	Optical unit					33-1/2
1	Power cable (3-pin)	7 ft				1-1/2
1	Transmitter cable (4-pin)	6 ft				1

3. TABLE OF MAJOR COMPONENTS (contd).

Quan	Component	Physical Characteristics: Dimensions (in.) Length	Width	Height	Volume (cu ft)	Weight (lb)
1	Receiver cable (5-pin)	6 ft				1
1	Carrying Case	17-1/2	14-1/2	14	2.1	12-1/2
	Package 2:					
1	Amplifier	15-1/4	8	7	0.5	14-1/2
1	Power supply with set of misc spare parts and alignment tool≠	15-1/4	8	6	0.4	15
	Package 3:					
1	Tripod	39-5/8	5		0.5	10-2/10
1	Tripod carrying case					1-3/10
	Package 4:					
1	Storage battery					38-6/10
1	Battery case	10-3/16	8-3/16	10-5/8	0.5	7-2/10
	Package 5:					
1	Telephone EE-8-(*)	9-9/16	7-11/16	3-1/2	0.1	9-3/4

NOTE: Running spare parts are for initial issue only and are not to be requisitioned as a kit or group as mentioned in this list.

≠ Telephone EE-8-(*) refers to models EE-8, EE-8-A, or EE-8-B. For detailed information, see TM 11-333.

≠ Signal Corps stock numbers for spare parts are shown in figure 3.

4. OPTICAL UNIT.

The optical unit contains the necessary elements for the transmission and reception of speech over a beam of light. It consists of a transmitting chamber and receiving chamber cast as a unit, fastened by means of a movable yoke to a mounting connected by a ball and socket to a base. Equipment is provided for leveling, orientation, and alignment of the unit. The entire optical unit is made of non-magnetic material.

a. Transmitting Chamber (fig. 4). The transmitter chamber consists of a metal tube approximately 14 inches long and 5 inches in diameter, inside of which a modulating cell, a two-lens optical system, a filter, and a lamp are mounted.

Figure 2. Optiphone AN/TVC-1 (XC-1), assembled view.

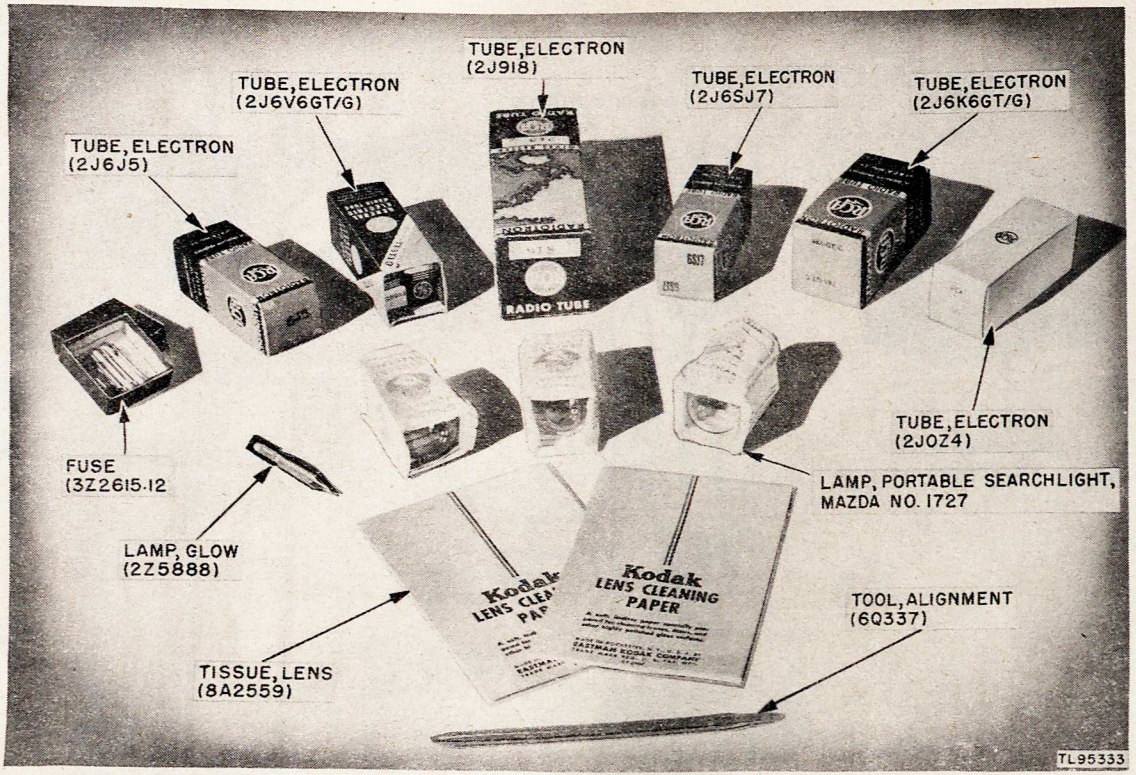

Figure 3. Spare parts.

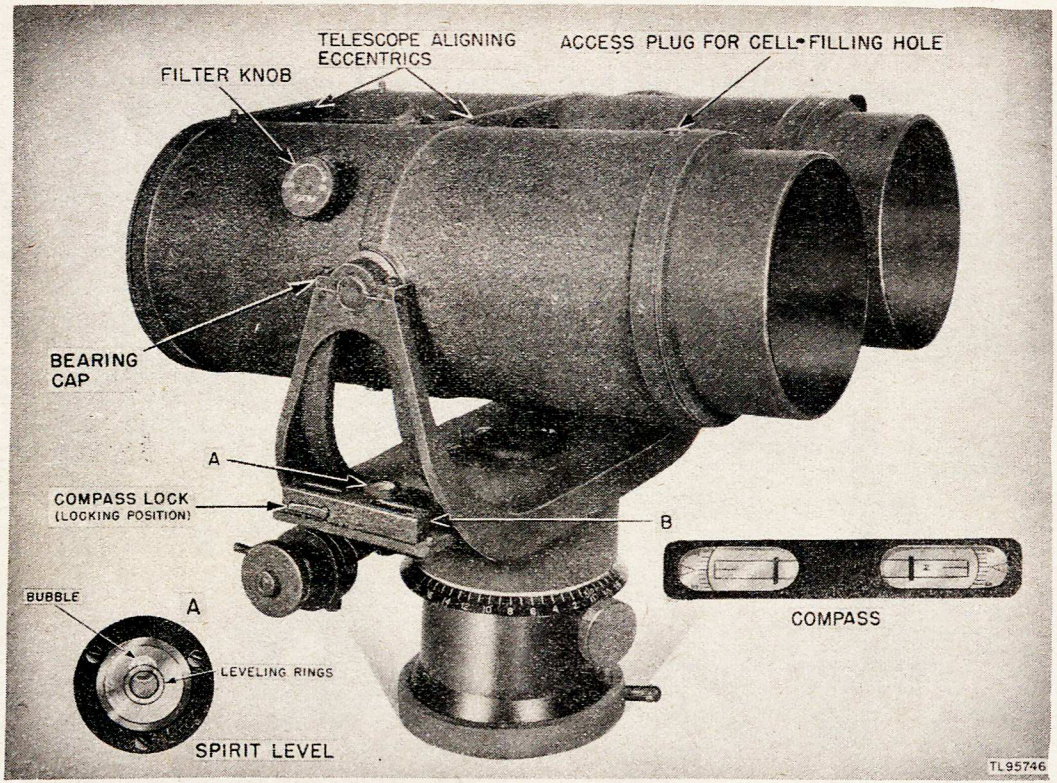

Figure 4. Optical unit, side view.

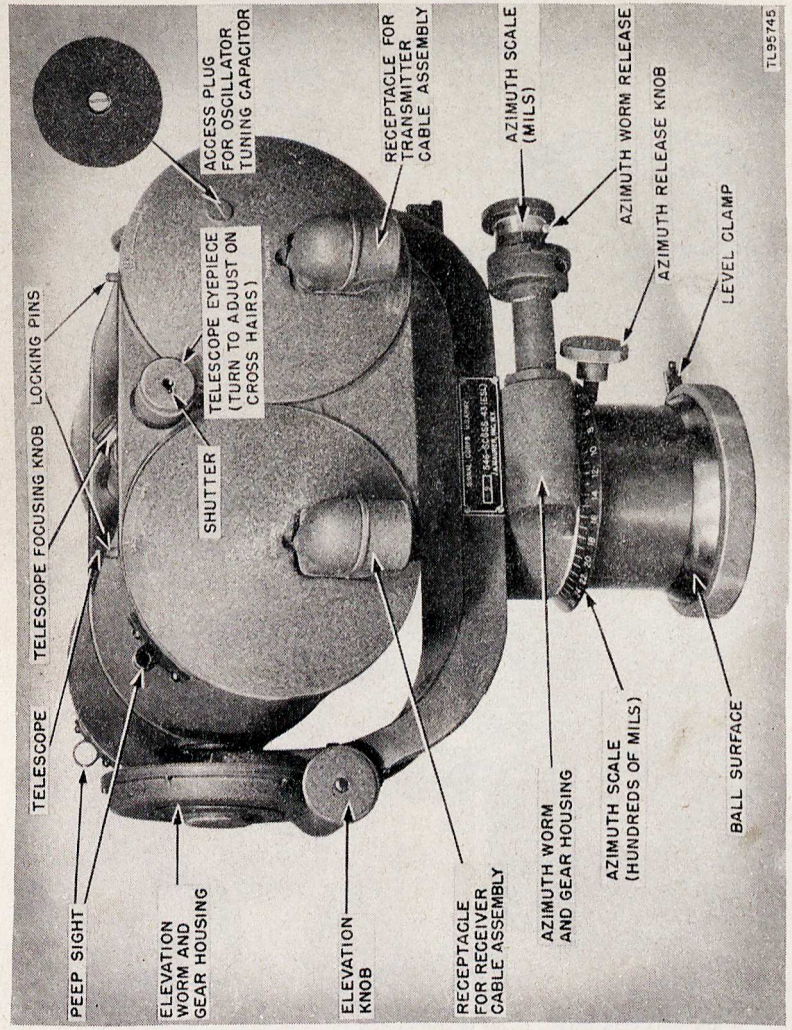

Figure 5. Optical unit, end view.

A removable cover at the rear of the chamber serves as a mounting for an oscillator. A four-pin male receptacle mounted on the cover provides a means of connecting the cable from the control unit to the oscillator (fig. 5). A small knob on the right side of the chamber serves as a means of placing the dark-red filter between the optical system and the lamp. One side of the transmitting chamber is fastened by an axle to a bearing on the yoke and the other side is cast to the receiving chamber.

b. Receiving Chamber. The receiving chamber is similar in appearance to the transmitting chamber, and mounted in it are a two-lens optical system and aperture plate. A removable cover at the rear of the chamber serves as a mounting for the phototube and receiver pre-amplifier. A five-pin, male receptacle, mounted on the cover, provides a means of connecting the pre-amplifier by means of a cable to the receiving amplifier in the control unit (fig. 5). The left side of the receiving chamber is fastened by a short axle to a gear mounted in a housing on the yoke. This gear meshes with a worm which can be turned by a knob mounted on the left rear side of the yoke (fig. 5). Rotation of this knob will result in a change of elevation of both the transmitting and receiving chambers.

c. Mounting and Base (fig. 4). The base can be fastened to the tripod by means of a threaded hole in the bottom of the base plate. Above the plate is a ball and socket joint which allows movement of the mounting in any direction for the purpose of leveling. A level clamp on the side of the lower part of the base permits locking the mounting in position when the unit has been leveled. Above the ball and socket joint is an azimuth ring calibrated in hundred mils marked off around its circumference. An azimuth release knob just below the scale allows the scale to move freely for purposes of orientation. Above the azimuth scale is a housing which contains the azimuth worm and gear. A shaft projecting from the side of this housing ends in an azimuth control knob which is provided with a scale calibrated in mils. Turning this knob will cause the unit to move through an angle of 360°. To the left of the calibrated knob a small lever is provided which will disengage the worm from the worm gear when rapid rotation of the unit is desired.

d. Sights. A telescopic sight mounted on the top of the unit between the two chambers is provided for alignment of the unit by visual sighting. A small knurled knob projecting from the body of the telescope is used to focus the telescope on the object. The rear end of the telescope tube revolves and serves as a means of focusing the cross-

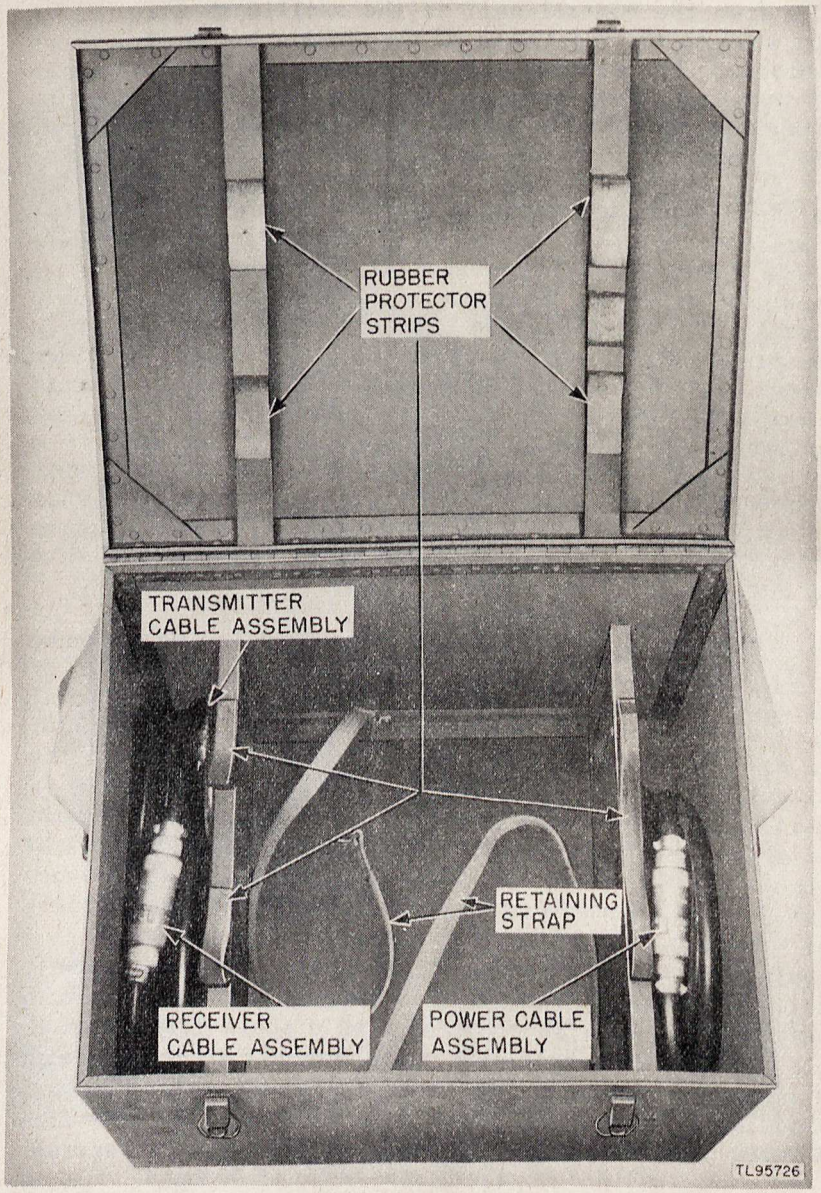

Figure 6. Carrying case, optical unit.

hairs reticule. For use of the telescope at night illumination is provided for the cross hairs. A small shutter is provided over the eye-piece of the telescope to protect it from dust and dirt when not in use. A set of peep sights, mounted on the left side of the receiving chamber, is provided for rapid alignment of the unit.

e. Level. For leveling purposes a spherical bubble-type level is mounted on the horizontal portion of the yoke to the right of the transmitter chamber (fig. 4).

f. Compass. A compass mounted to the right of the level is provided for alignment of the unit relative to magnetic north (fig. 4).

g. Carrying Case (fig. 6). The carrying case for the optical unit is made of reinforced sheet metal and is approximately 17-1/2 inches long, 14-1/2 inches wide, and 14 inches deep. Two partitions in the lower part of the case serve as mountings for the optical unit and the space formed at either end is used to store the necessary cables. A web strap fastened to the bottom of the case holds the unit in place during transportation. Two strips mounted in the hinged lid are padded with soft rubber and help to keep the unit in place when the lid is closed. A web carrying strap approximately 1-1/4 inches wide and 8 feet long is provided for carrying purposes.

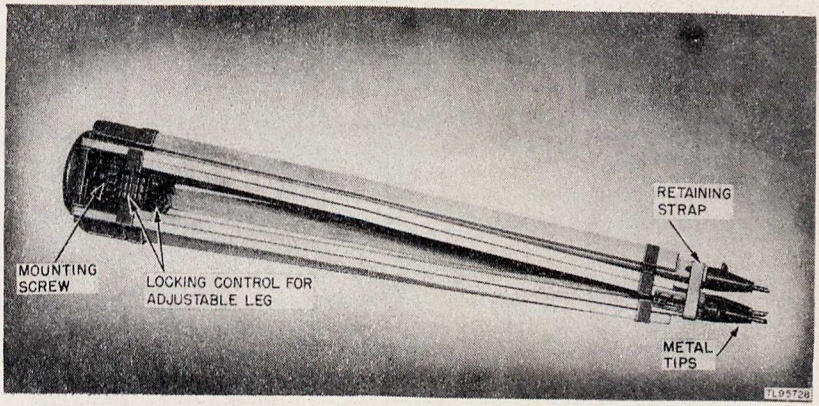

Figure 7. Tripod.

5. TRIPOD AND TRIPOD CASE (fig. 7).

a. Tripod. The tripod has wooden two-section extendable legs terminating in metal tips. Collapsed and extended

lengths of the legs are 39 and 68 inches respectively. When the legs are extended to the desired length they may be locked in position by knurled knobs on each leg. The top of the tripod consists of a flat metal plate through which a mounting screw protrudes for fastening the optical unit to the tripod (fig. 7).

b. Tripod Case (fig. 2). The case consists of two cup-shaped pieces of canvas webbing fastened together by web straps. Snap fasteners along the edge of each piece provide a means of fastening the case around the tripod. A metal grommet in the bottom piece fits over the tripod tips.

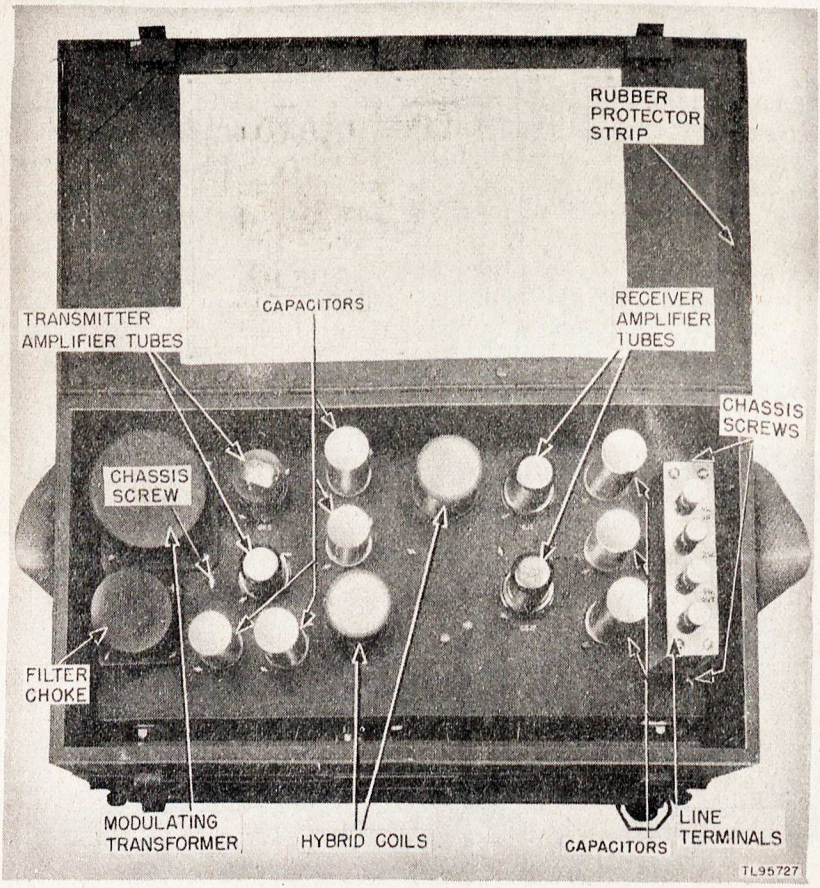

Figure 8. Control unit, cover raised.

6. CONTROL UNIT (figs. 8 and 9).

The control unit consists of an amplifier and power supply

section joined together by suitcase-type latches. The upper unit contains the control panel and amplifiers and the lower unit contains the vibrator-type power supply. The lower case also contains a storage compartment for spare parts and alignment tool.

a. Amplifier Section. The amplifier section is contained in a sheet metal case 15-1/4 inches long, 8 inches wide, and 7 inches high. A hinged lid fastened by two suitcase-type latches provides access to the line terminals and the chassis of the amplifier. The terminals, starting from the rear, are marked as follows: 4W IN, 2W, and 4W OUT (fig. 8). A rubber-padded notch in the lid near the line terminals provides a means of bringing out the lines when the lid is closed. A hinged door fastened by two suitcase-type latches in the front of the unit provides access to the control

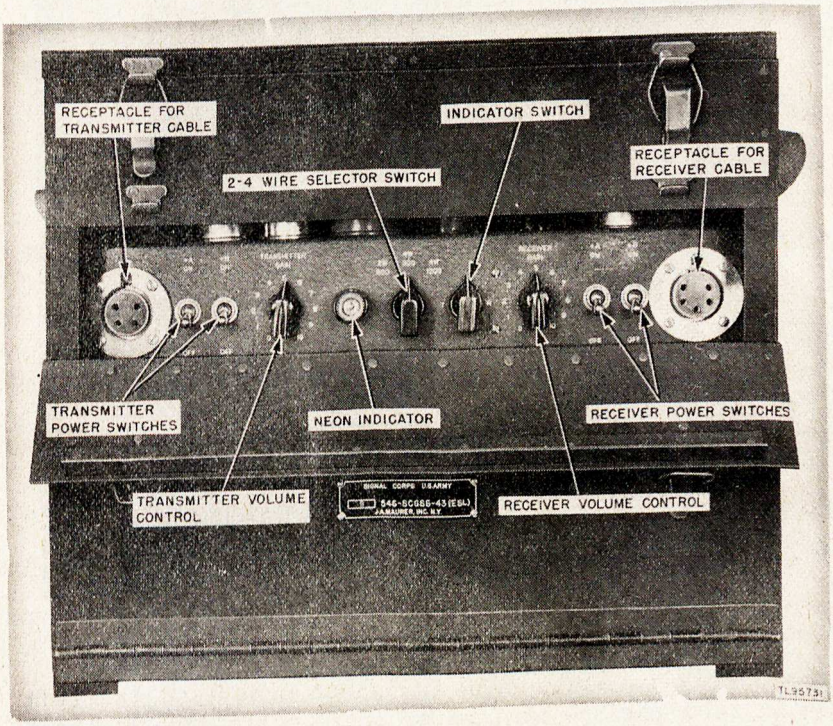

Figure 9. Control panel, control unit.

panel. The control panel contains, on the left side, a four-terminal female receptacle for connection of the transmitter cable, two switches for the power supply to the transmitter, and a knob for control of the transmitter gain. The right side of the panel contains the line selector

switch, indicator switch, receiver gain control, two switches for the receiver power supply, and a five-terminal female receptacle for connection of the receiver cable (fig. 9). In the center of the panel a neon light is provided for checking either the transmitter or receiver during operation.

b. Power Supply Section (fig. 10). The lower section is contained in a sheet metal case 15-1/4 inches long, 8 inches wide, and 6 inches high. Entrance to the inside of the case is gained by releasing two suitcase-type latches and loosening two thumbscrews in the front panel. The vibrator type

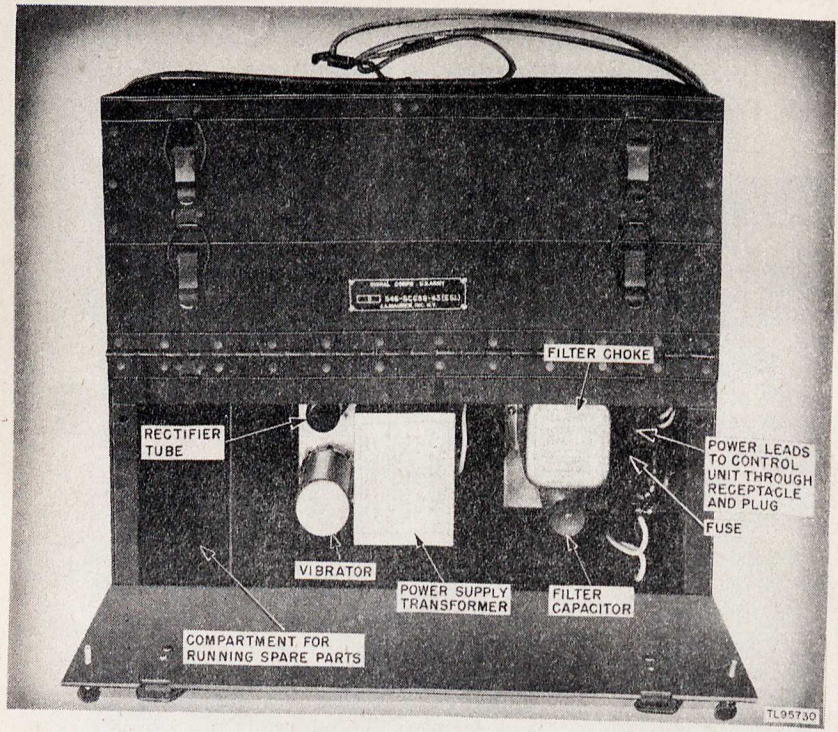

Figure 10. Control unit, power pack compartment.

power supply is mounted on the right side, and the left side is used for the storage of spare parts and alignment tool (fig. 10). On the outside of the case are mounted a three-terminal male receptacle, for connection of the battery power supply cable, and a master power switch, (fig. 11).

7. BATTERY AND BATTERY CASE (fig. 12).

a. Battery. Battery BB-49 is supplied with the equipment

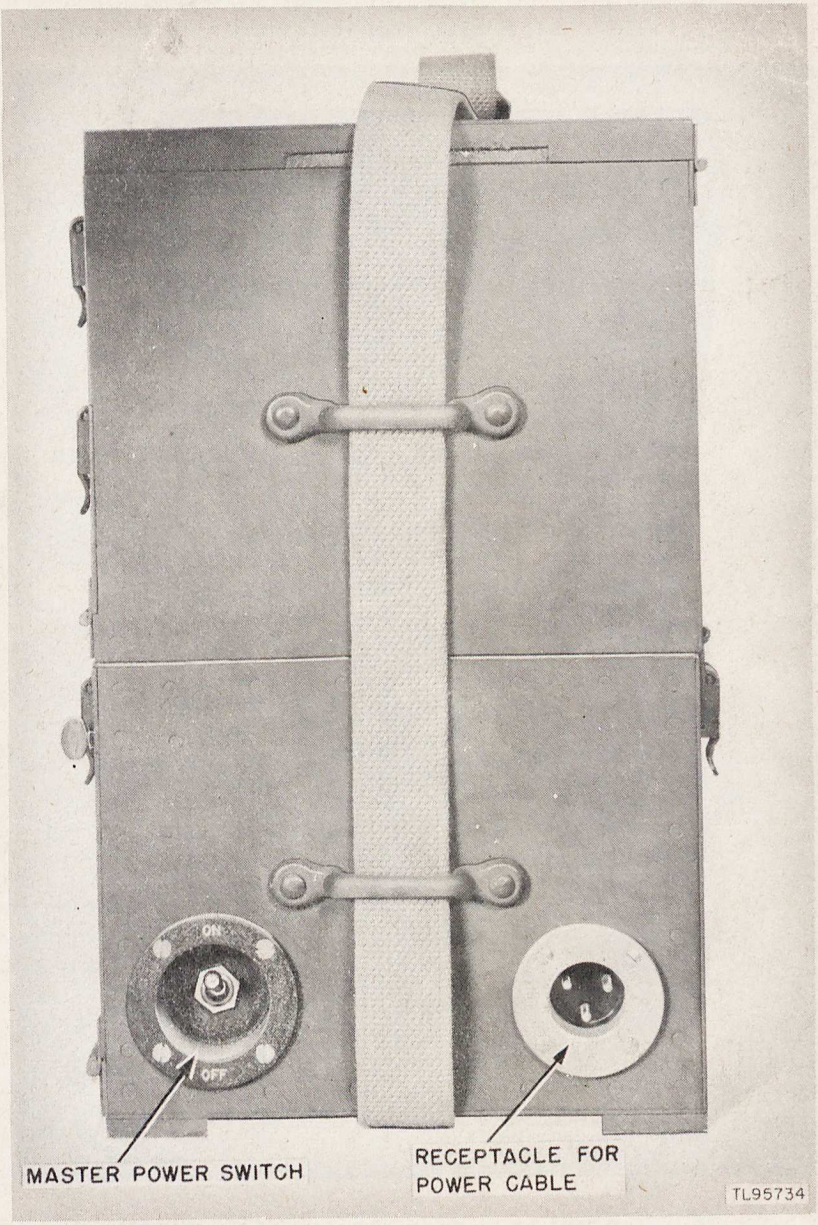

Figure 11. Control unit, end view.

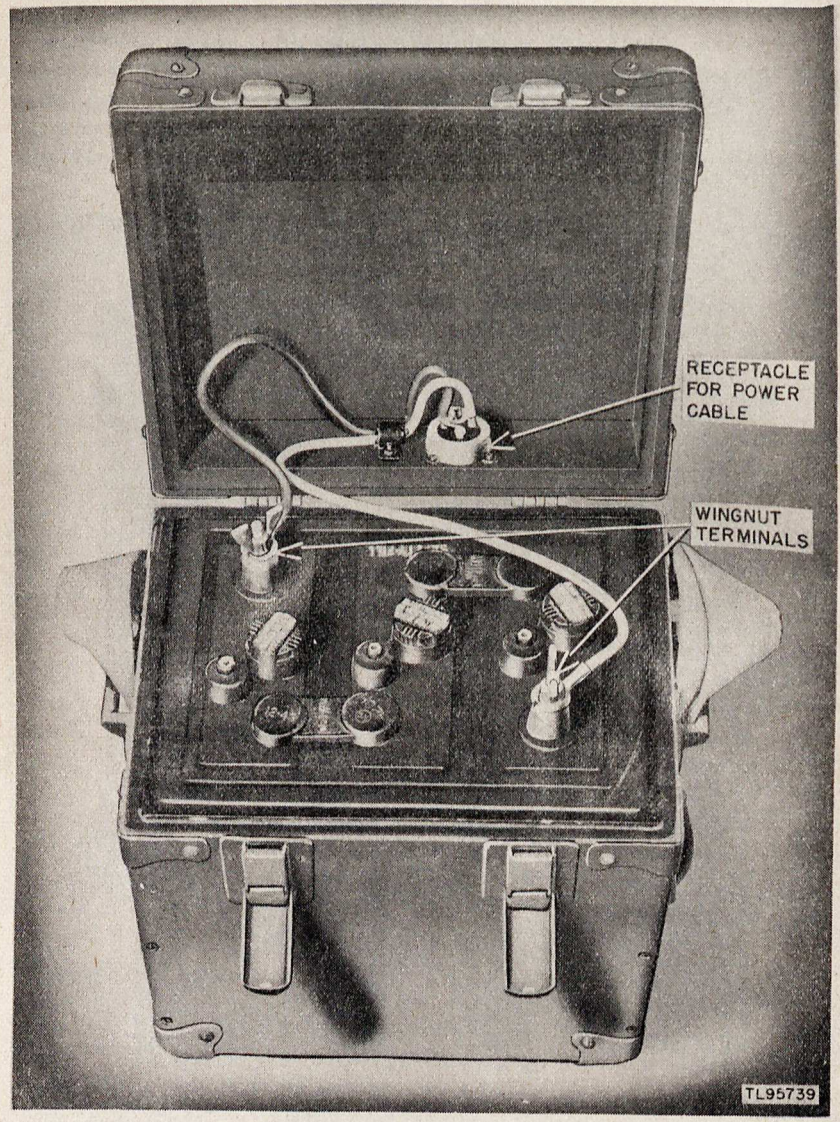

Figure 12. Battery BB-49 and case.

as a primary source of power. The battery is rated at 90 ampere-hours and will operate the equipment for approximately 10 hours when used in temperatures of 70°. The battery is provided with wingnut terminals (fig. 12).

b. Battery Case. The battery is contained in a reinforced wooden case 10-3/4 inches long, 8-13/64 inches wide, and 10-39/64 inches deep. The case is provided with a hinged lid fastened by two suitcase-type latches. A three-conductor male receptacle is mounted in the lid for connection of the power cable to the battery. The case is furnished with a web carrying strap.

NOTE: All Batteries BB-49 are not of the same size. Care should be taken when ordering a replacement battery that the dimensions of the battery do not exceed the inside dimensions of the battery case.

SECTION II

INSTALLATION AND ASSEMBLY

8. LOCATION.

When selecting a location for the optiphone bear in mind that line of sight is required between stations desiring communication. When setting up the equipment from map data a preliminary investigation will be necessary to determine whether any foliage, buildings, etc., are present which would interfere with the operation of the equipment. Care should also be taken when selecting a location that no high-power transmission lines or radio transmitters are in the immediate vicinity because they will affect the receiving circuit and the compass.

9. PRECAUTIONS ON HANDLING.

The optiphone, in addition to its electrical features, is a precision optical and mechanical instrument. Use special care when handling the optical unit to prevent damage to any of its parts. Observe the following special precautions:

a. When removing the optical unit from the case, tip the unit slightly toward the back of the case, as soon as the transmitting and receiving chambers have cleared the top edge, to prevent the compass assembly from hitting the side of the case.

b. When engaging the azimuth worm, do not force the lever

into position. Forcing the lever into position may result in damage to the gear mechanism. Rotate the azimuth adjustment knob until a point is reached where the lever will slide easily into position. When engaged, the worm release lever should be in a horizontal position, and when disengaged, in a vertical position.

c. Do not aim the optical unit at, or within 10° of the sun. Violation of this precaution may cause damage to the phototube and receiver focal plane aperture.

d. Do not use any materials for cleaning the optical surfaces other than the lens tissue (fig. 3) issued with the equipment or a clean, soft, lintless cloth.

e. When storing or transporting the equipment in temperatures below minus 50° F or above 165° F, remove the liquid from the modulator cell in the optical unit. Temperatures below -50° F will cause the liquid to freeze and temperatures above 165° F will cause the liquid to expand beyond the normal amount allowed.

f. The storage battery vents are not spillproof. Do not allow the battery to be inverted or laid on its side when containing electrolyte. When charging, remove the battery from the case to prevent damage to the case by acid or acid fumes.

10. PRELIMINARY PREPARATIONS.

The equipment, with the exception of the telephone and storage batteries, is shipped ready for operation. The following preparations must therefore be made.

a. Telephone EE-8-(*). Insert two Batteries BA-30 in the battery compartment of the telephone.

b. Storage Batteries. Unless special instructions are furnished with the batteries they must be filled with electrolyte and charged before they can be put into operation. Electrolyte with a specific gravity of 1.250 to 1.300 is supplied with the batteries. When putting new batteries in operation proceed in the following manner:

(1) Remove the vent plugs from the battery and fill each cell with electrolyte to a height of 3/8 inch above the top of the separators. After approximately 15 minutes recheck and if necessary replace electrolyte absorbed by the plates.

(2) Allow the battery to stand for 8 to 10 hours and recheck the level of the electrolyte. Add more electrolyte

if the level has fallen to a point below 3/8 inch above the separators.

(3) For further details on the care and charging of storage batteries see TM 11-430, Batteries for Signal Communication Except Those Pertaining to Aircraft.

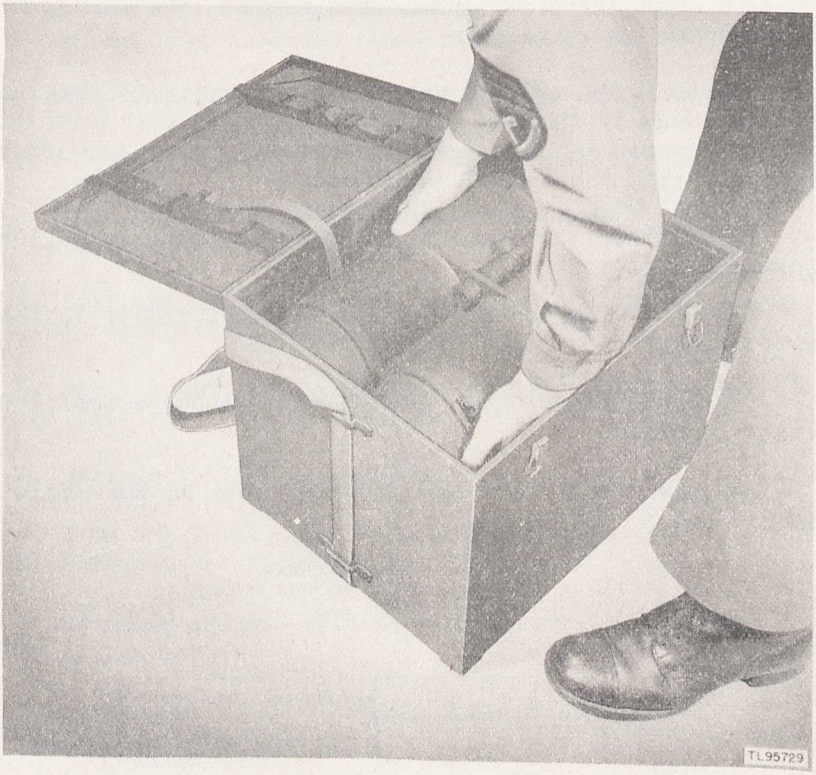

Figure 13. Removing optical unit from case.

II. PREPARATION FOR USE.

a. Assembly.

(1) Remove the tripod from the canvas carrying case.

(2) Set up the tripod and adjust the legs to a convenient length. Keep in mind the clearance necessary for the light beam of local obstacles, and convenience of access to the telescope and peepsights. Lock the legs in position. When tightening the locking controls, turn them outward as viewed from the top.

into position. Forcing the lever into position may result in damage to the gear mechanism. Rotate the azimuth adjustment knob until a point is reached where the lever will slide easily into position. When engaged, the worm release lever should be in a horizontal position, and when disengaged, in a vertical position.

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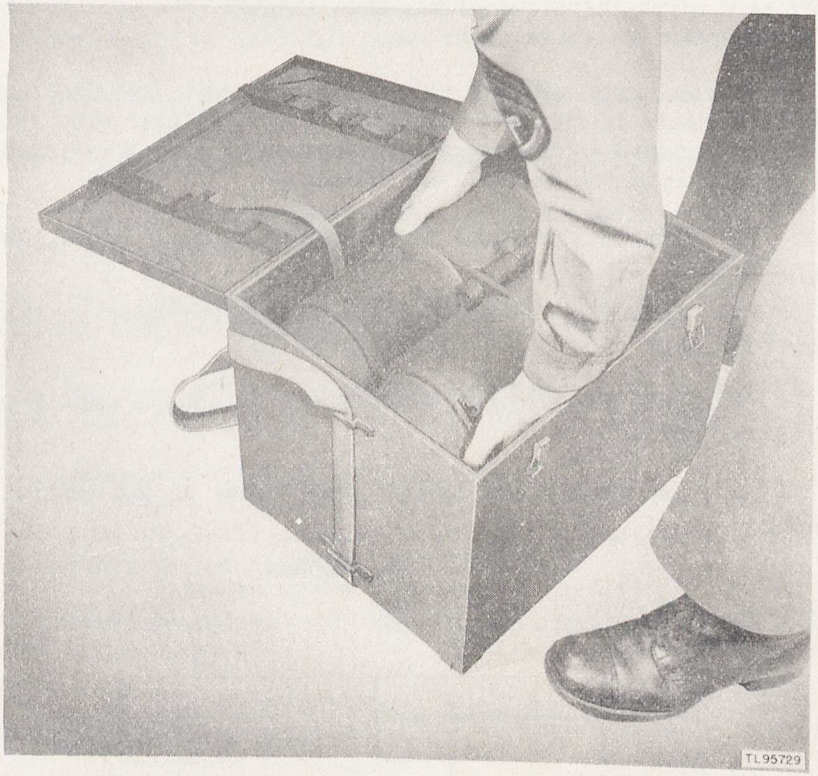

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(3) Press the metal end-tips of the tripod legs firmly into the ground, or when using the equipment on a hard surface, brace them to prevent sliding.

(4) Open the optical unit carrying case, release the canvas retaining strap, and remove the optical unit from the case. When removing the unit from the case observe the precaution given in paragraph **9a**. When removing the unit grasp it as shown in figure 13.

(5) Set the optical unit on the tripod. Center the mounting hole in the base plate of the optical unit over the mounting screw in the top of the tripod. Fasten the screw securely into the optical unit base.

(6) Tighten the level clamp before letting go of the equipment.

(7) Place the control unit in close proximity to the optical unit and tripod (figs. 1 and 2).

(8) Place the storage battery and telephone near the control unit.

(9) Open the lid and control panel cover on the control unit.

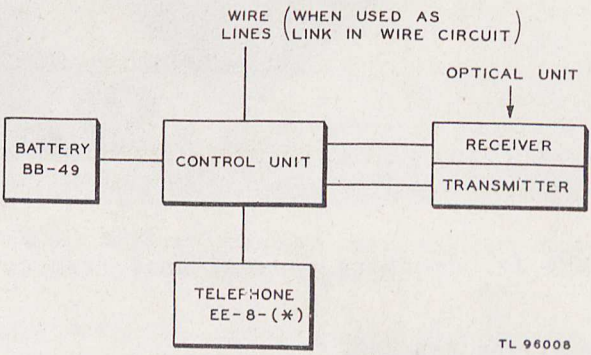


Figure 14. Optiphone AN/TVC-1 (XO-1), block diagram.

b. Interconnections (fig. 14).

(1) Connect the receiver cable (five-pin connector) between the receiving chamber and the receptacle on the right side of the control unit panel (fig. 9).

(2) Connect the transmitter cable (four-pin connector) between the transmitter chamber and the receptacle on the left side of the control unit panel (fig. 9).

(3) Connect the storage battery and control unit by means of the power cable (three-pin connector) (fig. 10).

(4) Connect the line terminals on the telephone to the terminals marked 2W on the terminal board of the control unit (fig. 8).

(5) Lay the telephone line wires over the right side of the control unit case and close and fasten the cover.

12. REPACKING FOR TRANSPORT AND STORAGE (fig. 15).

a. Disconnect the receiver, transmitter, and power cables.

NOTE: To release the connectors press down on the spring release catch.

b. Coil the cables, engage their ends, and place in the optical unit carrying case (fig. 6).

c. Lay the ends of the canvas retaining strap in the optical unit carrying case over the sides of the case.

d. Release the tripod mounting screw.

e. Turn the level clamp to a horizontal position so that the unit will fit properly into its case.

f. Grasp the optical unit as shown in figure 13. Place the unit in the case.

g. Fasten the retaining strap, close the cover, and engage the latches on the case.

h. Collapse the tripod legs to minimum length. Fasten the retaining strap (fig. 7) and place in the tripod case (fig. 15).

i. Disconnect the telephone from the control unit.

j. Place the connecting wire in the top of the control unit or in the handset compartment of the telephone.

k. Place the handset of the telephone in the handset compartment.

l. Close and fasten the control unit lid and control panel cover.

m. If the equipment is to be stored remove the batteries from the telephone.

n. During storage of the equipment, test, and if necessary, recharge the storage batteries every 30 days.

o. When storing equipment in extreme temperatures observe the precaution given in paragraph **9e.**

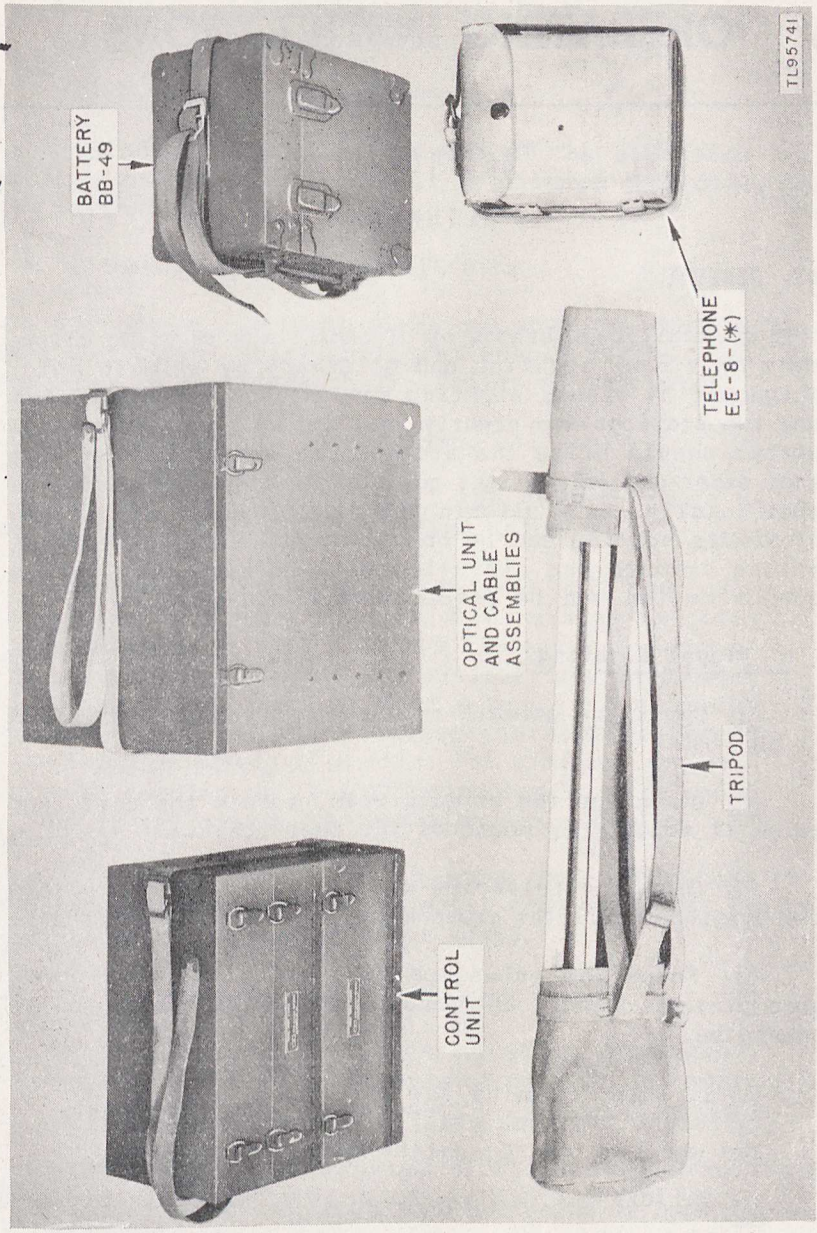


Figure 15. Optiphone AN/TVC-1 (XO-1), packed for transportation.

PART TWO
OPERATING INSTRUCTIONS

SECTION III
ALIGNMENT

13. GENERAL.

In general, two methods of alignment may be used: alignment by visual sighting and alignment by azimuth data. Alignment by visual sighting can only be performed when the two stations are clearly in sight of each other. This method should bring the stations in communication with each other and only slight adjustment will be required for best results. When aligning by azimuth data only an approximate setting can be obtained, and final adjustment of the azimuth and elevation will be necessary before communication can be established (par. 15).

a. Visual Sighting.

(1) Check the azimuth release knob to make sure that it is tight.

(2) Disengage the azimuth worm, rotate the unit, and align it roughly by means of the peepsights.

(3) Open the telescope eyepiece shutter and rotate the eyepiece until the cross hairs appear clear and sharp.

(4) Focus the telescope on the distant station or some distant object, by means of the knurled knob on the telescope.

NOTE: When focusing the telescope at night on a distant light or star, adjust the focus until the smallest and brightest image is obtained.

(5) When aligning the unit at night throw the master-power switch and +A transmitter switch to the ON position. This will turn on the light in the optical unit and illuminate the cross hairs.

CAUTION: Before turning on the lamp be sure that the filter is in place. The unfiltered beam, especially at night, is visible in all directions for great distances.

(6) Engage the azimuth worm.

(7) Adjust the unit by means of the elevation and azimuth control knobs until it is aligned accurately on the distant station.

b. Alignment by Known Azimuth Data.

(1) Loosen the level clamp and move the unit on the ball and socket joint until the bubble in the level is centered in the rings in the center of the level.

(2) Tighten the level clamp.

(3) Rotate the unit until the azimuth scale indicates the azimuth of a selected datum point.

CAUTION: The scales on the optical unit are calibrated in mils, therefore when azimuth is given in degrees it will first be necessary to convert the readings to mils. For military use in angular measurement, the value of a mil is considered 1/6,400 of 360°. One degree therefore is equal to approximately 17.8 mils. For example: an azimuth reading of 22-1/2° converted to mils would be 22-1/2 x 17.8 or approximately 400 mils.

(4) Release the azimuth release knob and rotate the optical unit until the datum point appears at the intersection of the telescope cross hairs.

(5) Tighten the azimuth release knob.

NOTE: Any object, such as a building, cross-road, hill top, or star, whose exact azimuth is known, may be used as a datum point.

(6) Turn the unit by means of the azimuth adjustment knob, to the known azimuth of the distant station.

(7) Final adjustment must be made with the unit in operation. This adjustment is covered in paragraph 15.

c. Alignment by Magnetic Azimuth (fig. 16).

(1) Level the unit as described in subparagraph b (1) and (2) above.

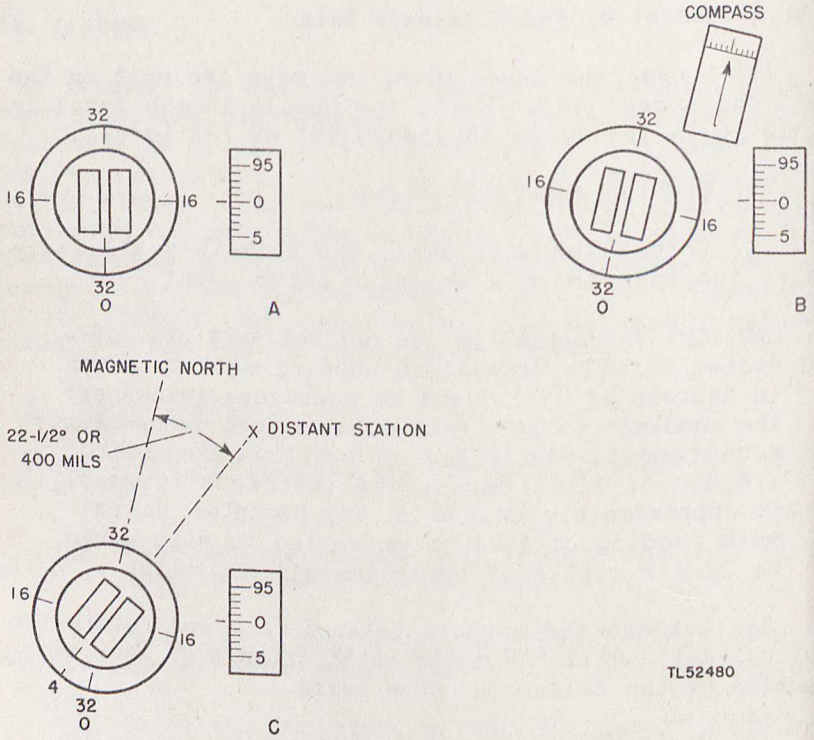


Figure 16. Alignment of optiphone relative to magnetic north.

(2) Set the azimuth scale to indicate O (fig. 16-A).

(3) Release the compass lock on the side of the compass. Be sure that the lock on the compass is completely released and that the needle swings freely.

CAUTION: Magnetic compasses are affected by any magnetic material such as iron, steel, etc. Vehicles should be at least 150 feet away from the compass (par. 8). The operator should have no magnetic metal on his person. In any case, keep the body as far away as possible by leaning forward at the waist, thus minimizing the magnetic attraction of any metal on the person.

(4) Release the azimuth release knob.

(5) Rotate the unit until the compass needle coincides with the mark in the center of the compass scale (fig. 16-B).

(6) Tighten the azimuth release knob.

(7) Engage the compass lock.

(8) Rotate the unit by means of the azimuth control knob until the mark on the unit coincides with the azimuth of the distant station relative to magnetic north (fig. 16-C).

(9) Final adjustment must be made with the unit in operation (par. 15).

d. Alignment by Azimuth from True North.

(1) Level the unit as described in subparagraph b(1) and (2) above.

(2) Set the azimuth scale to indicate O.

(3) Determine the magnetic declination of the locality. For example 2° east or 35 mils (fig. 17).

(4) Rotate the unit by means of the azimuth control knob through the number of mils of magnetic declination (fig. 17-A).

NOTE: If the magnetic declination is to the west the unit must be turned in a counterclockwise direction and if the declination is to the east the unit must be turned clockwise as viewed from the top.

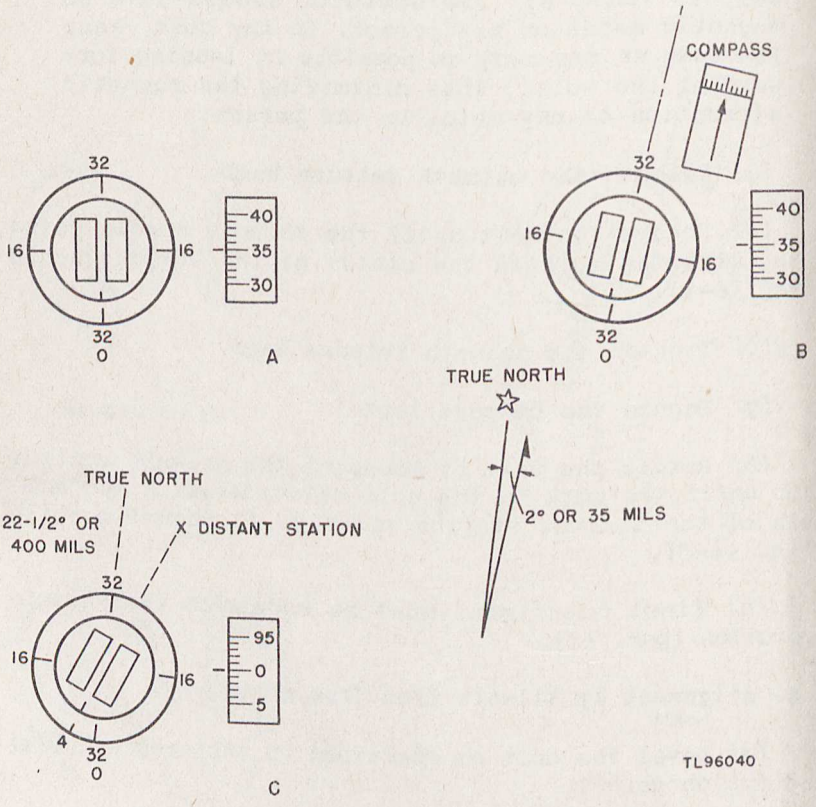


Figure 17. Alignment of optiphone relative to true north.

(5) Release the compass lock on the side of the compass.

(6) Release the azimuth release knob.

(7) Rotate the unit until the compass needle coincides with the mark in the center of the compass scale (fig. 17-B).

(8) Tighten the azimuth release knob.

(9) Engage the compass lock.

(10) Rotate the unit by means of the azimuth control knob until the mark on the unit coincides with the azimuth of the distant station relative to true north (fig. 17-C).

(11) Final adjustment must be made with the unit in operation (par. 15).

SECTION IV

OPERATION

14. GENERAL.

a. Throw the master power switch on the side of the control unit to the ON position.

b. Throw the +A and +B switches on the control panel to the ON position.

c. Throw the selector switch to the 2W position.

d. Allow approximately 30 seconds for the tubes to warm up.

e. Press the handswitch of the telephone and talk into the transmitter in a normal tone. While talking, turn the transmitter volume control toward the maximum position until the neon indicator just flashes on the speech peaks when the indicator switch is deflected to the T position. Normally this point will be between 4 and 6 on the volume control scale.

f. Adjust the receiver volume control until the desired sound level is obtained.

15. OPERATION DURING ALIGNMENT.

a. Roughly align the unit by one of the methods described in paragraph 13.

b. Put the unit into operation as described in paragraph 14a through e.

c. Turn the receiver volume control up until a steady rushing sound is heard in the receiver.

d. Press the handswitch on the telephone and talk into the transmitter while slowly exploring the area in which the distant station has been approximately located.

NOTE: The angle of the projected beam is approximately 1° and the area over which reception may be obtained approximately $1/3^{\circ}$. To facilitate searching during the day the filter should be off while communication is being established. At night, removal of the filter may not be necessary since the filtered beam will be visible within the 1° cone except at the greater ranges.

e. When communication has been established a singing sound will usually be heard in the receiver. When this sound is heard or when the distant station is heard transmitting, turn the receiver volume control down until a suitable receiving volume is obtained and the singing stops.

NOTE: When all adjustments have been completed, the operator may move some convenient distance from the station, if a suitable length of wire is available for connecting the telephone to the control unit.

16. STAND-BY OPERATION.

a. Visual Signaling. When standing by for visual signals, such as blinking of the light in the equipment, have all switches except the master power switch ON. When a signal is received from a distant station it will then only be necessary to snap the master power switch to the ON position and the unit will be ready for operation.

b. Aural Signaling.

(1) Turn off the +A and +B transmitter switches on the control panel.

NOTE: When the +B transmitter switch is turned off the receiver volume will drop.

(2) Adjust the receiver volume control so that the distant station will be heard easily.

17. OPERATION AS LINK EQUIPMENT.

Optiphone AN/TVC-1 (XO-1) may be used as telephone link equipment in either a two or four-wire system. When used in a two-wire system only one line to the subscriber is needed and is used for both transmitting and receiving. When used in a four-wire system two separate lines are run to the subscriber, one for transmitting and the other for receiving. The usable length of line to the subscriber will depend upon the length and condition of the subscriber line.

a. Two-wire Operation.

(1) Set the unit in operation as described in paragraph 14a through e.

(2) Connect the subscriber's line to the two terminals marked 2W on the control unit.

NOTE: The operator's telephone may now be used for monitoring purposes, and to ring the subscriber. The subscriber can also ring into the operator's telephone but neither subscriber or monitor can ring over the light beam.

(3) Adjust the transmitter gain control until the neon indicator just flashes, when the subscriber is transmitting and the indicator switch is deflected to the T position.

(4) Adjust the receiver volume control until the subscriber reports satisfactory reception. When the wire lines are more than a few miles in length singing may occur in the circuit. Therefore the operators and subscribers at both stations must collaborate with each other until satisfactory adjustment is reached.

(5) On long lines, if the reception is not quite satisfactory when the controls have been adjusted for best results, remove the monitoring telephone from the terminals marked 2W, connect it to the two outside terminals, and readjust the volume controls. In this position the monitor can talk and listen to the other monitor and both subscribers but cannot ring or be rung.

CAUTION: Do not use the generator of the monitor's telephone when it is connected across the two outside terminals, or damage to the equipment will result.

b. Four-wire Operation.

(1) Throw the selector switch to the 4W 300 or 4W 1 200 position, depending on whether a low- or high-impedance line is being used.

(2) Identify the two pairs of wires by communicating with the subscriber and determine which pair will be used for transmitting and which for receiving.

(3) Connect the transmitting circuit to the two terminals marked 4W IN and the receiving circuit to the two terminals marked 4W OUT on the control unit.

(4) Connect the telephone across one wire pair and an auxiliary telephone, if available, across the other pair for monitoring purposes.

(5) Adjust the transmitter gain so that the neon indicator will glow on the speech peaks when the subscriber is transmitting and the indicator switch is deflected to the T position.

(6) Adjust the receiver gain control until the subscriber reports satisfactory reception.

NOTE: No ringing of or by the monitor is possible when the line and monitoring telephones are connected to the optiphone. Attempts to ring will damage the equipment.

18. PURPOSE AND USE OF CHECK LIST.

a. General. The equipment performance check list (table I) helps the operator to determine if Optiphone AN/TVC-1 (XO-1) is functioning properly. The check list gives the item to be checked, the condition under which the item is checked, the normal indications of correct operation, and the corrective measures that the operator can take. Items 1 to 6 inclusive are checked before starting, items 7 to 10 inclusive when starting, items 1 to 5 inclusive during operation, and item 16 when stopping. Items 9 to 13 on this check list should be checked at least once during a normal operating period or at least four times a day during continuous operation.

b. Action or Condition. For some items the information given in the action or condition column consists of the settings of various switches and controls under which the item is to be checked. For other items it represents an action that must be taken in order to check the normal indication given in the normal indications column.

c. Normal Indications. The normal indications include the visible and audible signs that the operator perceives when he checks the items. If the indications are not normal, the operator should apply the recommended corrective measures.

d. Corrective Measures. The corrective measures listed are those the operator can make without turning the equipment in for repairs with the exception of item 15. If the set is completely inoperative or if the recommended corrective measures do not yield results, trouble shooting is necessary. However, if the tactical situation requires that communication be maintained and if the set is not completely inoperative, the operator must maintain the set in operation as long as it is possible to do so.

TABLE I

EQUIPMENT PERFORMANCE CHECK LIST

PREPARATORY

No.	Item	Action or condition	Normal indications	Corrective measures
1	Telephone EE-8-(*).	Connected to 2W terminals.		
2	Power cable assembly.	Plugged into battery case receptacle and control unit receptacle.		
3	Receiver cable assembly.	Plugged into control unit receptacle and receiver receptacle.		
4	Transmitter cable assembly.	Plugged into control unit receptacle and transmitter receptacle.		
5	2-4-wire selector switch.	Set at 2W position.		
6	Filter.	In place (at night).		
7	Master-power switch.	Throw to ON position.	Vibrator starts. Vibration can be felt in lower half of control unit case.	Check seating of vibrator in socket. Check battery connections and fuse. Replace battery.
8	Transmitter +A OFF-ON switch.	Throw to ON position.	Transmitter lamp lights.	Check connection between power supply and amplifier sections of control unit. Replace lamp[1] (refer to par. 48).

TABLE I (contd).

EQUIPMENT PERFORMANCE CHECK LIST

	No.	Item	Action or condition	Normal indications	Corrective measures
START	9	Transmitter +B OFF-ON switch.	Throw to ON position about 30 seconds after step 8.	With filter in place, and looking directly at the lamp filament, multiple images of the filament should appear.	Replace Tube JAN-6V6GT[3] (Tube JAN-6K6GT[6] may be used to replace 6V6GT in emergency). Replace battery.[4]
	10	Receiver +A and +B OFF-ON switches.	Throw to ON position.	Sound in telephone receiver.	Turn up receiver volume (GAIN) control.
EQUIPMENT PERFORMANCE	11	Telephone EE-8-(*).	See TM 11-333.	See TM 11-333.	See TM 11-333.
	12	Modulation.	Transmitter volume (GAIN) control set at 5, indicator switch deflected to T, talking into transmitter of telephone at conversational level.	a. Neon lamp flashes. b. With filter in IN position, looking into transmitter chamber at the front through the center of the cell, the side images flicker.	See notes 1 and 2 at at end of table.
	13	Reception.	a. Daylight reception: move hand so that it passes in front of the receiver lens. b. Night reception: shine flashlight on aperture through front lens (small hole in back of receiver lenses and in center of chamber).	a. Rushing sound in telephone will decrease. b. Rushing sound in telephone will increase.	

TABLE I (contd).

EQUIPMENT PERFORMANCE CHECK LIST

	No.	Item	Action or condition	Normal indications	Corrective measures
	14	Receiver volume control	Control is rotated in a clockwise direction.	Increased output will be heard in the receiver.	
	15	Alignment.	a. Reception of signal from other station.	a. Best when far station is at or near intersection of telescope cross hairs.	Refer to pars. 53d and e.
			b. Reception by far station.	b. Best when far station is at or near intersection or telescope cross hairs.	Check seating of transmitter lamp. in socket[1]. Refer to pars. 48, 53d, and 53e.
STOP	16	Master switch and all OFF-ON switches in OFF position.	Turn to OFF position.	Transmitter lamp goes out. Vibrator stops.	

[1]Indication "b" is obtained and not "a". A signal is being projected, but may not be of proper level. Increase the transmitter volume control setting. If setting required for indication "a" exceeds 6[4], replace the battery. If the neon lamp will not light at maximum setting of transmitter volume control, replace the neon lamp.

[2]Neither "a" nor "b" indication. Increase the transmitter volume control setting until "b" is obtained, then follow corrective measure in footnote 1 above. If neither is obtained with the transmitter volume control at maximum, check battery, replace Tube JAN-6K6GT.

[3]CAUTION: Be sure that transmitter +B switch is thrown to OFF position when replacing oscillator tube of transmitter lamp.

[4]This is normally the first indication during operation that the battery needs recharging.

PART THREE

PREVENTIVE MAINTENANCE

SECTION V

PREVENTIVE MAINTENANCE TECHNIQUES

19. MEANING OF PREVENTIVE MAINTENANCE.

Preventive maintenance is a systematic series of operations performed at regular intervals on equipment, when turned off, to eliminate major break-downs, unwanted interruptions in service, and to keep the equipment operating at top efficiency. To understand what is meant by preventive maintenance, it is necessary to distinguish between preventive maintenance, trouble shooting, and repair. The prime function of preventive maintenance is to *prevent* break-downs and, therefore, the need for repair. The prime function of trouble shooting and repair is to locate and correct *existing* defects. The importance of preventive maintenance cannot be overemphasized. The entire system of communication depends upon equipment being *ready for operation* when it is needed and upon its *operating efficiency*. It is vitally important that operators and repairmen maintain their equipment properly.

NOTE: The operations in section VI are considered first and second echelon (organization operators and repairmen) maintenance.

20. DESCRIPTION OF PREVENTIVE MAINTENANCE TECHNIQUES.

a. General. Most of the parts used in Optiphone AN/TVC-1 (XO-1) require routine preventive maintenance. Those requiring maintenance differ in the amount and kind required. Because hit-or-miss maintenance techniques cannot be applied, definite and specific instructions are needed. This section of the manual contains these specific instructions and serves as a guide for personnel assigned to perform the six basic maintenance operations: Feel, Inspect, Tighten, Adjust, and Lubricate. Throughout this

manual the following lettering system will be used for the six operations:

F - Feel.

I - Inspect.

T - Tighten.

C - Clean.

A - Adjust.

L - Lubricate.

The first two operations establish the need for the other four. The selection of operations is based on the general knowledge of field needs. For example, dust encountered on dirt roads during cross-country travel filters into the equipment no matter how much care is taken to prevent it. Rapid changes in weather (such as heavy rain followed by blistering heat), excessive dampness, snow, and ice tend to cause corrosion of exposed surfaces and parts. Without frequent inspections and the performance of necessary tightening, cleaning, and lubricating operations, equipment becomes undependable and subject to breakdown.

b. Feel. The feel operation is used most often to check rotating machinery, such as blower motors, drive motors, etc., and to determine if electrical connections, bushings, etc., are overheated. Feeling indicates the need for lubrication or the existence of similar types of defects requiring correction. The maintenance man must become familiar with the normal operating temperature of motors, etc., in order to be able to recognize signs of overheating.

NOTE: It is important that the feel operation be performed as soon as possible after shut-down and always before any other maintenance is done.

c. Inspect. Inspection is the most important operation in the preventive maintenance program. A careless observer will overlook the evidences of minor trouble. Although these minor defects may not interfere with the performance of the equipment, valuable time and effort can be saved if they are corrected before they lead to major breakdowns. Make every effort to become thoroughly familiar with the indications of normal functioning, in order to be able to recognize the signs of defective equipment.

Inspection consists of carefully observing all parts of the equipment, noticing their color, placement, state of cleanliness, etc. Inspect for the following conditions:

(1) Overheating, as indicated by discoloration, blistering, or bulging of the parts or surface of the container; leakage of insulating compounds; and oxidation of metal contact surfaces.

(2) Placement, by observing that all leads and cabling are in their original positions.

(3) Cleanliness, by carefully examining all recesses in the units for accumulation of dust, especially between connecting terminals. Parts, connections, and joints should be free of dust, corrosion, and other foreign matter. In tropical and high-humidity locations, look for fungus growth and mildew.

(4) Tightness, by testing any connection or mounting which appears to be loose.

d. Tighten, Clean, and Adjust. These operations are self-explanatory. Specific procedures for performing them are given in part three whenever necessary.

> CAUTION: Screws, bolts, and nuts should not be tightened carelessly. Fittings tightened beyond the pressure for which they are designed will be damaged or broken. Whenever a loose connection is tightened, moistureproof and fungiproof it again by applying the varnish with a small brush. See section VIII for details of moistureproofing and fungiproofing.

e. Lubricate. Lubrication refers to the application of grease or oil to the bearings of motors or other rotating surfaces. It may also mean the application of light oil to door hinges or other sliding surfaces on the equipment.

SECTION VI

ITEMIZED PREVENTIVE MAINTENANCE

21. INTRODUCTION.

For ease and efficiency of performance, it is suggested that preventive maintenance on Optiphone AN/TVC-1 (XO-1) be broken down into operations that can be performed at different time intervals. The general techniques involved and the application of the FITCAL operations in performing preventive maintenance on individual parts are discussed in the following paragraphs. These general instructions apply throughout the remainder of this section. All work is to be performed with the power removed from the equipment. After preventive maintenance has been performed on a given day, the equipment should be put into operation and checked for satisfactory performance.

22. COMMON MATERIALS NEEDED.

The following materials are needed in performing preventive maintenance:

a. Common hand tools (Tool Equipment TE-41 or equivalent).

b. Clean, soft, lintless cloth.

c. #0000 sandpaper.

d. Screwdriver (long shaft, small).

e. Solvent, Dry Cleaning (SD), Federal spec No. P-S-661a.

23. EXTERIOR OF OPTICAL UNIT.

a. Inspect, (1).

(1) Inspect the exposed surface of the ball and socket mechanism for particles of dirt or other foreign matter which is likely to mar the ball surface.

(2) Inspect the mounting hole in the base for marred or stripped threads and for accumulation of dirt and other foreign matter.

(3) Inspect the operation of the elevation and azimuth control knobs for binding or excessive backlash. The azimuth backlash should not exceed two mils.

(4) Inspect the surface of the entire optical unit for signs of rust and marred finish.

b. Tighten, (T). Tighten all loose screws except those used for adjustment.

c. Clean, (C).

(1) Clean all dirt and other foreign matter from the ball surface.

(2) Clean the mounting hole and mounting surface.

24. CONTROL UNIT.

a. Inspect, (I).

(1) Inspect the finish for scratched or marred portions.

(2) Inspect the master-power switch on the side of the unit for looseness of the switch and mounting.

(3) Inspect the power cable receptacle for accumulation of dirt. Check to see that the receptacle is tight in the mounting.

(4) Inspect the suitcase-type latches for worn or broken parts.

(5) Inspect the interconnection of power supply and amplifier sections.

b. Tighten, (T).

(1) Tighten the nut which holds the master-power switch to the mounting.

(2) Tighten the screws around the circumference of the switch mounting.

(3) Tighten the screws around the circumference of the receptacle mounting.

c. Clean, (C).

(1) Clean all dirt and other foreign matter from the outside of the unit.

(2) Clean all dirt from the receptacle and burnish the contacts, if necessary, with a piece of #0000 sandpaper.

25. STORAGE BATTERY.

a. Feel, (F). Feel the outside of the battery and the

battery terminals and leads for signs of overheating caused by too great a discharge rate.

b. Inspect, (I).

(1) Inspect the outside of the battery case for chips and breaks and marred portions in the finish. Check carefully for signs of acid holes which may indicate a leaking battery.

(2) Inspect the power-cable receptacle for bent or broken parts and dirt or other foreign matter.

(3) Open the battery case and inspect the battery terminals for tightness.

(4) Inspect the battery for cracks or breaks in the case and top.

(5) Inspect the specific gravity of the battery. Specific gravity should be between 1.275 and 1.300.

c. Clean, (C).

(1) Clean the outside of the battery case.

(2) Clean off the top of the battery with water. Dry thoroughly with a dry rag to prevent shorting of the terminals.

(3) Clean the battery terminals, removing all corrosion.

d. Tighten, (T).

(1) Tighten the battery terminals.

(2) Tighten the mounting screws which hold the receptacle to the case.

26. OPTICAL SURFACES.

a. Inspect, (I).

(1) Inspect the front and back lenses of the telescope for fingerprints, dust, dirt, and other foreign matter.

(2) Inspect the external modulator and receiver lens surfaces for fingerprints, dust, dirt, and other foreign matter.

(3) Turn the filter control knob so that the filter is

out. Look into the transmitting chamber and inspect the lamp bulb for fingerprints.

b. Clean, (C). Clean all optical surfaces with the lens tissue supplied with the equipment or with clean, dry, lintless cloth.

27. TRIPOD.

a. Inspect, (I).

(1) Inspect the tripod legs for broken parts.

(2) Inspect the tripod mounting surface to see that it is free from dirt or other foreign matter.

(3) Inspect the mounting screw for worn or stripped threads.

(4) Inspect the locking knobs to see that they work freely and lock the legs in place when tightened.

b. Clean, (C).

(1) Clean the tripod mounting surface using a clean cloth.

(2) Clean all dirt from the tripod legs and tips.

28. CABLES.

a. Inspect, (I). Inspect cables for cracked, frayed, cut, or deteriorated insulation at the connecting points.

b. Tighten, (T). Tighten all loose clamps and connections.

c. Clean, (C). Clean all dirty or corroded connections. The easiest way to clean dirty connections is to remove the connection and clean it with a brush dipped in dry-cleaning solvent (SD). Make sure that the connection is thoroughly dry. Use a dry cloth. Clean corroded connections with #0000 sandpaper.

29. CONTROL PANEL.

a. Inspect, (I). Inspect the paint for scratches, chips, and blisters. Check for dents, cuts, or bends in the panel. The hinged panel cover should fit tightly. Inspect all controls for proper operation. Replace all knobs that are chipped or broken.

b. Tighten, (T). Tighten all mounting screws and nuts. Tighten the setscrews which hold the knobs on their shaft.

c. Clean, (C). Remove all dirt, dust, fungus, or other foreign matter. Use a damp cloth for cleaning.

d. Adjust, (A). Adjust the position of the knobs on their shafts so that they will align themselves with the markings on the panel.

30. TUBES.

a. Inspect, (I).

(1) Open the cover of the control unit. Remove the back covers from the receiver and transmitter chamber.

(2) Inspect glass and metal tube envelopes for accumulation of dirt. When tubes with loose envelopes are found, replace the tubes if possible.

(3) Inspect the firmness of tubes in their sockets. Make the inspection by pressing the tubes down in the sockets and test them in that position, not by partially withdrawing the tubes and juggling them from side to side. It is desirable to inspect the sockets at the time the tubes are removed.

b. Clean, (C).

(1) Clean the tubes only when inspection shows cleaning to be necessary. The tubes used in the optiphone operate at low voltages, and not having exposed grid and plate caps, do not require frequent cleaning. However, do not permit dirt to accumulate on the tubes.

(2) When tube sockets are cleaned and the contacts are accessible, fine sandpaper may be used to remove corrosion, oxidation, and dirt.

31. RESISTORS.

a. Inspect, (I). Inspect the bodies of resistors for blistering and discoloration which indicate overheating. Look for arc pits. Inspect all connections for corrosion, dirt, dust, and looseness. Look for broken strands in the connecting wire. Do not attempt to move resistors with pigtail connections because of the danger of breaking the pigtail connection at the point where it enters the body of the resistor. Such damage cannot be repaired. Inspect the connections of the pigtail resistors for proper soldering.

b. Clean, (C).

(1) Clean resistors with pigtail connections with a small brush dipped in dry-cleaning solvent (SD).

(2) Discolored resistors cannot be cleaned. Slight discoloration of the resistor body at the center is normal. Excessive discoloration, however, is indicative of overloading at some time prior to the inspection and is probably due to some circuit trouble which requires analysis.

32. POTENTIOMETERS.

a. Inspect, (I). Inspect the mechanical operation of the potentiometers. Inspect the assembly and mounting screws and nuts. All metallic parts should be inspected for dust, dirt, and corrosion.

b. Tighten. Tighten all loose assembly or mounting screws.

33. CAPACITORS.

a. Inspect, (I).

(1) Inspect the plates of the variable capacitor for dented plates.

(2) Inspect for dirt and other foreign matter between the plates of the variable capacitor.

(3) Inspect the fixed capacitors for signs of leaking.

(4) Inspect the capacitors for looseness in their mountings and for loose connections.

b. Tighten, (T). Tighten all loose connections and mounting screws.

c. Clean, (C). If dirt is found between the plates of the variable capacitor, clean with a brush dipped in dry-cleaning solvent (SD).

34. TRANSFORMERS.

a. Inspect, (I).

(1) Inspect transformers for general cleanliness. Examine for tightness of connection, terminals, and mountings.

(2) Inspect transformers for signs of overheating

indicated by the presence of insulating compound on the outside seams of the case.

35. LUBRICATION.

a. Recommended Lubricants. The following table lists the lubricants required in servicing the optiphone:

Approved symbols	Standard nomenclature	Specification No.
GL	Grease, Lubricating, Special	Ordnance AXS-637
OE	Oil, Engine, SAE-10	U.S. Army 2-104B

b. Lubrication Interval. Optiphone AN/TVC-1 (XO-1) should be lubricated every six months, or whenever the optical unit is completely disassembled.

c. Lubrication Procedure. Complete disassembly of the optical unit for lubrication is obtained by the following steps:

(1) Barrel Assembly.

(a) Remove the seven fillister-head screws holding the elevation worm and gear housing (fig. 5).

(b) Remove the four fillister-head screws holding the worm assembly in place. Two of the screws are removed from the front of the elevation gear housing and the other two are removed from inside the yoke. When removing the two screws inside the yoke, tilting the chamber assembly to its extreme limits will give sufficient room to use an ordinary screwdriver. Remove the worm assembly.

(c) Remove the elevation gear rear housing cover from the yoke by removing two screws through holes in the elevation gear.

(d) Remove the two bearing caps by taking out two screws in each cap (fig. 4).

(e) Lift the chamber assembly from the yoke.

(2) Yoke and Upper Parts.

(a) Remove the azimuth shaft cap screw, cap, and felt washer (on top of the yoke).

(b) Remove six flathead screws from the top of the yoke and lift off the yoke.

(c) Throw the azimuth worm to the released position and remove the gear housing.

(d) Remove the azimuth worm from the gear housing by removing the four screws holding the azimuth control assembly to the azimuth gear housing.

(3) *Base and Lower Parts.*

(a) Remove six flathead screws from the bottom of the base and remove the base.

(b) Unscrew the crown gear located inside the base.

(c) Pull off the spherical clamp segment. Remove the Woodruff key from the shaft.

(d) Remove the lock ring and the felt sealing washer.

(e) Remove the spherical clamp socket by removing four fillister-head countersunk screws.

(f) Remove six screws from the retaining washer, remove the washer, loosen the azimuth dial clamp, and remove the segment housing.

(4) *Cleaning.* Wash all parts *except the chamber assembly* with dry-cleaning solvent (SD). Allow the parts to dry thoroughly.

NOTE: Leaded gasoline will not be used as a cleaning fluid for any purpose. Dry-cleaning solvent (SD), is available, as a cleaning fluid, through established supply channels. Oil, Fuel, Diesel (DA), U.S. Army spec No. 2-102C, may be used for cleaning purposes when dry-cleaning solvent is not available. Since unleaded gasoline is available only in limited quantities, and only in certain locations, it should only be used for cleaning purposes when no other agent is on hand. Carbon tetrachloride, or fire-extinguishing liquid (carbon tetrachloride base), will be used, if necessary, *only on control parts of equipment.*

(5) *Lubrication and Reassembly.*

(a) Coat the outer surfaces of the azimuth shaft below the azimuth scale, and the surfaces of the azimuth scale bearing washers, with a light coat of special lubricating grease (GL). Reinstall the segment housing, the retaining washer, and the six screws.

(b) Coat the bearing surfaces of the clamping cap and spherical clamp socket with a light coat of special lubricating grease (GL), and reinstall in the segment housing with the four fillister-head screws.

(c) Install the felt seal and the locking ring.

(d) Coat the surface of the spherical clamp segment with a light coat of special lubricating grease, (GL), and replace in the housing. Coat the Woodruff key with a light film of grease to hold it in the keyway when replacing the spherical clamp segment. Grasp the threaded end of the shaft when it appears through the hole in the spherical segment and pull it out as far as it will go. Attempt to turn it while holding the segment stationary. If the shaft turns, the Woodruff key has been pushed out off the keyway, and the procedure will have to be repeated. If the shaft does not turn inside the spherical clamp segment, proceed with the next step.

(e) Screw the threaded crown gear on the threaded shaft. Then coat the teeth of the crown gear and clamping pinion sparingly with special lubricating grease (GL).

(f) Reinstall the base with the six flathead screws.

(g) Coat the upper bearing surface of the azimuth shaft, upper and lower azimuth shaft bearing washers, and teeth of the azimuth worm and gear with a light coating of special lubricating grease (GL), and install azimuth worm control in the gear housing. Then with the control in the release position, replace the azimuth gear housing on the azimuth shaft.

(h) Replace the yoke over the azimuth gear housing and fasten with the six flathead screws.

(i) Saturate the felt sealing washer with engine oil (OE), and replace on the azimuth shaft. Replace the azimuth shaft cap, making sure that the dowel in the azimuth shaft enters the hole in the cap. Secure the cap with the azimuth shaft cap screw.

(j) Lubricate each support bearing with 2 or 3 drops of engine oil, OE, and replace the chamber assembly.

(k) Replace the bearing caps and fasten the elevation gear rear housing cover to the yoke with two screws.

(l) Coat the teeth of the elevation worm and gear with a light coat of special lubricating grease (GL). Lubricate

the worm shaft bearings with 1 or 2 drops of engine oil, OE, and replace the worm assembly. Leave the four screws slightly loose and adjust the worm to the elevation gear for smooth and free operation by adjusting the two screws on the bottom of the elevation gear housing. Then tighten securely the four screws holding the worm assembly.

(m) Replace the elevation worm and gear housing with the seven fillister-head screws.

36. PREVENTIVE MAINTENANCE CHECK LIST.

The following check list is a summary of the preventive maintenance to be performed on Optiphone AN/TVC-1 (XO-1). Suggested time intervals for performing preventive maintenance may be varied at any time by the local commander. However, for best performance of the equipment it is recommended that the operations be performed at least as frequently as called for in the check list.

The last column indicates whether the operation is first or second echelon maintenance.

Item No.	Operation	Item	When performed			Echelon
			Daily	Weekly	Monthly	
1	I, T, C, L	Exterior of optical unit	X			1st
2	I, T, C	Control unit	X			1st
3	I, T, C	Storage battery	X			1st
4	I, C	Optical surfaces	X			1st
5	I, C	Tripod	X			1st
6	I, T, C	Cables		X		2d
7	I, T, C	Control panel		X		2d
8	I, C	Tubes			X	2d
9	I, C	Resistors			X	2d
10	I, T, C	Potentiometers			X	2d
11	I, T, C	Capacitors			X	2d
12	I, T, C	Transformers			X	2d

F Feel I Inspect T Tighten C Clean A Adjust L Lubricate

SECTION VII

LUBRICATION

Lubrication instructions appear in section VI, itemized preventive maintenance, paragraph 36.

SECTION VIII

MOISTUREPROOFING AND FUNGIPROOFING

37. GENERAL.

The operation of Signal Corps equipment in tropical areas where temperature and relative humidity are extremely high requires special attention. The following items represent problems which may be encountered in operation:

a. Resistors, capacitors, and transformers fail.

b. Electrolytic action takes place in resistors, coils, chokes, transformer windings, etc., causing eventual breakdown.

c. Hook-up wire and cable insulation break down. Fungus growth accelerates deterioration.

d. Moisture forms electrical leakage paths on terminal boards and insulating strips, causing flash-overs and cross-talk.

e. Moisture provides leakage paths between battery terminals.

38. TREATMENT.

A moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection against fungus growth, insects, corrosion, salt spray, and moisture. The treatment involves the use of a moisture- and fungi-resistant varnish applied with a spray gun or brush. Refer to TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, for a detailed description of the varnish-spray method of moistureproofing and fungiproofing, and the supplies and equipment required in this treatment.

> CAUTION: Varnish spray may have toxic effects if inhaled. To avoid inhaling spray, use a respirator if available; otherwise, fasten cheesecloth or other cloth material over nose and mouth.

39. STEP-BY-STEP INSTRUCTIONS FOR TREATING OPTIPHONE AN/TVC-1 (XO-1).

a. **Preparation.** Make all repairs and adjustments necessary for proper operation of the equipment.

b. Disassembly.

(1) Control Unit.

(a) Release the two latches on the front of the unit and raise the cover.

(b) Remove the three long screws from the top of the amplifier chassis (fig. 8).

(c) Open the cover of the power pack compartment by releasing the two latches and unscrewing the two wingnut-type screws on the front of the case (fig. 10).

(d) Disconnect the power supply connector plug from the amplifier chassis by reaching in the power pack compartment (fig. 10) and pulling the plug from the receptacle on the bottom of the amplifier chassis.

(e) Lift the amplifier chassis from the case.

(f) Remove the screw from the side of the power supply receptacle on the underside of the chassis (fig. 18 (4)) and withdraw the plug body.

(g) Release the latches on the rear of the case and remove the top half of the case.

(h) Turn the bottom half of the case frontside up and remove the running spare parts.

(i) Remove the master power switch from the case by unscrewing the hexagonal retaining nut (fig. 11).

(j) Remove the four screws from the power cable receptacle (fig. 11) and pull receptacle from the case.

(k) Remove the two small screws from the side of the receptacle and remove the plug body.

(l) Note the position of the two wires connected to the plug body, then unsolder them.

(m) Remove the four screws from the spare parts compartment panel and take out the panel.

(n) Remove the four screws from the other end of the support strips and lift the power pack assembly from the case.

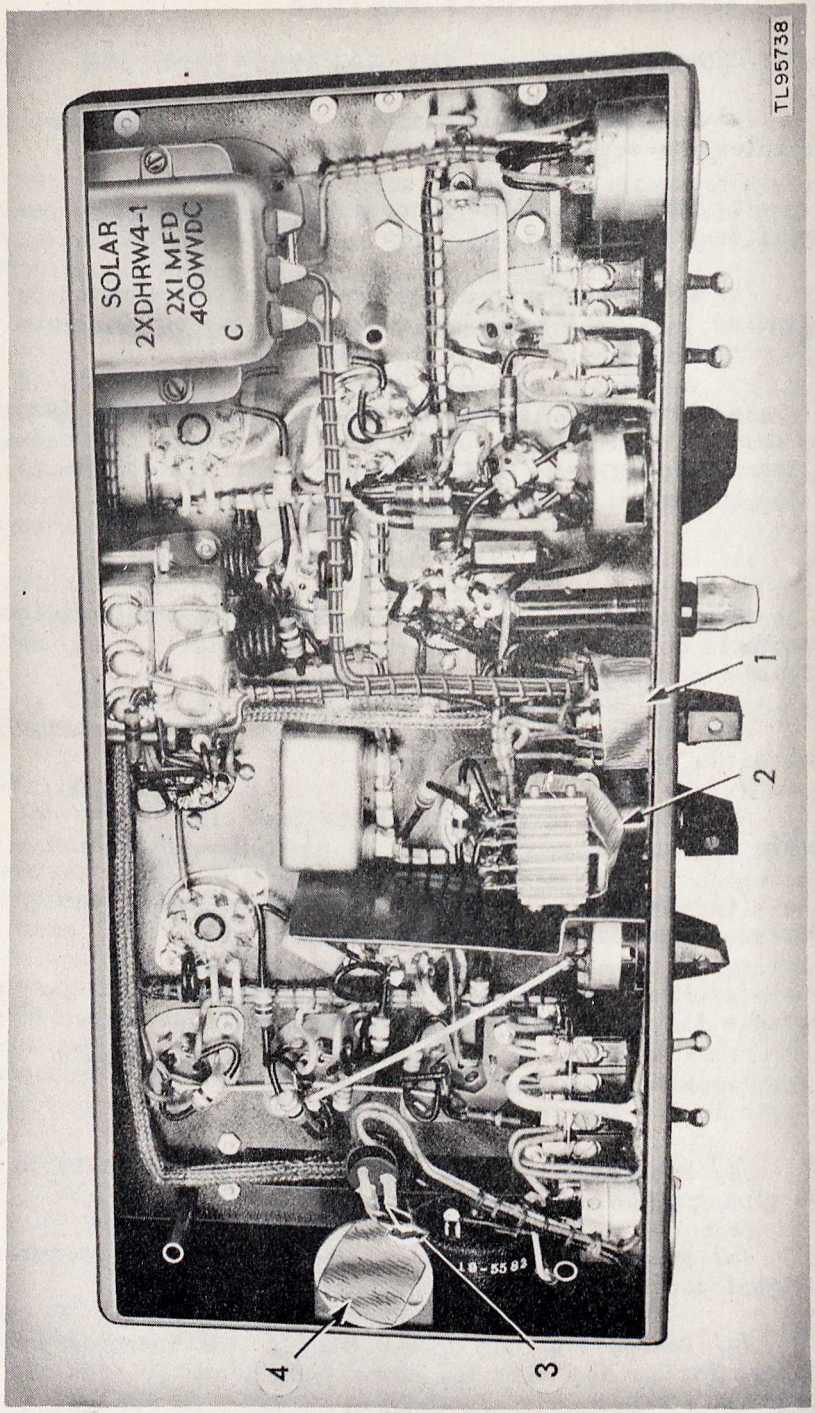


Figure 18. Amplifier chassis, bottom view, masking details.

(o) Disassemble the power pack as follows:

1. Remove eight nuts holding the filter unit and vibrator pack to the support strips (fig. 19).

2. Remove four screws from the bottom edge of the filter unit and six screws from the bottom edge of the vibrator pack. Remove the two covers (fig. 19).

(2) Optical Unit.

(a) Remove the back cover of the transmitter chamber by pressing down on the locking pin (fig. 5), turning the cover in a counterclockwise direction to the OPEN position, and pulling out on the cover.

(b) Remove the back cover of the receiver chamber in a similar manner.

(c) Lay the covers aside for further disassembly.

(d) Mark the position of the transmitter shade with a scriber, loosen the three small setscrews on the outside of the chamber, and remove the shade by pulling straight out.

CAUTION: Do not twist the shade when pulling it out.

(e) Mark the position of the modulator cell on the cell holder and carefully remove the cell (fig. 25).

(f) Unsolder the two top leads (CELL CIRCUIT CONNECTIONS) from the bakelite contact strip in the rear of the transmitter chamber (fig. 38). Straighten out the leads.

(g) Mark the position of the front transmitter lens holder in the transmitter chamber. Remove by inserting two stiff wires, with a small hook bent in the end of each, into the small holes opposite each other in the lens holder. Apply a steady pressure and ease the holder and lens out of the chamber, guiding the cell circuit wires carefully through the rubber grommets in the rear of the chamber (fig. 20).

(h) Disassemble the back covers of the transmitter and receiver chambers as follows:

1. Remove the four screws from the outer edge of the mounting plate inside each cover.

2. Lift up the mounting plate and remove the three

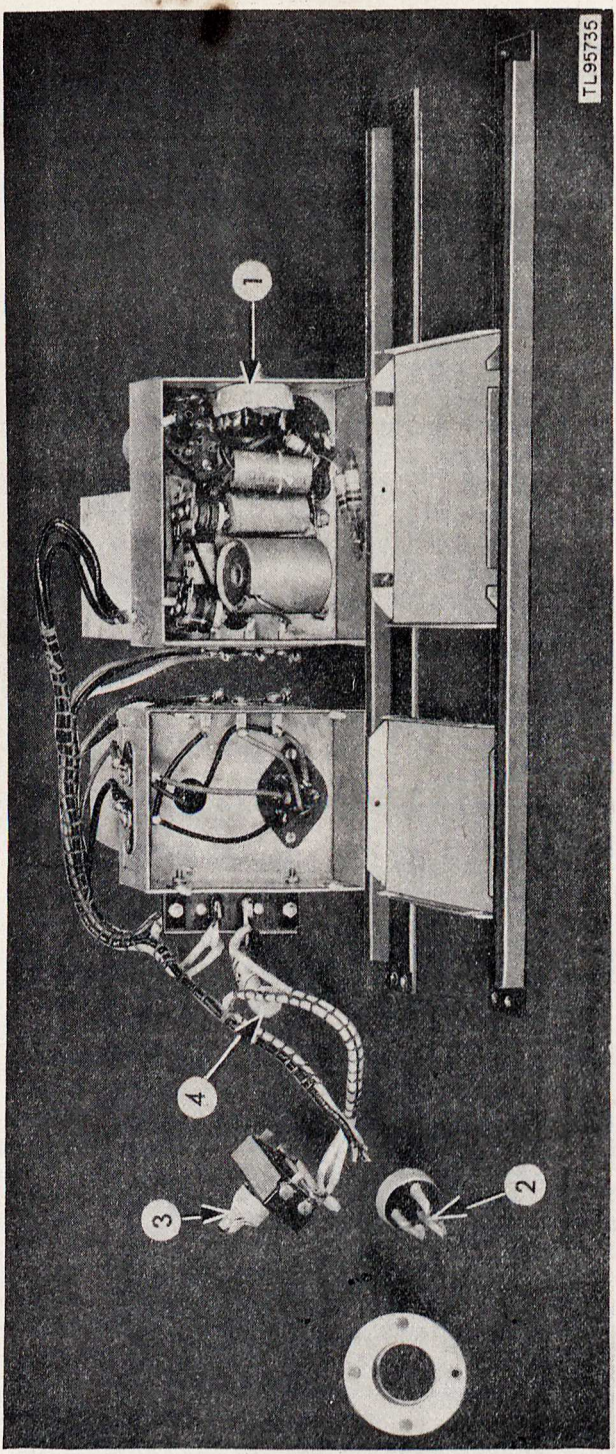


Figure 19. Power supply, vibrapack assembly, masking details.

screws holding the Cannon male receptacle to the cover. Detach the receptacle.

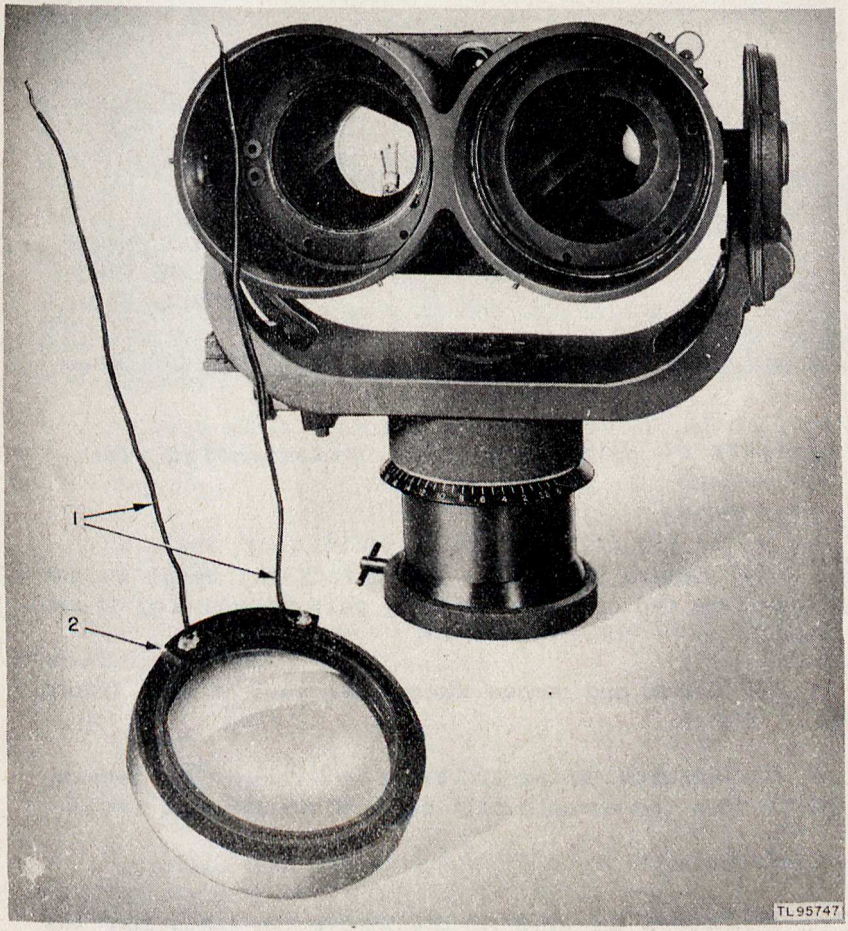


Figure 20. Transmitter chamber, front lens removed.

3. Remove the setscrew from the top of the receptacle and lift the plug body from the receptacle housing.

(3) Cable Assemblies.

(a) Remove the two small setscrews on the side of each of the receptacles.

(b) Loosen and unscrew the cord clamp at the base of each receptacle.

(c) Push the cord through the shell of each receptacle

housing, exposing the soldered terminals and the bakelite plug.

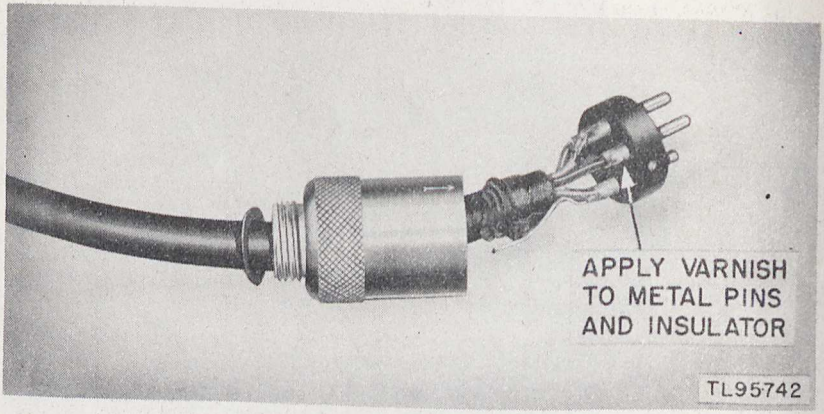


Figure 21. Cable connector, disassembled view.

(4) Tripod.

(a) Remove the screws and detach the metal guides at the lower end of the stationary part of each leg of the tripod.

(b) Extend and remove the movable part of each tripod leg.

(c) Unscrew two small screws and remove the locking control from the movable part of each tripod leg.

(5) Battery.

(a) Loosen the wingnuts and remove the leads from the battery.

(b) Remove the battery from the case.

(c) Remove the machine screws holding the power cable receptacle in the lid of the battery case, loosen the clamp holding the battery leads, and remove the receptacle and leads from the battery case.

(d) Remove the screws holding the plug body in the receptacle and slide the receptacle shell back on the leads, baring the plug body and soldered terminals for varnishing.

c. Cleaning. Clean all dirt, dust, rust, fungus, oil, grease, etc., from the equipment to be processed.

NOTE: Unless cleaning is done carefully and completely, the effectiveness of the moistureproofing and fungiproofing operation will be impaired.

d. Masking.

(1) Control Unit.

(a) Mask the wire selector switch on the underside of the chassis (fig. 18 (1)).

(b) Mask the contacts of the indicating lamp switch (fig. 18 (2)). Push small pieces of tissue paper between and around the contact.

(c) Wrap small strips of masking tape around the contacts of the power supply plug body (fig. 18 (3)), and mask the screw hole in the side of the plug body.

(d) Mask the opening in the power supply receptacle (fig. 18 (4)).

(e) Cover the control panel with paper held in place with masking tape.

(2) Power Pack.

(a) Mask the selector switch on the underside of the vibrapack chassis (fig. 19 (1)).

(b) Mask the contacts and threaded screw holes of the power supply plug body (fig. 19 (2)).

(c) Mask the holes of the power supply connector plug (fig. 19 (4)).

(d) Wrap masking tape around the toggle and threaded neck of master power switch (fig. 19 (3)).

(3) Optical Unit.

(a) Back Cover of Transmitter Chamber.

1. Mask the tuning capacitor (fig. 22 (1)).

2. Mask the contacts of the bakelite contact strip (fig. 22 (2)).

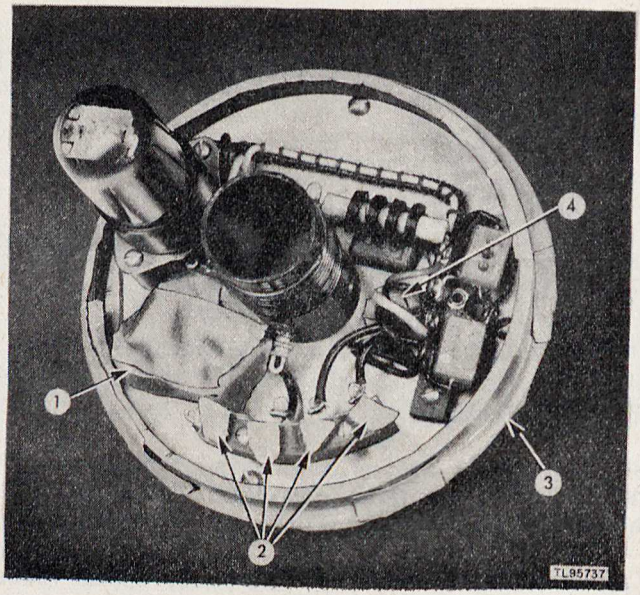


Figure 22. Transmitter chamber cover, masking details.

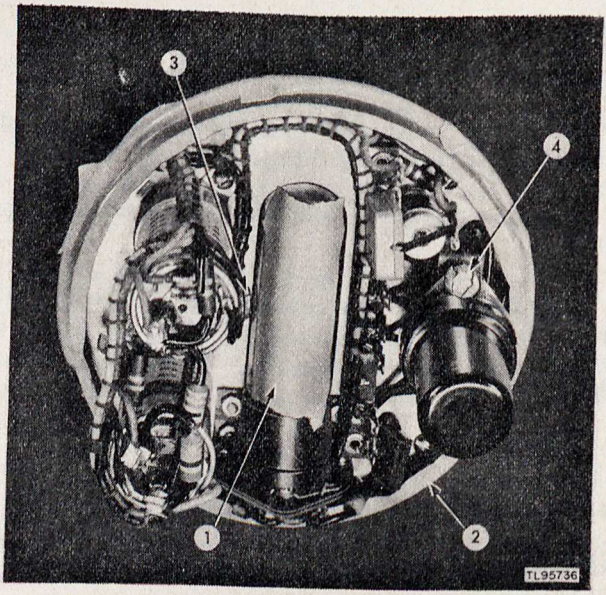


Figure 23. Receiver chamber cover, masking details.

3. Place small pieces of masking tape over the four threaded mounting screw holes in the cover.

4. Mask the engaging grooves and the chamber contacting surface around the rim of the cover (fig. 22 (3)).

5. Mask the rubber grommet (fig. 22 (4)).

(b) Back Cover of Receiver Chamber.

1. Mask the front of the phototube (fig. 23 (1)).

2. Place small pieces of masking tape over the four threaded mounting screw holes in the cover.

3. Mask the engaging grooves and the chamber contacting surface around the rim of the cover (fig. 23(2)).

4. Mask the rubber grommets (fig. 23(3) and (4)).

(c) Transmitter Chamber.

1. Insert small wooden pegs in the two banana-plug receptacles on the transmitter lens holder.

2. Mask the contacts of the bakelite contact strip in the rear of the transmitter chamber.

e. Drying.

(1) Place the control unit chassis and power pack chassis in oven or under heat lamps and dry for 2 to 3 hours at 160° F.

(2) Place the optical unit, including the supersonic cell, transmitter lens, chamber covers, cable assemblies, battery case, and tripod in oven or under heat lamps and dry for 3 to 4 hours at 130° F.

f. Varnishing.

(1) Apply three coats of moistureproofing and fungiproofing varnish (Lacquer, Fungus-resistant, spec No. 71-2202 (stock No. 6G1005.3), or equal) with a spray gun to:

(a) The amplifier chassis of the control unit, top and bottom.

(b) All parts of the power pack assembly.

(c) The back covers of the transmitting and receiving chambers, including the leads under the mounting plates.

CAUTION: Do not spray the connector receptacles and the painted surfaces on the chamber covers.

(2) Using a small brush, apply two coats of varnish to:

(a) The edges of the bakelite contact strip, wires, and soldered terminals in the rear of the transmitter chamber. *Do not apply* varnish to the flat *surface of the strip* which contains the contacts.

(b) The edges of the insulating material under the base of the transmitter lamp support.

(c) The insulating washers under the four slotted-head screws on the outside of the transmitter chamber, directly below the transmitter lamp support.

(d) The bakelite parts, soldered terminals, and gaskets of the Cannon male receptacles on the back of the two chamber covers. *Avoid the contacts and threaded mounting screw holes.*

(e) The bakelite parts and the soldered terminals of the disassembled connectors of the three cable assemblies (fig. 21), and the power cable receptacle from the battery case. *Avoid the contacts and threaded screw holes.*

(f) The two bakelite rings which retain the glass in the front and back of the modulator (supersonic) cell. Apply only *one* coat of varnish to the side of the cell which comes in contact with the cell holder. *The application of more than one coat will make the replacement of the cell in the cell holder difficult.* Avoid placing varnish on the two banana-plug connectors mounted on the bakelite ring.

NOTE: If any old varnish is present, remove with fine sandpaper before applying a new coat of varnish.

(g) The bakelite terminal strip on the lens holder, the two wires, and soldered terminals of the disassembled front transmitter lens. *Do not apply* varnish to the chamber contacting surface of the lens holder.

(3) Apply two coats of varnish by brush to:

(a) The inside surfaces of the battery case.

(b) All *wooden* parts of the disassembled tripod.

g. Reassembly.

(1) Remove all masking tape.

(2) Clean all switch and terminal contacts with varnish remover, burnishing if necessary.

(3) Reassemble the equipment. Apply varnish with a small brush to all newly soldered connections. Test the operation of the equipment.

h. Marking. Mark the letters MFP and the date of treatment near the nameplate on the optical unit, tripod, battery case, power pack case, and control unit amplifier case.

EXAMPLE: MFP ——20 Jan 45.

40. MOISTUREPROOFING AND FUNGIPROOFING AFTER REPAIRS.

If, during repair, the coating of protective varnish has been punctured or broken, and if complete treatment is not needed to reseal the equipment, apply a brush coat to the affected part. Be sure the break is completely sealed.

PART FOUR
AUXILIARY EQUIPMENT

(NOT USED)

PART FIVE

REPAIR INSTRUCTIONS

SECTION IX

THEORY OF EQUIPMENT

41. OPTICAL UNIT TRANSMITTER CHAMBER (fig. 24).

a. Optical System. The optical system of the transmitter consists of a lamp mounted in an adjustable socket, an adjustable filter, light trap, and two lenses. These lenses together project an image of the lamp filament to infinity, that is, an image of the filament can be seen on a distant screen.

(1) *Lamp.* The lamp has a nominal rating of 2 amperes at 5 volts. The filament of the lamp is a cylindrical coil whose axis is parallel to the axis of the lamp. The lamp bulb is spherical in shape and the center of curvature of the sphere coincides closely with the position of the filament. This construction causes a faint image of the filament to be formed quite close to the filament by reflection of light from the back of the bulb. This image is incidental however, and because of its relatively low intensity, has no effect on the performance of the equipment.

(2) *Lenses.* The front lens of the optical system is a plano-convex lens mounted with its convex face outward. The rear lens is a cemented doublet. Together the lenses comprise a system whose effective focal length is 5 inches, and diameter is 4 inches. The lens system is corrected for spherical aberration, but not for chromatic aberration. Color effects resulting from chromatic aberration provide a means of determining when the lamp is in proper focus.

(3) *Filter.* The filter provided in the optical unit is relatively opaque to all colors other than dark-red. The signal transmitted through the filter is approximately one third of the signal without it. It is a dyed gelatine-base material having the color transmission characteristics designated Wratten 88A. For protection, the filter material is cemented between two thin glass disks.

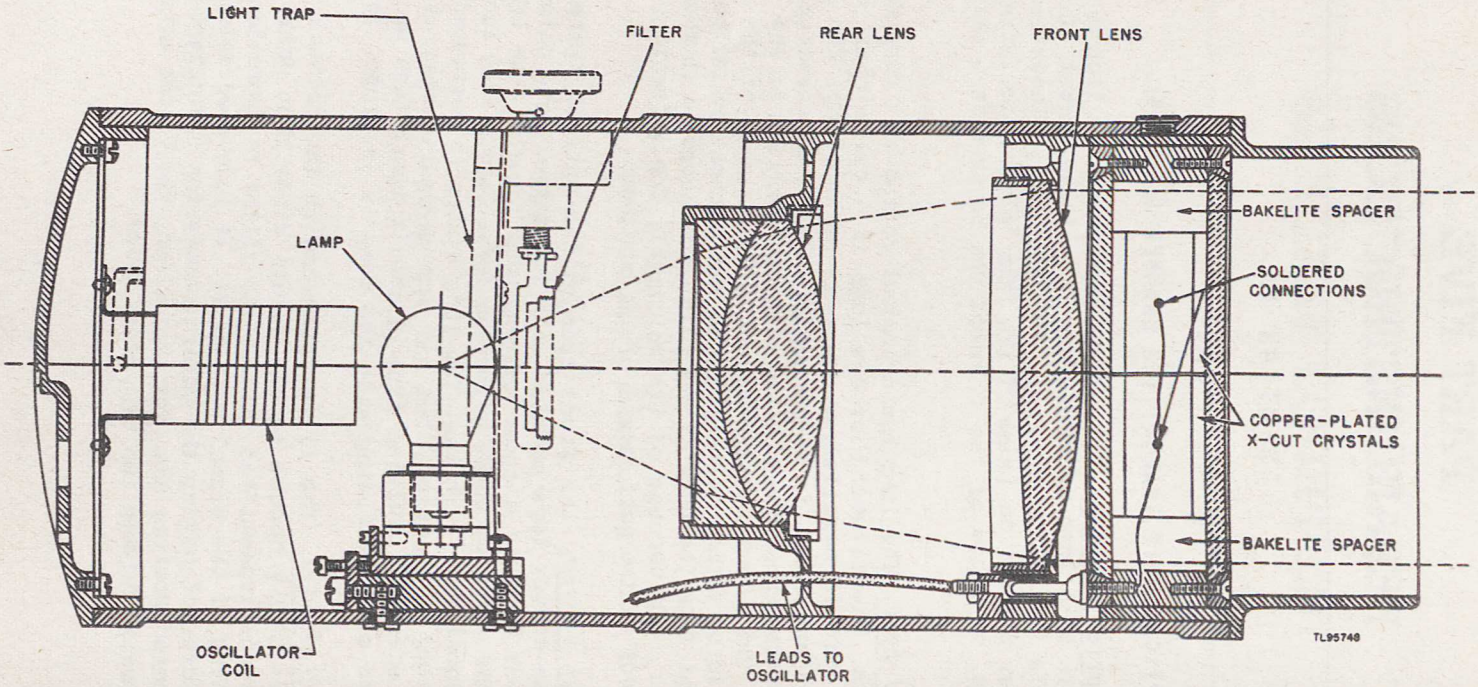


Figure 24. Transmitter, cutaway view.

(4) Light Trap. When the filter is in place the light trap keeps stray light from coming out around the filter.

b. Modulating Cell. The modulating cell causes the intensity of the light projected by the transmitter to vary with speech. It accomplishes this by utilizing the effect on light of high-frequency sound waves in a liquid.

(1) Physical Characteristics. The modulating (supersonic) cell consists of a bakelite cylinder with glass end plates. These plates are assembled by means of screws to the cell body with Koroseal gaskets and bakelite retaining rings. Mounted centrally in the cell, and supported in grooves ground in the glass plates, are two X-cut quartz crystals 1-1/2 inch long, 1 inch wide, and 1/32 inch thick, and two bakelite spacers (fig. 25). The crystals are chemically silvered and copper-plated over their entire length and most of their width on both sides. Opposite faces of the crystals are insulated from each other. The platings are connected by wires soldered to them so that the crystals are connected electrically in parallel. These wires are connected to banana-plug terminals by means of which the cell is connected to its power source in the optical unit. The terminals engage in connectors fitted into the front lens mount and are insulated from it by lucite grommets. The cell is filled to a level slightly above the top of the upper quartz crystal with Xylene (dimethylbenzene). The cell is not usually filled completely to provide for expansion of the liquid with increase in temperature. As long as the crystals are immersed in liquid, performance of the cell is not impaired. If the liquid drops below this level, the percentage loss of signal will be proportional to the percentage loss of liquid. The top of the cell is provided with a hole for filling, fitted with a vent screw. The capacity of the cell is approximately 7 fluid ounces.

(2) Generating High-frequency Sound Waves. The high-frequency sound waves (supersonics) required for operation of the cell are produced by the quartz crystals. The crystals are piezoelectric; that is, they have the property that when an a-c potential is applied to the faces of the crystals, they will vibrate (expand and contract in thickness) with very small amplitude at that frequency. The effect is greatest, though still much too small to see, at a frequency (fundamental) determined by the thickness of the crystal, or an odd multiple (odd harmonic) of this fundamental frequency. The fundamental frequency of vibration of the quartz crystals

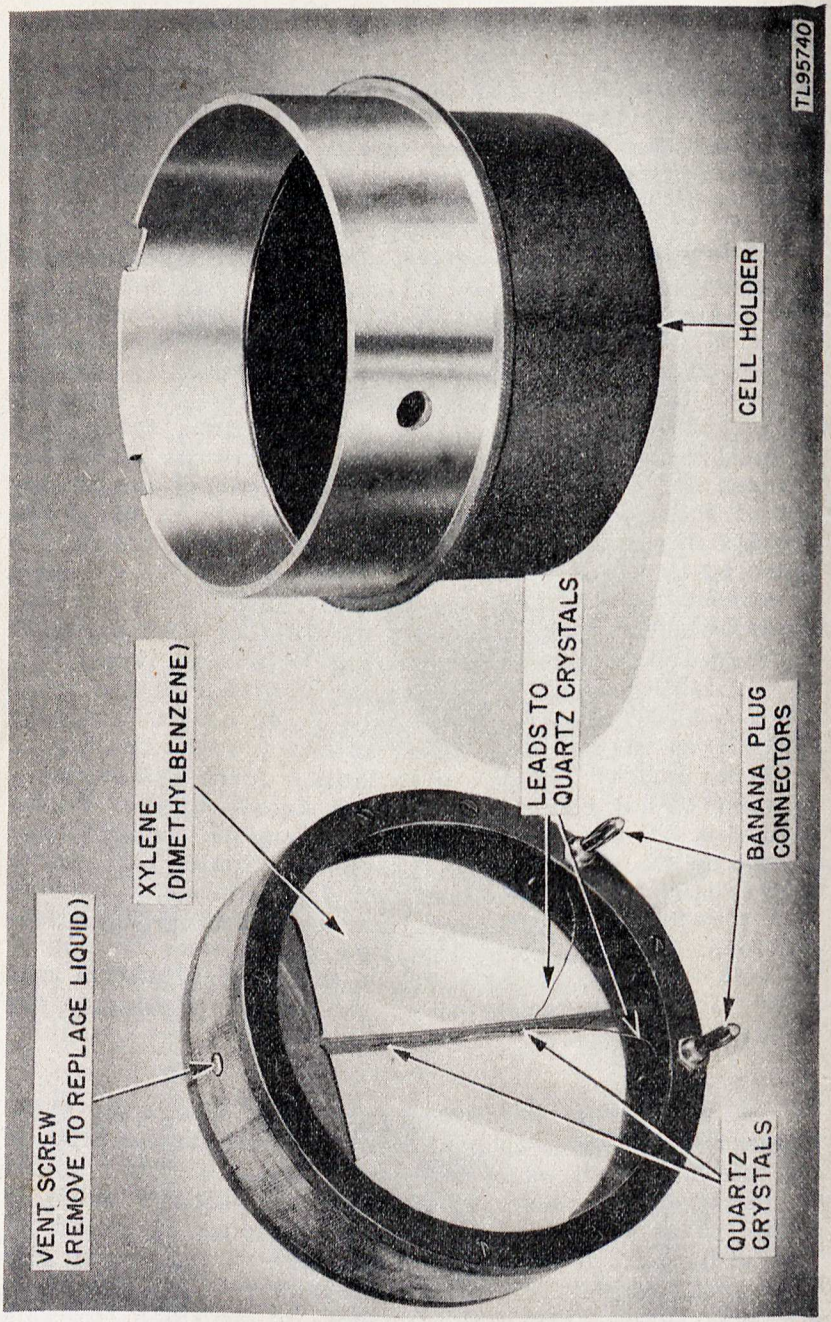


Figure 25. Modulating cell.

in the cell is approximately 3.3 megacycles per second. The crystals are operated on the third harmonic of this frequency or at approximately 10 megacycles per second. When power is supplied to the crystals by an oscillator at this frequency, sound waves of that frequency, are radiated by them into the liquid. (Tuning of the oscillator to the crystal frequency is not critical due to loading of the crystal by the liquid.) These waves are radiated in a direction perpendicular to the faces of the crystals and are absorbed at the end of their path by the walls of the cell. Consequently there is no sound field, and no optical effect, in those portions of the cell perpendicular to the bakelite spacers. The upper and lower portions of the cell therefore, do not contribute to the modulating action, and light will travel through these portions without being affected.

(3) Optical Effect. With no power applied to the modulating cell, but with the lamp turned on, the optical system of the transmitter will cause an image of the tungsten filament of the lamp to be projected. When +B power is

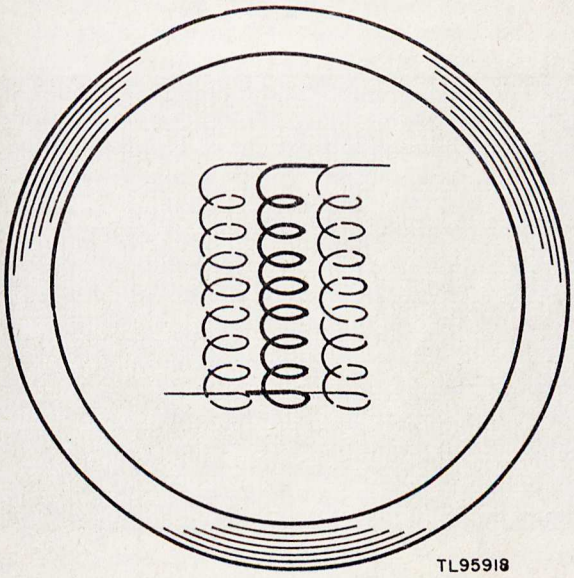


Figure 26. Diffraction pattern.

applied to the oscillator in the optical unit, which in turn will cause r-f power to be applied to the crystals, a sound field will be set up in the modulating cell. Additional images of the tungsten coil will now be projected on either side of the original. The original image will

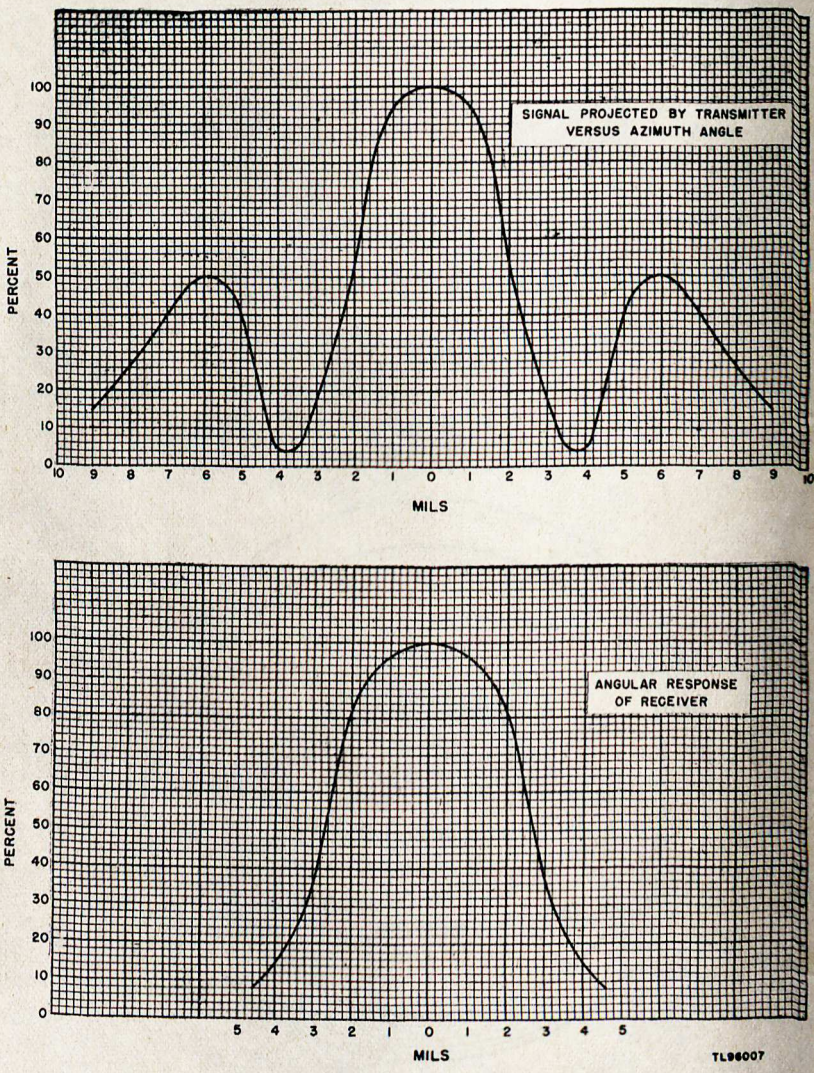


Figure 27. Angular characteristics of transmitter and receiver.

drop in intensity and this drop will be exactly equal to the intensity of the side images. This is called a diffraction pattern (fig. 26) showing the central image and first order diffraction images. (The incidental image described in paragraph 41a *(1)* is not shown in figure 26.) In general there may be additional side orders visible, and the pattern may not be symmetrical. The action of the modulating cell therefore may be described briefly as causing some of the light to be deflected to the right and to the left of its original direction. The diffraction pattern may also be observed by looking directly at the lamp in the transmitter chamber, through the filter.

(4) Modulating the Light. The amount of light which is thrown out of the central image is proportional to the intensity of the sound field in the liquid. The intensity of sound in the liquid is proportional to the amplitude of the voltage applied by the oscillator to the crystals. Therefore, by modulating the amplitude of the oscillations with speech, the intensity of the central image will be modulated correspondingly. About 70 percent of the light in the central image may be controlled in this manner. To utilize this range of control most efficiently the unmodulated carrier applied by the oscillator causes 30 to 35 percent of the light to be thrown out of the central image. When the carrier is fully modulated, the intensity of the central image may thus be made to vary between the limits of full intensity and 30 percent of full intensity. The visual indication of modulation is the appearance of second and sometimes third order images of fluctuating intensity in the pattern. The appearance of these images is a reliable indication that the transmitter is projecting a strong signal in the central image. Most of the light however, is deflected into the first side orders, and consequently a signal of good quality but of not more than half the intensity of the signal in the central image is obtained in the side orders. The amplitude of the signal projected by the transmitter consequently varies with the azimuth angle (fig. 27). Little or no variation of the projected signal should be observed with variation of elevation over the vertical spread of the beam. The vertical spread of the beam is approximately 1° or 17.8 mils.

c. Oscillator. The oscillator is of the conventional Hartley type, using a 6V6GT tube. It is located on the back cover of the transmitter chamber. The 10 megacycle per second r-f output of the oscillator is plate-modulated by the audio output of the transformer T4, appearing at terminals 1 and 2, and fed through the shielded transmitter cable to the oscillator (fig. 29). The modulating cell is

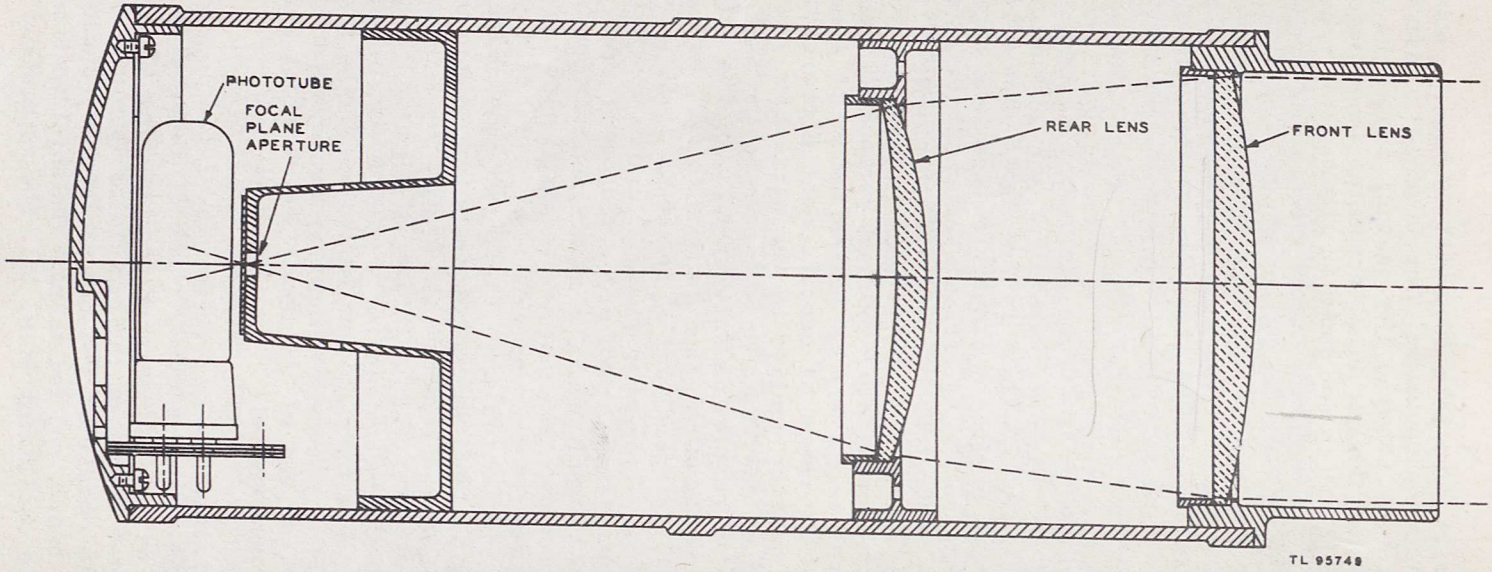


Figure 28. Receiver, cutaway view.

connected to the oscillator by means of leads running from the contact strip in the transmitter chamber, through the light trap and rear lens mount, to the connectors which engage the cell terminals. The cell is connected in parallel with the tank coil L2 and the tuning capacitor C7. The load effectively presented to the oscillator by the modulating cell, when the oscillator is tuned to the cell frequency, is a capacitance of 65 micromicrofarads in parallel with a resistance of 10,000 ohms. The maximum capacitance of the tuning capacitor is 25 micromicrofarads, so that the greater part of the oscillating circuit capacitance is in the modulating cell. Resistor R23 is placed in the circuit for the suppression of parasitic oscillations. Except for

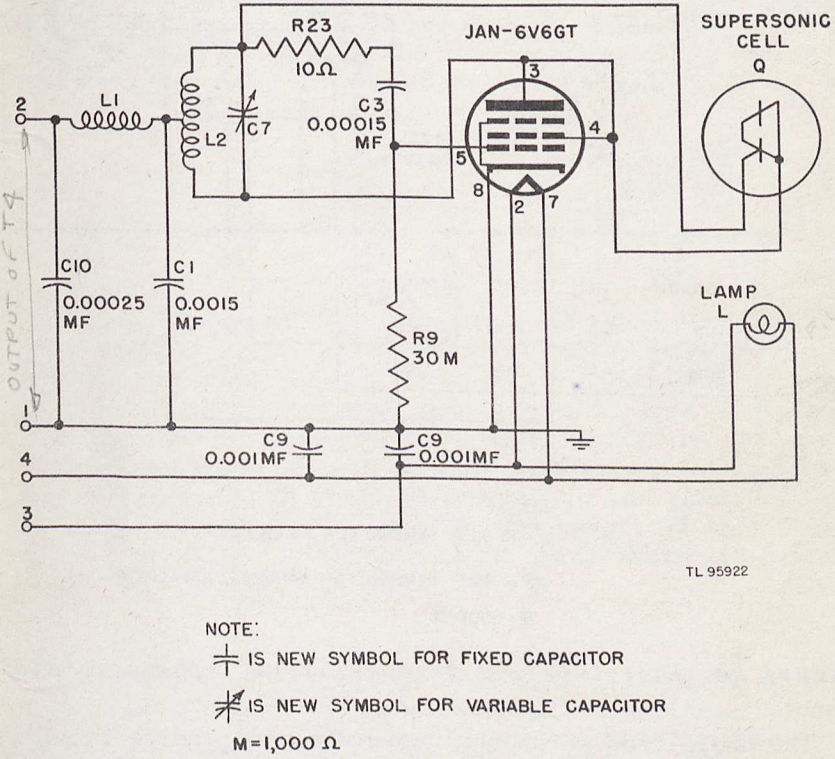


Figure 29. Oscillator, transmitter lamp and modulating cell, schematic diagram.

capacitors C9, the A circuit of the oscillator and lamps is isolated from the optical unit to minimize electrical coupling between this circuit and the receiver circuit. Any coupling between these two results in increase of vibrator noise in the receiver output. Capacitors C9 are required to suppress the r-f radiation which results from isolating this A circuit.

42. OPTICAL UNIT RECEIVER CHAMBER (fig. 28).

a. Optical System. The receiver optical system consists of two lenses having an effective focal length of 9 inches and diameter of 4-1/2 inches, an aperture plate or diaphragm, and a phototube. The effect of the two lenses is to focus an image of a distant scene in the plane of the receiver aperture plate. However, only light from that part of the image which falls on the aperture itself, (a hole 0.060 inches in diameter) illuminates the phototube. Therefore

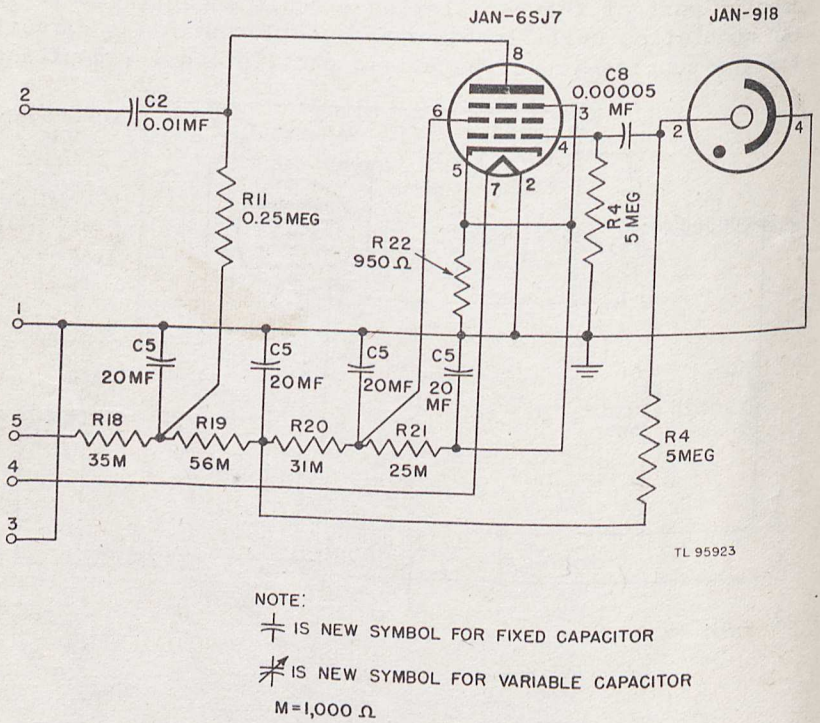


Figure 30. Phototube and pre-amplifier, schematic diagram.

the angle from which the phototube can receive light is greatly restricted. The response of the receiver to a signal from a fixed point will vary as the receiver is rotated. The angle within which the receiver response falls to one half of its maximum is 5.5 mils or about 0.35°. This limitation of the angular field of the receiver is necessary to reduce the illumination of the phototube by background light during daylight operation.

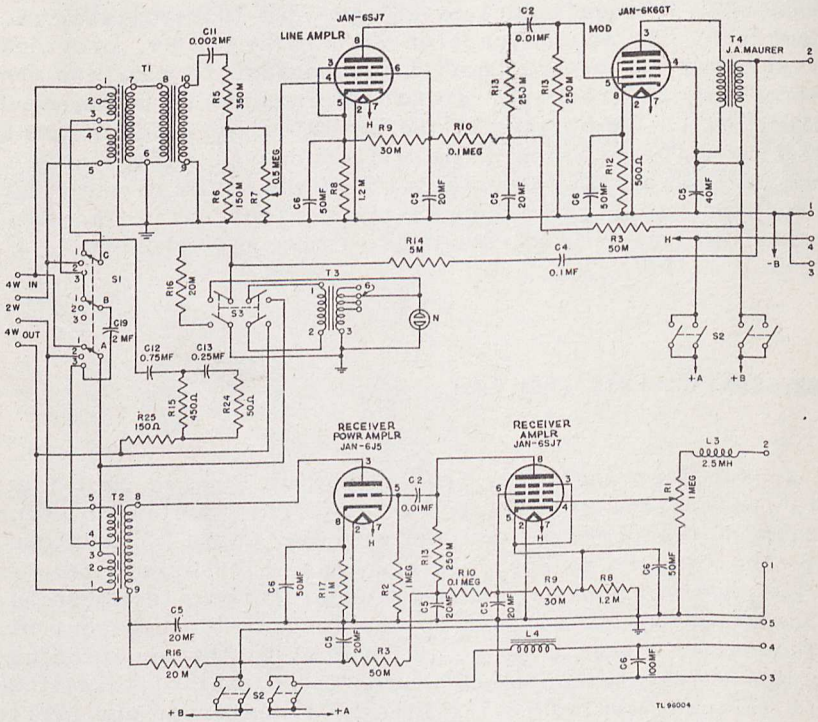
b. Phototube and Pre-amplifier. The phototube JAN-918 is a gas-filled photo-emissive type tube which is particularly

sensitive to red light. When the phototube is illuminated, electrons are emitted from the cylindrical-shaped cathode and are collected by the anode, to which a positive polarizing voltage is applied through phototube load grid-leak resistor R4. The gas in the tube serves to increase the phototube current. This current flowing through the load resistor causes a voltage to appear across the load resistor which is proportional to the illumination on the phototube cathode. This voltage is coupled to the grid of the pre-amplifier tube 6SJ7 through capacitor C8 and grid-leak resistor R4. Capacitor C8, in conjunction with resistor R4, provides a coupling circuit of short time constant to minimize the effect on the receiver signal of changes in background illumination. The output of the pre-amplifier appears across the resistor R11, which is wire-wound to reduce noise, and is fed through the shielded receiver cable to the first receiver amplifier stage in the control unit. The pre-amplifier tube is shock-mounted to reduce microphonics.

43. CONTROL UNIT (fig. 31).

a. Receiver Amplifier. The output of the pre-amplifier in the optical unit is fed to the first amplifier stage through r-f choke L3 and resistor R1. Choke L3 is placed in the circuit to suppress coupling which exists between the receiver and transmitter under certain conditions. Potentiometer R1 is used as the receiver volume control. The output of this stage is coupled to the power output stage which uses a JAN-6J5 tube. The output of this stage is in turn coupled to the line by transformer and hybrid coils T2.

b. Transmitter Amplifier. An incoming signal from the line is matched to the first transmitter amplifier stage, which uses a JAN-6SJ7 tube, by transformer T1. Capacitor C11, in combination with resistors R5 and R6, and potentiometer R7, which is the transmitter gain control, limits the low-frequency response of the transmitter amplifier, which has a drop of three decibels at 300 cps from the gain at mid-band. The output of this stage is resistor-capacitor



NOTE:
IS NEW SYMBOL FOR FIXED CAPACITOR
IS NEW SYMBOL FOR VARIABLE CAPACITOR
M=1,000 Ω

Figure 31. Control unit, amplifier section, schematic diagram.

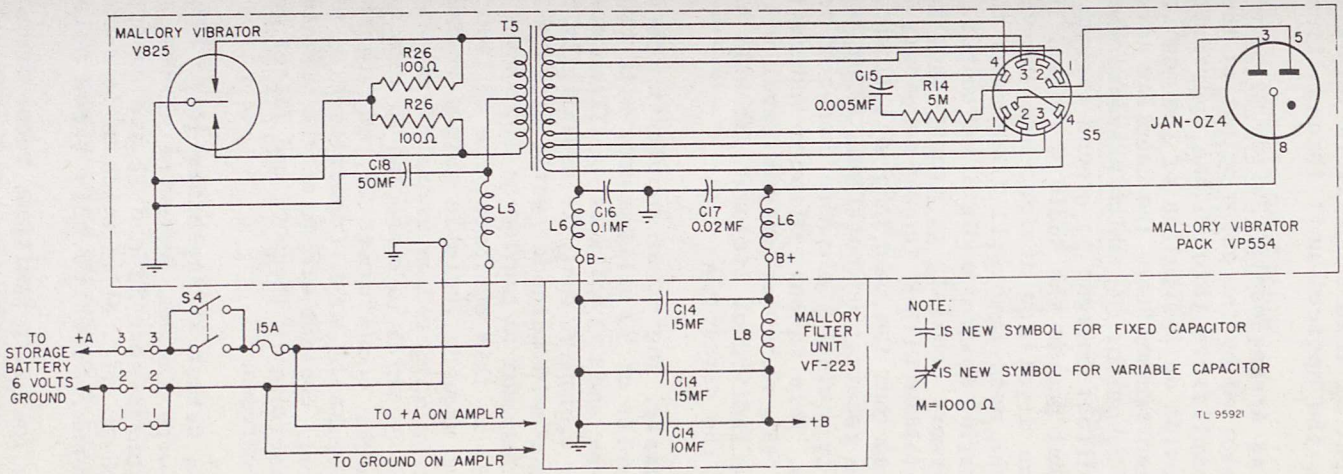


Figure 32. Control unit, power supply, schematic diagram

coupled to the modulator stage which uses a JAN-6K6GT tube. The output of this stage is in turn coupled to the oscillator in the optical unit through transformer T4.

c. Monitoring Arrangements. Switch S2 permits the neon lamp N to be excited by the audio output of the transmitter or receiver amplifiers through the appropriate coupling network to provide an indication of the magnitude of these outputs. For the transmitter, the coupling network consists of a blocking capacitor C4, which prevents shorting of the high-voltage direct current to ground through the rest of the network, but passes the audio voltages. Resistors R14 and R16 act as a voltage divider and the values are so chosen that the neon lamp will flash when the modulator stage is delivering maximum undistorted output. The receiver monitoring network consists of transformer T3 which is a step-up transformer with a tapped secondary. The tap has been selected so that the neon lamp will flash on the speech peaks when the receiver output level is at least adequate for listening by a single telephone connected to the 2W output terminals. This is only a rough indication however, and normally the receiver output level will be set to accomodate the individual listener, or will be determined by singing of the circuit.

d. Power Supply. The power supply in the control unit supplies 180 volts at 50 milliamperes with transmitter and receiver both on, and 140 volts at 4 milliamperes on standby operation. The vibrapack consists essentially of a vibrator transformer and cold-cathode rectifier tube JAN-0Z4. The power pack is designed to provide an ungrounded -B connection if desired, but in this equipment the -B lead is connected to the chassis ground. Variable output voltage available from the pack is adjusted by means of the two-pole four-position switch S5 which is connected to taps on the secondary of the power transformer T5, and to the plates of the rectifier tube JAN-0Z4. Capacitor C15, and resistors R14 and R26 limit contact arcing on the vibrator; the other chokes and capacitors in the pack and filter unit are used for filtering purposes.

e. Input and Output Arrangements (fig. 33). To provide alternate two-wire 500-ohm, four-wire 300-ohm, and 1,200-ohm operation, transformers T1 and T2 are connected through selector switch S1 (fig. 31). Switch S1 is a three-position, four-pole switch, of which only three poles are used.

(1) In the four-wire position, receiver and transmitter amplifiers are completely separated from each other, the change from the 300-ohm to 1,200-ohm position being accom-

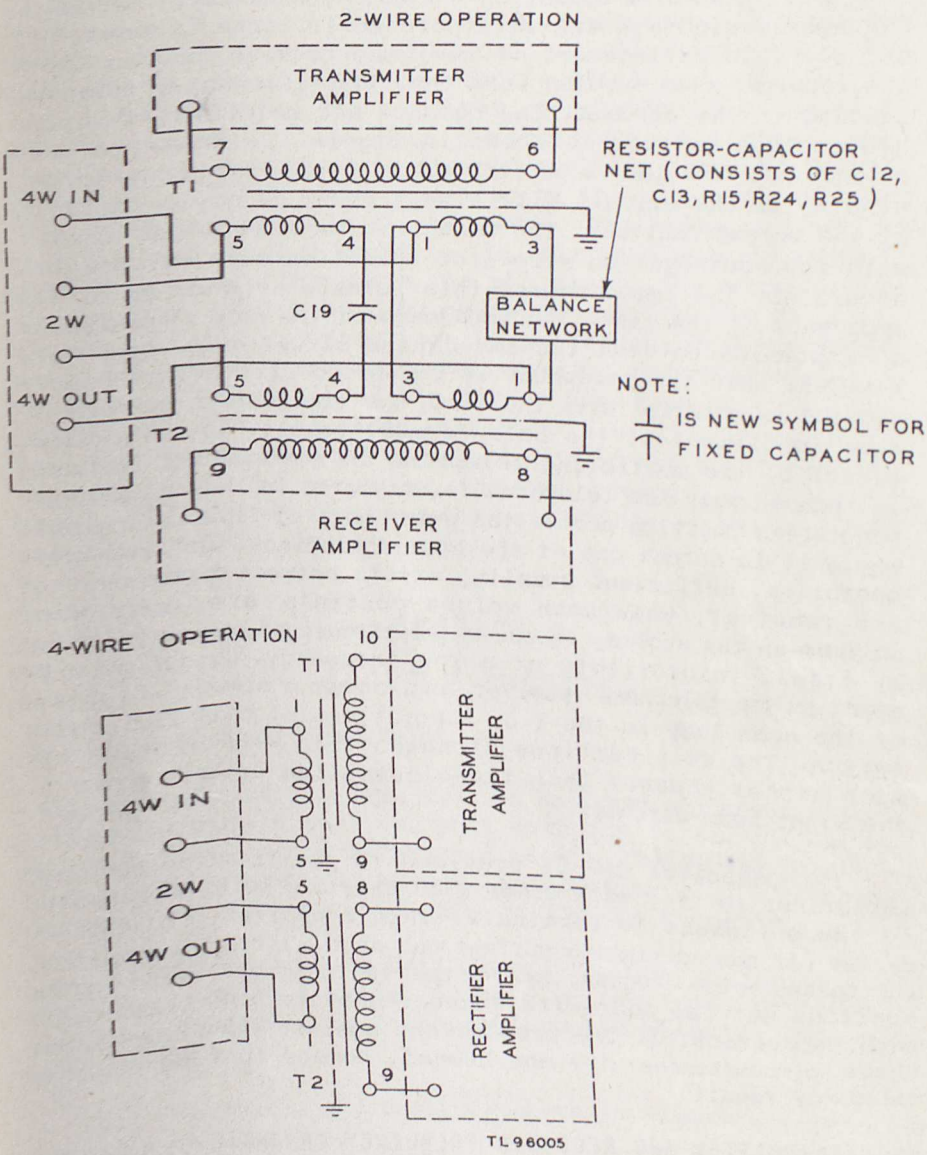


Figure 33. 2- and 4-wire operation, simplified schematic diagram.

plished by switch S1 by changing to different taps on the transformer primaries.

(2) For two-wire operation a hybrid connection is used. The hybrid windings are incorporated in transformers T1 and T2. This arrangement is designed to keep power from the receiver from feeding into the transmitter and causing singing in the circuit. The balance net required for the hybrid line balance is shown in figure 33. Because the balance net is seldom a perfect match to the line impedance, singing in the circuit will always occur at some setting of the volume controls. The amount of two-wire line usable with the equipment on wire-link operation depends on how accurately the impedance of this balance net matches the impedance of the line. The impedance of the net represents a compromise between the impedances of wet and dry Wire W-110-B. When the telephone is connected at the optiphone station in parallel with the line, for monitoring purposes, some impairment of the balance must result. The loading effect of the monitoring telephone on the hybrid balance is reduced when the telephone is connected in the alternate monitoring position across the outer pair of line terminals where it is across one of the hybrid windings. On two-wire operation, sufficient coupling exists between transmitter and receiver, when both volume controls are set near maximum on the scales, to cause the circuit of one equipment by itself to oscillate at a low frequency. This may be heard in the telephone receiver, and causes a steady lighting of the neon lamp in the T or R positions of the indicator switch. The gain settings at which this will occur are much higher however than those permitted by singing in the light beam circuit.

(3) Capacitor C19 is provided to permit monitor and subscriber to ring each other when they are both connected to the optiphone 2W terminals. This capacitor blocks 20 cycles per second ringing current out of the hybrid windings, but passes voice frequencies. Neither the alternate monitoring position not the four-wire connections are provided with such capacitors. If the precautions against ringing under these circumstances are not heeded, damage to the hybrid coils may result.

44. TRANSMITTER AND RECEIVER FREQUENCY CHARACTERISTICS.

The frequency response of the transmitter, including the light beam modulation, is flat from 500 cps to 4,000 cps. The receiver frequency response including the effect of the phototube drops 6 db at 500 cps and 4,000 cps from that at mid-band. Both these sets of data were taken of the two-wire terminals with capacitor C19 shorted.

45. DIFFERENCE BETWEEN DAY AND NIGHT OPERATION.

The range of this equipment is less during the day than at night. This reduction in range is due to the effect of background light illuminating the phototube. Although the amount of background light which can illuminate the phototube is made as small as practicable by restricting the field of view of the receiver, an appreciable amount of steady light still falls on the phototube. This steady light causes a d-c current to flow through the tube and results in noise, which, when amplified by the receiver, is heard as a rushing sound in the telephone. This noise is identical in quality to that heard in the telephone when no light is permitted to illuminate the phototube. The magnitude of the ratio of day to night noise depends on the amount of steady light illuminating the phototube. Under ordinary daytime conditions, with the receiver oriented at sky or foliage, the ratio of the day to night noise is 6 to 12 decibels. Thus the signal-noise ratio will be worse during the day than at night and the range of the equipment will be reduced. The day noise, however, provides a convenient means of quickly checking the performance of the phototube and electrical circuit.

SECTION X

TROUBLE SHOOTING

46. TROUBLE-SHOOTING AIDS.

No matter how well equipment is designed and manufactured, faults occur in service. When such faults occur, the repairman must locate and correct them as rapidly as possible. This section contains general information to aid personnel engaged in the important duty of trouble shooting.

a. Trouble-shooting Data. Take advantage of the material supplied in this manual to help in the rapid location of faults. Consult the following trouble-shooting data when necessary:

(1) Complete and partial schematic diagrams (figs. 29, 30, 31, 32 and 45).

(2) Simplified schematic diagram (fig. 33).

(3) Voltage and resistance charts for socket connections (table II).

(4) Illustrations of components. All views which aid

in locating and identifying parts, particularly figures 34, 35, 36 and 37.

(5) Pin and terminal connections. Pin connections on sockets, plugs, receptacles, and terminal connections on transformers are numbered on the various diagrams. Where numbers appear on the items themselves, these numbers agree with those on the diagrams. Seen from the bottom, pin connections are numbered in a clockwise direction around the tube sockets. On octal sockets the first pin clockwise from the keyway is the No. 1 pin. On the phototube base, with the thick pins toward oneself, the thick pin on the left is the No. 1 pin.

b. Access to Components for Trouble Shooting. For access to the components in the rear of the receiver or transmitter chambers, depress the locking pin and rotate the back cover counterclockwise until it can be removed easily (fig. 5). Do not remove the receiver back cover in daylight while the receiver +B switch is on, as the phototube may be damaged. Remove or cover the phototube if the receiver is to be energized while the receiver back cover is removed. For access to the under side of the amplifiers, remove the three retaining screws, (fig. 8), disconnect the plug connecting the amplifier and power supply section of the control unit, (fig. 10) and remove the chassis. To energize the amplifier when removed, unlatch the amplifier and power supply cases and separate them. Lay the chassis on its back (side opposite the chassis panel) on top of the power supply case. Draw the connecting plug through the top of the power supply case and connect it to the receptacle on the under side of the chassis.

47. TROUBLE-SHOOTING STEPS.

a. General. The first step in servicing defective equipment is to sectionalize the fault. Sectionalization means tracing the fault to the component or circuit responsible for the abnormal operation. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition. Some faults, such as burned-out resistors, r-f arcing, and shorted transformers can be located by sight, smell, and hearing. The majority of faults however, must be located by checking voltage and resistance.

b. Sectionalization. Careful observation of performance, particularly of the indications given in table I, while turning on the equipment, sectionalizes the fault to the transmitter, lamp, oscillator and cell, monitoring circuit, transmitter amplifier, receiver, or the power supply.

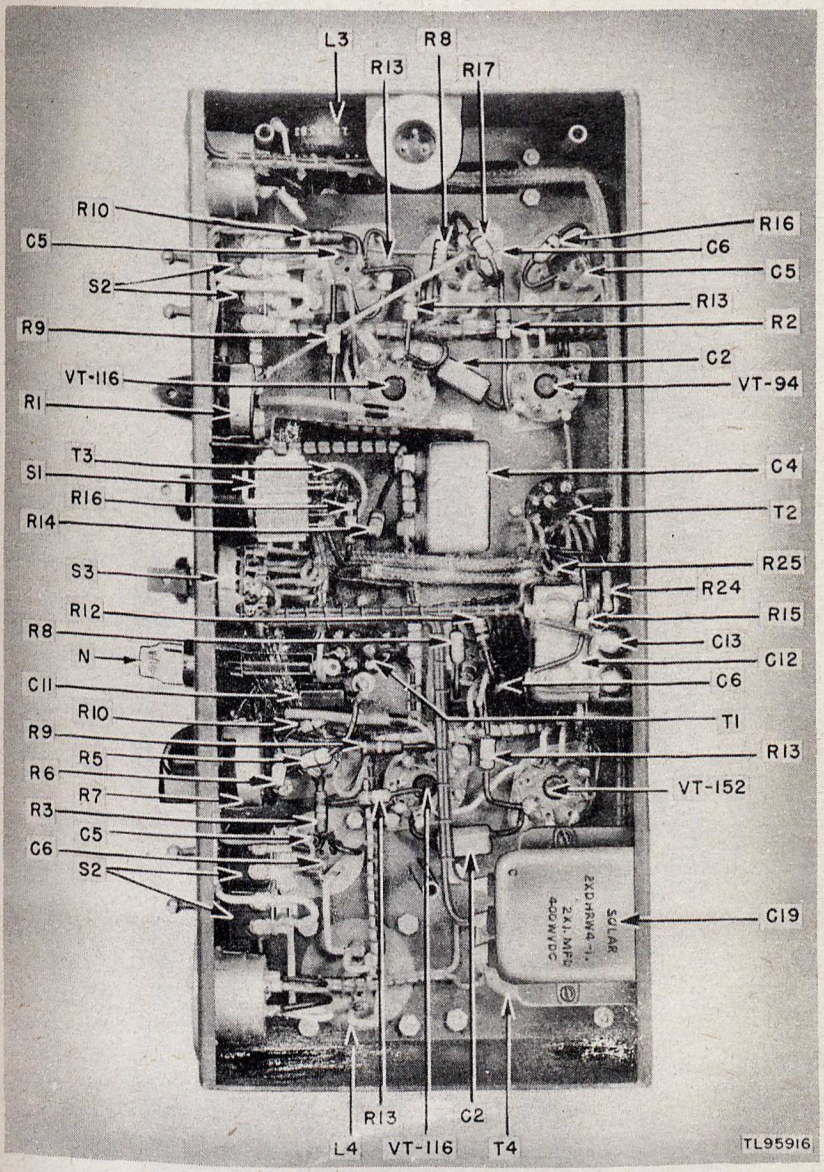


Figure 34. Underside of control unit amplifier chassis.

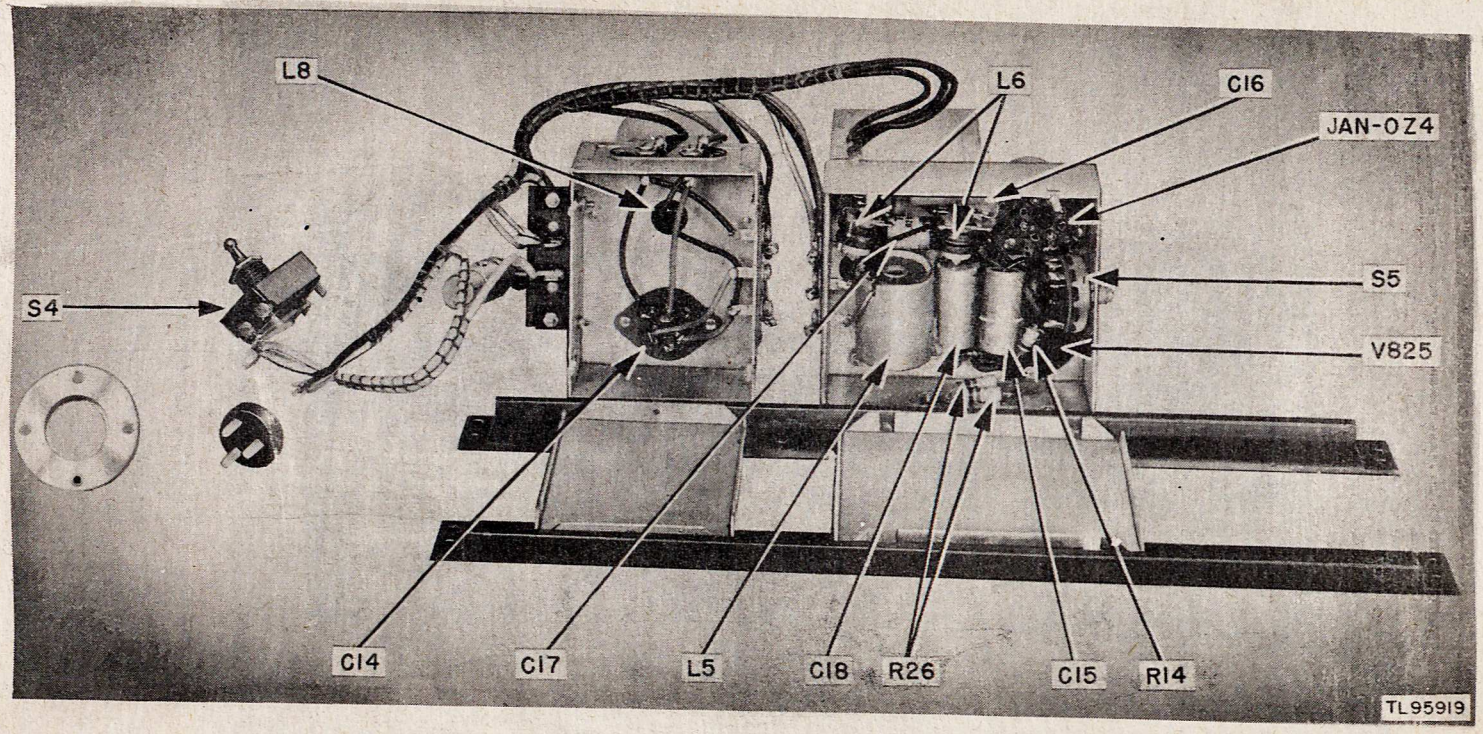


Figure 35. Underside of control unit power supply chassis.

c. Localization. Paragraph 48 describes the method of localizing faults to the individual components. These paragraphs are accompanied by trouble-shooting charts which list abnormal symptoms and their probable causes. The charts also give the procedures for determining which of the probable locations of the faults is the exact one.

d. Voltage and Current Measurements. Voltage measurements are an almost indispensable aid to the repairman, because most troubles either result from abnormal voltages or produce abnormal voltages. Voltage measurements are taken easily because they are always made between two points in a circuit and, except for the oscillator and phototube, the circuit need not be interrupted or excessively loaded.

(1) The voltages listed on the voltage charts are measured between the indicated points and ground.

(2) Always begin by setting the voltmeter on the highest range so that the voltmeter will not be damaged. Then, if it is necessary to obtain increased accuracy, set the voltmeter to a lower range.

(3) In checking cathode voltage, remember that a reading can be obtained when the cathode resistor is actually open. Thus the cathode voltage may be approximately normal only as long as the voltmeter is between cathode and ground. Before the cathode voltage is measured, make a resistance check with a cold circuit to determine whether the cathode resistor is normal.

(4) No voltage data is provided for the pins of the oscillator tube itself, because to obtain such data, the oscillator stage must be disconnected from its load (the modulating cell). Without its normal load, the operating conditions of the tube will be modified, and the voltage readings will be without particular significance. Resistance checks on a cold circuit must be relied upon primarily for the oscillator, though +B supply voltage and current measurements may also be helpful. The +B current drain of the oscillator stage may be measured from the under side of the amplifier chassis after the line amplifier and modulator tubes have been removed from their sockets, by shorting the poles of the +B transmitter switch with a milliammeter, with the switch in the OFF position. This current value should be approximately 25 milliamperes.

e. Voltmeter Loading. It is essential that the voltmeter resistance be at least 10 times as large as the resistance of the circuit across which the voltage is measured, if accurate readings are to be obtained. If the voltmeter resistance is

comparable to the circuit resistance, the voltmeter will indicate a voltage which may be substantially lower than the voltage actually present when the voltmeter is removed from the circuit. Many of the circuits in this equipment are of high resistance, particularly those of the receiver and line amplifier. Consequently the effect of voltmeter loading will be frequently observed, though in all but one case, namely in measurements at the phototube anode, the effect may be made negligible by using the proper voltmeter on the proper range. The phototube anode circuit has a resistance to ground of 5 megohms, so that a voltmeter of 50 megohms resistance would be required if the voltmeter loading is to be negligible for this measurement. A voltmeter having this resistance and sufficient sensitivity will rarely be available. When trouble shooting on the phototube circuit, a voltage check may be made at that end of the phototube load resistor where resistance to ground is low (end connected to No. 1 pin). This voltage should be between 65 and 70 volts. The load resistor itself may be checked by a resistance measurement.

(1) The resistance of the voltmeter on any range can always be calculated by the following simple rule: resistance of the voltmeter equals the ohms per-volt multiplied by the full-scale range in volts. For example: The resistance of a 20,000 ohms-per-volt meter on the 300-volt range is 6,000,000 ohms (R = 20,000 ohms per volt times 300 volts = 6,000,000 ohms).

(2) To minimize the voltmeter loading in high-resistance circuits, use the highest voltmeter range. Although only a small deflection will be obtained (possibly only 5 divisions on a 100-division scale), the accuracy of the voltage measurement will be increased. The decreased loading of the voltmeter will more than compensate for the inaccuracy which results from reading only a small deflection on the scale of the voltmeter.

(3) When a voltmeter is loading a circuit, the effect can always be noted by comparing the voltage reading on two successive ranges. If the voltage readings on two ranges do not agree closely, the voltmeter loading is excessive. The reading (not deflection) on the higher range will be greater than that on the lower range. If the voltmeter is loading the circuit heavily, the deflection of the pointer will remain nearly the same when the voltmeter is shifted from one range to another.

(4) The ohms-per-volt sensitivity of the voltmeter used to obtain the readings on the voltage and resistance charts in this manual is 20,000 ohms per volt. Use a meter having the same ohms-per-volt sensitivity; otherwise it will be necessary to consider the effect of loading.

TABLE II

VOLTAGE AND RESISTANCE

Control unit (receiver)			
Tube	Pin	Voltage (volts)	Resistance (ohms)
JAN-6SJ7	1	0	0
	2	0	0
	3	1.4	1.2M
	4	0	1.2Meg
	5	1.4	1.2M
	6	28	35
	7	5.4	2
	8	50	300M
JAN-6J5	1	0	0
	2	0	0
	3	115	20M*
	4	NC	
	5	0	1Meg
	6	NC	
	7	5.4	2
	8	2.7	950

Control unit (transmitter)			
JAN-6SJ7	1	0	0
	2	0	0
	3	1.5	1.2M
	4	0	110M
	5	1.5	1.2M
	6	28	31M
	7	5.4	.5
	8	50	300M
JAN-6K6GT	1	0	0
	2	0	0
	3	172	350*
	4	180	0*
	5	0	250M
	6	NC	
	7	5.4	0.5
	8	10	500

TABLE II (contd).

VOLTAGE AND RESISTANCE

Control unit (power supply)			
Tube	Pin	Voltage (volts)	Resistance (ohms)
JAN-OZ4	3	O (Needle wobbles)	90
	5	O "	90
	8	185	100*

Control unit (panel transmitter receptacle)			
	1	175	
	2	O	
	3	5.4	
	4	O	

Pre-amplifier (phototube removed from socket)			
JAN-6SJ7	1	O	O
	2	O	O
	3	1.3	950
	4	O	5 Meg
	5	1.3	950
	6	26	25M
	7	5.4	2
	8	50	300M

Phototube			
JAN-918	2		5 Meg
	4		O

Oscillator			
JAN-6V6GT	1		O
	2		O
	3		340*
	4		340*
	5		30M
	6		NC
	7		.5
	8		O

NOTES:

(1) All voltage measurements are made with a terminal voltage of 6-volts on the battery under full load.

(2) All voltage measurements are made with the whole equipment connected, all switches in the ON position, switch S5 in the No. 1 position and both volume controls set at minimum.

(3) All resistance measurements are made to ground with all switches OFF, switch S5 in the No. 1 position, and both volume controls set at maximum.

(4) All resistance measurements are made with the equipment normally connected, except for those marked with an asterisk (*). Those so marked are measured with +B shorted to the chassis.

48. SECTIONALIZATION AND LOCALIZATION.

a. Sectionalization.

(1) A high degree of sectionalization can be accomplished in this equipment by reference to the indications and recommended corrections in table I, with an understanding of the circuit interrelationships. Thus, if neither receiver nor transmitter is functioning, but the lamp lights, the trouble may be presumed to be in the high-voltage power supply. The last recommended correction in table I in every case sectionalizes the trouble to the component involved in the correction or to the circuit of which it is a part, if all the preceding indications have been normal. Thus, in step 12, if flickering of the diffraction images is not obtained after the Tube JAN-6K6GT is replaced, and all the preceding indications have been normal, it should be inferred that the trouble is in the transmitter amplifier between the input and the modulator stage. Similarly in step 12, if replacement of the neon lamp does not give the correct indication, and all the other indications are normal, the trouble must be in the monitoring circuit.

(2) Two further points may be brought out here, which are mentioned in paragraphs 43e(2) and 41c. On two-wire operation a single equipment will oscillate at a low frequency with both transmitter and receiver gains near maximum. This is normal, and not an indication of trouble unless this oscillation occurs at gain settings required for operation. If oscillation does set in at low-gain settings, check resistor R23, cable shielding, and the metal partition in the control

unit chassis between transmitter and receiver stages. The other point is vibrator hum in the receiver. This will be audible when the phototube is not illuminated, but should be low compared to the rushing sound. If the hum should be high enough to impair reception, trouble is indicated. Check the electrical filtering circuits, and the isolation of the transmitter A circuit from the optical unit.

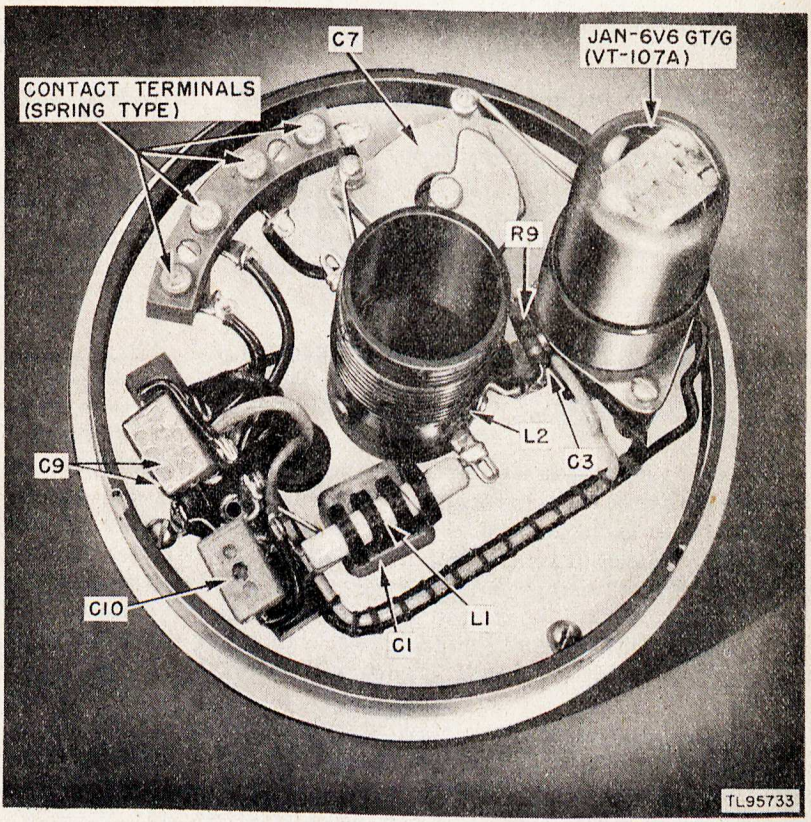


Figure 36. Transmitter chamber cover.

b. Localization.

(1) The localization procedures to be followed on the electrical parts of this equipment are, in general, common to those used on conventional high-gain audio amplifiers and on oscillators, and are outlined in the following chart. Localization of mechanical alignment troubles can be accomplished from the indications in step 15 of table I.

(2) Trouble in the phototube itself can be satisfactorily localized in it by replacement, using the indication in step

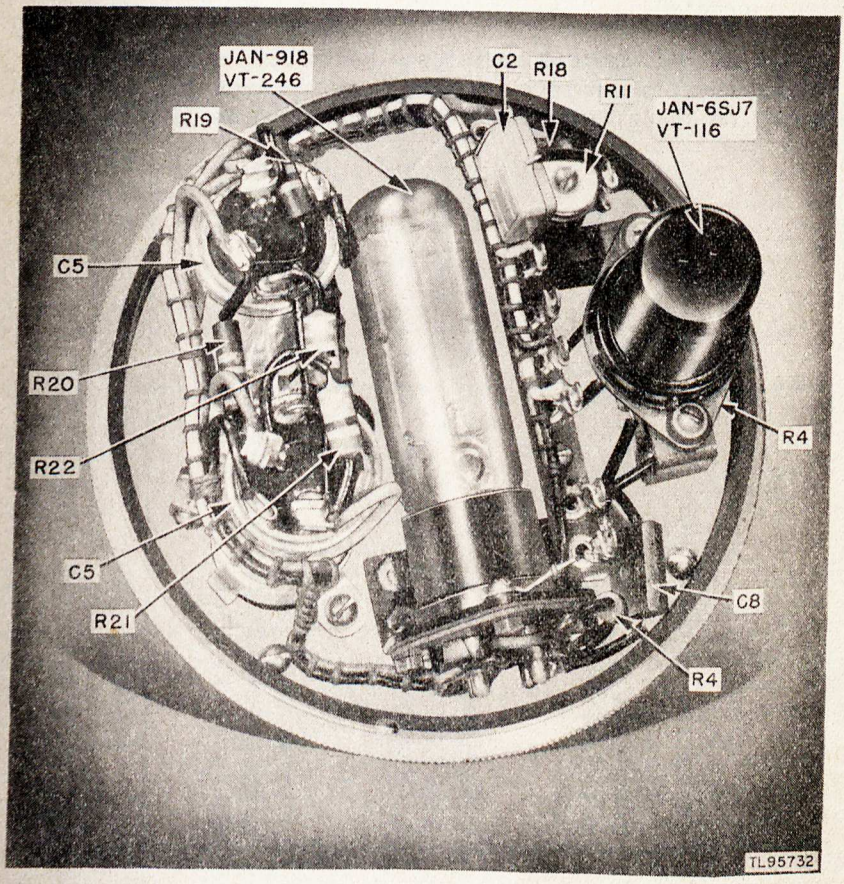


Figure 37. Receiver chamber cover.

13 of table I (the difference between day and night noise) but preferably after the procedures in the localization chart for the pre-amplifier stage and power supply have been exhausted.

(3) When localizing electrical trouble in the transmitter chamber, bear in mind that on d-c measurement the modulator cell is open-circuited both between its terminals and to ground. For trouble-shooting purposes from an electrical point of view the modulator cell may be considered simply as a fixed capacitor of 65 micromicrofarads. Thus a continuity check through a cell can be made with a bridge capable of making measurements in the micromicrofarad ranges. Replace-

ment of the cell is the final localization procedure if the indication of step 9, table I, is not obtained after localization procedures for the oscillator and power supply have been exhausted.

(4) All voltage and resistance measurements in the localization chart given below are to be made under the same conditions as those under which the data in table II were made.

TABLE III

LOCALIZING TROUBLE IN TRANSMITTER

Symptom	Probable cause	Correction
OSCILLATOR: TUBE JAN-6V6		
1. Pin 5 open to ground	Resistor R9 open	Replace resistor R9
2. Pin 3 and 4 open to ground	Transformer T4 burned out	Replace transformer T4
	choke coil L1 open	Replace choke coil L1
MODULATOR TUBE JAN-6K6GT all voltages normal except:		
1. No voltage on pin 3	Transformer T4 burned out	Replace transformer T4
2. No voltage on pin 8	Resistor R12 open	Replace resistor R12
	Capacitor C6 shorted	Replace capacitor C6
LINE AMPLIFIER TUBE JAN-6SJ7 all voltages normal except:		
1. No voltage on pin 8	Resistor R13 open	Replace resistor R13
2. No voltage on pin 6	Capacitor C5 shorted	Replace capacitor C5
	Resistor R10 open	Replace resistor R10
3. No voltage on pin 5	Capacitor C6 shorted	Replace capacitor C6

TABLE IV

LOCALIZING TROUBLE IN RECEIVER

Symptom	Probable cause	Correction
PRE-AMPLIFIER TUBE JAN-6SJ7 and PHOTOTUBE JAN-918 all voltages normal except:		
1. No voltage on pin 8	Resistor R11 open	Replace resistor R11
2. No voltage on phototube pin 2	Resistor R4 open	Replace resistor R4
	Resistor R19 open	Replace resistor R19
	Capacitor C5 shorted	Replace capacitor C5
3. No voltage on pin 6	Capacitor C5 shorted	Replace capacitor C5
	Resistor R20 open	Replace resistor R20
RECEIVER AMPLIFIER JAN-6SJ7 all voltages normal except:		
1. No voltage on pin 8	Resistor R13 open	Replace resistor R13
2. No voltage on pin 6	Capacitor C5 shorted	Replace capacitor C5
	Resistor R10 open	Replace resistor R10
3. No voltage on pin 5	Capacitor C6 shorted	Replace capacitor C6
RECEIVER POWER AMPLIFIER JAN-6J5		
1. No voltage on pin 3	Transformer T2 burned out	Replace transformer T2
	Capacitor C5 shorted	Replace capacitor C5
	Resistor R16 open	Replace resistor R16
2. No voltage on pin 8	Capacitor C6 shorted	Replace capacitor C6

TABLE V

LOCALIZING TROUBLE IN POWER SUPPLY

Symptom	Probable cause	Correction
RECTIFIER TUBE JAN-OZ4 vibrator working		
1. No needle wobble when meter is between pin 3 or 5 and ground	Switch S5 defective	Replace switch S5
	Transformer T5 burned out	Replace transformer T5
2. No voltage on pin 8	Defective tube JAN-OZ4	Replace tube JAN-OZ4

SECTION XI

REPAIR

NOTE: Failure or unsatisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on W.D., A.G.O. Form No. 468 (Unsatisfactory Equipment Report). For particulars see paragraph 52. If Form No. 468 is not available, see TM 38-250. Failure or unsatisfactory performance of equipment used by Army Air Forces will be reported on Army Air Forces Form No. 54 (unsatisfactory report).

49. REPLACEMENT OF PARTS.

a. Lamp. If the lamp becomes blackened or burned out it can be replaced in the following manner:

(1) Remove the cover from the rear of the transmitter unit.

(2) Remove the lamp from its socket by pressing down and turning it in a counterclockwise direction.

CAUTION: When removing the lamp be careful not to damage the cross-hair illuminator.

(3) Clean the replacement lamp with lens tissue or clean, dry, lintless cloth.

(4) Place the new lamp over the socket so that the small notch cut at one point in the mounting flange is between the two forward bosses.

(5) Press down on the lamp and turn it in a clockwise direction until it is seated firmly in the socket.

CAUTION: When placing the lamp in the socket be careful not to get finger prints on that portion of the lamp which is toward the front of the optical unit.

b. Modulator Cell Liquid.

(1) Remove the plug from the top of the transmitter barrel.

(2) Remove the vent plug from the top of the modulating cell.

NOTE: This vent plug has been put in with Duco cement and may be difficult to remove. Use a screwdriver of proper size.

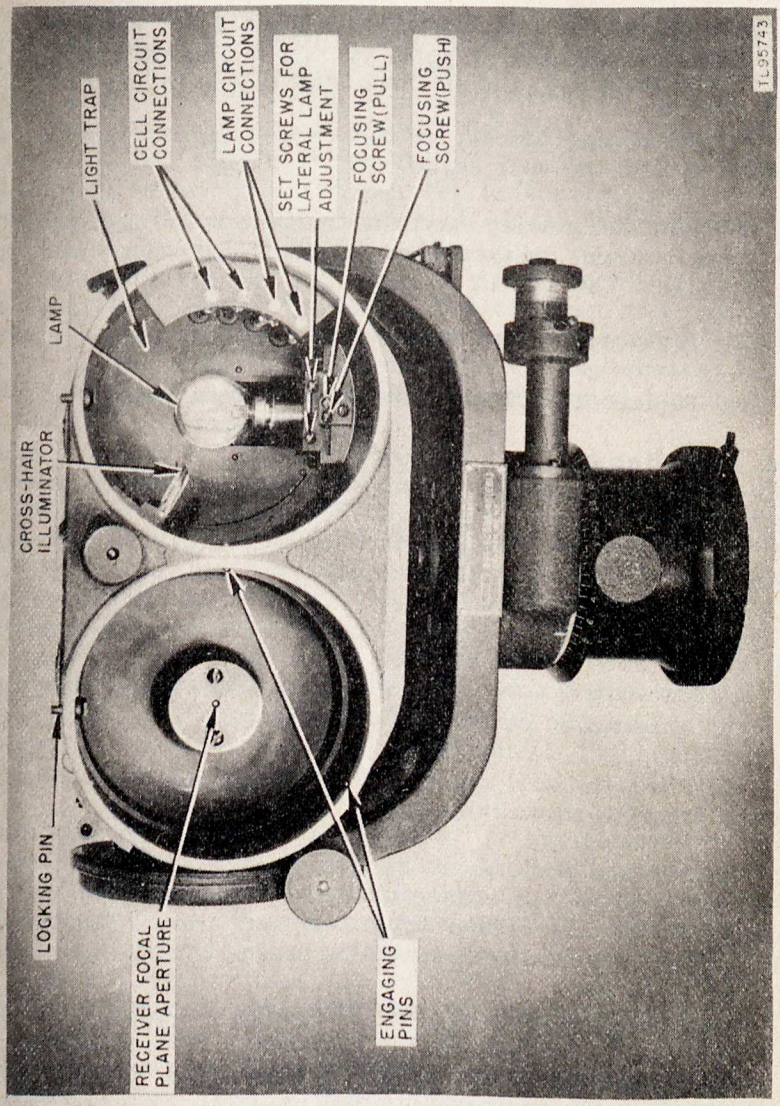


Figure 38. Optical unit, chamber covers removed.

(3) Remove any dried pieces of cement from or near the filling hole.

(4) Fill the cell with liquid, using an eyedropper, until the level of the liquid is 1/8 inch above the top of the crystals.

NOTE: Grades of liquid usable in the cell are known as Xylene cp (chemically pure) or Xylene Reagent. Refer to paragraph 50 if the quality of the Xylene is in doubt.

(5) Rub a small amount of Duco cement on the threads and tapered end of the vent screw.

CAUTION: When placing cement on the vent screw, use only a small amount. An excessive amount of cement may leak down into the liquid or close off the filling hole.

(6) Replace the vent screw, seating it firmly in place.

(7) Replace the plug in the transmitter chamber.

c. Modulator Cell. If the modulator cell develops a rapid leak or becomes damaged in any way replace it as follows:

(1) Loosen the three setscrews which secure the cell holder to the transmitter chamber.

(2) Pull the cell holder straight out of the chamber.

CAUTION: Do not rotate the cell when removing it until the banana-plug connectors are disengaged.

(3) Press the cell out of its holder by exerting pressure on the bakelite retaining rings.

(4) Put the replacement modulator cell in the holder so that the banana-plug connectors are over the center of the notches in the rim of the holder. Do not rotate the cell in its holder by pressing against the banana plugs.

(5) Press the cell firmly into place in the holder.

(6) Moistureproof and fungiproof the cell in accordance with the instructions given in section VIII.

(7) Push the cell holder into the transmitter chamber while observing that the banana-plug connectors are lined up with the jacks.

(8) Tighten the three setscrews which keep the holder in place.

50. EMERGENCY REPAIRS.

a. Monitoring Circuit. If replacement parts are not available for the components of the monitoring circuit, the equipment may be operated without the monitoring circuit indications. The transmitter volume control may be set by experience (it will usually be near 5 on the scale), or by reference to the flickering of the side images in the diffraction pattern. The only component of this circuit for which replacement may be difficult is the indicator switch. A double-pole, single-throw switch may be used in an emergency to obtain the transmitter indication on the neon lamp, as this is the more important of the two indications provided by the switch.

b. Oscillator Tube. The modulator tube has the same pin connections as the oscillator tube, and can be substituted for it in the circuit. When making this replacement, the tuning adjustment for the oscillator should be checked (refer to paragraph 55).

c. Replacement Liquid. If there is any doubt about the condition of the Xylene available for replacement in the modulator cell, check first to see thad it is clear. Pour some into a glass container which has been thoroughly cleaned and rinsed with Xylene, and measure the resistance between two clean test probes whose metal ends only are immersed in the liquid. The ends of the probes should be separated about 1/32 inch, and the resistance should be measured with a megger at a voltage of 500 volts. If the indication is not less than 250 megohms, the liquid will probably be safe to use.

d. Input and Output Transformers. If transformers T1 and T2, or transformers similarly provided with hybrid windings are not available for replacement, four-wire operation may be improvised using a commonly available microphone or line input transformer, and low-power plate to line or audio transformer. These improvisations alone will permit local operation of the station using one Telephone EE-8(*) for talking, and a headset for receiving, or using two telephones. Suggested transformers for the input circuit are Transformer, input, (Signal Corps stock No. 2Z9631.106), Transformer, input (Signal Corps stock No. 2Z9631.116), or equivalent. For the output circuit, Transformer, audio output, (Signal Corps stock No. 2Z9632.30), Transformer, output, (Signal Corps stock No. 2Z9632.91), or equivalent, are suggested. If local operation of the station with one handset, or microphone and headphones is desired, and the microphone requires a d-c power supply, this may be impro-

vised from the six-volt circuit in the control unit, using a series resistor to limit the microphone current to the proper value.

e. Resistor R11. Resistor R11, which is 0.25 megohm, 1-watt, wire-wound, is probably the only component among the resistors and capacitors which may not be easily available for replacement. Neither the resistance nor the wattage rating of this component is critcial. The gain is sufficient with lower resistance if, with the volume control at maximum, the rushing sound is clearly audible in the receiver. A carbon resistor should be used as a substitute only if no wire-wound types of suitable rating are available.

f. Transformer T4. If a transformer T4 is not available for replacement, any audio transformer may be used which matches 8,000 ohms to 7,200 ohms, with about 25 milliamperes d-c flowing in the primary and secondary.

51. RUSTPROOFING AND REPAINTING.

a. General. When the outer finish of any of the components or carrying cases of Optiphone AN/TVC-1 (XO-1) becomes rusted, marred, or otherwise damaged, the component must be refinished.

b. Treatment. Both wood and metal cases are refinished as follows:

(1) Clean the surface of the unit to be refinished with sandpaper (#00 or #000). All the finish need not be removed except where the surface film is broken.

> CAUTION: The use of steel wool, although permitting rapid removal of rust, is not recommended. Minute particles of steel wool frequently enter the equipment and cause harmful internal shorting or grounding of the circuits.

(2) Spray two coats of enamel, olive-drab, low-gloss, air-drying (stock No. 6G428), or equal, on the case. Air-dry between applications.

52. UNSATISFACTORY EQUIPMENT REPORT.

a. When trouble in equipment used by Army Ground Forces or Army Service Forces occurs more often than repair personnel feel is normal, War Department Unsatisfactory Equipment Report, W.D., A.G.O. Form No. 468 should be filled out and

forwarded through channels to the Office of the Chief Signal Officer, Washington 25, D.C.

b. When trouble in equipment used by Army Air Forces occurs more often than repair personnel feel is normal, Army Air Forces Form No. 54 should be filled out and forwarded through channels.

c. If either form is not available, Form No. 468 (fig. 39) may be reproduced, filled out, and forwarded to channels. When Army Air Forces Form No. 54 is required but unavailable, reproduce Form No. 468 and forward it through channels in accordance with directions on Form No. 468.

WAR DEPARTMENT

UNSATISFACTORY EQUIPMENT REPORT

FOR (Technical service) Signal Corps — MATÉRIEL — DATE: 20 Jan 45

FROM (Organization) 92d Div Sig Co — (Station) APO 911 — (Station) New York, N.Y.

TO (Next superior headquarters) Signal Officer - Fifth Army — (Technical service)

COMPLETE MAJOR ITEM

NOMENCLATURE: Optiphone AN/TVC-1 — TYPE:

MODEL: — MANUFACTURER: R.B. Blank Company

U. S. A. REG. NO.: Order No 2154 - Phila-44 — SERIAL NO.: 121 — DATE RECEIVED: 3 Jan 45

EQUIPMENT WITH WHICH USED (IF APPLICABLE):

NOMENCLATURE OF DEFECTIVE COMPONENT

PART NO.: Sig C stock No 3D4082 — TYPE: Capacitor: fixed; paper; 100 mmf; 750 Vdcw (vibrator pack)

MANUFACTURER: Gray Mfg Co, Inc — DATE INSTALLED: 9 Jan 45

LENGTH OF SERVICE

DATE OF INITIAL TROUBLE: 11 Jan 45 — TOTAL TIME INSTALLED: YEARS — MONTHS — DAYS

TOTAL PERIOD OF OPERATION BEFORE FAILURE (FILL IN WHERE APPLICABLE)

YEARS	MONTHS	DAYS	HOURS	MILES	ROUNDS
—	—	2	—	—	—

DESCRIPTION OF TROUBLE AND PROBABLE CAUSE

GIVE TYPE OF FAILURE, MECHANICAL, ELECTRICAL, WORKMANSHIP, MATERIAL, DESIGN

Capacitor shorted out. Same trouble 3 days later.

UNUSUAL SERVICE CONDITIONS

GIVE BRIEF DESCRIPTION

TRAINING OR SKILL OF USING PERSONNEL (CHECK ONE): POOR — FAIR — GOOD ✓

DESCRIPTION OF ANY REMEDIAL ACTION TAKEN: Replaced with spare. After second failure, replaced with capacitor with higher voltage rating.

RECOMMENDATIONS: Recommend substitution of capacitor with 1,200-volt rating.

1ST IND. — ORIGINATING OFFICER

OFFICE — STATION — DATE

SIGNATURE: C. R. Allen

TO CHIEF (Technical service) Signal Officer, Washington 25, D.C.

NAME: C. R. ALLEN

RANK AND TITLE: Capt, Sig C

STATION — RANK

ORGANIZATION: 92d Div Sig Co

INSTRUCTIONS

1. It is imperative that the Chief of Technical Service concerned be advised at the earliest practical moment of any constructional, design, or operational defect in matériel. This form is designed to facilitate such reports and to provide a uniform method of submitting the required data.

2. This form will be used for reporting manufacturing, design or operational defects in matériel with a view to improving and correcting such defects, and for use in recommending modifications of matériel.

3. This form will not be used for reporting failures, isolated material defects or malfunctions of matériel resulting from fair-wear-and-tear or accidental damage nor for the replacement, repair, or the issue of parts and equipment. It does not replace currently authorized operational or performance records.

4. Reports of malfunctions and accidents involving ammunition will continue to be submitted as directed in the manner described in AR 750-10 (Change No. 3).

5. It will not be practicable or desirable in all cases to fill all blank spaces of the report. However, the report should be as complete as possible in order to expedite necessary corrective action. Additional pertinent information not provided for in the blank spaces should be submitted as inclosures to the form. Photographs, sketches or other illustrative material are highly desirable.

6. When cases arise where it is necessary to communicate with a chief of service in order to assure safety to personnel, more expeditious means of communication are authorized. This form should be used to confirm reports made by more expeditious means.

7. This form will be made out by using or service organizations and forwarded in duplicate through command channels to the chief of technical service. The office of the chief of technical service receiving the report will forward an information copy to the Commanding General, Army Ground Forces or Army Air Forces, whichever is applicable, and to the Commanding General, Army Service Forces.

8. Necessity for using this form will be determined by the using or service troops.

W. D., A. G. O. Form No. 468
1 December 1943

16—37786-1 U. S. GOVERNMENT PRINTING OFFICE

TL 95917

Figure 39. W.D., A.G.O. Form No. 468 with sample entries.

SECTION XII

ALIGNMENT AND ADJUSTMENT

53. MECHANICAL ADJUSTMENTS.

Mechanical adjustments provided on the optiphone are those on the optical unit for gear backlash (fig. 40), and on the spherical bubble level. One adjustment for backlash is provided for the azimuth worm and gear, and two adjustments are provided for the elevation worm and gear. To avoid backlash, the gears must engage closely and yet not close enough to bind, as smooth and even operation of the instrument through its vertical and horizontal movement is essential.

a. Azimuth Adjustment. Adjustment of the azimuth worm and gear is made by loosening the hexagon locking nut (fig. 40), and tightening or loosening the slotted screw

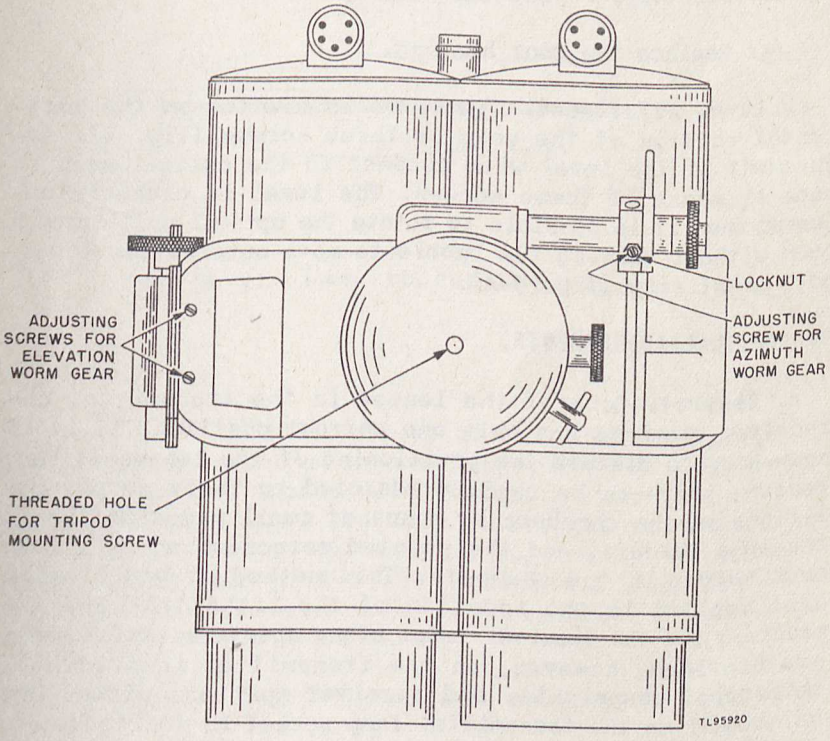


Figure 40. Location of gear backlash adjustments.

inside the nut. When the desired adjustment has been obtained, tighten the locking nut. The backlash in the azimuth worm and gear should *not exceed* two mils.

b. Elevation Adjustment.

(1) Remove the elevation worm and gear housing. The two adjustment screws (fig. 40) rest against the bracket in which the worm is mounted. This bracket is secured to the optical unit by four screws, two of which are to be loosened from inside the housing; and two of which are to be loosened from the yoke under the chambers of the optical unit.

(2) Loosen the four bracket mounting screws.

(3) Tighten or loosen the two adjusting screws as required.

(4) Tighten the bracket mounting screws. Turn the elevation knob and check the backlash. If the performance is not satisfactory, repeat the above procedure.

(5) Replace the gear housing.

c. Level Adjustment. The level is mounted on the horizontal portion of the yoke by three screws (fig. 4). Adjustment of the level with respect to the optical unit is made by means of these screws. The level is properly adjusted when it is possible to rotate the optical unit through 360° without causing the bubble to move outside the larger adjustment ring (fig. 4-A).

54. OPTICAL ADJUSTMENTS.

a. General. Each of the lenses in the transmitter and receiver chambers has only one correct position. If it is necessary to disturb the positioning of the lenses for any reason, they can be readily restored to their proper positions in the chambers by means of small indentations in the lens holders, and the pointed setscrews which retain each holder in the chambers. This method of positioning also applies to the location of the light trap and the mounting for the receiver focal plane aperture. Adjustments are provided, however, on the transmitter lamp socket, telescope, peepsights, and receiver aperture plate. One adjustment on the transmitter lamp socket is for focusing, and the other is for the proper alignment of the transmitter optical system relative to the modulator (supersonic) cell. These positions should be changed only in case the position

of the lamp socket or cell is changed or disoriented. The adjustments on the telescope peepsights, and receiver aperture plate are provided to assure that the optical axes of the transmitter, receiver, telescope, and peepsights may be made parallel if they are knocked out of alignment.

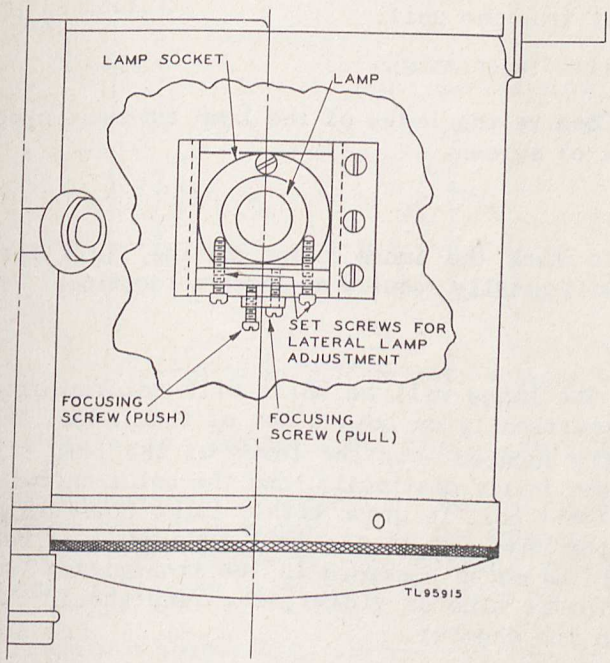


Figure 41. Lamp socket adjustments.

b. Lamp Focus.

(1) The transmitter lamp is of the standard prefocused base type, and mounts in a socket provided with three standard mounting bosses which engage in the holes of the lamp mounting flange. The lamp socket can be moved in a direction parallel to the axis of the transmitter chamber by means of a push-pull screw arrangement (fig. 41). One screw must be loosened before the other can be taken up as they work against each other.

(2) The focusing adjustment is made in the following manner:

(a) Remove the rear cover of the transmitter chamber.

(b) Connect leads from a 4- to 6-volt power source to the transmitter lamp circuit connections on the terminal strip in the rear of the transmitter chamber (fig. 38)

(c) Aim the transmitter at a wall or screen *not less* than 70 feet from the unit.

(d) Observe the image of the lamp filament appearing on the wall or screen.

NOTE: To check the image during daytime, this operation will usually require an indoors location.

(e) The image will be white with colored areas arranged symmetrically on both sides of the image. The lamp is correctly focused when the turns of the lamp filament coil are seen fairly distinctly, and the color on both sides of the filament coil is green with a faint trace of yellow. If the color adjacent to the coil is orange or red, the lamp should be moved backward in the transmitter chamber; if the color is blue or violet, the lamp should be moved forward in the chamber.

c. Lateral Lamp Adjustment. If the lamp is not properly centered in the transmitter chamber, a symmetrical diffraction pattern (fig. 26) will not be obtained. If the lamp is displaced to the right or left from its proper position, more light will be thrown to the right or left, respectively, of the image. To provide proper centering, the lamp can be pivoted about a screw at the front of the lamp socket (fig. 41) when the lateral lamp adjustment screws are released from their locking position. This adjustment is a cut-and-try procedure, as the transmitter chamber cover must be replaced after each adjustment, the modulator cell energized, and the light pattern observed. When the diffraction pattern is symmetrical, tighten the lateral adjustment setscrews against the body of the lamp socket. Again check the light pattern to make sure that the tightening of the setscrews has not shifted the position of the lamp socket.

d. Telescope Alignment. Alignment of the telescope is made with reference to the light beam projected by the trans-

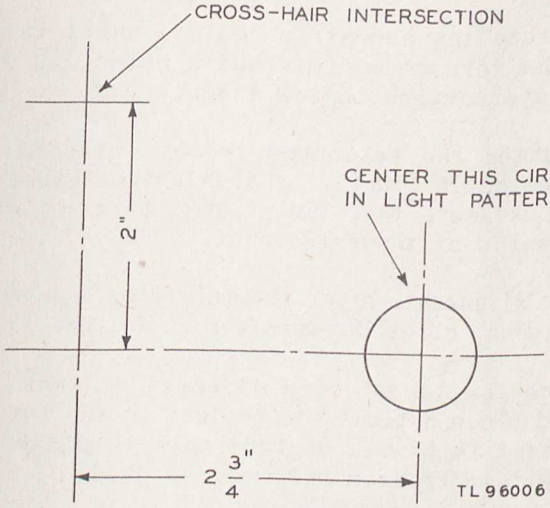


Figure 42. Target card for alignment.

mitter. No change should be made in the lateral adjustment of the transmitter lamp socket after the telescope has been aligned with the light beam. The correct procedure for aligning the telescope with the light beam is as follows:

(1) Prepare a target card dimensioned exactly as shown in figure 42.

(2) Place the target card at least 30 feet from the transmitter. More accurate adjustments can be made if the target card can be placed up to 100 feet from the transmitter.

(3) Project the light beam on the target card. Do not throw the transmitter +B switch to the ON position.

(4) Orient the transmitter so that the circle on the target card is centered in the light pattern.

(5) The intersection of the cross hairs of the telescope should not coincide with the cross-hair intersection on the target card. If the two do not coincide, adjust the alignment of the telescope as follows:

(a) Loosen the two setscrews in each of the two eccentric collars on the telescope mounting (fig. 4).

(b) Loosen the setscrew holding each collar to the optical unit.

(c) Rotate the eccentric collars until the intersection of the telescope cross hairs coincides with the cross-hair intersection on the target card.

(d) Fasten the telescope to the collars, and the collars to the optical unit, by tightening the setscrews, checking to make sure that the alignment is not disturbed by the tightening of the setscrews.

e. Receiver Alignment. After the telescope and transmitter have been aligned, align the receiver as follows:

(1) Place the target card at *least 30 feet* from the receiver, and place a light source next to the target card. An incandescent lamp with a clear bulb is preferred, although one with a frosted bulb may be used.

(2) Place the lamp so that its center is exactly 2-3/4 inches to the left of the cross-hair intersection on the target card, and 2 inches below the cross-hair intersection.

(3) Remove the receiver chamber cover.

(4) A method of determining when the aperture plate is properly positioned, is to observe the light pattern formed on a sheet of paper held so that it is illuminated by the light from the lamp at the target, coming through the aperture. A disk of light will be seen on the paper, its size depending on how far the paper is held from the aperture. When the aperture plate is properly positioned, the coloring of the disk of light on the paper will be symmetrical. If the coloring of the disk is not symmetrical, loosen the two aperture plate mounting screws and shift the aperture plate until the coloring is symmetrical. Tighten the mounting screws when the adjustment is completed.

NOTE: To obtain the best results, the above alignment should be performed at night or in a comparatively dark room.

f. Peepsights. This is a means of rough alignment, and is not critical with respect to adjustment. Sight the telescope on some distant object, loosen the screws holding the peepsights on the receiver chamber, and shift the sights in the oversized mounting holes until the object is approximately centered in the field of view of the peepsights.

55. OSCILLATOR ADJUSTMENT.

To tune the oscillator, remove the access plug (fig. 5) located on the rear cover of the transmitter chamber. Turn the two transmitter switches to the ON position and allow sufficient time (30-45 seconds) for the oscillator tube to heat up. With the alignment tool provided (fig. 3), turn the slotted shaft of the oscillator tuning capacitor C7 back and forth while observing the light pattern projected by the transmitter on a screen or wall. It will be seen that there are two points throughout the 360° rotation of the tuning capacitor at which the side images of the lamp filament have maximum intensity. Set the tuning capacitor at one of these points and replace the access plug.

56. MINIMUM TEST REQUIREMENT.

The best over-all qualitative tests of the performance of the transmitter and receiver, all of which can be made at any time during operation, are as follows:

a. Transmitter.

(1) Diffraction pattern approximately symmetrical. Side orders not much less intense than the central image.

(2) Side orders of the pattern fluctuate in intensity during modulation.

b. Receiver.

(1) Definite decrease in level of rushing sound heard in receiver when the receiver is aiming at ordinary sky or foliage background during the day and the receiver lens is suddenly covered. Definite increase in level of rushing sound when the receiver is illuminated by a flashlight at night.

NOTE: When using the flashlight test, look into the receiver chamber and be sure the light is so placed that the hole in the receiver aperture plate is seen to be illuminated by the light. When the hole is illuminated, a glint of light will be seen which is due to reflection from the glass bulb of the photo-tube.

(2) Hum, due to power supply, audible at night but small compared to the rushing sound, which should always be smooth without irregular cracking sounds.

57. TEST EQUIPMENT.

Special test equipment is not required for Optiphone AN/TVC-1 (XO-1). However, the test equipment used should be accurate and it is desirable to use a voltmeter with 20,000 ohms-per-volt sensitivity for the d-c voltage measurements. The voltage and resistance measurements given in table II will not be obtained on the optiphone if test instruments of lower sensitivity are used. Test Set I-176, or equivalent, is recommended for voltage and resistance measurements, and Tube Tester I-177, or equivalent, for the testing of tubes. If performing the emergency repairs described in paragraph 50, use a megger such as Test Set I-48-B.

APPENDIX

SECTION XIII

MAINTENANCE PARTS

58. MAINTENANCE PARTS FOR OPTIPHONE AN/TVC-1 (XO-1).

The maintenance parts for Optiphone AN/TVC-1 (XO-1) consist of running spare parts, and additional maintenance items shipped with the equipment due to the lack of a list of stock-numbered maintenance items for the optiphone.

Running Spares

Quantity	Item	Signal Corps stock No.
4	FUSE: 15a, 25v.	3Z2615.12
1	LAMP, glow.	2Z5888
3	LAMP, incandescent Mazda No. 1727.	---
2	TISSUE, lens: cleaning.	8A2559
1	TOOL, aligning: polystyrene.	6Q337
1	TUBE, electron: JAN-6K6GT.	2J6K6GT/G
1	TUBE, electron: JAN-6SJ7.	2J6SJ7
1	TUBE, electron: JAN-6V6GT.	2J6V6GT/G
1	TUBE, electron: JAN-6J5.	2J6J5
1	TUBE, electron: RMA No. OZ4.	2JOZ4
1	TUBE, electron: JAN-918.	2J918

Additional Items

1	Modulator cell, supersonic.	---
1	Vibrator, plug-in type.	V823
1	Xylene, 1-oz glass container; (liquid for modulator cell).	---
20	LAMP, incandescent: Mazda No. 1727, (transmitter lamp).	---

NOTE: All capacitors and resistors in the optiphone may be replaced with like capacitors and resistors available through regular supply channels. See SIG 5.

SECTION XIV

REFERENCES

59. ARMY REGULATIONS.

AR 380-5, Restricted Documents.

60. PARTS LIST.

SIG 3 . . . . . List of Items for Troop Issue.

SIG 4-1 . . . . . Allowances of Expendable Supplies.

SIG 5 . . . . . Stock List of All Items.

*SIG 7 (series) . . . . . Organizational Spare Parts.

*SIG 8 (series) . . . . . Higher Echelon Spare Parts.

61. TECHNICALS MANUALS ON TEST EQUIPMENT.

TM 11-2626 . . . . . Test Unit I-176.

TM 11-2627 . . . . . Tube Tester I-177.

TM 11-2050 . . . . . Test Set I-48-B.

62. DECONTAMINATION.

TM 3-220 . . . . . Decontamination.

63. CAMOUFLAGE.

TM 5-20 . . . . . Camouflage, Basic Principles.

64. PAINTING, PRESERVING, AND LUBRICATION.

SB 11-10 . . . . . Signal Corps Kit and Materials for Moisture- and Fungi-resistant Treatment.

TB SIG 13 . . . . . Moistureproofing and Fungiproofing Signal Corps Equipment.

TM 9-850 . . . . . Cleaning, Preserving, Sealing, Lubricating, and Related Materials Issued for Ordnance Materiel.

65. OTHER TECHNICAL PUBLICATIONS.

FM 21-6	List of Publications for Training.
FM 21-7	List of Training Films, Film Strips, and Film Bulletins.
TM 11-430	Batteries for Signal Communication Except Those Pertaining to Aircraft.
TM 9-1530	Aiming Circles, M1, M1918 (French), M1916, and M1916M1.
FM 21-25	Elementary Map and Aerial Photograph Reading.
FM 21-26	Advanced Map and Aerial Photograph Reading.
TM 11-455	Radio Fundamentals.
TM 1-455	Electrical Fundamentals.

66. FORMS.

W.D., A.G.O. Form No. 468	Unsatisfactory Equipment Report.
Army Air Forces Form No. 54	Unsatisfactory Report.

67. ABBREVIATIONS.

a-c	Alternating-current (adjective).
amplr	amplifier.
cp	chemically pure.
d-c	direct-current (adjective).
M	one thousand ohms.
Meg	one million.
mf	microfarad.
mmf	micromicrofarad.
mh	millihenry.

mod	modulator.
nc	no connection.
osc	oscillator.
pwr	power.
W.D., A.G.O.	War Department, Adjutant General's Office.

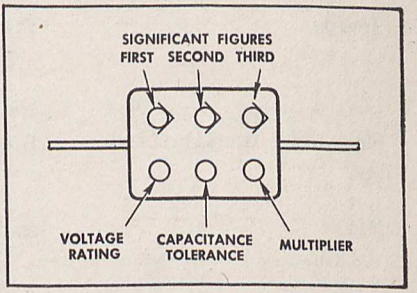
68. GLOSSARY.

Align	To aim, as at a distant station. To render parallel, as the telescope with the light beam.
Alignment tool	Insulated type screwdriver for adjusting a variable capacitor.
Azimuth	Angle measured in a horizontal plane.
Chromatic aberration	A defect by which the focal length of a lens or lens system varies with the color. The result is, an image formed by a lens or lens system showing color.
Datum point	A reference point whose azimuth relative to true north is known, such as a cross-road intersection, star, or mountain peak.
Diffraction	Deflection of rays (of light).
Eccentric collar	A ring, the center of whose inner boundary does not coincide with the center of its outer boundary.
Elevation	Angle measured in a vertical plane.
Filter, electrical	An electrical network design to reduce the effect of undesired frequencies.
Filter, optical	A material which will pass some colors and block others.
Focus	An adjustment to obtain an image.

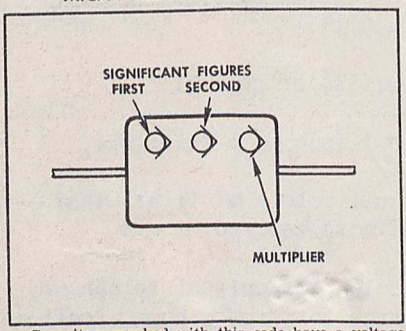
Hybrid coil	A special type of transformer for connecting one circuit to two others in a bridge-like arrangement.
Image	The optical counterpart of an object produced by a lens or system of lenses.
Magnetic declination	The azimuth between true north and the local compass indication.
Mil	Angular measure; 6,400 mils = 360°; 17.8 mils = 1°.
Modulator (supersonic) cell	A device for producing changes in the direction of light passing through it.
Monitor	To supervise or control.
Objective lens	The front lens of a telescope.
Opaque	Blocks all colors of light other than those desired.
Optiphone	Contraction for optical telephone. A device for speech communication over a light beam.
Orient	To aim, to align.
Supersonic	Sound waves of a frequency above the limit of audibility.

CAPACITOR COLOR CODES

RMA 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS

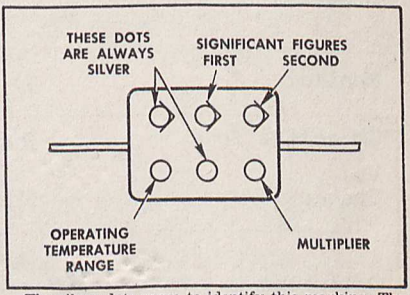


RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



Capacitors marked with this code have a voltage rating of 500 volts.

AWS 6-DOT COLOR CODE FOR PAPER-DIELECTRIC CAPACITORS

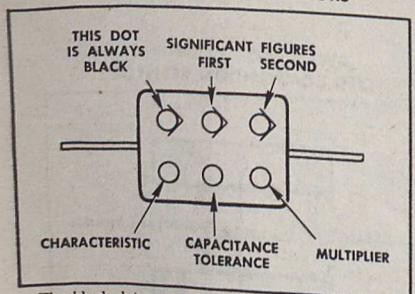


The silver dots serve to identify this marking. The sixth dot shows whether the capacitor has a maximum operating temperature of 167°F (black) or 185°F (brown).

COLOR	SIGNIFICANT FIGURE	MULTIPLIER		VOLTAGE RATING (VOLTS)	CHARACTERISTIC (AWS MICA-DIELECTRIC)
		RMA MICA- AND CERAMIC-DIELECTRIC AWS MICA- AND PAPER-DIELECTRIC	AWS CERAMIC-DIELECTRIC		
BLACK	0	1	1		A
BROWN	1	10	10	100	B
RED	2	100	100	200	C
ORANGE	3	1000	1000	300	D
YELLOW	4	10,000		400	E
GREEN	5	100,000		500	F
BLUE	6	1,000,000		600	G
VIOLET	7	10,000,000		700	
GRAY	8	100,000,000	0.01	800	
WHITE	9	1,000,000,000	0.1	900	
GOLD		0.1		1000	
SILVER		0.01		2000	
NO COLOR				500	

Figure 43. Capacitor color codes.

AWS 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



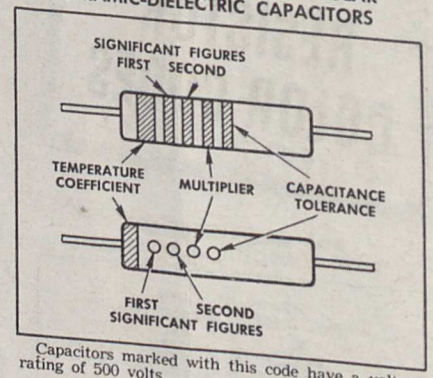
The black dot serves to identify the AWS marking. Capacitors marked with this code are rated at 500 volts, except the following. AWS type CM35 capacitors with capacitances of 6,800, 7,500, and 8,200 micromicrofarads, and AWS type CM40 capacitors with capacitances of 9,100 and 10,000 micromicrofarads are rated at 300 volts.

RMA: *Radio Manufacturers Association*

AWS: *American War Standard (American Standards Association)*

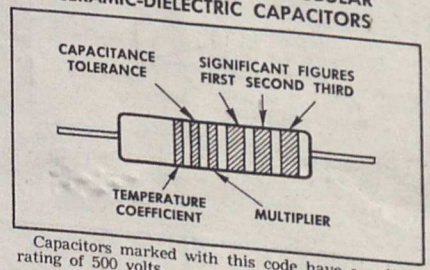
NOTE: These color codes give all capacitances in *micromicrofarads.*

AWS COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS



Capacitors marked with this code have a voltage rating of 500 volts.

RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS



Capacitors marked with this code have a voltage rating of 500 volts.

CAPACITANCE TOLERANCE				
RMA & AWS MICA- AND PAPER-DIELECTRIC (PERCENT)	RMA CERAMIC-DIELECTRIC (PERCENT)	AWS CERAMIC-DIELECTRIC GREATER THAN 10 MMF (PERCENT)	AWS CERAMIC-DIELECTRIC LESS THAN 10 MMF (MMF)	TEMPERATURE COEFFICIENT OF CAPACITANCE $\times 10^{-6}$ MMF/MMF/°C
20	20	20	2.0	0
1	1	1		− 30
2	2	2		− 80
3	3	2.5	0.25	−150
4	4			−220
5	5	5	0.5	−330
6	6			−470
7	7			−750
8	2.5			+ 30
9	10	10	1.0	Not specified
5				
10				
20				

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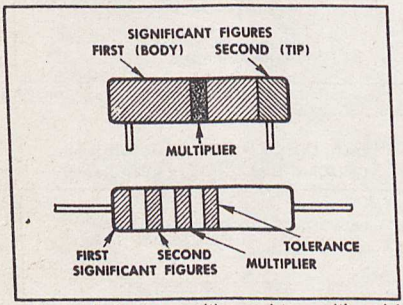
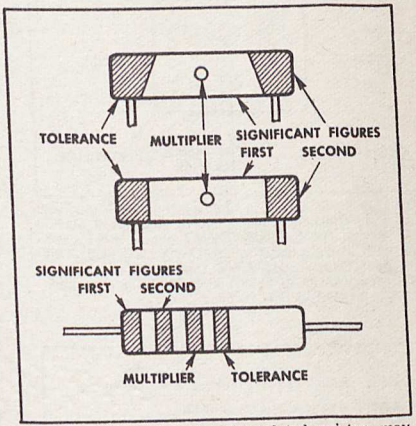
RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS



Insulated fixed composition resistors with axial leads are designated by a natural tan background color. Non-insulated fixed composition resistors with axial leads are designated by a black background color.

AWS COLOR CODE FOR FIXED COMPOSITION RESISTORS



The exterior body color of insulated resistors may be any color except black. The usual color is natural tan. The exterior body color of uninsulated resistors with axial leads may be either black or white. The exterior body color of uninsulated resistors with radial leads may be black or it may be the color of the first significant figure of the resistance value.

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	TOLERANCE (PERCENT)
BLACK	0	1	
BROWN	1	10	
RED	2	100	
ORANGE	3	1000	
YELLOW	4	10,000	
GREEN	5	100,000	
BLUE	6	1,000,000	
VIOLET	7	10,000,000	
GRAY	8	100,000,000	
WHITE	9	1,000,000,000	
GOLD		0.1	5
SILVER		0.01	10
NO COLOR			20

RMA: *Radio Manufacturers Association*
AWS: *American War Standard (American Standards Association)*

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Figure 44. Resistor color codes.

LEGEND

	DESCRIPTION
	SUPERSONIC CELL
	LAMP, 2A, 5V.
	NEON LAMP
	VIBRATOR PACK
	VIBRATOR
	FILTER UNIT
	INPUT TRANSFORMER
	OUTPUT TRANSFORMER
	MATCHING TRANSFORMER
	MODULATION TRANSFORMER
	POWER TRANSFORMER
	INDUCTANCE COIL (SEE NOTE)
	OSCILLATOR COIL (SEE NOTE)
	INDUCTANCE COIL, 2.5MH
	CHOKE
	INDUCTANCE COIL, 0.2MH
	INDUCTANCE COIL, 1.0MH
	CHOKE
SJ7	METAL TYPE TUBE
X6GT	GT TYPE TUBE
V6GT	GT TYPE TUBE
J5	METAL TYPE TUBE
Z4	METAL TYPE TUBE
18	PHOTOTUBE
	SWITCH, 3 POLE 3 POSITION
	SWITCH, DPST, 5A, 250V
	SWITCH, 2 POLE-2 POLE 2 POSITION
	SWITCH, DPST, 15A, 250V
	SWITCH, 2 POLE 4 POSITION
	CAPACITOR, MICA, 0.0015MF, 500V
	CAPACITOR, MICA, 0.01MF, 500V
	CAPACITOR, MICA, 0.00015MF, 500V
	CAPACITOR, PAPER, 0.1MF, 400V
	CAPACITOR, ELECT, 20-20MF, 450V
	CAPACITOR, ELECT, 50-50MF, 50V
	CAPACITOR, VARIABLE, AIR, 25MMF
	CAPACITOR, MICA, 0.00005MF, 500V

SYMBOL	DESCRIPTION
C9	CAPACITOR, MICA, 0.001MF, 500V
C10	CAPACITOR, MICA, 0.00025MF, 500V
C11	CAPACITOR, MICA, 0.002MF, 500V
C12	CAPACITOR, PAPER, 0.75MF, 400V
C13	CAPACITOR, PAPER, 0.25MF, 400V
C14	CAPACITOR, ELECT, 15-15-10MF, 450V
C15	CAPACITOR, MICA, 0.005MF, 1,600V
C16	CAPACITOR, PAPER, 0.1MF, 300V
C17	CAPACITOR, PAPER, 0.02MF, 1,000V
C18	CAPACITOR, ELECT, 50MF, 50V
C19	CAPACITOR, PAPER, 1-1MF, 400V
R1	POTENTIOMETER, 1 MEG
R2	RESISTOR, CARBON, 1 MEG, 1/2W
R3	RESISTOR, CARBON, 50M, 1/2W
R4	RESISTOR, CARBON, 5 MEG, 1/2W
R5	RESISTOR, CARBON, 350M, 1/2W
R6	RESISTOR, CARBON, 150M, 1/2W
R7	POTENTIOMETER, 0.5 MEG
R8	RESISTOR, CARBON, 1.2M, 1/2W
R9	RESISTOR, CARBON, 30M, 1/2W
R10	RESISTOR, CARBON, 0.1 MEG 1/2W
R11	RESISTOR, WIRE-WOUND, 0.25MEG, 1W
R12	RESISTOR, CARBON, 500 OHM, 1/2W
R13	RESISTOR, CARBON, 250M, 1/2W
R14	RESISTOR, CARBON, 5M, 1/2W
R15	RESISTOR, CARBON, 450 OHM, 1/2W
R16	RESISTOR, CARBON, 20M, 1/2W
R17	RESISTOR, CARBON, 1M, 1/2W
R18	RESISTOR, CARBON, 35M, 1/2W
R19	RESISTOR, CARBON, 56M, 1/2W
R20	RESISTOR, CARBON, 31M, 1/2W
R21	RESISTOR, CARBON, 25M, 1/2W
R22	RESISTOR, CARBON, 950 OHM, 1/2W
R23	RESISTOR, CARBON, 10 OHM, 1/2W
R24	RESISTOR, CARBON, 50 OHM, 1/2W
R25	RESISTOR, CARBON, 150 OHM, 1/2W
R26	RESISTOR, CARBON, 100 OHM, 1/2W
F	FUSE, 15A, 25V

NOTE: L1 SHALL BE 2.5MH, R-F ISOLANTITE FORM, 150MA, 50 OHM D-C RESISTANCE, 4 PI-WOUND SECTIONS.

L2 SHALL BE APPROXIMATELY 9-1/2 TURNS WITH TAP 4 TURNS FROM ONE END ON 1-1/4" DIAM X 2-1/8" LONG, COIL 1-1/4" LONG, BAKELITE FORM, ONE COAT OF COIL DOPE.

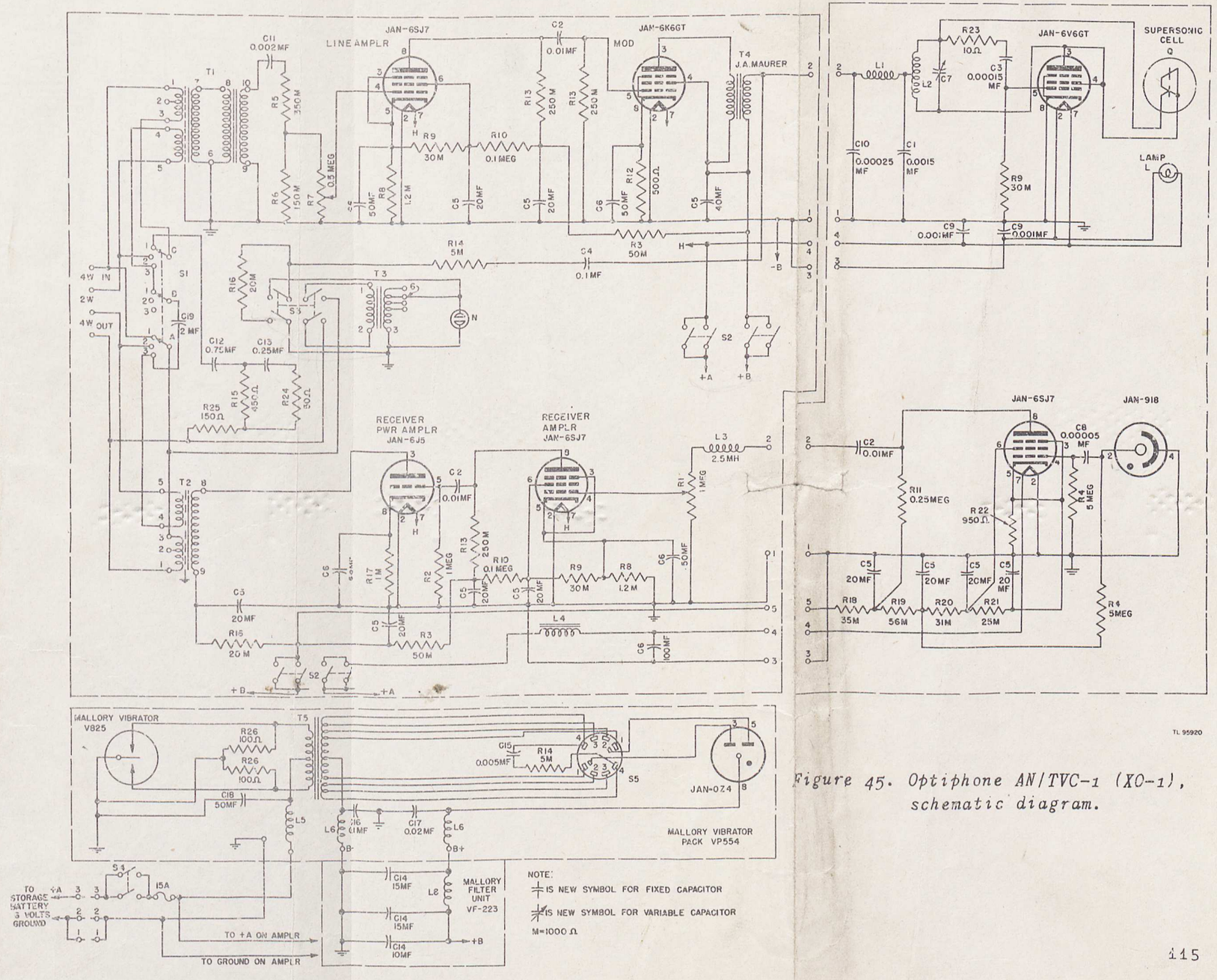

Figure 45. Optiphone AN/TVC-1 (XO-1), schematic diagram.