TM 11-4068

WAR DEPARTMENT TECHNICAL MANUAL

FACSIMILE TRANSCEIVER FX-1 AND RECTIFIER POWER SUPPLY PE-140

REPAIR INSTRUCTIONS

WAR DEPARTMENT • *MAY 1946*

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TM 11–4068, Facsimile Transceiver FX–1 and Rectifier Power Supply PE–140, Repair Instructions, is published for the information and guidance of all concerned.

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Refer to FM 21–6 for explanation of distribution formula.

Contents

		Paragraph	Page
SECTION I.	**DESCRIPTION.**		
	Characteristics	1	1
	Over-all system function (TRANSMIT)	2	1
	Over-all system function (RECEIVE)	3	1
	Simplified transmitter circuit analysis	4	1
	Simplified receiver circuit analysis	5	4
	II. DIFFERENCES BETWEEN MODELS.		
	Differences between Facsimile Transceivers FX–1 and FX–1 modified for 12 inch by 18 inch copy	6	5
	III. INITIAL REPAIR PROCEDURE.		
	General	7	7
	Tools, test, and cleaning equipment	8	7
	IV. PRELIMINARY TROUBLE-SHOOTING PROCEDURES.		
	Scope	9	8
	Preparing set for operation	10	8
	Starting transceiver under test	11	8
	Starting transceiver for direct recording	12	9
	Direct recording operation	13	9
	Photo recording operation	14	10
	Trouble tracing	15	10
	V. DETAILED TROUBLE-SHOOTING PROCEDURES.		
	General	16	12
	Use of signal tracing charts	17	12
	Synchronous motor unit	18	13
	Leadscrew and drum	19	14
	Motor amplifier	20	17
	Fork oscillator unit	21	17
	Signal amplifier (RECORD PHOTO)	22	18
	Meter circuit	23	18
	Signal amplifier (RECORD DIRECT)	24	18
	Phasing amplifier	25	19
	Photocell circuit	26	19
	Signal amplifier (TRANSMIT)	27	19
	Signal amplifier (SET RANGE)	28	19
	Signal amplifier (STANDBY)	29	20
	Voltage regulator	30	20
	Rectifier power supply	31	20
	Exciter lamp supply	32	20

Paragraph *Page*

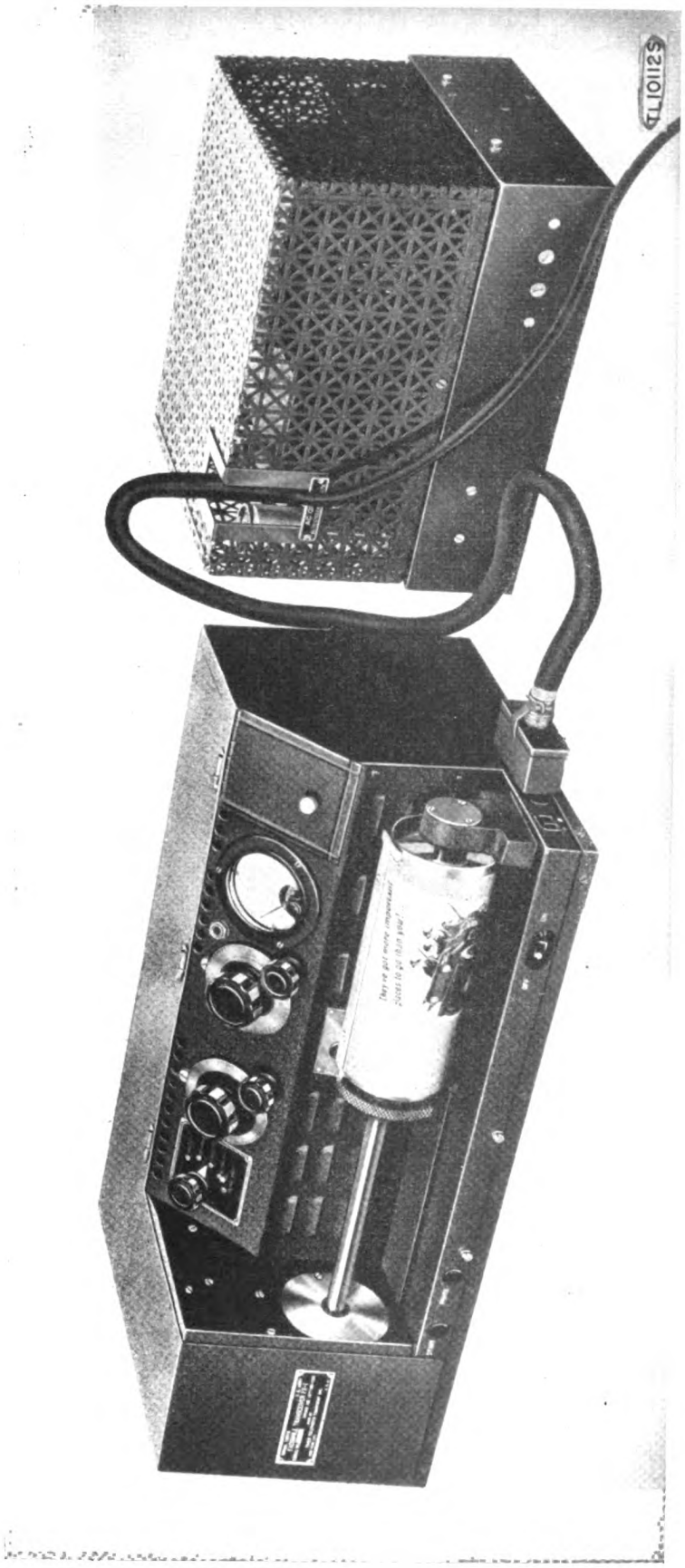
SECTION VI. INDIVIDUAL UNIT ALIGNMENT AND REPAIR DATA.

General	33	21
Synchronous motor unit	34	21
Drum	35	22
Leadscrew	36	23
Dynamotor	37	24
Transmitter optical system	38	24
Recorder optical system	39	25
Motor amplifier	40	26
Fork oscillator unit	41	26
Phasing amplifier	42	27
Photocell circuit	43	28
Signal amplifier	44	29
Selector switch	45	29
Meter circuit	46	30
Voltage regulator	47	30
Rectifier power supply	48	30
Exciter lamp supply	49	30

VII. INDIVIDUAL STAGE AND CIRCUIT REPAIR DATA.

General	50	32
Component replacements	51	32
Conditions of test	52	33
Fork amplifier, input stage	53	33
Fork amplifier, drive stage	54	34
Fork amplifier, output stage	55	34
Motor amplifier, driver stage	56	36
Motor amplifier, output stage	57	36
Voltage regulator, output stage	58	37
Voltage regulator, control stage	59	38
Signal amplifier, first stage	60	38
Signal amplifier, second stage	61	40
Signal amplifier, third stage, transmit output, RECORD PHOTO-	62	40
RECORD DIRECT, driver stage	63	42
Signal amplifier, output stage, RECORD DIRECT and RECORD PHOTO	64	42
Phasing circuit, voltage amplifier	65	44
Phasing circuit, output stage	66	44
Exciter lamp supply, input stage	67	45
Exciter lamp supply, driver and rectifier stage	68	45
Exciter lamp supply, output stage	69	46
Exciter lamp supply, voltage regulator detector stage	70	46
Rectifier power supply	71	47
Connector plug to rectifier power supply and exciter lamp supply	72	49
Photocell bridge circuit	73	49
Coupling coils and cords	74	50
Dynamotor	75	50
Synchronous motor	76	52
Trip magnet	77	52
Start magnet	78	54
Clutch	79	55
Leadscrew, dog, and bearing	80	56
Drum	81	57
Transmitter optical system, 80 series, part of original equipment	82	59
Transmitter optical system, 90 series for replacements	83	59
Recorder optical system	84	61
Stylus holder assembly	85	63
Miscellaneous accessory equipment	86	63

	Paragraph	Page
SECTION VIII. FINAL TESTING.		
Recheck of individual unit performances	87	65
IX. SUPPLEMENTARY DATA.		
General	88	66
Emergency TRANSMIT allowances	89	66
Emergency RECORD PHOTO allowances	90	66
Emergency RECORD DIRECT allowances	91	67
Radio interference (TRANSMIT)	92	67
Radio interference (RECORD DIRECT)	93	67
Field wire operational troubles	94	67
Loaded cable circuit operational troubles	95	67
Timefax recording	96	67
Recording paper substitutes	97	68
Preparing Facsimile Transceiver FX–1 for shipping	98	68
Voltage and resistance chart	99	68
Moistureproofing, fungiproofing, and refinishing	100	68
Nomenclature	101	69



SECTION I
DESCRIPTION*

1. Characteristics

a. GENERAL. Facsimile Transceiver FX–1 with its Rectifier Power Supply PE–140 is designed for wire and radio transmission of maps, messages, and photographs. The normal operating range of the facsimile equipment, over a communication channel, is in most cases equal to the voice range. A frequency band between 1,200 and 1,800 cycles is required. Degradation of received copy will be noticeable if the transmission level varies more than 6 decibels (db) in this range.

b. POWER REQUIREMENTS. (1) *Alternating current operation.*

Voltage, 100 to 130.
Frequency, 50 to 65 cycles.
Power, 250 watts at 115 volts.

(2) *Direct current operation.*

Voltage, 6.
Current, 25 amperes.

c. OUTPUT SIGNAL LEVEL. The output signal level at the feed coil jack is in the order of 26 dbm (1 dbm = 1 mw into 600 ohms). Signals of a lower level are available at the output jacks of a special (type UC) coupling coil. The output impedance at the coupling jacks is in the order of 15 ohms. The coupling coils, type UC or KC, may be used to magnetically induce the signals into a telephone receiver. The telephone receiver coils in a normal telephone set will pass the signal on to the telephone line. The level of the induced signal will be between −10 and 0 dbm, depending upon the telephone receiver.

d. INPUT SIGNAL LEVEL. The input signal level applied to the feed coil jack must not be less than −50 dbm and not stronger than 0 dbm.

2. Over-all System Function (TRANSMIT) (fig. 2)

a. GENERAL. Facsimile Transceiver FX–1 is set as a transmitter when the selector switch is turned to TRANSMIT.

b. MECHANICAL. The subject to be transmitted is wrapped around a scanning drum, which is rotated by a synchronous motor. While rotating, the drum feeds along its shaft, or leadscrew, in front of a light-beam scanning system.

c. ELECTRO-OPTICAL. A small beam of reflected light is focused on a photocell. The photocell modulates an 1,800-cycle signal. The 1,800-cycle signal, modulated in accordance with the reflected light, passes through three stages of amplification. The amplifier output signal is utilized either directly over a wire line or to modulate a radiotelephone transmitter.

d. SYNCHRONIZING. The speed of the synchronous motor is controlled by an 1,800-cycle fork oscillator.

3. Over-all System Function (RECEIVE) (fig. 3)

a. GENERAL. Facsimile Transceiver FX–1 is set as a receiver when the selector switch is turned to RECORD PHOTO or RECORD DIRECT.

b. MECHANICAL. Photographic recording film or paper is wrapped around the receiver drum. Both transmitter and receiver drums will rotate in synchronism and feed along their shafts at the same rate.

c. ELECTRO-OPTICAL (RECORD PHOTO). The signal received from the transmitter is amplified to operate a neon recorder lamp. Its light focuses to a small spot on the film or photographic paper. The recording beam produces exposures in accordance with the intensity of the reflected beam at the transmitter.

d. ELECTRICAL (RECORD DIRECT). For daylight direct recording, a special paper, Teledeltos or Timefax, is used. The received signal is amplified to a high voltage and then applied to a needle, or stylus, riding on the recording paper. The high voltage burns off a white coating on a black conducting paper.

4. Simplified Transmitter Circuit Analysis

a. RECTIFIER POWER SUPPLY PE–140 (fig. 4). This unit supplies to the transmitter:

(1) *Unregulated plate supply (450 volts).* A conventional rectifier and filter circuit, using a rectifier tube 5Z3, supplies the unregulated 450-volt power.

(2) *Filament supply (6 volts).* The filament supply is taken from one 6-volt winding on the power transformer. A second 6-volt winding supplies filament power for the facsimile transceiver.

(3) *Start motor power (9 volts, power line frequency).* All of the first filament winding and half of the second connects to the start motor when starting the synchronous motor.

*See TM 11-375B for installation, operation, and other maintenance data on this equipment.

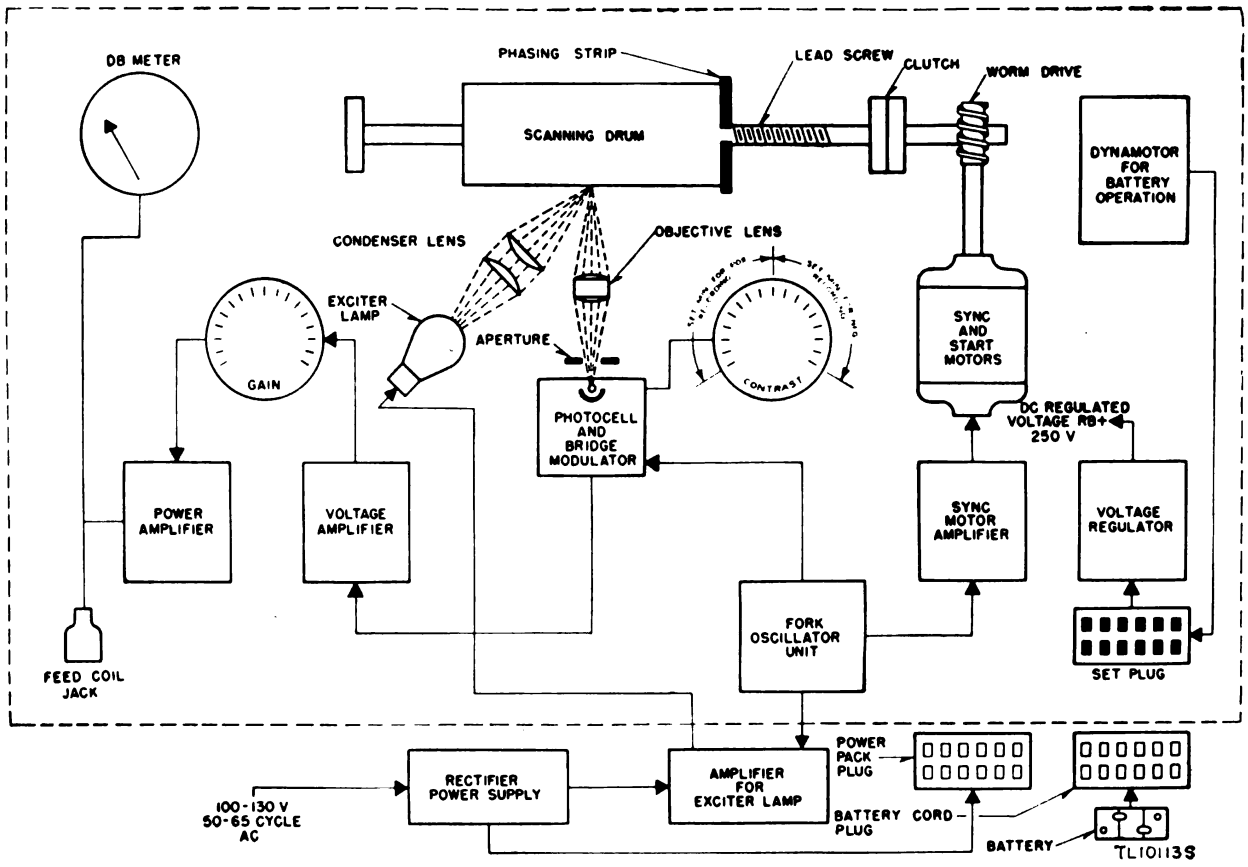


Figure 2. *Block diagram of Facsimile Transceiver FX–1 and Rectifier Power Supply PE–140, operating as transmitter.*

(4) *Exciter lamp power: 6 volts, 1,800 cycles.* A regulated power amplifier amplifies an 1,800-cycle signal from the fork unit. Two amperes at 6 volts are taken from the output to supply the exciter lamp power.

b. VOLTAGE REGULATOR. The plate current for all signal amplifier stages passes through a voltage regulator. The cathode-plate resistance of a triode is connected in series with the amplifier plate supply. If there is a tendency for the amplifier plate voltage, RB+, to change, the grid of this triode changes the cathode-plate resistance to produce a compensating effect. For example: if RB+ starts to drop, the grid voltage of the triode drops, its plate to cathode resistance is reduced, and the voltage will return to normal.

c. FORK OSCILLATOR. A signal of 1,800 cycles is generated in an electromagnet which is placed close to one tine of an 1,800-cycle tuning fork. The signal is amplified to supply driving power to an electromagnet placed close to the other tine. The output of the fork oscillator unit supplies signal to the rectifier power supply, the photocell modulating circuit, and the motor amplifier.

d. PHOTOCELL CIRCUIT. The photocell is connected in one arm of an alternating-current (a-c) capacity bridge. The alternating current for the bridge is supplied by the fork oscillator. Light on the cell will either balance or unbalance the bridge depending upon the initial adjustment. The initial adjustment is made with the CONTRAST control. Signals resulting from the unbalancing of the bridge, or bridge modulator, correspond to the light reflected from the scanned spot, or elemental area.

e. SIGNAL AMPLIFIER CIRCUIT. Output signals from the bridge modulator pass through two stages of voltage amplification. A potentiometer GAIN control in the plate circuit of the second stage regulates the voltage supplied to the grid of the third stage. The third stage or output stage is a power amplifier. It will supply 27 dbm, or less, into a 600-ohm line.

f. SYNCHRONOUS MOTOR AMPLIFIER CIRCUIT. The input stage of the synchronous motor amplifier is a driver for the output stage operating class AB_2. A choke and capacitor assist in matching the impedance of the motor load to the plate circuit.

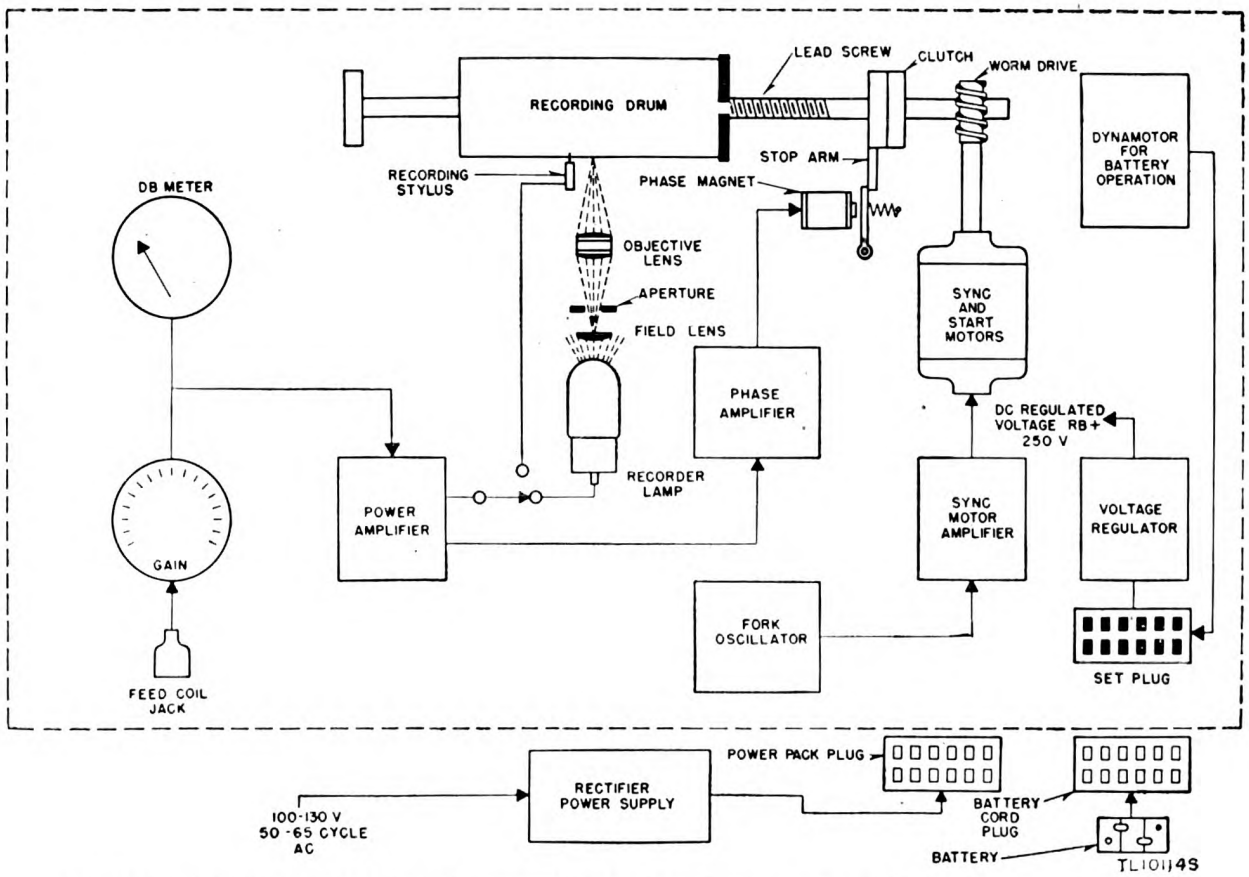


Figure 3. Block diagram of Facsimile Transceiver FX-1 and Rectifier Power Supply PE-140, operating as receiver.

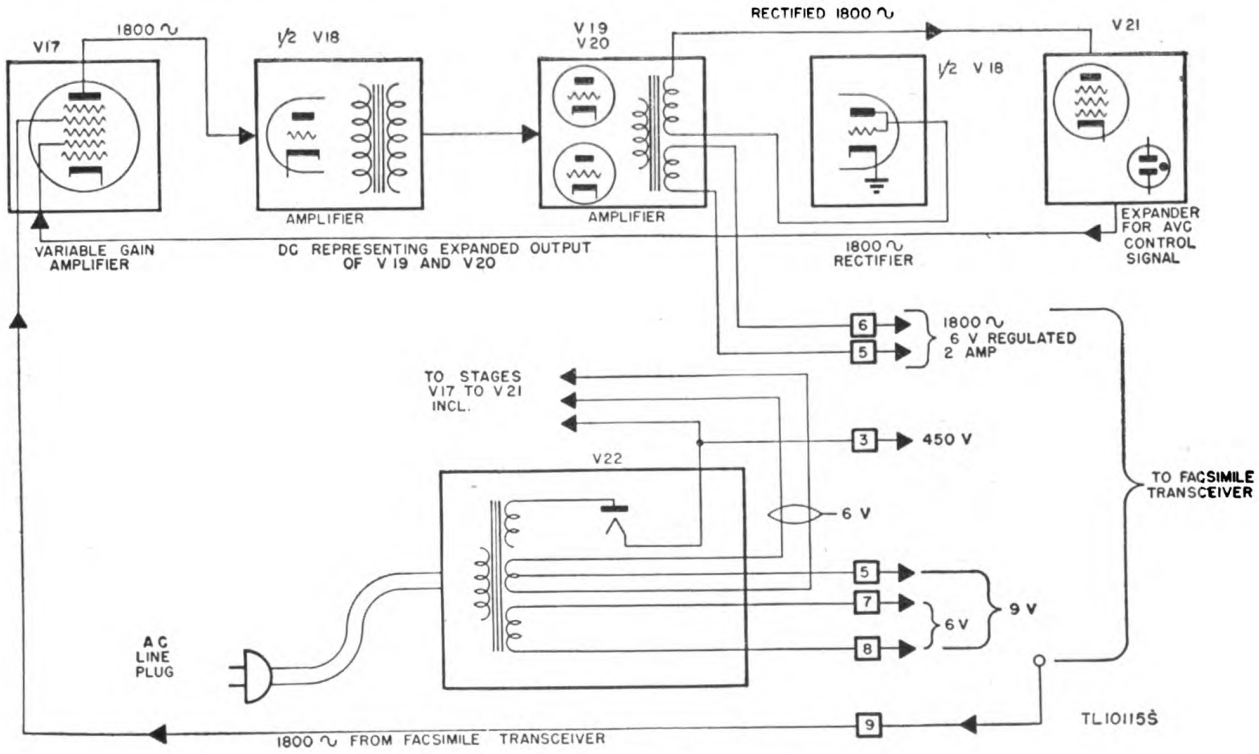


Figure 4. Block diagram of Rectifier Power Supply PE-140.

5. Simplified Receiver Circuit Analysis

a. RECTIFIER POWER SUPPLY PE–140. This unit supplies the receiver: (1) *Unregulated plate supply* (*450 volts*). See paragraph 4*a*(1).

(2) *Filament supply* (*6 volts*). See paragraph 4*a*(2).

(3) *Start motor power* (*9 volts, power line frequency*). See paragraph 4*a*(3).

b. VOLTAGE REGULATOR. See paragraph 4*b*.

c. FORK OSCILLATOR. Only the 1,800-cycle fork oscillator supply to the motor amplifier is used when receiving.

d. SIGNAL AMPLIFIER CIRCUIT (RECORD PHOTO). With the selector switch set on RECORD PHOTO, the input level of the received signal is controlled by a potentiometer GAIN control. The signals pass through the same amplifier that is used for transmitting. The potentiometer between the second and third stage is inoperative. The third stage power amplifier drives a class B stage which feeds the recorder lamp.

e. SIGNAL AMPLIFIER (RECORD DIRECT). With the selector switch set on RECORD DIRECT, the fourth stage feeds a step-up transformer connected to the recording stylus.

f. SYNCHRONOUS MOTOR AMPLIFIER CIRCUIT. See paragraph 4*f*.

g. PHASING CIRCUIT. At the start of each transmission, the receiver drum is held stationary by a trip magnet until released by a phasing pulse. The pulse is selected by rectification in the recorder lamp circuit. The pulse is amplified to trip a gas triode thyratron which in turn operates the trip magnet.

SECTION II
DIFFERENCES BETWEEN MODELS

6. Differences Between Facsimile Transceivers FX–1 and FX–1 Modified for 12-Inch by 18-Inch Copy

a. The FX–1 is designed to handle 7- by 8⅝-inch copy. A small number of units were built in a modified form to handle 12- by 18-inch copy. (See fig. 5.)

b. The drum of the modified transceiver has considerable inertia. The phasing mechanism is arranged so that the drum does not come to a dead stop at any time. Therefore, the load on the clutch and motor is reduced.

c. The modified FX–1 has no provision for 6-volt operation.

d. The scanning speed of the modified FX–1 is approximately 19 inches per second compared to 13 inches per second for the FX–1. The higher scanning speed makes it necessary to use a smaller coupling capacitor between the first and second stages. For

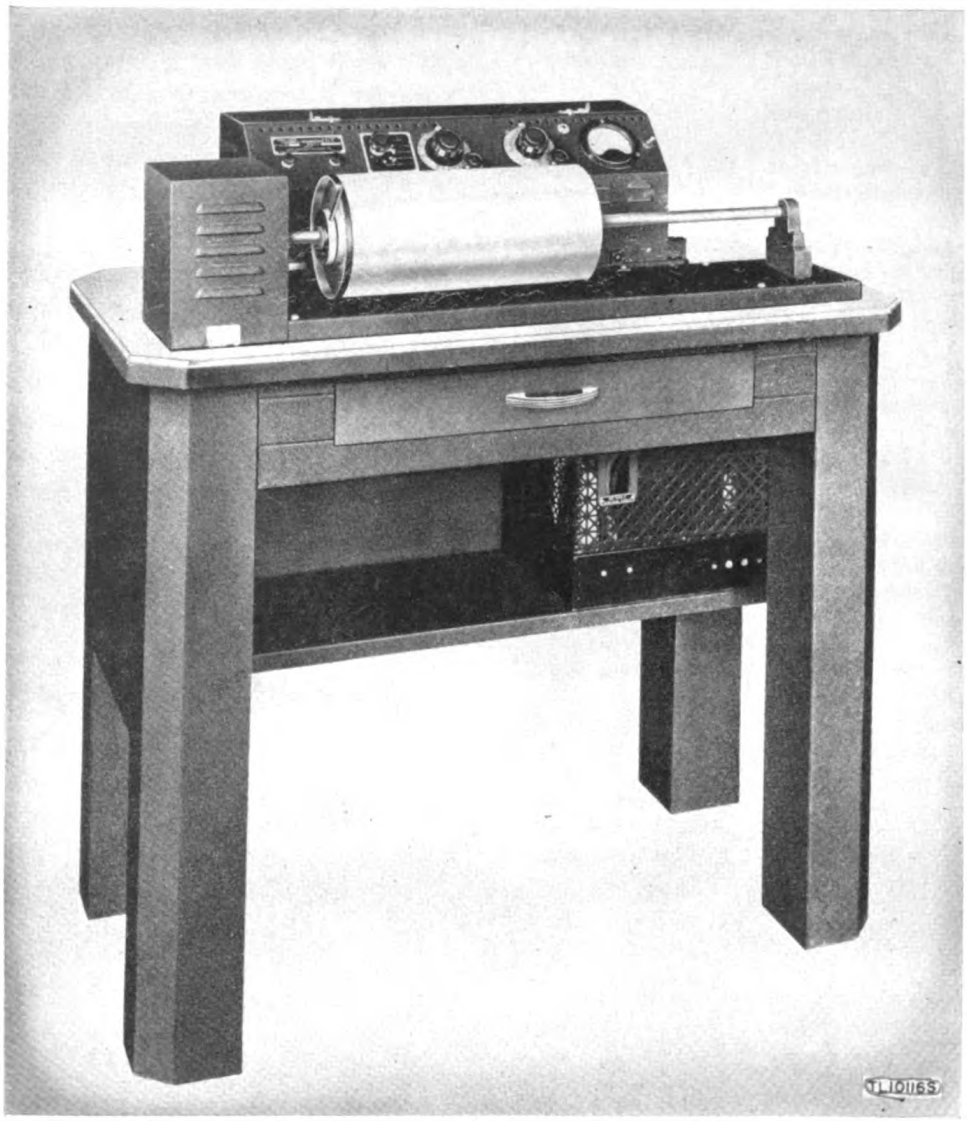


Figure 5. Facsimile Transceiver FX–1 modified for 12- by 18-inch copy.

the same reason, it is also necessary to operate the equipment over telephone circuits having a very small amount of phase distortion. The phase distortion is primarily caused by the *loading* in cable circuits.

e. This manual does not attempt to cover all the details of the modified transceiver. Some information pertaining to the ordering of spare parts is given. The information on electrical circuits applies to the modified unit except as noted in paragraph 6*d*.

SECTION III
INITIAL REPAIR PROCEDURE

Note. Before making any repairs or adjustments, all authorized modification work orders must be applied. See FM 21–6 for list of applicable Modification Work Orders.

7. General

a. Inspection and repair of facsimile equipment must be done under favorable conditions. The technician responsible for the work must thoroughly study TM 11–375B and section I of this manual.

b. Secure the equipment and facilities outlined in paragraph 8. Final tests must be made with photographic transmission and receptions. This necessitates the use of a darkroom. If necessary, the photographic receptions on Facsimile Transceiver FX–1 may be taken with the use of the portable darkroom supplied with Facsimile Equipment RC–120.

c. Before making operational tests, examine the equipment for obvious defects such as—

(1) Tubes out of sockets.
(2) Tubes loose in sockets.
(3) Broken exciter lamp.
(4) Damage to leadscrew.
(5) Blown rectifier power supply fuse.

d. Proceed with preliminary trouble shooting (sec. IV) without making a detailed inspection of tubes or components.

8. Tools Test, and Cleaning Equipment

The equipment listed in Table I must be available to meet the average maintenance and repair requirements of Facsimile Transceiver FX–1 and Rectifier Power Supply PE–140.

Table I

Item	Description
Cathode ray oscilloscope.	Size, 5-inch or 3-inch.
Test meter.	Such as the I–56.
Db meter.	−10 to +30 db, 1,800 cycles; 0–50–250–1,000 volts, 1,800 cycles.
Radio receiver.	Capable of receiving WWV, Washington, D. C., on the following frequencies: 10, 5, and 2.5 mc.
Headphones.	High resistance, magnetic type.
Facsimile equipment.	Facsimile Equipment RC—120 or RC—120—B to be used in operational tests.
Screwdrivers.	Size, 6 inches by ¼ inch across blade.
Diagonal pliers.	Size, 6 inches
Long-nose pliers.	Size 3½-inch nose.
Hammer.	Eight ounces.
Pin punches.	0.05-inch diameter.
Eraser.	Rubber (ink eraser).
Lint-free cloth.	Size, 1 square yard.
Compressed air.	Pressure, 40 to 80 pounds.
Vacuum tube voltmeter (such as RCA Voltohmyst).	Range, 0.001 to 100 volts; input impedance 500,000 ohms.
Darkroom.	Photographic equipment supplied with Facsimile Equipment RC—120 or RC—120—B. Additional equipment: 3 developing trays, 8 x 10 inches; 1 safelight with Wratten filter series OA and 25-watt bulb or 25-watt ruby lamp.
Storage battery.	6-volt, 100-ampere hour capacity.
Glyptal cement.	
Glyptal solvent.	General Electric Company 1511S or equal.
Cleaning fluid.	Solvent, dry-cleaning.
Lubricating oil.	Oil, Lubricating, Preservative, Special PS 512 or PS 32.
One- to three-pound fish scale.	See figure 12.
Magnifying glass.	Four to ten power.

SECTION IV
PRELIMINARY TROUBLE-SHOOTING PROCEDURES

9. Scope

Instructions are given in this section for making operational tests on equipment to be inspected for repairs. If the equipment fails to operate, refer to table II for information indicating the probable cause. Detailed information that will in most cases aid in localizing the trouble is supplied in section V.

10. Preparing Set for Operation

a. Location of Equipment. Set up equipment *under test* in a lighted room. Set up the equipment *known to be in good condition*, in a darkroom. (See fig. 6.) If a darkroom with usual equipment is not available, the portable darkroom Bag BG–140 (fig. 77) and its associated equipment can be used. (See TM 11–375B.)

b. Check Power Connections. Refer to TM 11–375B for detailed information on power connections.

c. Signal Line Connections. To interconnect two transceivers for test purposes, first plug the UC coupling coil (fig. 39) into the feed coil jack (fig. 73) of the set outside of the darkroom. Plug the line connector cord (fig. 39) into the low-voltage (l-v) receptacle of the UC coupling coil. Clip the line connector cord to the line connecting to darkroom set. Clip a second line connector cord to the other end of the line in the darkroom. Plug the line connector cord into the line jack of the transceiver in the darkroom.

11. Starting Transceiver Under Test

Proceed with a test transmission in the following steps:

a. Turn selector switch of set under test (located outside of the darkroom) to STANDBY.

b. Turn power switch to ON. Wait approximately 30 seconds for 1,800 cycle tone in synchronous motor. Be on the alert for indications of trouble that may be detected by a frying sound or the smell of burnt insulation. Shut power off immediately if such indications appear.

c. Press backward the engaging knob on the left end of the drum (fig. 7) to disengage the drum from the shaft. Push the drum to the right-hand end of the lead screw. Rotate the drum until the clamping bar is at the top.

d. Raise the front edge of the clamping bar and place one edge of a test copy, face up, under it.

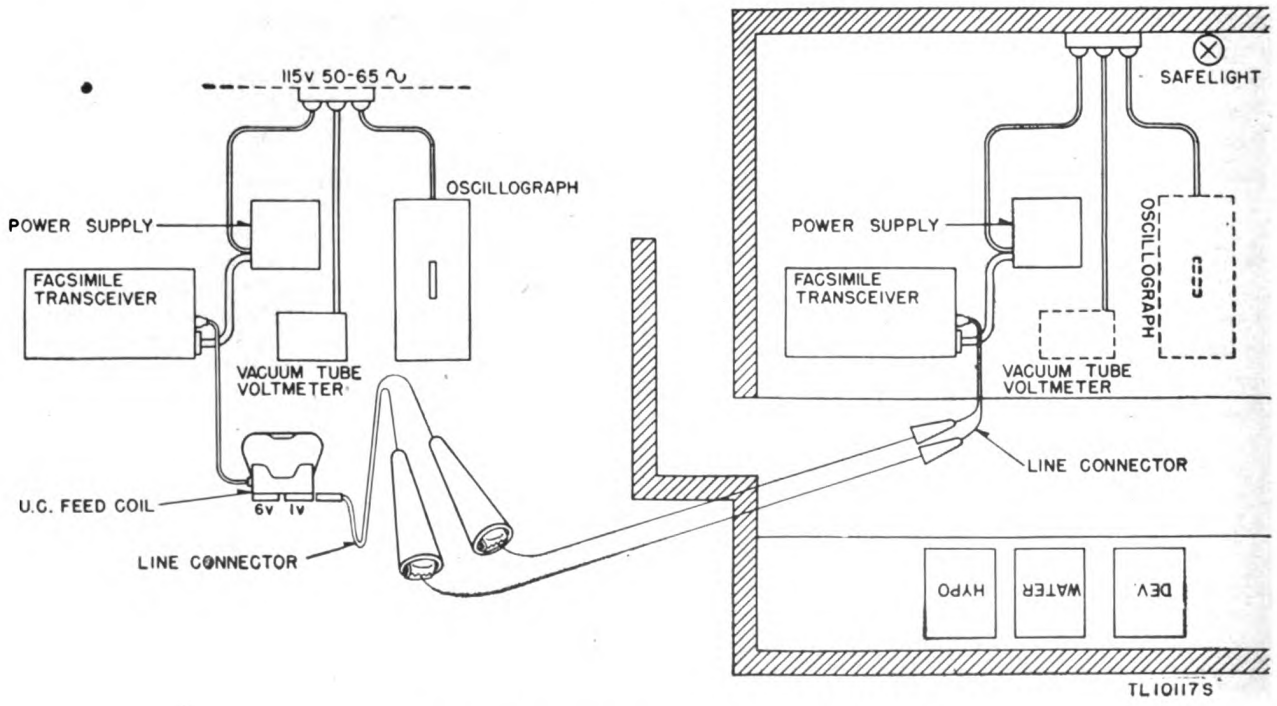


Figure 6. Equipment set up for operational test.

Revolve the drum, wrapping the copy around the drum. Raise the back edge of the bar and place the other edge of the copy under it, pulling the copy tight on the drum with a wiping motion. Make certain that there are no bulges in the copy.

e. As a starting point, set the GAIN control at 65 and the CONTRAST control near 0.

f. Turn the drum so that the whitest portion of the copy is illuminated by the spot of light. Raise the CONTRAST control until the meter reads −10db.

Caution: Do not turn the CONTRAST control so that it passes through a minimum meter reading before reaching −10 db.

g. Move the drum so that the blackest portion of the copy is illuminated by the spot of light.

h. Adjust the GAIN control so that the meter reads +2 db. Shift back to the whitest portion of the copy and readjust the CONTRAST control to obtain a −10 db meter reading.

i. Return to the blackest portion of the copy and readjust the GAIN control for a +2 db meter reading. The final adjustments must show a difference of 12 db between the black and white on the copy. The maximum reading must not exceed +2 db.

12. Starting Transceiver for Direct Recording

a. Remove the clamping bar from the drum of the transceiver in the dark room by loosening the two screws in the bar. Keep this bar in the compartment of the transceiver when it is not in use.

b. Take the two garter springs and form a loop with each around the shaft at the right-hand end of the drum. Work the springs onto the drum. Place one spring at each extreme end of the drum surface.

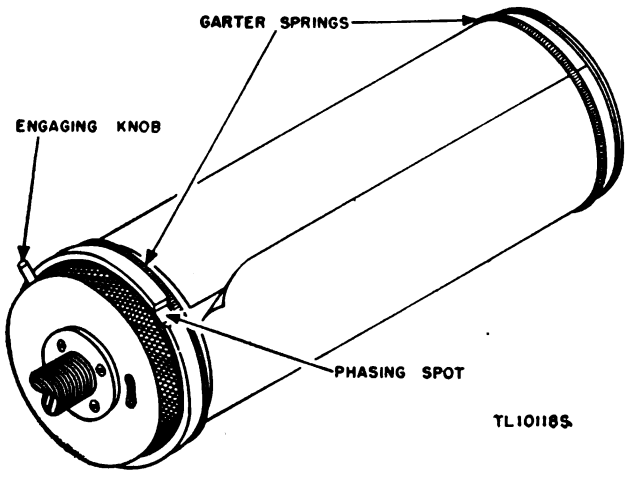


Figure 7. Loading drum with direct recording paper.

c. Wrap the direct process paper around the drum, with the metallic or white side toward the drum. Keep the overlap of the paper alongside the white spot on the phasing ring. The paper must lap so the stylus needle will drop off the edge. (See fig. 7.) Do not get finger marks on the glazed surface of the paper. Hands should be clean and dry. Move the drum so that the left-hand garter spring is slightly to the left of the stylus needle.

d. Turn the power switch to ON and wait until the high-pitched tone is heard.

e. Turn the selector switch to STANDBY.

13. Direct Recording Operation

a. Set the transmitter drum so that the scanning beam is on black.

b. Turn the transmitter selector switch to TRANSMIT.

c. Turn the recorder selector switch to RECORD PHOTO.

d. Adjust the recorder GAIN control to +3.

e. Move transmitter drum along the leadscrew until the scanning beam is focused on the phasing ring. The feed mechanism is left in the disengaged position so the drum will not feed along the leadscrew when the motor is started.

f. Press the START button long enough to bring the drum speed above 90 revolutions per minute (rpm). After releasing the button, the speed will decrease until synchronous speed is reached. The motor should lock in synchronism, if not, repeat the start operation.

g. Start the recorder drum as above.

h. Press the PHASE button of the recorder, holding it down for at least 3 revolutions of the drum.

i. Pull down the engaging knob on the left-hand side of the transmitter drum. This engages the feed mechanism, which moves the drum lengthwise on the leadscrew.

j. Check the location of the recorder drum. The stylus must not strike the garter spring when the selector switch is turned to RECORD DIRECT.

k. Pull down the engaging knob on the recorder drum.

l. Turn the recorder selector switch to RECORD DIRECT.

m. Readjust the GAIN control if the recording density appears too light or too heavy.

n. After 1 or 2 inches of copy have been transmitted, turn the selector switches on both machines to STANBY and examine the received copy.

14. Photo Recording Operation

a. Prepare photo equipment in a darkroom in accordance with conventional practice. Arrange three trays so that they are lighted by the safelight. Put developer in the first tray at the left of the operator, clean water in the middle tray, and hypo in the right-hand tray. There must be enough solution in each tray to cover the copy being processed by at least ½ inch.

(1) For Royal Bromide paper, use one part of D–72 solution mixed with two parts of water. Try to keep the temperature of the developer between 60° F and 80° F. Approximately 1½ minutes are required to develop the exposed paper to the required density. When the proper density has been reached, place the paper in the water tray.

(2) The hypo fixing solution must be mixed in accordance with instructions on the container. For test work, the paper should stay in the fixer about 1 minute. It must than be washed for at least 10 seconds in running water before it is exposed to light. For permanent copies, the fixing time is 10 minutes and the washing time 15 minutes.

b. Replace clamping bar on recorder drum.

c. Turn off all lights in the darkroom except the safelight.

d. Turn recorder selector switch to STANDBY.

e. Load recorder drum with photographic paper, Royal Bromide F–1, in the following manner:

(1) Lift the front side of the clamping bar. Place one edge of the paper under it with the glossy side up. Revolve the drum, wrapping the copy around it.

(2) Raise the back side of the bar and place the other edge of the paper under it. Pull the paper tight on the drum with a wrapping motion. Make sure the paper does not bulge. Move the drum to the right-hand end of the leadscrew.

f. Set the transmitter drum so the scanning beam is on black.

g. Turn the transmitter selector switch to TRANSMIT.

h. Locate the receiving drum so that scanning beam will fall on the phasing ring.

i. Turn the recorder selector switch to RECORD PHOTO

j. Adjust the recorder GAIN control to +3.

k. Move the transmitter drum along the leadscrew until the scanning beam will focus on the phasing ring.

l. Press the transmitter START button long enough to bring the drum speed above 90 rpm. After releasing the button, the speed will decrease until the synchronous speed is reached.

m. Start the recorder drum as above.

n. Press the receiver PHASE button, holding it down for at least 3 revolutions of the drum.

o. Pull down the engaging knob on the left-hand side of the transmitter drum.

p. Pull down the engaging knob on the recorder drum.

q. After the transmission has been completed, turn the selector switches on both machines to STANDBY.

r. Remove the photographic paper from the drum and develop it in accordance with *a* (1) and (2) above.

15. Trouble Tracing

a. Table II lists in the probable sequence, a number of common troubles which may be encountered when making a test run. For a more detailed description of trouble shooting, refer to section V.

b. If there is indication that the set under test operates satisfactory, interchange the two transceivers so that the unit which is suspected to be defective may be tested as a recorder.

c. If the set under test appears to be satisfactory, both as a transmitter and recorder, examine carefully for defects as indicated in figures 10, 11, 12, and 16. Check for requirements as indicated in sections V, VI, and VIII.

Table II

Trouble	Cause	Ref par.
Motor, fails to start.	Trip magnet not releasing clutch.	18*c*, 34*h*.
	Brushes not making contact.	19*c*, *d*; 34*d*, *f*.
	No start voltage.	18*c*, 48*a*.
	Bearings frozen.	34*a*, 34*b*.
•	Rotor hitting stator.	
	Start magnet resistor R31 open.	76.
	Flexible brush leads broken.	34*f*.
Motor, fails to synchronize.	Trip magnet not releasing clutch.	34*h*.
	No a-c signal from motor amplifier.	20,40.
	Low a-c signal from motor amplifier.	20,40.
•	Drum friction load excessive.	19*d*, 35*d*.
	Synchronous rotor too loose or too tight on shaft.	34*c*.
Motor, stops after synchronizing.	Clutch too tight.	34*i*.
	Drum load excessive.	19*d*, 35*d*.
	Low a-c signal from motor amplifier.	20,40.

Trouble	Cause	Ref par.
Signal amplifier, no output.	No input from coil circuit.	26,43.
	No input from line.	
	Defective tubes.	
	Transmitter optical system grounded to case.	
	Defective gain control.	62.
	No plate voltage.	30,31,47,48.
Signal amplifier, low output, TRANSMIT.	Excessive load on output.	30c.
	Defective tubes.	
Signal amplifier, low output, RECEIVE.	Low input.	
	Defective tubes.	
Exciter lamp no light.	Burned out lamp.	32,49.
	Tube failure.	
	Transformer T15 failure.	32,49.
	No input signal.	21, 41.
Exciter lamp, low or flickering.	Defective tubes.	
	Defective exciter lamp.	
	Defective regulator lamp in power pack.	32,49.
	Low input.	21, 41.

SECTION V
DETAILED TROUBLE-SHOOTING PROCEDURES

16. General

The purpose of this section is to assist in finding trouble suspected to be in a unit. Make a real effort to definitely locate the trouble, analyze it thoroughly, then make repairs and adjustments in accordance with section VI.

17. Use of Signal Tracing Charts

To determine whether a circuit is performing in accordance with the requirements, it is necessary to compare the signal voltage measurements at various points with the values specified by the manufacturer. At many points, the waveform of

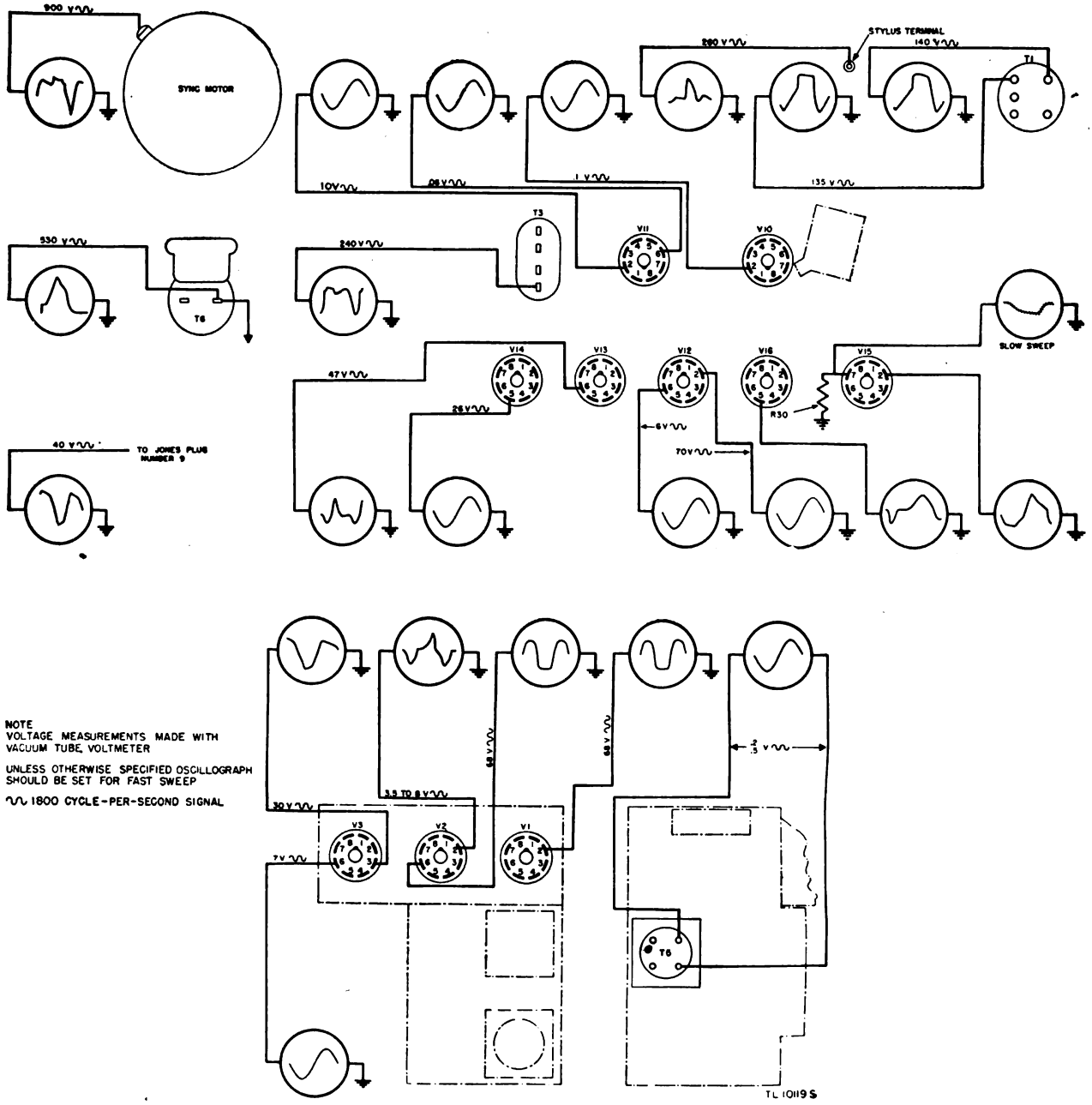


Figure 8. Facsimile Transceiver FX-1, signal tracing chart.

the signal is an important consideration. Therefore, in tracing a signal in a facsimile set an oscilloscope must be used as well as a voltmeter. Reference to the signal tracing charts (figs. 8 and 9) is made in the following paragraphs of this section.

18. Synchronous Motor Unit

Refer to paragraphs 76, 77, 78, and 79 and figures 41, 42, 43, and 44.

a. Lack of Power. When the clutch is properly adjusted (par. 34) and the motor does not hold synchronism when phasing, the trouble is caused by lack of power. This may be due to the following:

(1) Lack of lubrication on the worm and gear or the top and bottom motor bearings.

(2) Synchronous motor current less than 85 ma.

(3) Synchronous rotor hitting the pole pieces.

(4) Binds in the bearings caused by dirt or binds caused by improper assembly of the upper and lower sections of the motor.

b. Failure to Lock in Synchronism. The synchronous motor should fall into synchronism at least three out of every four times it is started. When starting, the engaging knob must be in the released position. *Falling in* failures will be caused by:

(1) Synchronous motor current less than 85 ma.

(2) Clutch locked up.

(3) Synchronous rotor floating too freely or too lightly on its shaft.

(4) Binds in the bearings caused by dirt or binds caused by improper assembly of the upper and lower sections of the motor.

c. Start Motor Failures. Under normal temperature conditions, the start motor when operating properly will accelerate the drum past synchronous speed in one or two seconds. Additional time must be allowed for cold weather conditions. Failures are caused by:

(1) Lack of input voltage, 6-volt direct current or 9-volt alternating current.

(2) Broken connections in brush leads.

(3) Improper operation of start magnet.

(4) Worn brushes.

(5) Dirty commutator.

(6) Clutch locked.

(7) Tight motor bearings.

d. Start Magnet Failures (par. 78 and fig. 43). Failure of start magnet to operate may be caused by—

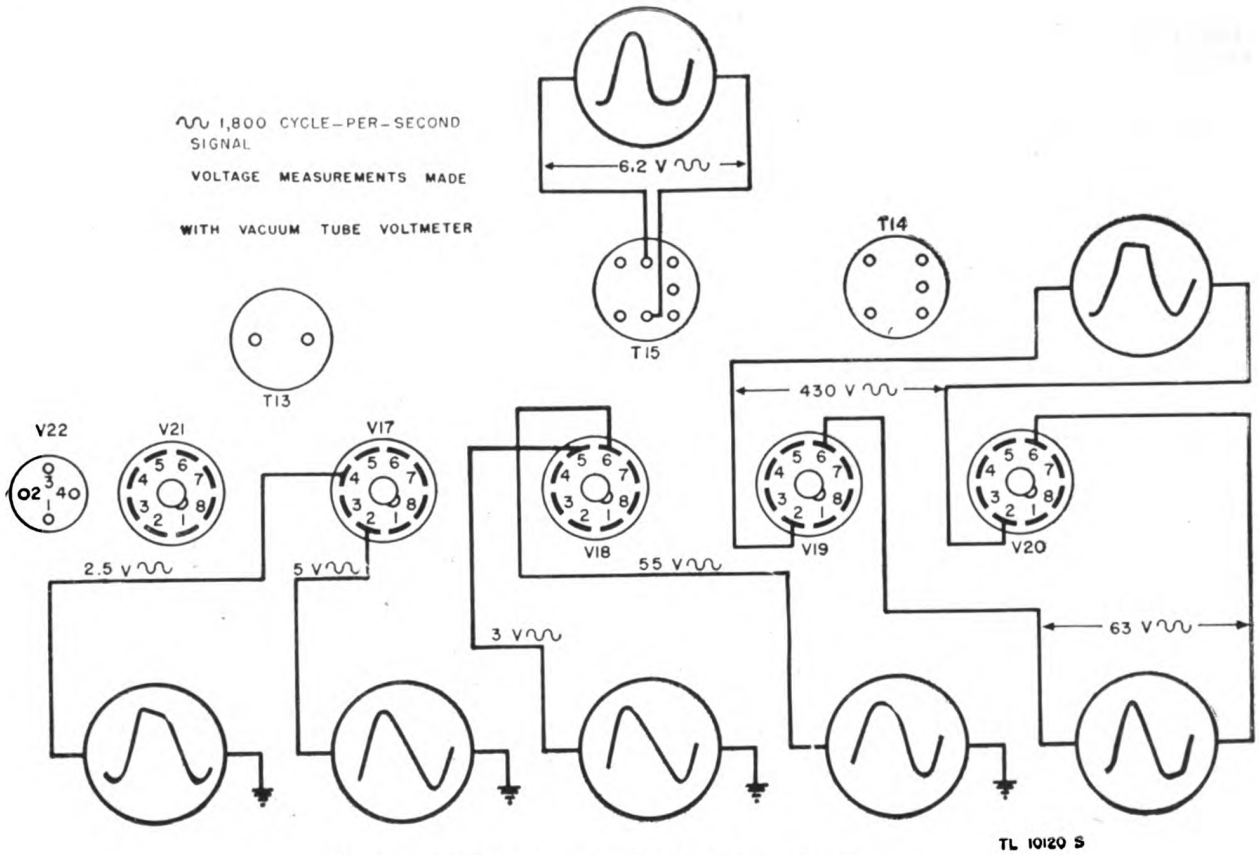


Figure 9. Rectifier Power Supply PE–140, signal tracing chart.

(1) Low voltage or no voltage across coil when start button is depressed. Voltage should be 85 or higher.

(2) Armature hanging up on motor casting.

(3) Open winding.

(4) Brush holders binding in motor casting.

e. Clutch and Trip Magnet Failures (par. 79 and fig. 44). When the phase button is not depressed, the armature of the phase magnet must lock down permitting the stop arm of the clutch to pass by. When the button is depressed, the armature should release to intercept the stop arm and lock up the clutch. Upon receipt of a phasing pulse, it is required that the phase magnet pull away from the stop arm.

(1) Failure of the armature to release the stop arm may result from improper adjustment of the armature back stop screw, tightness of the clutch pressure adjustment, insufficient application of electrical power to the phase magnet when phasing pulse is received, tightness of the armature return-spring, or contacts not closed.

(2) Failure of the armature to remain locked when the PHASE button is released may be traced to lack of voltage for V4.

(3) Failure of armature to release when PHASE button is depressed may be caused by a weak armature return spring, improper adjustment of the PHASE switch contacts, or a bind in the pivots.

(4) Failure of the armature to pull in when PHASE button is pressed or released may be traced to an open coil winding.

(5) A slow irregular skew in the received copy is generally caused by a slipping clutch; the slip may be traced to low clutch pressure or excessive uncontrolled friction between the clutch ring and the clutch bearing. (See fig. 12.)

f. Drive Shaft. A *line feed* pattern in received pictures is sometimes caused by longitudinal motion of the drive shaft or countershaft on the motor.

(1) A loose or worn ball X (fig. 41) at the left end of the drive shaft will cause line feed trouble. (See fig. 9.)

(2) Synchronous motors having serial numbers below 400 utilize a hardened steel thrust plate to take the thrust load of the steel ball. Chipping or corrosion of this plate will cause longitudinal motion of the drive shaft.

(3) Ball bearings must be free of tight spots.

(4) The drive shaft must be free to move longitudinally in the bearings.

g. Motor Thrust Bearing (fig. 41). Improper action of the motor thrust bearing may cause patterns or jagged lines in received pictures. (See fig. 11.) The *gear hash* (fig. 16) pattern is never caused by the transmitter.

(1) The thrust ball R must show no signs of wear.

(2) Trouble may be expected if the end of the motor shaft is worn where it comes in contact with the thrust ball.

(3) The shaft must be able to move up and down freely without riding on the top shoulder of the bearing.

(4) Jitters (par. 19 and fig. 11) in the received picture indicates that the synthetic rubber cushion is too soft. If it is too hard, it will not serve its purpose of reducing gear hash. Before assuming that the motor is responsible for gear hash, make sure that the tubes in stages V10 and V11 (pars. 60 and 61) are not microphonic.

19. Leadscrew and Drum (pars. 80 and 81, and figs. 45 and 46)

a. Line Feed Pattern. Line feed pattern (fig. 10) may develop as a result of irregular longitudinal travel of the drum. If the drum does not advance uniformly at the rate of 1/96 inch per revolution, some of the photographically recorded scanning lines will overlap and others will underlap, thereby creating a blank space between the two lines. If the effect is sufficiently great to cause a noticeable degradation in the received copy, corrective measures must be taken. The most common cause of trouble lies in the drum or leadscrew system. To determine whether the trouble originates in the drum or leadscrew, make a test recording using the drum of another machine. Before making this test, make certain that the snubber (N in fig. 49) is set up firmly against the lens barrel. A final test should be made by using both the drum and leadscrew of another machine. If the line feed trouble remains, it can be assumed that the trouble is in the motor or optical system.

b. Jag or Jitters. These are the terms used to described irregular or saw-tooth recording of lines that should be straight. (See fig. 11.) The source of trouble is generally in the drum and leadscrew system. It can, however, originate in the motor system. To determine if it is in the motor, replace the drum and leadscrew with one from another machine which is operating satisfactorily and make a test run. Use a transmission test copy having straight lines running parallel to the axis of the drum. The recording of the straight line should not deviate from its correct position by more than the width of one recording dot or elemental area. This is approximately 0.007 inch. A bind in the

drum and leadscrew system will cause jitters which will be aggrevated considerably if the synthetic rubber plate P in figure 41 is too soft. If it is too hard, a gear hash pattern may appear in the recorded copy. This trouble may be localized between the drum and leadscrew by making test transmissions with a drum or leadscrew from another machine.

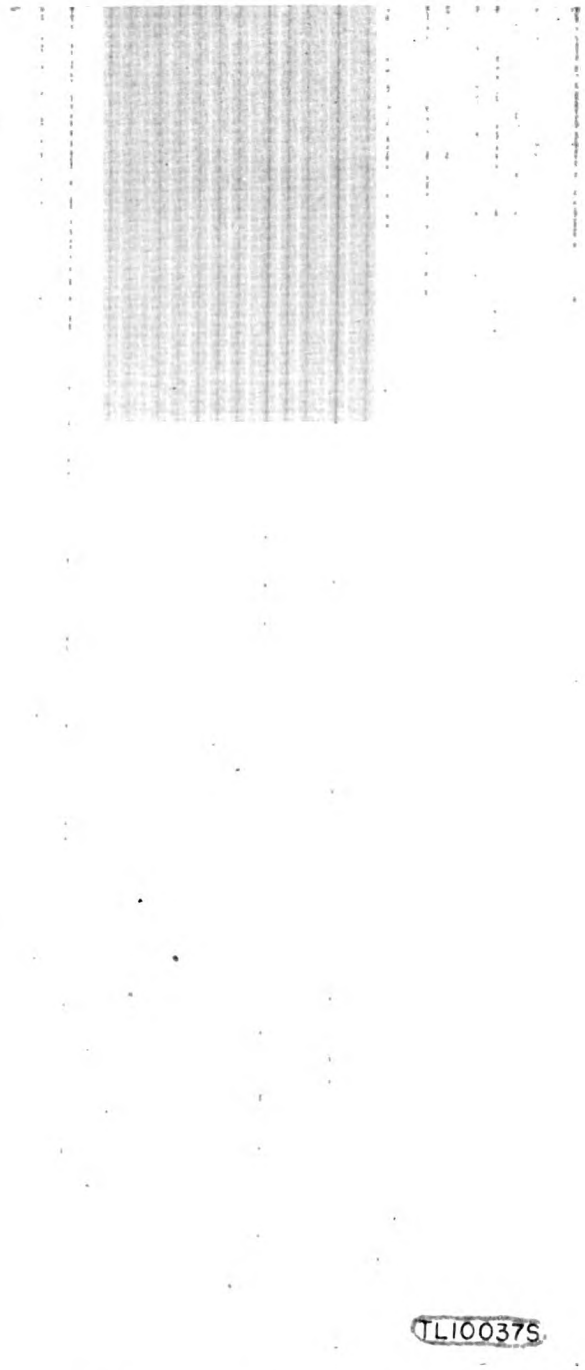


Figure 10. Exaggerated example of line feed overlap and underlap.

c. Drum Wobble. There may be an eccentric rotation of the drum sufficiently great to throw the optical system out of focus during portions of the revolution. The eccentricity may be caused by a bent leadscrew or a worn bearing in the drum. Ordinarily, eccentricity of 0.008 inch will not cause

Figure 11. Enlarged example of jitters.

trouble. A simple and practical way to test the effect of eccentricity is to place a white sheet of paper on the drum, adjust for a positive transmission having a 15 db contrast range (par. 26*b*) and scan the white sheet on the drum, noting the variation in output level as measured by the db meter. The level from one side of the drum to the other should not exceed ½ db; if it does, corrective measures must be taken as described in paragraph 36.

d. Irregular Skew. If the received copy shows an irregular skew as illustrated in figure 12, it is very probable that the clutch of the transmitter or receiver motor is slipping. The clutch slippings can often be traced to a bind in the drum system of the transmitter or receiver. To determine whether the defect is in the transmitter or receiver, examine the photographically recorded copy with a magnifying glass. If the individual recorded elemental areas are in approximate straight alignment (fig. 13), the defect lies in the transmitter system. If the individual recorded elemental areas follow the contour of the skew, the trouble lies in the recorder system. When receiving on direct recording paper, observe the direction of the skew before removing the paper from the drum. If the right-hand side of the copy is skewed to the rear of the machine, the clutch is slipping in the tranmitting machine. Check the clutch tension in accordance with paragraph 34. If the clutch tension is correct, necessary measures must be taken to eliminate the bind in the defective drum or leadscrew (pars. 35 and 36.)

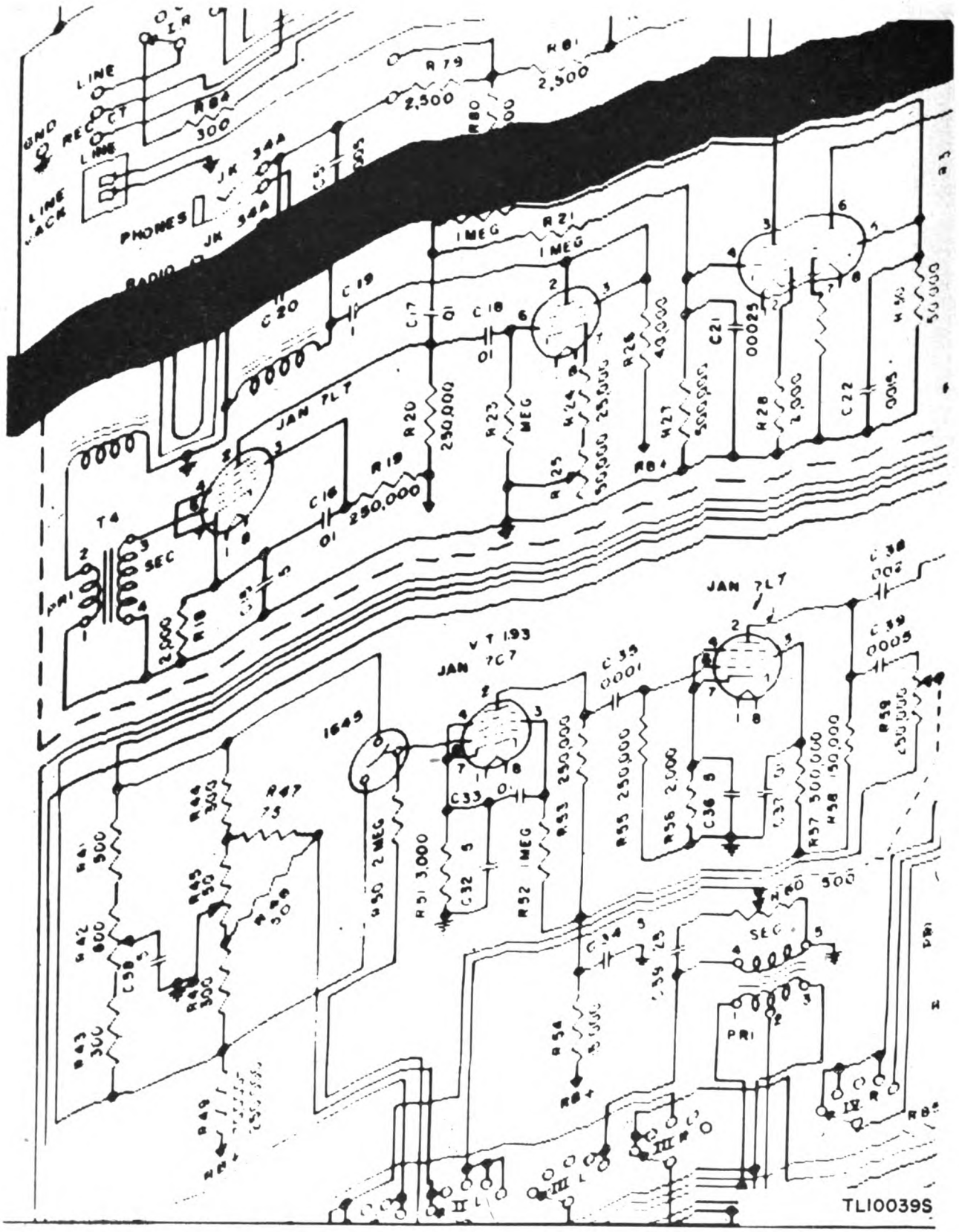


Figure 12. Example of irregular skew.

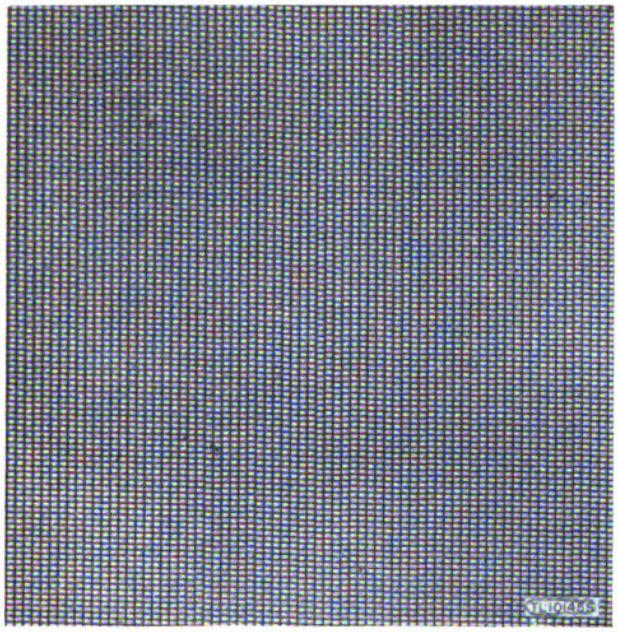


Figure 18. Enlarged section of photo recording.

e. FAILURE TO FEED. If the drum fails to feed or hangs up in one spot, it is probable that the half nuts (J in fig. 46) are damaged. The trouble may have started with a bind between the drum and leadscrew. If the trouble persists after the bind appears to be cleared, examine the leadscrew with a magnifying glass for defects before replacing the drum or the half nuts.

20. Motor Amplifier

a. GENERAL. The output circuit of the motor amplifier includes a choke, T6, capacitors C6 and C7 as well as the synchronous motor.

Caution: HIGH VOLTAGE! The high voltage at the terminals of the following parts may be dangerous to life:

Synchronous motor,
Choke T6,
Capacitors C6 and C7.

Shut off power when connecting meter or oscilloscope to these components. *Do not touch meter or oscilloscope when power is on.*

b. LOW OUTPUT. Before following through a detailed tracing plan, a few quick checks can be made that will in many cases save time. A convenient way of measuring the amplifier output is to connect the milliammeter between the hot side of C1 and the B+ side of the synchronous motor. By depressing the start button slightly, the normal circuit will be broken and the current will flow through the milliammeter. The current should be at least 85 milliamperes (ma).

(1) If the input to the motor amplifier is low, the exciter lamp will not light up to its full brilliancy.

(2) If the motor current is between 40 and 85 ma any one or more of the three tubes may be weak.

(3) If the current is less than 40 ma, the trouble will probably be found in a defective component.

(4) If the current is greater than 110 ma, the input to the motor amplifier may be high or one of the output tubes, V5 or V6, may be defective.

(5) If the troubles are not located by the above checks, follow through the signal tracing plans indicated in figure 8.

21. Fork Oscillator Unit

a. OFF FREQUENCY. If the received copy shows a straight uniform skew or a drift, either the frequency of the transmitter or receiver fork is off standard.

(1) The set under question can be tested by using it as a recorder to record radio signals from station WWV, Washington, D. C. The signals include a pulse each second. If the fork is properly adjusted, a straight line pattern parallel to the drum clamp will be recorded. If a signal is available from a facsimile transceiver having a fork known to be in perfect adjustment, a comparison can be made with the set under test and adjustments made. Feed the signal known to be accurate into the transceiver under test, through the UC feed coil, using the 6 V jack connection. Set the selector switch at RECORD PHOTO. Adjust the GAIN control for a meter reading of −2db. Move the feed coil close to the synchronous motor. The db meter will rise and fall, the amount of rise and fall will depend upon the position of the feed coil to the motor, and the rate of rise and fall will indicate the off-frequency condition of the fork. Adjust potentiometer R45 (fig. 19) until the rate drops to less than one full swing in 2 minutes.

(2) Condensation or moisture on the tuning fork will cause a frequency drift until the moisture evaporates.

(3) Rusting of the tuning fork will affect the frequency.

(4) Slight changes in component values will affect the frequency.

(5) Deviations from the values shown in the signal tracing chart (fig. 8) may point to the cause of off-frequency operation.

b. LOW OUTPUT. Low brilliancy of the exciter lamp and low power in the synchronous motor indicater a low fork amplifier output.

Caution: Do not promiscuously swap tubes in the fork amplifier unit. If a tube is removed and found to be good, it must be placed back in its original position. New tubes require about 30 hours of ageing to stabilize.

(1) If there is no signal output, measure the voltage across primary T4 to determine if the fork pick-up coil is delivering the proper signal. If it is not, test for continuity of fork coils. If the voltage at T4 is correct, trace the signal in accordance with figure 8.

(2) If mechanical trouble exists in the fork or in its mount, replace the entire fork oscillator unit from depot stock. The fork or mount are not field replaceable parts.

22. Signal Amplifier (RECORD PHOTO)

a. SIGNAL TRACING. Apply an input signal of 0.0015 volt to the feed coil jack connector (GE plug receptacle); connect a voltmeter between the grid and ground of stage V14 (par. 64) with the selector switch at RECORD PHOTO and the GAIN control set at 100. The voltage on the grid of V14 should be approximately 26. In some sets, it may be necessary to raise the input voltage to 0.002 to obtain a 26 volt reading on the grid of V14. The oscilloscope should show the waveform as indicated in the signal tracing chart. (See fig. 8.) If the voltage and waveform is not up to requirements, trace the signal through in accordance with the signal tracing chart (fig. 8) to localize the trouble. The performance of stage V14 can be checked by measuring the current in the recorder lamp. The current should be approximately 35 ma with the 26 volts on the grid. This current will vary somewhat with different recording lamps and different 6AC5G tubes. A ±5-ma current is within working tolerance.

b. LEVEL CHANGES. Occasionally, recordings will show undersirable changes in density. To localize the trouble, apply to the input of the facsimile transceiver a steady tone, known to be free of level changes. If necessary, connect the meter across the input and watch it for several minutes, making sure that there is no change in level corresponding to more than ⅗ of a db; watch the db meter in the facsimile transceiver for 5 to 10 minutes. Bounce or jar the set in an effort to aggravate the troubles caused by poor contacts. If the db meter stands steady, it is quite possible the level changes are the result of a defective recorder lamp. Replace the recorder lamp with a new one. Line up and adjust it in accordance with paragraph 39. Take a photographic test on a steady input signal. As a final check, a test should be taken at several levels, for example, −4 db, −1 db, +2 db, and +4 db. +4 db is not an operating level, but it is possible defects will show up quicker on this overload signal.

23. Meter Circuit

a. GENERAL. The meter is connected across the feed coil jack when the selector switch is set for TRANSMIT. It is connected across a dummy load when set for SET RANGE. In the RECORD PHOTO or RECORD DIRECT positions, the meter measures the voltage on the grid of the 6AC5G output stage V14. (See par. 64.) Resistors R29 and R56 serve as voltage-multiplier resistors to obtain the desired readings.

b. CORRECT METER READING. The exact value of R29 or R56 is within the 10 percent range of 50,000 ohms or 40,000 ohms. If the meter does not read correctly, resistors within the tolerance range are selected to obtain a reasonably exact reading. To determine whether the reading is correct with the selector switch in TRANSMIT position, measure output signal across the feed coil jack after connecting a 600-ohm, 20-watt resistor across the test meter. The measurement should be between +25 db and +28 db when the set meter reads +2 db. To test the set meter in the RECORD PHOTO position of the selector switch, put a 0-db signal across the feed coil jack terminals. The set meter should read between 0 db and +3 db. If the reading is correct in the transmit position, it will also be correct in the RECEIVE position, unless the value of R29 has changed. This may be checked with a simple resistance measurement.

24. Signal Amplifier (RECORD DIRECT)

a. GENERAL. When the selector switch is set to RECORD DIRECT, the signal amplifier RECORD PHOTO is changed in the following manner:

(1) Tube 7C5 of stage V12 (par. 62) is cut out by opening the plate circuit. Tube 7N7 of stage V13 (par. 63) is switched in, that is, tube 7N7 takes the place of tube 7C5. This is done for the purpose of increasing the direct recording contrast. The cut-off bias is supplied in part by bias from the cathode circuit of V4 (par. 56).

(2) The output of V14 is switched to transformer T3. The output of T3 delivers the power to the recording stylus. It is to be noted when operating through transformer T3 that the plate voltage on tube 6AC5G is B+ (450 volts).

b. LOW OUTPUT. If the signal amplifier is tested in accordance with the signal tracing chart (fig. 8) and found to be satisfactory, but has a very

low recording density, it may be traced to a feedback condition. Some sources of trouble which are indicated by signal tracing are:

(1) Excessive bias on cathode 7 of stage V13.
(2) Defective transformers T2 or T3.
(3) Defective tube 6AC5G in stage V14.

c. Poor Contrast. If the recorded copy lacks contrast and if the transmitted signal has a range of 15 db, the trouble may be traced to a low bias voltage on cathode 7 of stage V13. This cathode voltage may be increased by increasing the value of R26. A defective tube in stage V4 may also be the cause of low bias voltage.

25. Phasing Amplifier

a. No Output. To determine whether the 885 thyratron delivers power to the trip magnet, watch the tube when receiving phasing pulses. There should be a flash within the tube at each pulse if the PHASE button is depressed and a good phasing signal is being received. A quick test with no received signal can be made by depressing the PHASE button and giving the START button a short quick push. A flash within the 885 thyratron should occur each time the START button is depressed.

b. Signal Tracing. Connect the transceiver under test to a second transceiver for the purpose of obtaining a phasing signal (pars. 10 and 11). Set the CONTRAST control of the sending transceiver so as to produce a 6- to 8-db phasing pulse with the CONTRAST control in the TRANSMIT NEGATIVE position.

(1) Connect the oscilloscope between ground and the cathode of V14 (par. 64). With the PHASE button depressed, the signal should appear as indicated by the signal tracing chart. (See fig. 8.) If it does not, trace trouble in the V14 stage.

(2) Check the signal at the other points indicated in figure 8.

c. Trip Magnet. The trip magnet is a part of the cathode circuit of stage V4 (par. 56) when the PHASE button is not depressed. Failure of the trip magnet to lock when the PHASE button is not depressed may be traced to stage V4.

26. Photocell Circuit

a. Signal Tracing. Because the output of the photocell circuit is so sensitive, it is not practical to make direct measurements with a meter or oscilloscope. It is convenient to use the signal amplifier to feed the oscilloscope which can conveniently be connected across the db meter terminals. The signal amplifier and meter circuit must first be checked for satisfactory operation in accordance with paragraphs 22 and 23. If the required measurements at the db meter and oscilloscope are not obtained, the circuit will have to be traced on a stage-to-stage basis as indicated in the signal tracing chart. (See fig. 8.)

b. Output Requirements. Set GAIN control at 100 and adjust the CONTRAST control for minimum meter reading when the scanning beam is on the phasing spot. This is the condition for positive transmission. The db meter should read +2 or +3 db when the scanning beam is on the raised portion of the phasing ring. The equipment will operate satisfactorily even though the reading is not above 0 db.

c. Low Contrast. Insufficient contrast when balanced on black or white can generally be corrected by the adjustment of C8. Excessive voltage from the fork unit will reduce the contrast range. The voltage can be reduced by lowering the value of resistor R59 which shunts the output of the fork unit.

27. Signal Amplifier (TRANSMIT)

a. Low Output. The signal amplifier with the selector switch in the TRANSMIT position is a modification of the signal amplifier with the selector switch in the RECORD position. In practice, it is generally found that if the signal amplifier has been lined up properly in the RECORD PHOTO position, it will perform properly with the selector switch in the TRANSMIT position. A quick check to determine whether the input circuit has been properly switched to the photocell circuit is to place a screwdriver under the extension of the photocell shield pan. If the amplifier is performing properly, it will break into oscillation. In most cases, if the input circuit is open, the amplifier will motorboat. For information on switching circuit changes, which may affect the output, see paragraphs 62, 63, 64, and 73.

b. Signal Compression. Connect the oscilloscope across the db meter. The waveform should be sinusoidal between the balance point and +2 db. If the waveform tends to compress before reaching +2 db, trace through the circuit to localize the trouble. Flattening or compression of the signal may be caused by low plate voltage, low cathode bias voltage, low screen voltage, or defective tubes.

28. Signal Amplifier (SET RANGE)

With the selector switch in the SET RANGE position, the transmission output circuit is switched from the line jack to a dummy load. All of the

other circuits remain the same as for the TRANSMIT position.

29. Signal Amplifier (STANDBY)

With the selector switch in the STANDBY position, the connections to the feed coil jack are broken and the plate circuits of stages V12 and V14 (pars. 62 and 64) are opened.

30. Voltage Regulator

a. REQUIREMENTS. It is required that the voltage regulator deliver B+ voltage that does not vary more than 2 volts under normal variation of operating conditions. The nominal voltage may be anywhere between 240 and 255 volts direct current. The measurement may be made at the bottom end of R1 or R3 on the regulator panel terminal strip, or pins No. 3 and No. 6 of stage V16.

b. EFFECTS OF POOR OPERATION. If the regulated voltage is too high, the fork frequency will deviate from 1,800 cycles and cause a noticeable drift in the recorded copy. A low voltage will also result in a drift. A low voltage will permit the amplifiers to overload on a low signal level. The overloading will show up as flattened shadows when transmitting for positive reception. A flickering voltage regulator may produce level changes. Sometimes they will oscillate when the line voltage is low. The oscillations will show up in the recorded copy.

c. TRACING TROUBLE. When trouble is suspected to exist in the regulator unit, check the output voltage with the line voltage varying between 100 and 130 volts. The power frequency may be between 50 and 65 cycles. Watch the meter for several minutes when level-change trouble is being traced. If the voltage takes a jump when the line voltage is within a few volts of 100, there is danger of the regulator breaking into oscillation at low line voltages. If operation at 100 volts is a critical consideration, the accuracy of the voltmeter measuring the line voltage is an important consideration. Most rectifier type voltmeters cannot be depended upon for an accuracy of better than 5 percent at temperatures between 65° F. and 100° F. Above and below these temperatures, the accuracy is generally poor. If it is found that the regulated B+ voltage is not within a predetermined range, check the voltage across the regulator lamp. This can be done by measuring the voltage between cathode 7 of V7 and ground. Use a voltmeter having a resistance of 1,000 ohms per volt or higher on the 250-volt scale. The voltage across the regulator lamp may be between 70 and 110 volts, depending upon the type of regulator lamp used. Weak tubes in stages V7, V8, or V9 (pars. 58 and 59) may be responsible for a low RB+ voltage. There is a possibility that an excessive load is responsible for the low output voltage. If there is reason to suspect this, disconnect the load from the regulator panel and measure the open circuit voltage. If it is necessary to trace further, test the components for the correct value as indicated in paragraphs 58 and 59. Capacitors must be tested for leaks, especially capacitor C2.

31. Rectifier Power Supply

a. GENERAL. The term rectifier power supply is used to describe he complete unit which includes the conventional rectifier power supply and the exciter lamp power supply system. In this section, the term rectifier power supply does not include the exciter lamp supply system. The rectifier power supply is conventional and can be treated as such.

b. TUBE REPLACEMENT. Rectifier tube 5Z3 may require replacement after a few hundred hours of operation especially if the equipment is to operate on low line voltages, that is, 100 to 110 volts. A tube selected for high emission will permit operation on voltages between 90 and 100. If the unregulated B+ voltage falls below 400 when the line voltage is 100, the tube emission is too low for satisfactory operation.

32. Exciter Lamp Supply

a. SIGNAL TRACING. For a quick check of satisfactory operation, measure the voltage across the exciter lamp. It should be between 6.1 and 6.3 at any line voltage between 100 and 130. The 6-volt measurement is made across SEC 2 of transformer T15. The voltage drop to the lamp socket is approximately 0.2 volt. If the voltage is not correct, measure the voltage on grid 4 of stage V17 (par. 67). This should be approximately 2 to 6 volts. If further signal tracing is necessary, follow through the steps shown in the signal tracing chart. (See fig. 9.)

b. OUTPUT TRANSFORMER T15. When the exciter lamp burns out, the load on transformer T15 becomes practically zero, which results in a very high voltage across SEC 1. There have been transformer failures as a result of the high voltage. In tracing trouble, consideration must be given to the probability of failure of this transformer.

SECTION VI
INDIVIDUAL UNIT ALIGNMENT AND REPAIR DATA

33. General

Only after a particular trouble is located, should replacements or repair work be made. There are a few exceptions to this rule which are explained in section V. Replacements made on a hit-or-miss basis may develop complications that will take hours to untangle. Except in cases of simple trouble, do not attempt to repair mechanical parts such as motor, leadscrew, drum, and tuning fork, unless new parts are not available. In case of kill or cure, try to obtain help from those skilled in the particular type of work involved. Put replacements and lead wires in the exact physical location as the original. When replacing components in the amplifier system, take into account protection necessary because of high voltages.

34. Synchronous Motor Unit

a. Top Bearing B (par. 76 and fig. 41). It is not practical to replace this bearing in the field. Use solvent, dry-cleaning, in removing gummed-up oil and grease. After bearing has been thoroughly cleaned, dry out all traces of dry-cleaning solvent (SD) before re-oiling with special preservative lubricating oil (PS 512).

b. Lower Bearing (items C, R, P, Q and O, fig. 41). Do not attempt to replace side wall bearing C in the field. Clean and re-oil in accordance with the instructions above. If tests (par. 18*g*(4)) indicate that synthetic rubber pad P is too soft, it will be necessary to replace it. A satisfactory material to use for this purpose is Hycar. If the pad is too hard, a portion of the center can be cut away. If ball R is replaced, select one that will not bind on the side wall of the bearing.

c. Synchronous Rotor Bearing D (fig.41). This bearing cannot be replaced in the field. If the rotor turns too freely on the shaft and does not fall into synchronism as it should, the free oscillating action must be reduced by adding some end-thrust. This is done by inserting thin washer U between flat washer V and collar S. The collar can be removed after driving out taper pin T with a pin punch having a tip approximately 0.05 inch in diameter. A washer can be cut from a thin piece of celluloid or fiber. For celluloid, use a piece of photographic film after removing the emulsion with hot water.

d. Commutator E (fig. 41). Clean the commutator with a rubber eraser, preferably one containing grit such as an ink eraser. Do not use emery or sandpaper.

e. Synchronous Motor Field Coils F (fig. 41). In emergencies, a defective coil can be disconnected and the motor operated on three coils. The power will be reduced, making it difficult to phase.

f. Brushes C (par. 78 and fig. 43). To replace the brushes, first remove the entire start magnet assembly. If the bakelite sleeve holder is in good condition, the brush with the flexible lead may be pulled out and replaced with a new one. If the holder is defective, it can be replaced after removing the two nuts. In making the replacement, first set the nuts approximately in the same position as before. Replace the start-coil assembly in its proper location to permit free action of the brush holders. With the armature in the down position, the nuts should clear the top of the armature extension by a little more than $\frac{1}{16}$ inch. With the nuts in the correct position, screw them together so they lock firmly. When the armature is released, the brushes should lift a little more than $\frac{1}{16}$ inch. The correct amount can be controlled by the armature back-stop adjustments.

g. Gear H (par. 76 and fig. 41). The gear on the drive shaft can be replaced if suitable shop facilities are available. The new gear will have to be pinned to the shaft with a 7/0 taper pin. Improvised pinning arrangements may be used in emergencies. Sometimes a damaged gear can be moved along the shaft and pinned in a new place so that a good portion of the gear will mesh with the worm.

h. Trip Magnet (par. 77 and fig. 42). The armature return-spring H must produce a strong snappy action. If it is too weak, replace it with any spring available, possibly from teleprinter spare parts. Pivots F and G (fig. 42) should not cause binds or side play. To adjust armature backstop B, set it up for a receiving test on a phasing signal. Proceed as follows: with the PHASE button depressed, back off on the adjusting screw until the armature fails to operate. Screw in on the armature back-stop screw until the armature fails to catch the top arm. Return the screw to a position halfway between the two points. It is required that push rod J (fig. 42) operate freely and make proper contact. If trouble is experienced, the contact connections may be shorted. If this is done,

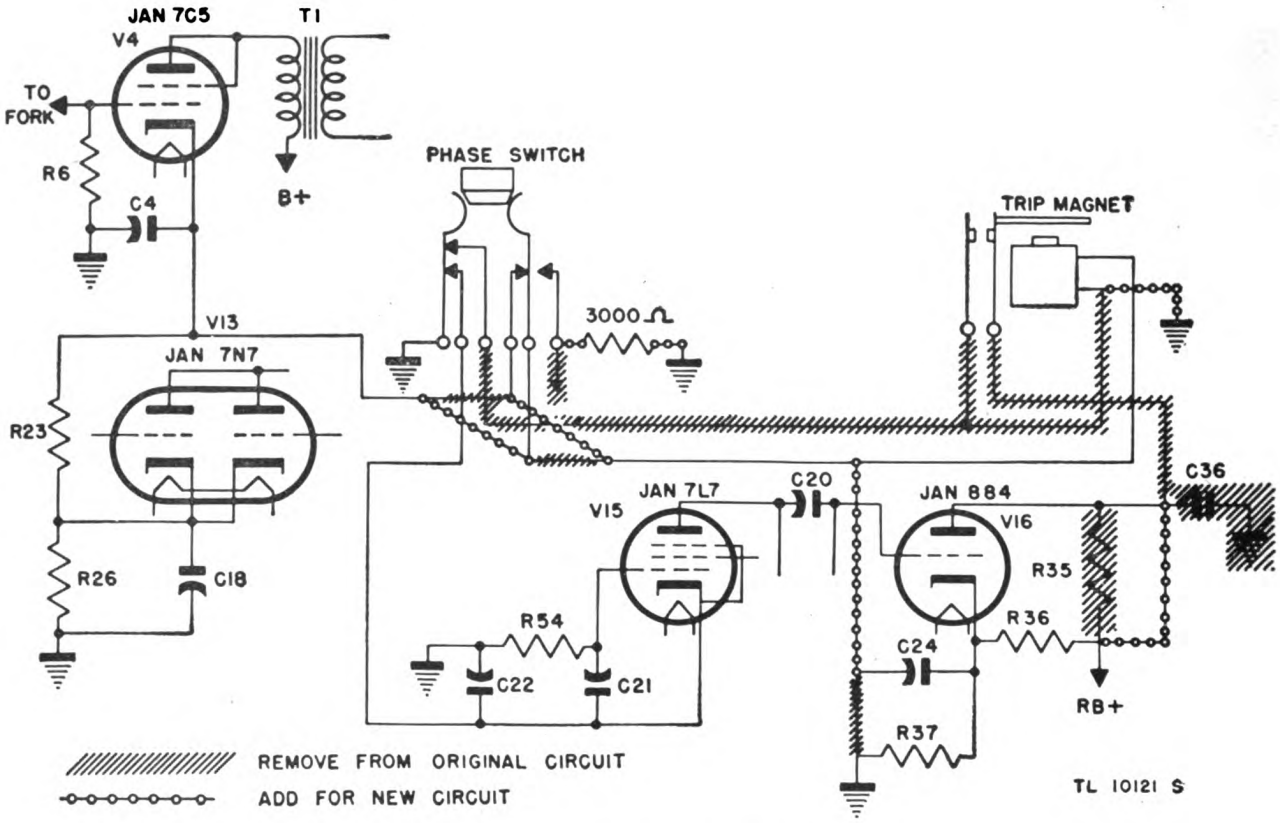


Figure 14. Improved trip magnet circuit with changes in wiring.

it may be necessary to select an 884 tube for satisfactory operation. Best results will be obtained by changing the circuit over to that shown in figure 14. (See par. 42*d*.)

i. CLUTCH (par. 79 and fig. 44). The clutch pressure must be tight enough so that there is no slip or creep. It must not be so tight that it causes stalling of the motor while phasing. Factory adjustment is made by hooking a fish scale onto the clamp bar of the drum and adjusting the pressure until the pull is between 12 and 16 ounces (motor running). (See fig. 15.) If there is a creep, it may be due to excessive friction between clutch ring B, and clutch bearing I. The cause of this friction can be removed by polishing clutch bearing I, and bearing surface of clutch ring B.

Caution: Work on a synchronous motor should be done in a clean, dry place, free from dust. Disassemble and assemble motor parts with great care, avoiding risks of scratching and damaging any of the machined surfaces. Take care not to lose lower thrust bearing ball R (par. 76 and fig. 41) when disassembling the motor.

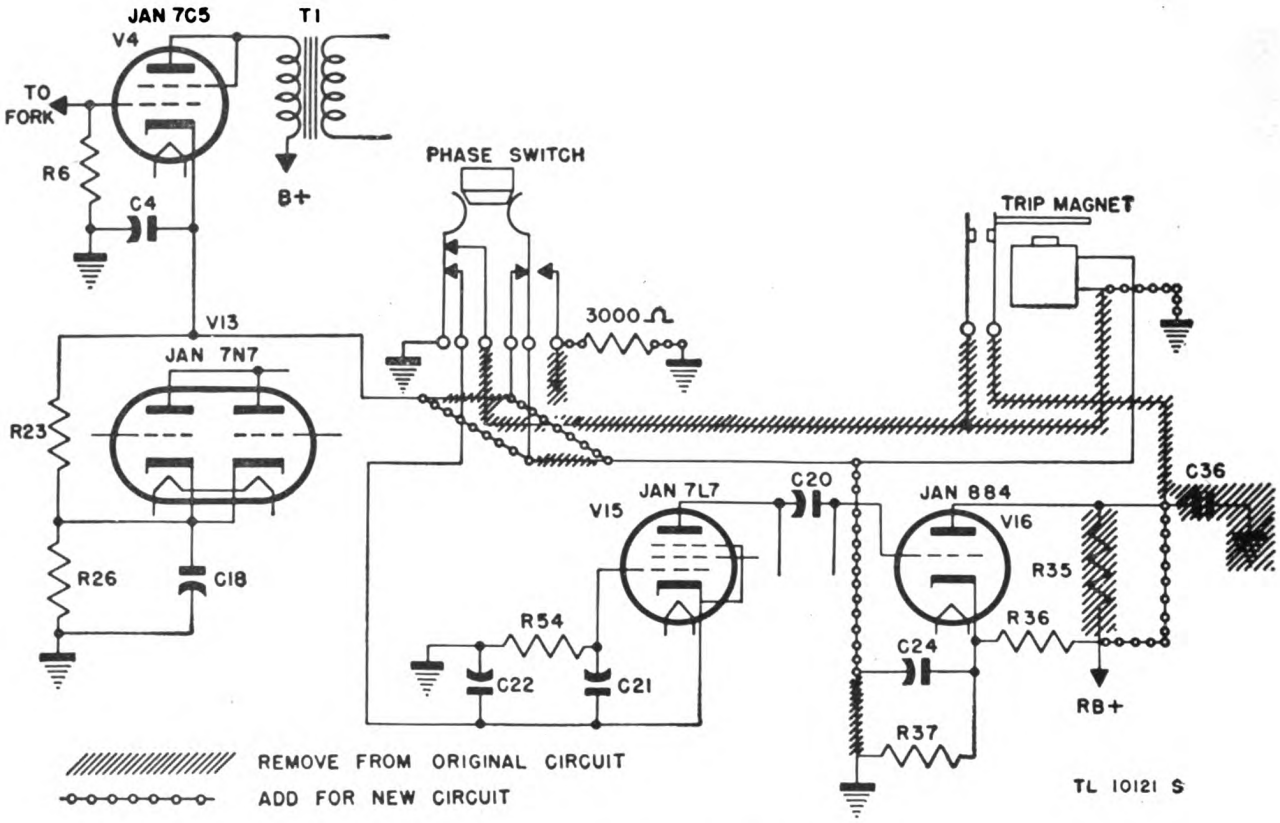
35. Drum

a. GENERAL. The drums originally supplied with Facsimile Transceivers FX–1 are constructed as illustrated by the 80 series drum. (See fig. 46.) An improvement in construction shown in the 90 series drum (fig. 46) was made for the purpose of reducing gear hash pattern (fig. 16). This is accomplished by decoupling drum sleeve A from the leadscrew driving system B and C by mounting the drum sleeve on bearings D and E. Bearing E at the left end is of the sleeve type, and bearing D at the right end is a ball bearing. The drum is driven through a small wire spring F. Slight vibrations originating in the gear drive are absorbed by the spring drive F, since drum sleeve A acts as a flywheel and will not respond to the fast vibrations.

Caution: Before assuming the drum is responsible for gear hash, make sure that the tubes in stages V10 and V11 (pars. 60 and 61) are not microphonic.

b. GEAR HASH. Failure of the drum decoupling system to operate properly may result in a gear hash pattern. The decoupling may be considered satisfactory if the drum will return to its normal position after being displaced either side of center. If the drum binds either side of the center position, correction may be made by washing the drum in dry-cleaning solvent (SD) and relubricating *immediately* with special preservative lubricating oil (PS 512).

c. HALF NUTS (par. 81 and fig. 46). The half



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Caution: Work on a synchronous motor should be done in a clean, dry place, free from dust. Disassemble and assemble motor parts with great care, avoiding risks of scratching and damaging any of the machined surfaces. Take care not to lose lower thrust bearing ball R (par. 76 and fig. 41) when disassembling the motor.

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Caution: Before assuming the drum is responsible for gear hash, make sure that the tubes in stages V10 and V11 (pars. 60 and 61) are not microphonic.

b. GEAR HASH. Failure of the drum decoupling system to operate properly may result in a gear hash pattern. The decoupling may be considered satisfactory if the drum will return to its normal position after being displaced either side of center. If the drum binds either side of the center position, correction may be made by washing the drum in dry-cleaning solvent (SD) and relubricating *immediately* with special preservative lubricating oil (PS 512).

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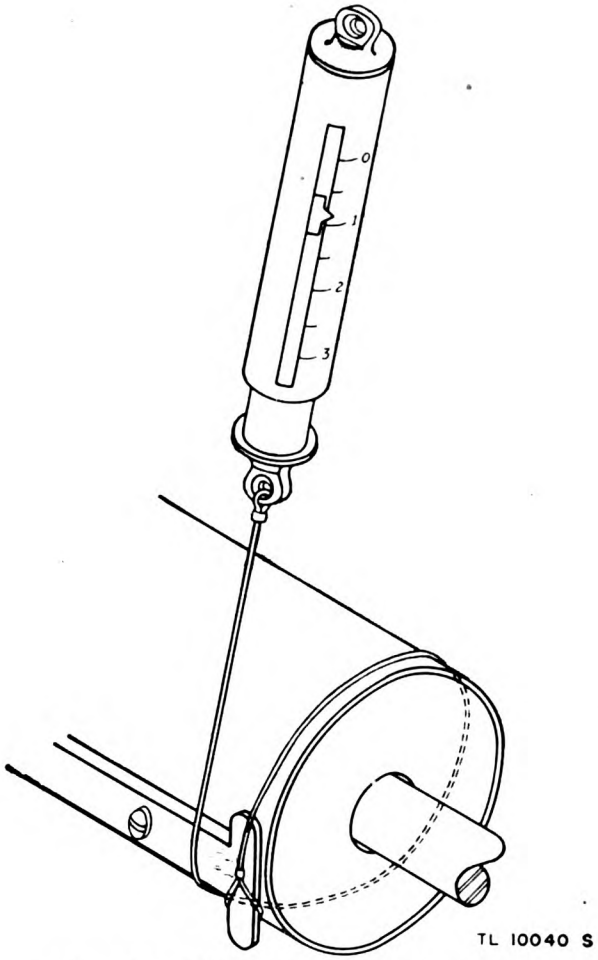

Figure 15. Method of measuring clutch tension.

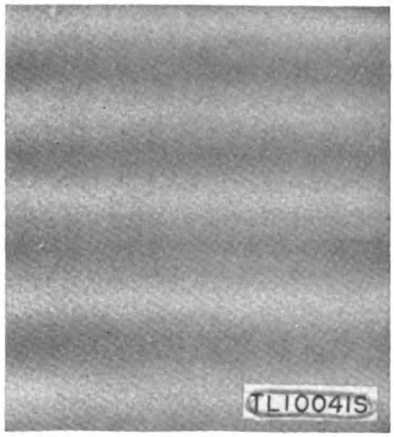

Figure 16. Exaggerated example of gear hash pattern.

nuts are machined in the drum, and it is improbable that half nuts from another set will mesh properly with the leadscrew. Replacement drums having serial numbers above 370, have half nuts that may be replaced by spares available at depots. The number is found on the cover plate at the right end of the drum. The letter markings must be matched up in making half nut replacements. (See fig. 46.)

d. Binding. If the drum tends to bind on the leadscrew when it is moved longitudinally along the leadscrew by hand, it is probable that the leadscrew is bent or nicked. Do not blame the cause of binding on the drum unless replacement of the latter clears the trouble. Binds can sometimes be cleared by flushing the drum bearings with dry-cleaning solvent (SD) and relubricating with special preservative lubricating oil (PS 512). To do this, first remove the drum from the leadscrew.

e. Jitters (fig. 11). If key B (fig. 46) is too loose and is free to move sidewise, there may be jitters in the recorded copy. If a replacement drum is not available, the excessive play may be taken up temporarily by squeezing in on the walls of retainer C.

36. Leadscrew

a. Cleaning and Lubrication. Thoroughly clean the leadscrew with dry-cleaning solvent (SD). The leadscrew should be removed when cleaning so that plunger F and spring G (fig. 45) may be cleaned and lubricated. Take great care not to scratch the threaded portion of the leadscrew. After cleaning, inspect the leadscrew for scratches and nicks. The inspection should be done with a magnifying glass. If nicks appear in the threaded portion of the leadscrew, the threads may sometimes be chased by a skilled machinist working with a hand tool. Any nicks or dents in the other portion of the leadscrew should be smoothed out with a fine oil stone. Examination of the leadscrew should include an inspection of ball K in the plunger assembly. The ball should be free of any flat spots, and should be tight in the assembly. Line feed patterns may result from a flat or loose ball. If the ball is loose, a skilled machinist can tighten the retainer by spinning.

b. Straightening Leadscrew. If the leadscrew runs eccentric by more than 0.003 inch, it can be straightened by setting the screw up between centers in the lathe and pressing against the high part with a block of wood. The pressing can be controlled by pushing the wood with the cross-feed. Be careful not to pass the critical point. By measuring the deflection on a scale of the compound feed, the amount can be gradually increased until the leadscrew runs true.

c. Keyway. Nicks in the keyway will cause jitters in the recorded copy. A nick can sometimes be smoothed out with a very fine three-cornered file; the file marks may be smoothed out with a fine stone.

d LUBRICATION. After a leadscrew has been cleaned, inspected, and repaired, lubricate lightly with special preservative lubricating oil (PS 32 or PS 512). Make certain that the plunger is lubricated and operates freely.

37. Dynamotor

a. GENERAL. The dynamotor, under normal conditions, is seldom used. There is, therefore, very little probability that it will develop any defects. The brushes have a life of approximately 2,000 hours. Except in rare instances, the life of the bearing should be greater than the life of the brushes.

b. REPLACEMENT OF BRUSHES. There is a possibility of brushes sticking in the holder or developing weak springs. In such cases, it will be necessary to remove the brushes for cleaning or replacing. If the brush caps are cemented in place with blue glyptal, heat them with a soldering iron before attempting to unscrew them. If the heating does not sufficiently loosen the glyptal, try to soften with lacquer thinner or paint remover. Do not attempt to remove the cap if exceptional force is required, as this may rotate the entire brush holder assembly.

c. GROUNDING STRAPS. Replace any grounding straps that are frayed or that appear to be breaking up. Grounding straps are not provided on sets having serial numbers below 125.

38. Transmitter Optical System (pars. 82 and 83 and figs. 47 and 48)

a. GENERAL. The cause of insufficient light on the photocell will in most cases be dirt on lenses or poor adjustment of the optical system. Before tracing for troubles, clean and adjust the system in accordance with paragraph 38*c* and *f*.

b. INSPECTION. The following points in the transmitter optical system must be examined for defects before starting any repair work.

(1) *Exciter lamp.* Sometimes the exciter lamp has a poor internal contact which causes it to flicker. Try a second lamp known to be good to determine whether the first lamp is at fault.

(2) *Lamp holder.* The bakelite clamp must hold the lamp firmly to the part. Replace any burred clamp screws. Filister-head screws are more serviceable than roundhead screws.

(3) *Capacitor lens.* Examine the capacitor lens for dirt and fitting in the mount.

(4) *Objective lens barrel.* Inspect the objective lens for dirt and fittings in the mount. The barrel must not be loose in the block. Inspect the lens for defects. It may be necessary to remove the lens barrel. If the cementing between the elements of the lenses appears to be fernlike when examined under a magnifying glass, the lens should be replaced. If any other defects appear under examination with a magnifying glass, replace the lens unless the defects occur at the outer rim of the lens.

c. CAPACITOR LENS. Normally, the capacitor lens may be cleaned sufficiently for operation by dusting off the top surface and wiping with a soft cloth. It is this top surface that collects most of the dirt. If the lenses are fogged inside, they must be removed. The nut is cemented in place with glyptal, which must first be loosened with a solvent such as Glyptal thinner or paint remover. Use a form tool as shown in figure 66 for unscrewing the nut. Be careful not to damage the paper washers which help to hold the lenses in place.

d. OBJECTIVE LENS. The objective lens must not be removed unless it is deemed necessary to make a replacement because of cracked element or cracked cementing. Cleaning of the front surface of the lens may be accomplished without removing the barrel. To remove the objective lens, first remove the entire barrel. In removing the barrel, unloosen locking screw R. (See fig. 47.) From sheet metal, form a screwdriver or spanner wrench tool, as shown in figure 66. Do not attempt to use a single pointed screwdriver as it is apt to slip and scratch the lens. Try to break the nut loose without using a solvent. Solvent will damage the cement between the lens elements. If it is necessary to use a solvent, use it very sparingly, keeping the lens barrel in a vertical position with the lens down.

e. PHOTOCELL. Do not remove the photocell unless there is good reason to suspect replacement is necessary. (See par. 43*c*.)

f. ALIGNMENT AND ADJUSTMENTS OF EXCITER LAMP AND CAPACITOR OPTICAL SYSTEM. Adjust the exciter lamp mounting bracket so the light beam appears to strike a spot on the drum directly in alignment with the lens barrel. Set the photocell lens barrel A (fig. 47) with dot U or line marker in the top position. If the lens barrel has been removed and the focal point is not known, set the barrel back so that the lens is ⅛ of an inch back from the front panel. Tighten clamp screw R. (See fig. 47.) Wrap a piece of white paper around the drum; set the selector switch for TRANSMIT; set the contrast control about five points higher than the balance point for negative transmission; set the GAIN control at 100.

(1) Loosen the lockscrew clamps on the bakelite lamp holder and adjust the filament alignment of lamp C (fig. 48); move the socket up and down in

the holder until the maximum meter reading is obtained. If there is no meter reading, loosen the lockscrew and move the lamp holder sideways.

(2) If the capacitor lens system has been removed so the alignment is uncertain, loosen the mounting screws and move the lens system sidewise for maximum reading.

(3) With the drum rotating, refine the adjustments of the eccentric screws. Adjust for the steadiest signal. If at any time during the adjusting procedure, the meter reads above +2, adjust the gain control to bring the reading in the range between −4 and +2.

g. Alignment and Adjusting of Photocell Lens Barrel. Remove the white paper from the drum and replace with a sheet of 65-line half-tone or very fine print. The 65-line half-tone copy may be obtained from large newspaper photographs having light gray or white background. Connect a headset across the db meter. Listen to the signal as the drum rotates; move the lens barrel in and out until the sharpest and loudest modulation tones are heard. Keep the line or indicator U in the top position. Again refine the adjustments of the exciter lamp position. Replace the white sheet on the drum for a final check.

39. Recorder Optical System (par. 84 and fig. 49)

a. General. Failure to obtain recordings of sufficient density will in most cases be traced to a weak recorder lamp. Make a test with a replacement lamp and check the current going through the lamp (par. 22*a*) before suspecting faults in the optical system.

b. Cleaning Lenses The lens surface, with the exception of the front face of the objective lens E (fig. 49), are protected. The dust can be removed, in most cases, with a camel's-hair brush without having to tamper with the adjustments of the optical system.

c. Recorder Lamp Replacement. The recorder lamp can be replaced, without removing the recorder lamp optical system from its bracket, in the following manner:

(1) Remove push-on connectors from recorder lamp A.

(2) Remove four screws B at the rear of recorder optical system.

(3) Remove the pressure plate C and the retainer cup D.

(4) Carefully pull lamp A out of optical system. If the lamp comes out without a rubber ring F around the bulb, remove rubber ring from the inside of the optical system.

(5) Place the rubber ring F on the bulb of the new recorder tube and reassembly the system, leaving the four pressure plate screws loose.

(6) Connect the recorder tube leads to the prongs, the red lead (+) going to the No. 7 prong, which is nearest the aligning projection.

(7) Connect the UC coupling coil to the transceiver and place the coil on the front of the top left-hand side of the transceiver.

(8) Turn the selector switch to RECORD PHOTO.

(9) Adjust the GAIN control and the position of the UC coupling coil until the meter reads about +2 db.

(10) Move the drum to the extreme right and shade the transceiver from direct light; slip a piece of thin tissue paper or a piece of undeveloped film in front of the recorder optical system, close to the objective lens. A ring of light should be visible on the tissue or film, as the case may be. This ring must be within the field of the lens, preferably in the center. If the light is off to one edge so that some of the light is being cut off by the lens barrel or is not visible at all, orient the recorder tube by pressing on the retainer cup in different directions so as to center the ring of light well within the confines of the objective lens. Once the ring of light is centered, the pressure of plate screws should be tightened progressively and the ring of light rechecked. If there is a clamp under one of the pressure plate screws, the recorder tube wires should be placed under the clamp in such a manner that they are captive but free enough to slip so as to prevent cutting of the insulation.

Caution: 250 volts direct current on recorder tube terminals.

d. Testing Alignment of Recorder Optical System. Set up for photographic reception and make a test run on photographic paper or film. One minute of recording is required at the following levels: −4, −2, 0 and +2 db. Develop the exposed paper, examine it under a magnifying glass and note how the rectangular images stack up on one another in sharpness and size. (See fig. 13.) When in proper adjustment, the rectangles just touch one another on all four sides. If the rectangular images are not obvious to the naked eye at 8 to 10 inches distance, the image can be considered satisfactory. If the rectangles are obviously undersize or oversize, it will be necessary to readjust the lens barrel.

e. Alignment of Recorder Optical System. Loosen locking ring I (fig. 49) and turn adjusting

ring G and lens barrel H, two turns in the proper direction. If the rectangles are too small, turn the lens barrel into the housing. If they are too large, turn the lens barrel out of the housing and tighten the locking ring. Move the drum to the extreme left and place a thin negative on the drum so that the negative is perfectly tight and extends about ¼ inch over the right-hand edge of the drum, keeping the emulsion side out. Adjust the transceiver so that the meter reads +2. The image of the rectangle should be visible on the film beyond the edge of the drum. If it is not visible, push the drum to the left. It may be necessary to remove the motor housing and press the upright part of the chassis to the left in order to get a good image. If the readjustment has caused the image to go out of focus, it will be necessary to loosen the screw in clamp L which supports the optical system. Carefully slide the optical system back and forth until the image is sharp. A magnifying glass is necessary to see the image clearly. It may be necessary to repeat this image size adjustment several times to get satisfactory results. Care must be taken, when adjustments are made, to tighten the screws and locking rings securely after each adjustment. The long dimension of the rectangular image must lie along the length of the drum. When making the focus adjustment, the optical system tends to turn, since it is being moved in and out of the clamp. The direction of the image must therefore be restored to its original position.

40. Motor Amplifier (pars. 56 and 57 and figs. 21 and 22)

a. Input Stage, V4. The cathode bias for V4 (par. 56) is developed across the resistors R23, R26 (fig. 28) and the trip magnet coil (par. 66). These resistors are associated with stage V13. (See par. 63.) The value of R23 may be altered to improve the direct recording. Before changing any resistors, make certain that the tubes involved are not defective and that the resistance of other resistors in the circuit are correct. Transformer T1 is a class B driver transformer and may be replaced with any similar transformer which will fit in place. In making a replacement, try reversing the direction of current through the primary winding to obtain the maximum current in the motor circuit.

b. Output Tube Stage, V5 and V6. There have been instances of flash-overs in the sockets of stages V5 and V6 (par. 57). Do not attempt to clear the trouble by scraping away the carbonized portion of the sockets. They must be replaced with new ones. The work must be done very carefully and inspected thoroughly for good joints, loose strands, and loose solder. If the plate circuit becomes shorted to ground either through the socket, wiring, or tubes, the motor will burn out if the power is left on for more than a few seconds.

Caution: Under normal operating conditions, the a-c voltage across T6 is approximately 800 volts. Because of the high voltage, considerable care must be taken when testing the circuit with the power on.

c. Filter. A high voltage leak in choke T6 or capacitor C6 may not interfere with the operation of the synchronous motor but will cause disturbances in nearby radio-receiving equipment. In such cases, the choke or capacitors must be replaced. A short to ground in this filter circuit will cause the synchronous motor to burn out.

d. Motor Jack. The input circuit includes the motor jack which may give contact trouble. The contact pressure can be increased by bending the springs with long-nose pliers.

e. Alignment. With 16 volts on grid 6 of V4, the direct current in the synchronous motor as measured in paragraph 20*b* should be between 85 and 110 ma. If the input voltage is not right, it may be adjusted by changing R6 to a higher or lower value. If the voltage is not correct as indicated by the signal tracing chart, first try changing tubes. The current measurements are to be made with the motor running.

41. Fork Oscillator Unit (pars. 53, 54, and 55 and figs. 18, 19, and 20)

a. Requirements. The fork oscillator unit is designed to supply a 1,800 cycle signal of extreme accuracy. This signal supplies and controls three circuits: first, is the motor amplifier. Second, the rectifier power supply; this signal is taken from the same connections at the fork unit. In the rectifier power supply, the signal is amplified to operate the exciter lamp. Third, it supplies the signal for the bridge circuit of the photocell modulator. This signal must be free from harmonics and must not be influenced by variations in the motor circuit. Therefore, the amplifier stage supplying this signal is isolated from the stage supplying the other two signals. The harmonics are eliminated in output transformer T5 which is shunted with capacitors on the primary and secondary sides.

b. Over-all Function. Assuming the tuning fork is oscillating, a voltage will be induced in the pick-up coil because its core includes a permanent magnet. The flux will therefore vary as the tine of the fork oscillates. Approximately 0.4 volt is generated across the pick-up coil. Step-up trans-

former T4 (par. 53) delivers approximately one volt to the grid of V1. This is a voltage-amplifier stage which develops approximately a sine wave signal across plate resistor R41. Coupling capacitor C26 passes the signal to the grid of the output stage feeding the motor circuit. This stage has a limiting resistor R48 (par. 55) in series with grid 4. In case the grid is driven positive, the resistor prevents the load from reflecting to the plate circuit of V1. The other side of the dual triode tube of the V3 stage (par. 55) amplifies the signal for the photocell bridge circuit (par. 73). The grid of this stage receives its signal from transformer T4. Coupling capacitor C27 passes the signal from input stage V1 to the grid of the drive stage (par. 54). This is called a drive stage because its output supplies power to the drive coil of the fork unit. For constant frequency operation, it is necessary that there be no variation in the drive power. To keep variations to a minimum, the drive stage is saturated by applying excessive signal to the grid. The RB+ voltage must not vary more than ±5 volts. The oscillator unit is carefully calibrated at the factory. However, small adjustments may be made in the field by varying cathode resistor R45. There is enough adjustment available to compensate for minor changes due to ageing of tubes, new tubes, and small differences in the RB+ voltage that may result from changes in the regulator circuit caused by ageing of tubes, ageing of regulator lamp, new tubes, or new regulator lamp.

c. Replacement. Since it takes very little to upset the frequency of the fork oscillator unit, it is not practical in most cases to make repairs in the field. Under emergency conditions, it may be necessary to attempt repairs which may or may not be successful. Component replacements which will seriously affect the frequency are T4, R39, R41, R46, and C25.

42. Phasing Amplifier (pars. 65 and 66 and figs. 30 and 31)

a. General. The phasing amplifier is inoperative except during the phasing operation. When the phase button is depressed, the input signal is picked up across cathode resistor R30 (par. 65) of V14 (par. 64). The signal is rectified by recorder lamp R1130 in the plate circuit.

b. Pulse Filter. The phasing pulse (which is represented by a dip in a steady 1,800-cycle signal or an increase in a steady 1,800-cycle signal) is smoothed out into a d-c pulse by the action of smoothing capacitor C22, which has a capacity of 10 microfarads (mf). In case of failure and if an exact equivalent is not available, a replacement may be made with a capacitor having a value between 10 and 50 mf. The voltage rating must be between 25 and 50 volts.

c. Stage V15. The input stage V15 (par. 65) is a voltage amplifier. The signal is applied to the cathode. The grid is at ground potential. This must be taken into account in tracing trouble since it is frequently a cause of confusion.

d. Stage V16, Original Circuit. As the strength of the pulse increases, a positive potential is applied to the grid of the thyratron (884) (par. 66) causing current to flow in the plate circuit. The positive voltage develops at the beginning of the phasing pulse *when transmitting for negative reception.* At this time, the signal level increases, scanning from black to white. The positive pulse is generated immediately *after* scanning the phasing pulse *when transmitting for positive reception.* At this point, the signal increases when scanning from white to black. It is therefore obvious that the exact phasing point for negative recording is displaced from the exact phasing point for a positive recording by the length of the phasing pulse. The drive dog (par. 80) must be so positioned that it will split the two pulses (positive and negative) evenly on each side of center. When the phase button is depressed, the RB+ voltage passes through the trip magnet to the plate of the 884, provided the contacts controlled by push rod J (fig. 42) in the armature are closed. The contacts are closed when the drum is in position for phasing. The contacts are opened immediately after phasing, thus breaking the plate circuit of the 884. Once plate current flows in a thyratron, the grid is powerless to stop the flow. It is necessary to reduce the plate-to-cathode potential below a certain critical value. In the FX–1 this is done by breaking the plate circuit since other means were not found reliable with the 884 tubes manufactured at the time the FX–1 was designed. With tubes of the present standards, it is generally safe to depend upon the excessive cathode bias to reduce the plate-to-cathode potential below the critical value. The contacts may therefore be shorted out. A more reliable method is that used in a later model, FX–1–B, as shown in figure 14.

e. Stage V16, FX–1–B Circuit. The FX–1–B phasing circuit is shown in figure 14. In this circuit, the plate is connected directly to RB+. When current flows through the plate, it must pass through the cathode circuit. The low impedance path to the cathode is through the phase magnet and capacitor C24. Before phasing, one side of

former T4 (par. 53) delivers approximately one volt to the grid of V1. This is a voltage-amplifier stage which develops approximately a sine wave signal across plate resistor R41. Coupling capacitor C26 passes the signal to the grid of the output stage feeding the motor circuit. This stage has a limiting resistor R48 (par. 55) in series with grid 4. In case the grid is driven positive, the resistor prevents the load from reflecting to the plate circuit of V1. The other side of the dual triode tube of the V3 stage (par. 55) amplifies the signal for the photocell bridge circuit (par. 73). The grid of this stage receives its signal from transformer T4. Coupling capacitor C27 passes the signal from input stage V1 to the grid of the drive stage (par. 54). This is called a drive stage because its output supplies power to the drive coil of the fork unit. For constant frequency operation, it is necessary that there be no variation in the drive power. To keep variations to a minimum, the drive stage is saturated by applying excessive signal to the grid. The RB+ voltage must not vary more than ±5 volts. The oscillator unit is carefully calibrated at the factory. However, small adjustments may be made in the field by varying cathode resistor R45. There is enough adjustment available to compensate for minor changes due to ageing of tubes, new tubes, and small differences in the RB+ voltage that may result from changes in the regulator circuit caused by ageing of tubes, ageing of regulator lamp, new tubes, or new regulator lamp.

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42. Phasing Amplifier (pars. 65 and 66 and figs. 30 and 31)

a. GENERAL. The phasing amplifier is inoperative except during the phasing operation. When the phase button is depressed, the input signal is picked up across cathode resistor R30 (par. 65) of V14 (par. 64). The signal is rectified by recorder lamp R1130 in the plate circuit.

b. PULSE FILTER. The phasing pulse (which is represented by a dip in a steady 1,800-cycle signal or an increase in a steady 1,800-cycle signal) is smoothed out into a d-c pulse by the action of smoothing capacitor C22, which has a capacity of 10 microfarads (mf). In case of failure and if an exact equivalent is not available, a replacement may be made with a capacitor having a value between 10 and 50 mf. The voltage rating must be between 25 and 50 volts.

c. STAGE V15. The input stage V15 (par. 65) is a voltage amplifier. The signal is applied to the cathode. The grid is at ground potential. This must be taken into account in tracing trouble since it is frequently a cause of confusion.

d. STAGE V16, ORIGINAL CIRCUIT. As the strength of the pulse increases, a positive potential is applied to the grid of the thyratron (884) (par. 66) causing current to flow in the plate circuit. The positive voltage develops at the beginning of the phasing pulse *when transmitting for negative reception.* At this time, the signal level increases, scanning from black to white. The positive pulse is generated immediately *after* scanning the phasing pulse *when transmitting for positive reception.* At this point, the signal increases when scanning from white to black. It is therefore obvious that the exact phasing point for negative recording is displaced from the exact phasing point for a positive recording by the length of the phasing pulse. The drive dog (par. 80) must be so positioned that it will split the two pulses (positive and negative) evenly on each side of center. When the phase button is depressed, the RB+ voltage passes through the trip magnet to the plate of the 884, provided the contacts controlled by push rod J (fig. 42) in the armature are closed. The contacts are closed when the drum is in position for phasing. The contacts are opened immediately after phasing, thus breaking the plate circuit of the 884. Once plate current flows in a thyratron, the grid is powerless to stop the flow. It is necessary to reduce the plate-to-cathode potential below a certain critical value. In the FX–1 this is done by breaking the plate circuit since other means were not found reliable with the 884 tubes manufactured at the time the FX–1 was designed. With tubes of the present standards, it is generally safe to depend upon the excessive cathode bias to reduce the plate-to-cathode potential below the critical value. The contacts may therefore be shorted out. A more reliable method is that used in a later model, FX–1–B, as shown in figure 14.

e. STAGE V16, FX–1–B CIRCUIT. The FX–1–B phasing circuit is shown in figure 14. In this circuit, the plate is connected directly to RB+. When current flows through the plate, it must pass through the cathode circuit. The low impedance path to the cathode is through the phase magnet and capacitor C24. Before phasing, one side of

capacitor C24 is at cathode potential and the other side at ground potential. After the capacitor is charged, the impedance of the cathode circuit is very high and the plate current ceases to flow. A failure of capacitor C24 will cause current to flow in the plate circuit at all times. This condition is indicated by the glow in the thyratron tube. The normal bias voltage is controlled by the voltage bias resistors R36 and R37. If the trip magnet fails to operate and no discharge glow is noted in the thyratron tube, try another tube before tracing trouble in the trip magnet.

43. Photocell Circuit (par. 73 and fig. 38)

a. Resistance and Voltage Measurements. With the power turned off, measure all resistances, referring to paragraph 73, for resistance information. Check potentiometer R11 for good contact between the contact arm and resistor. A poor contact in a machine that has been standing idle for some time can be cleared by rapidly rotating the CONTRAST control back and forth 15 or 20 times.

b. Switching Circuit. With the selector switch in SET RANGE or STANDBY position, any unbalances in the bridge circuit develops a voltage across R13 which is applied to grid 6 of V10. (See par. 60.) In tracing circuit continuity, switch 1L must be taken into account.

c. Trimmer Capacitor C8. Photocell type 1645 is provided with one working anode and one balancing anode which is placed behind the plate. The capacitance between cathode and each anode should be equal. Since the capacitance cannot be controlled accurately enough in manufacturing, a small amount of capacitance is generally inserted between cathode and the anode having the lowest capacitance. Balancing capacitor C8 consists of a small plate or wire attached to the cathode pin and directed to the pin of the anode requiring the added capacitance.

d. Adjusting Photocell Balance. If the db meter does not register sufficient contrast between black and white, or if the minimum reading (balance point) on either black or white does not appear at −10 db or lower, balancing capacitor C8 may need adjusting. Set the selector switch on SET RANGE and adjust the CONTRAST control to dip on black of the phasing ring. Have the GAIN control set high enough to get a good indication on the meter. Remove the pan from the base of the photocell and reset it to act as a shield. (See fig. 17.) Connect the ground wire back to the post. Using a nonconducting aligning tool, vary the spacing of copper strip capacitor C8 to the anode. Watch the db meter and adjust the capacitor for minimum meter reading. After each movement of the capacitor strip, rebalance for dip with the CONTRAST control. It is possible to obtain an absolute minimum by proper adjustment of C8 with the scanning beam on black, but a compromise is generally desirable so that proper contrast may also be obtained for positive transmission. Therefore, check the balance with the scanning beam on white of the phasing ring. When doing this, it will be necessary to swing the CONTRAST control for minimum reading and then readjust the capacity of C8 to further decrease the reading. Several repeats of these operations, balancing on black and then white, will be necessary until optimum adjustment is obtained. It is recommended that the cell be adjusted for at least 15 db contrast when set on either black or white for best results. Insufficient contrast may also be caused by an improperly adjusted exciter lamp. The exciter lamp should be checked before working on the photocell.

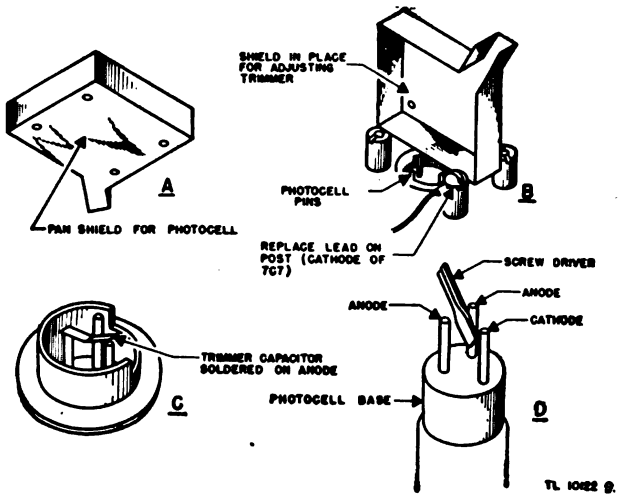


Figure 17. Adjustment of trimmer capacitor on photocell.

e. Replacing Photocell. Unless the photocell is broken physically, there is extremely little probability that it will ever need replacing since it is operated at 0 d-c potential. However, if the cell is to be replaced, remove the pan (par. 82) from the bottom and unsolder the wires from the pins of the cell, observing carefully which wire goes on which pin. Remove shield ring F from the base of the cell by means of the three screws through the flange. Remove cell L and note the position of sponge rubber rings G and H. Before handling the new cell or the old cell (if it is to be replaced), wash and dry your hands. The cell must not be handled, particularly around the base, if your hands are perspiring. The cell to be installed should be wiped off, prefera-

bly, with a little cotton moistened in alcohol. Place the rubber rings on the cell and pack them into place as the cell is replaced. Be sure that the front of the cell lines up with the scanning beam. Replace the shield ring and connect the wires to the pins. It will be necessary to determine which anode requires the trimming capacitor. To do this, temporarily mount the shield pan as shown in part B of figure 17. Turn on the power, flick the selector switch to SET RANGE, the GAIN control to 100 and the CONTRAST control to 50. Have the scanning beam on black of the phasing ring. Using a small screw driver with an insulated handle, place the blade on one anode-pin end and point it towards the cathode as illustrated in part D. (See fig. 17.) Repeat this test on the other anode. The anode requiring the trimmer capacitor will be indicated by a drop in level on the meter. The small copper capacitor plate may now be soldered directly to the top of the proper anode as illustrated in part C. (See fig. 17.) The cell may then be balanced as described above.

44. Signal Amplifier (pars. 73, 60, 61, 62, 63, and 64 and figs. 38, 25, 26, 27, 28, and 29)

a. General. The alignment of the signal amplifier involves nothing more than step-by-step checks of signal voltage and waveform. If there is any deviation from the voltages in the signal tracing chart (fig. 8), or if there is any tendency for the signal to flatten as shown by the oscilloscope, the faulty stage must be located and corrective measures taken. All parts may be replaced with approximate equivalents with the exception of transformer T2. In emergencies, this transformer can be replaced with a driver transformer, such as the one designed to operate into a tube 6N7 or a pair of tubes 6V6. Such a transformer should have a ratio of 1 : 1½ for full secondary. Connect one-half of the low impedance secondary of a driver transformer to terminal positions No. 1 and 2. The other half of the secondary is left open.

b. Cathode Bypass Capacitor C10 (par. 60). Cathode bypass capacitor C10 may be replaced by a capacitor having a 0.5 mf instead of 10 mf, the capacitance of the original capacitor. The connector leads to the capacitor will pick up stray fields which will be amplified sufficiently to produce fork beat unless care is taken to keep the leads short and properly placed to avoid pick-up. The stray field which causes the trouble comes from the motor circuit. The effect is seen in the recorded pictures as wide, gradual changing streaks. The number of streaks depends upon the difference in frequency between the fork in the transmitting receiver and the fork in the recording transceiver. The effect is produced only by the recording transceiver. To test the installation of the replacement capacitor, set the fork frequency control of the set under test to the top or the bottom of the dial. Note the reading of the dial before making the change so the original setting may be replaced after the test has been made. Send a steady tone from the transmitting transceiver and turn its GAIN control almost to zero. Adjust the gain control of the set under test to get a 0-db meter reading with the selector switch set at RECORD PHOTO. If the GAIN control reading is less than 75, shunt the connection between the two sets until it is necessary to set above 75. Fork beat will show up on the meter. Make connection adjustments until it is reduced to less than 1 db.

c. Stylus Transformer. Stylus transformer T3 (par. 64) should be replaced with an exact equivalent. In an emergency, a driver transformer, such as the one designed to operate into a pair of tubes 6V6 or a tube 6N7, will serve the purpose. The voltage break-down rating should be above 2,000 volts. If a line-to-line transformer is used, the recording will not be at full density.

d. Stylus Filter. R-f choke T7 (par. 64) and capacitor C19 constitute a low-pass filter to suppress high frequencies developed by the spark at the stylus. Failure to properly suppress the high frequencies will cause poor recording. This is due to the high frequencies feeding back into the input circuits. The high frequencies will also cause radio interference. A 2,000-ohm, 2-watt carbon resistor, instead of choke T7, has been found to be more satisfactory. Further improvement may be realized by putting a 1,000-ohm, 1-watt carbon resistor between capacitor C19 and the stylus.

45. Selector Switch (par. 62)

a. General. The switch wafer-shaft assembly is so constructed that there is a danger the shaft may fall out of its socket. After replacing, cement the spring ring into place with gasket shellac or Glyptal.

b. Wafer Replacements. If a wafer is defective, it is easier to replace the defective wafer than to replace the entire switch and cable assembly. At the factory a special wrench (see fig. 69) is used for removing the nuts of the entire switch assembly. Similar socket wrenches may easily be made in the field. If materials are not available, long-nose pliers will serve the purpose.

c. Stylus Actuating System. After repairing the switch, make certain that the adjustments of

the stylus actuating system have not been upset. If the stroke is too short or too long, make correction by bending the actuating arm attached to the selector switch.

46. Meter Circuit (par. 62 and fig. 27)

a. No Reading. Failure of the meter to operate may be due to an open circuit in the cord connecting the meter to the terminal board. If a replacement cord of the same type is not available, use any light cord that will easily fit into the meter box.

b. Meter Alignment. If the meter readings are not correct as explained in paragraphs 22 and 23, check the resistance of R29 and R56 (par. 62). If the value of these resistors is found to be correct, that is, within 10 percent of rating, select a value in the rating range to get the required reading.

47. Voltage Regulator (pars. 58 and 59 and figs. 23 and 24)

a. Regulator lamps are now designated as 1B46/R1160A. The range of the 1B46/R1160A is 79 to 85 volts. When used as a replacement for the R1160 or ¼-w neon lamp, file off the pin nearest the bulb. In placing the lamp in the socket, file off the top locating-pin, leaving only the bottom one. Hold the lamp with the bottom toward you so that the remaining pin points to the left. In this position the upper contact is the anode (+). Insert the lamp into the socket so that the anode contact faces the + sign or the red dot painted on the socket. If there is no indicator, try each slot and examine the glow in the regulator lamp. The glow will concentrate on the wall of the small nickel sleeve in the lamp when it is in the correct position in the socket.

Caution: Do not remove regulator lamp or tube V7 with power on. If this is done, RB + voltage will rise to approximately 350 and may damage components.

b. Tube V7 is a critical factor in the voltage control. There are times when it may be easier to select a tube V7 than to select a voltage regulator lamp to produce desired output voltage.

c. Oscillations may develop in the regulator circuit at low-line voltages. Oscillations are sometimes aggrevated by a feedback condition. Sometimes feedback can be remedied by separating the grid leads of tube V7 from the plate and the grid leads of the other tubes.

d. If capacitor C3 becomes defective, it may be removed; that is, no replacement is necessary. (In later models, this capacitor is not used.)

48. Rectifier Power Supply (par. 71 and fig. 36)

a. Power Transformer T11. The original transformer used in Facsimile Transceiver FX–1 was the Kenyon T246. This transformer may be used as a replacement. The filament winding feeding the transceiver unit will be overloaded. The term 246 has been applied to transformers built to replace the original one. The original T246 has two 6.3-volt, 3-ampere filament windings. The modified transformers have one 6.5-volt, 1.75-ampere and one 6.5-volt, 6.25-ampere filament windings. The modified transformers have been made by Super Electric and Electricoil. The Kenyon version is their S19165 and S20165. The filament windings of a replacement transformer may not be phased the same as the original. If the phasing is not correct, the motor starting voltage across terminals 5 and 8 (fig. 36) will be about 3 volts instead of the required 10. To phase the windings, remove the jumper wire from the 1.75-ampere winding and connect it to the other end of the same winding.

b. Chokes T12 and T13. These chokes may be replaced with close equivalents that will fit in the space available.

c. Capacitors 60, 61, and 62. These capacitors have a rating of 4 mf at 600 volts. Replacements should be made with capacitors having a rating of 1,000 volts. A capacity of 2 mf is sufficient.

d. Power Cable. If the power cable or Jones plug is damaged, a replacement may be made with a complete cable and plug assembly, available at Signal Corps depots.

49. Exciter Lamp Supply (pars. 67, 68, 69, and 70 and figs. 32, 33, 34, and 35)

a. Condition. Set the selector switch in SET RANGE or TRANSMIT position. Turn the power on. Measure the exciter lamp voltage at SEC 2 on transformer T15 (par. 69) with an a-c voltmeter set on the lowest scale which will read 6 volts. The reading should be between a 6.1- and 6.3-volt alternating current when the exciter lamp is lit. If the lamp is lit and the voltage is slightly low (5 to 6 volts alternating current), check output tubes V19 and V20. (See par. 69.) If the tubes are in good condition, readjust potentiometer R91. (See par. 67.) If correct voltage cannot be obtained, check the regulator lamp with a d-c meter having a resistance of 1,000 ohms per volt or higher. Set meter on the 250-volt scale and connect across terminal R1160A or terminal 1B47. The voltage should be between 75 and 90 volts direct current. If the reading is out of range, the tube should be

replaced. (See par. 51*d*.) If the regulator lamp is in good condition, check tube V21. Some help may be obtained by adjusting R82. If the output voltage is below 5 volts alternating current, check tubes V19 and V20. If tubes are in good condition, check the signal voltage on grids (6) of tubes V19 and V20. If the grid voltage is normal or above, transformer T15 is defective. (See signal tracing chart, fig. 9.) This transformer must be replaced with an exact equivalent. The exciter lamp may be checked by connecting the transceiver to a 6-volt battery.

Caution: If exciter lamp is removed, a replacement must be made before the power is turned on. Operation without an exciter lamp may cause damage to transformer T15.

b. Replacement Parts. Potentiometer R82 and R91 may be replaced with any close equivalent which will fit into the available space. Transformer T14 may be replaced with a conventional driver transformer having a ratio between primary and one-half the secondary ranging from 1:1 to 1:½.

SECTION VII
INDIVIDUAL STAGE AND CIRCUIT REPAIR DATA

50. General

a. Individual stage circuits and individual mechanical assemblies are illustrated in this section under separate paragraphs. Socket terminal resistance and voltage measurements are shown to aid trouble shooting within the stage, after the faulty stage has been spotted by previously described test procedures. Included in each paragraph is a parts list which contains information necessary for the procurement of replacements. For the purpose of illustrating functions, many parts are listed in the mechanical assemblies which are not available at depots.

b. Parts and stock numbers found in the stage data parts lists represent the recommended replacement parts rather than the parts originally installed in the equipment.

c. Final checks of suspected faulty components will, in most cases, have to be made by disconnecting both terminals of each circuit. With this procedure, each circuit will be tested independently and will avoid possible shunting or leakage effects of other components in the same circuit.

51. Component Replacements

a. Resistors. Resistance values shown in all circuit diagrams are the values designated for the original equipment. Some resistors may be found in the set which do not conform to the specified values. This is due to deviations that might have been made for the purpose of securing standard operational characteristics. Without the changes, these characteristics could not be obtained on account of uncontrollable variations in fork oscillators, photocells, and regulator lamps. In making replacements, be guided by circuit performance rather than specified resistance values. Many of the specified values are no longer standard in accordance with the new standardization program. In some cases, the new American War Standard values are indicated in the stage data parts lists. All ½-watt resistors may be replaced with ¼- or 1-watt resistors.

b. Capacitors. In the original equipment, several cathode bypass capacitors were high capacity electrolytics. It has been found, however, that all capacitors, except the C22 (see par. 42*b*) can be replaced with a 0.5-mf paper capacitor. Most 0.5-mf capacitors available in depots will not fit into the space provided for the original capacitors. All cathode bypass capacitors except C10 may be mounted at some convenient place on the chassis. Both leads must be wired back to the original connecting points. When replacing C10, follow instructions in paragraph 44*b*. C1 may be replaced with a capacitor having a capacity of 1 mf. It is explained in paragraph 47*d* that capacitor C3 may be omitted. Original capacitor C6 rated at 0.01 mf, 2,000 volts, proved unsatisfactory because of deterioration of the foil. Replace this capacitor with two 0.02-mf capacitors in series. The capacitors should have a 2,000-volt rating. If none are available, use 1,000-volt capacitors. There have been instances of failure of capacitors 60, 61, and 62 after aging. These capacitors should be replaced with new ones having a voltage rating of 1,000 volts. The capacity may be 2 mf instead of 4 mf. When installing oil-filled capacitors, take care not to strain the terminal when tightening up on the nuts. There is danger of breaking the oil seal.

c. Transformers. Transformers and inductors, in the original equipment, were made to commerical specifications. Most replacements stocked in depots are of the hermetically sealed type. These will fit in the space provided for the original units. The following notes repeat and supplement some of the information given in earlier paragraphs.

(1) Transformers T1 and T14 are not critical and may be replaced by any one of several types and makes of driver transformers stocked by depots. (See pars. 40*a* and 49*b*.)

(2) Transformers T2 stocked in depots are of the type manufactured for Facsimile Transceiver FX–1–B. Disregard SEC 2. (See par. 44*a*.)

(3) Transformer T3 is difficult to replace with anything but the specified replacement part. If emergency demands the use of a substitute, it probably will be necessary to mount the substitute part outside the case in order to avoid feedback into other circuits. (See par. 44*c*.)

(4) Transformer T4. (See par. 41*c*.)

(5) Transformer T5 may be replaced by a plate-to-line transformer that will fit the space provided. The new type of T5 transformer includes a low-pass filter section. When substituting the new type for the old, adjust the value of R59 to give the correct voltage into the cell circuit (par. 73). (See par. 41*c*.)

(6) Transformer T6. (See par. 40*c*.)

(7) Replace transformer T7 with a resistor. (See par. 44*d*.)

(8) Transformer T11. (See par. 48*a*.)

(9) Transformers T12 and T13 may be replaced with similar chokes having a current rating of about 250 ma. In an emergency, T12 may be dispensed with if the line voltage does not exceed 115 volts.

(10) Transformer T15. (See par. 49*a*.)

d. Regulator Lamps. Several types of regulator lamps were used in the original equipment. In extreme cases, the measured voltage drop across the lamps may be between 60 and 115 volts. If the RB+ voltage is between 240 and 260 volts, do not change the regulator lamp in the FX–1 unit. Do not change the regulator lamp in the PE-140 unit it its operation is normal. If a replacement is deemed advisable, follow instructions in paragraphs 47 and 49. If regulator lamps 1B46 and 1B47 are not available, the lamp R1160A should be used. Resistor R1 will have to be trimmed to bring the RB+ voltage in the proper range. Potentiometer R82 will have to be adjusted to secure proper regulation of the 6-volt power to the exciter lamp.

e. Recorder Lamps. Recorder lamps R1130 vary in length. In making a replacement, it may be necessary to increase or decrease the number of front spacers (fig. 84), when making a replacement with recorder lamp R1130A or R1130B. Make lamp replacements in accordance with instructions contained in paragraph 39.

f. Motors. Motors stocked in depots are of the high serial number group, starting with No. 401, which do not have the push rod and contact arrangement. When making a motor replacement, shunt out resistor R39 which is mounted in the chassis and use the one mounted in the motor. Follow instructions given in paragraph 34*h*.

52. Conditions of Test

a. General. The voltage and resistance measurements are made with the meter connected from the indicated socket lug to the chassis. The bottom view is shown. Unless otherwise noted, all tests are made with the tube in place and under the conditions indicated below.

b. Voltage Measurements. Use a 1,000-ohm-per-volt voltmeter, 250-volt scale.

(1) Set selector switch on RECORD PHOTO unless otherwise indicated.

(2) No signal input.

(3) Line voltage 115 (or make allowance in circuits affected by line voltage if it is higher or lower).

(4) Power switch set to ON position.

c. Resistance Measurements. Use the voltmeter type of ohmmeter.

(1) Power switch set to off position.

(2) Remove plug connection to rectifier power supply.

d. Capacitance Values. Capacitance values indicated in the diagrams are in mf.

e. Abbreviations. The abbreviation T. T. E. indicates Times Telephoto Equipment Inc.

53. Fork Amplifier, Input Stage (fig. 18)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V1	2J7L7	TUBE: JAN–7L7	Voltage amplifier.
R38	3RC21BF105K	RESISTOR, fixed: carbon; 1.0 meg, ±10%; ½-w	Grid current limiting resistor.
R39	3Z4526	RESISTOR, fixed: carbon; 2,000 ohms, ±10%; ½-w	Cathode resistor.
R40	3Z4533	RESISTOR, fixed: carbon; 500,000 ohms, ±10%; ½-w	Screen resistor.
R41	3Z6725–17	RESISTOR fixed: carbon; 250,000 ohms, ±10%; ½-w	Plate resistor.
R42	3RC21BF105K	RESISTOR, fixed: carbon; 1 meg ±10%; ½-w	Voltage divider.
C25	3DA100–94	CAPACITOR, fixed: paper; 100,000 mmf; 600 vdcw	Coupling capacitor.
C26, C27	3DA10–16	CAPACITOR, fixed: paper; 10,000 mmf; 600 vdcw	Coupling capacitor.
C28	3DA10–16	CAPACITOR, fixed: paper, 10,000 mmf; 600 vdcw	Screen bypass.
C29	3DA500–37	CAPACITOR, fixed: paper; 500,000 mmf; 400 vdcw	Cathode bypass.
C37	3D9100–24	CAPACITOR, fixed: mica; 100 mmf; 1,250 vdcw	Suppress high frequencies.
T4	2Z9633.7	TRANSFORMER, A-f: grid input; T. T. E. No. 90–11–03.	Grid input.
	(*)	DRIVE COIL, A-f: polarized electromagnet; 1,500 ohm approx.	Fork drive coil.
	(*)	PICK-UP COIL, A-f: magnetic type pick-up; 1,500 ohms approx.	Fork pick-up coil.
	2Z8678.60	SOCKET, tube: 8-contact; loktal; Cinch No. 6969	Tube socket.

*Not stocked by depots.

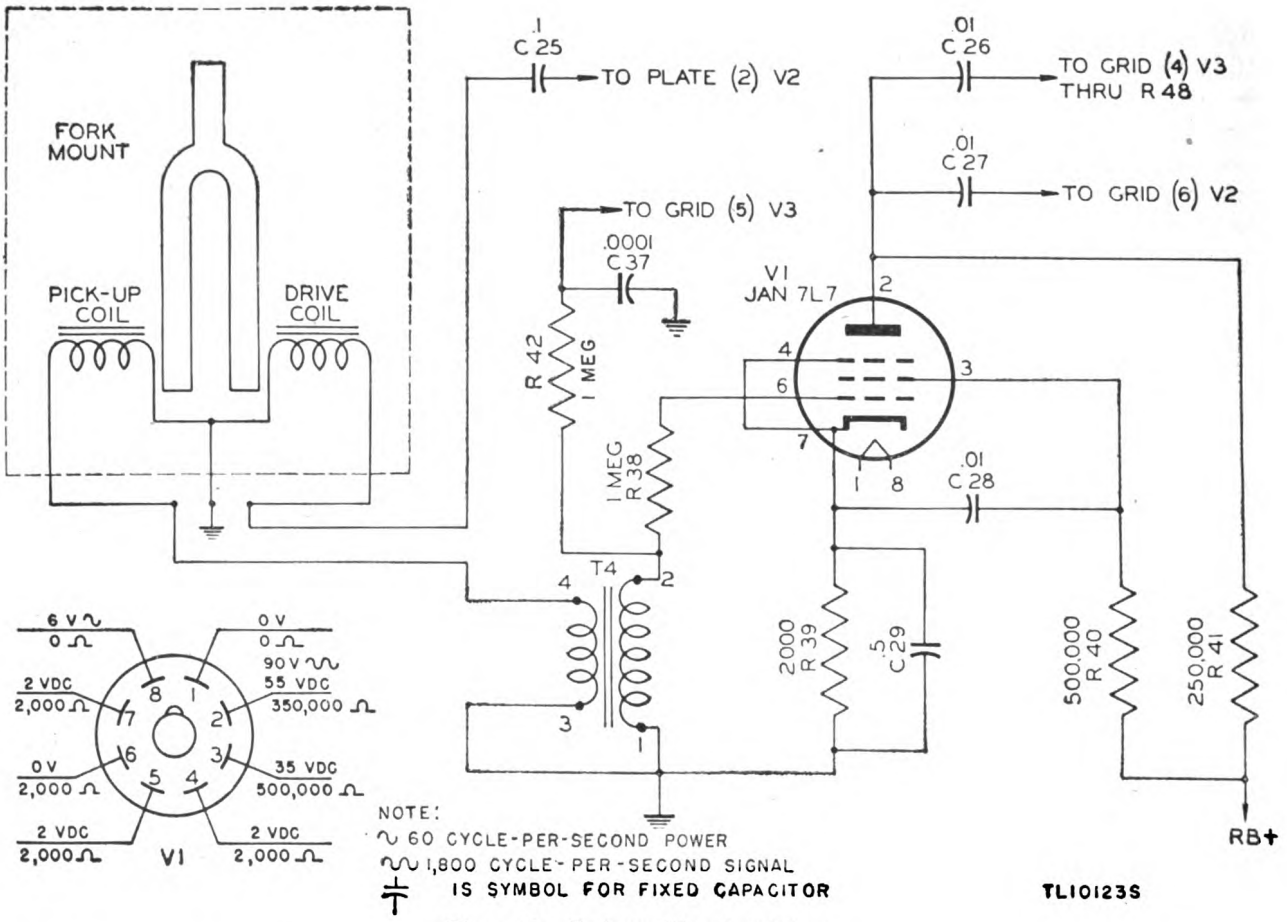


Figure 18. Fork amplifier, input stage.

54. Fork Amplifier, Drive Stage (fig. 19)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V2	2J7C5	TUBE: JAN–7C5	Fork drive.
R44	3RC21BF103K	RESISTOR, fixed: carbon; 10,000 ohms, ±10%; ½-w	Cathode resistor.
R45	2Z7281.51	RESISTOR, variable: wire-wound; 50,000 ohms; Clarostat No. P58; 3 terminals.	Frequency adjustment.
R46	3RC21BF39SK	RESISTOR, fixed: carbon; 40,000 ohms, ±10%; ½-w	Plate resistor.
R43	3RC21BF105K	RESISTOR, fixed: carbon; 1 meg, ±10%; ½-w	Grid resistor.
	2Z8678.60	SOCKET, tube: 8-contact; loktal, Cinch No. 6969	Tube socket.

55. Fork Amplifier, Output Stage (fig. 20)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V3	2J7N7	TUBE: JAN–7N7	1. Output to motor amplifier and rectifier power supply. 2. Output to photocell circuit.
R48	3RC21BF105K	RESISTOR, fixed: carbon; 1 meg, ±10%; ½-w	Voltage divider.
R49	3RC21BF154K	RESISTOR, fixed: carbon; 150,000 ohms, ±10%; ½-w	Grid resistor.
R50, R51	3RC20BF202J	RESISTOR, fixed: carbon; 2,000 ohms, ±10%; ½-w	Cathode resistor.
R52, R53	3RC20BF243J	RESISTOR, fixed: carbon; 24,000 ohms, ±10%; ½-w	Plate resistor.
R59	3RC20BF511J	RESISTOR, fixed: carbon; 510 ohms, ±5%; ½-w	Loading resistor.
C30	3DA500–37	CAPACITOR, fixed: paper; 500,000 mmf; 400 vdcw	Cathode bypass.
C31, C32	3DA10–16	CAPACITOR, fixed: paper; 10,000 mmf; 600 vdcw	Coupling capacitor.
C33	3DA100–94	CAPACITOR, fixed: paper; 100,000 mmf; 600 vdcw	Improve waveform.
C34	3DA20–58.2	CAPACITOR, fixed: paper; 20,000 mmf; 600 vdcw	Improve waveform.
T5	2Z9632.22	TRANSFORMER, a-f: output; T. T. E. No. 3154. See paragraph 41c.	Output coupling transformer to photocell circuit.
	2Z8678.60	SOCKET, tube: 8-contact; loktal; Cinch No. 6969	Tube socket.

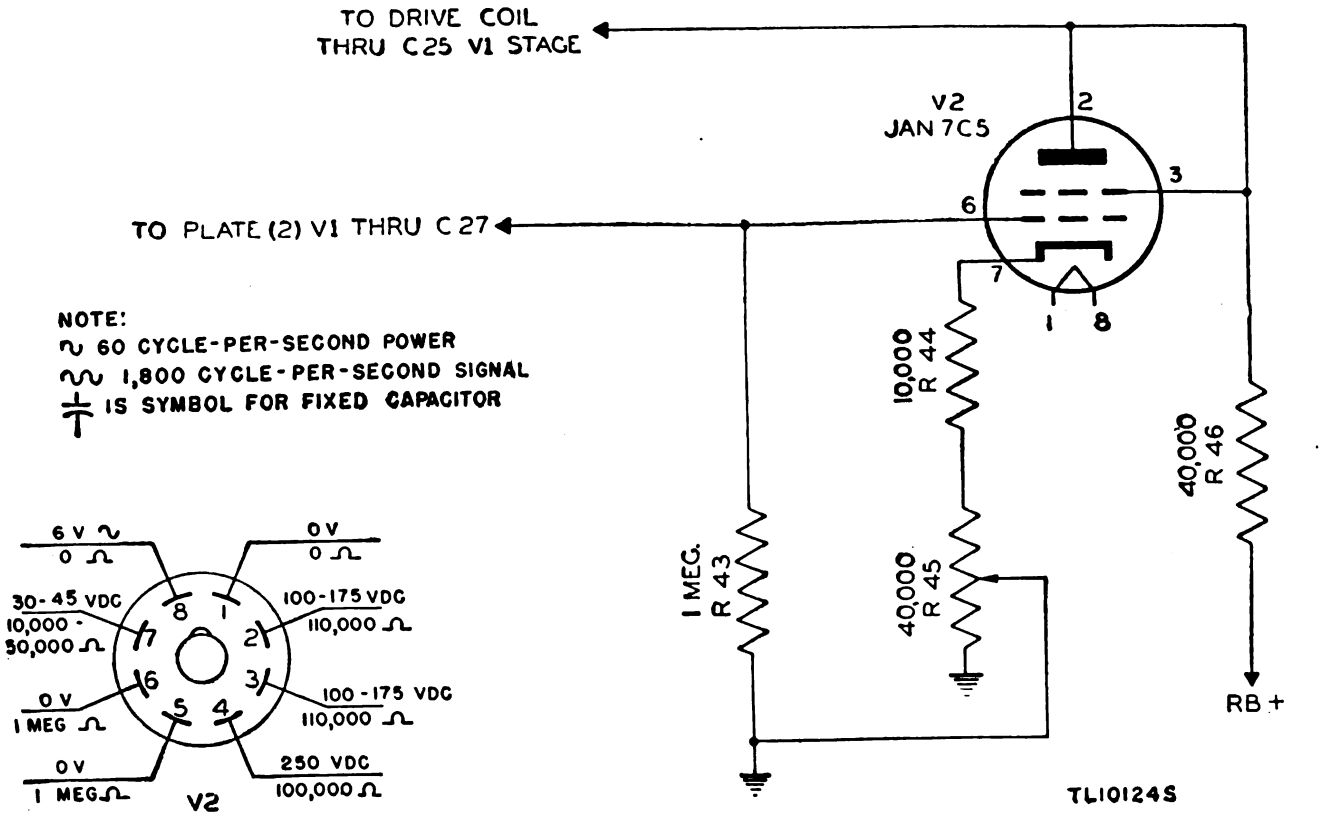


Figure 19. Fork amplifier, drive stage.

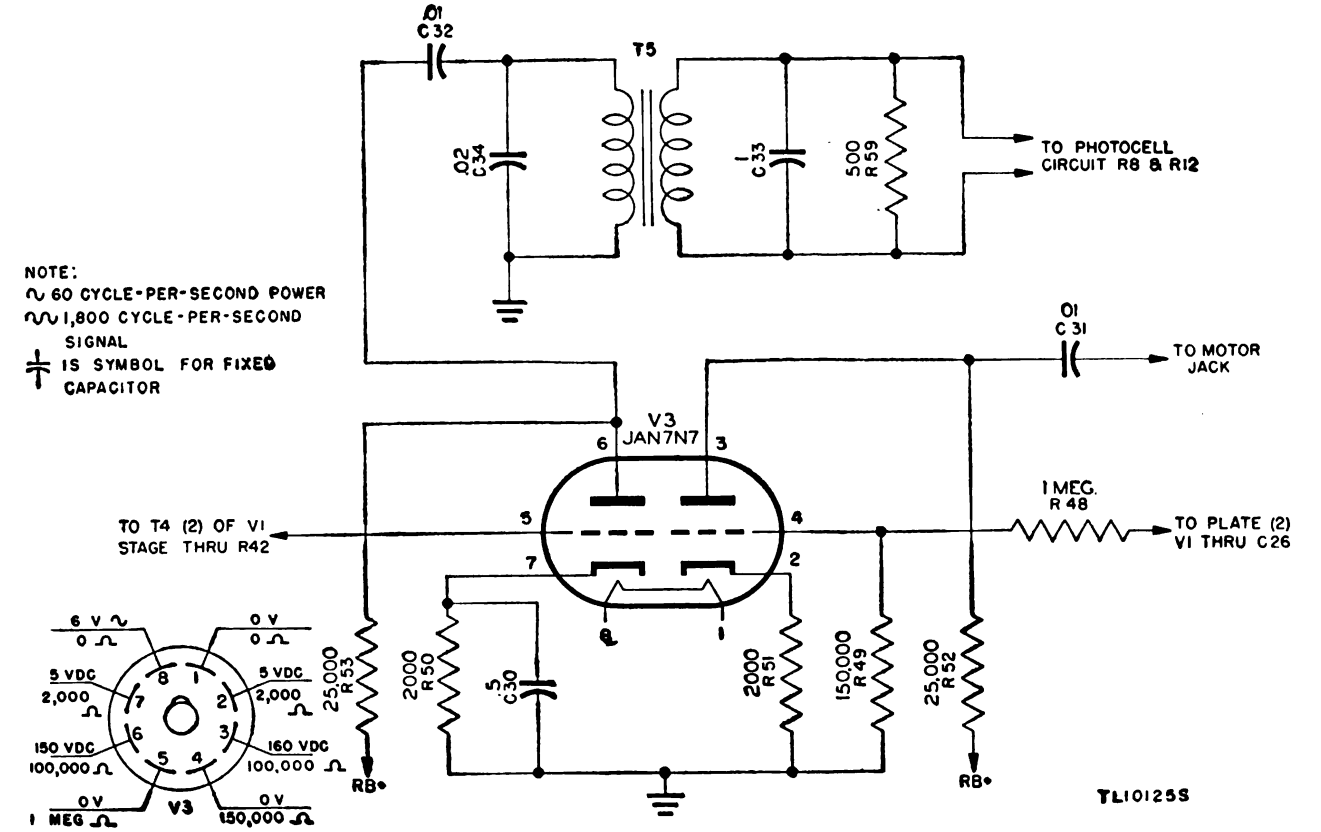


Figure 20. Fork amplifier, output stage.

56. Motor Amplifier, Driver Stage (fig. 21)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V4	2J7C5	TUBE: JAN-7C5	Driver.
R6	3RC20BF243J	RESISTOR, fixed: carbon; 24,000 ohms, ±10%; ½-w	Grid resistor.
R23	3RC21BF182K	RESISTOR, fixed: carbon; 2,000 ohms, ±10%; ½-w	Cathode resistor.
C4	3DA500-37	CAPACITOR, fixed: paper; 500,000 mmf; 400 vdcw	Cathode bypass.
T1	2Z9633.4	TRANSFORMER, A-f: driver; T. T. E. No. 90-11-00. (See par. 51.)	Driver transformer.
	(†)	JACK: tip, ring, and sleeve; long frame; Mallory No. 116481.	Connection for external motor control signal.
	2Z8678.60	SOCKET, tube: 8-contact; loktal; Cinch No. 6969	Tube socket.

†Stock number not assigned at time of manuscript writing.

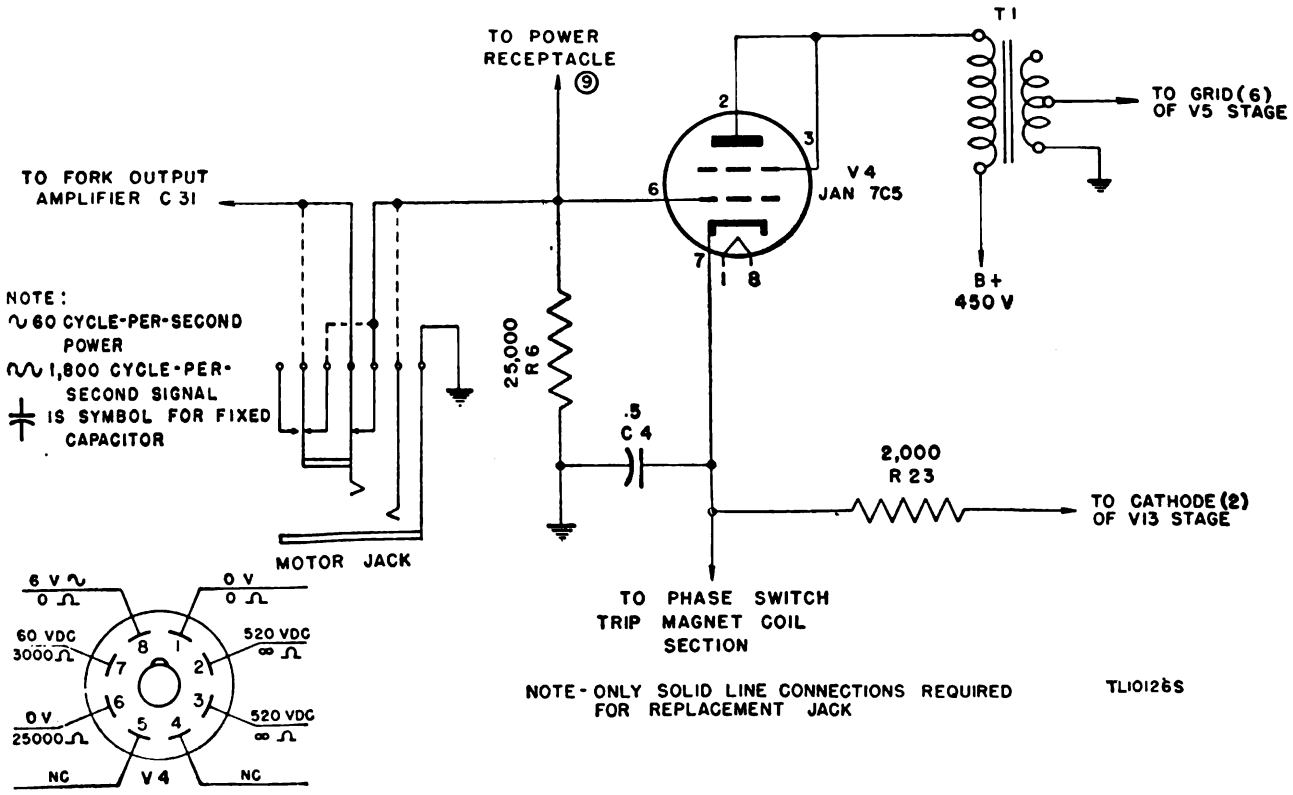


Figure 21. Motor amplifier, driver stage.

57. Motor Amplifier, Output Stage (fig. 22)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V5	2J7C5	TUBE: JAN-7C5	Power output to motor.
V6	2J7C5	TUBE: JAN-7C5	Power output to motor.
R7	3Z6080-20	RESISTOR, fixed: wire-wound; 800 ohms, ±10%; 10-w; Clarostat 10C.	Cathode resistor.
C5	3DA500-37	CAPACITOR, fixed: paper; 500,000 mmf; 400 vdcw	Cathode bypass.
C6	3DA20-65	CAPACITOR, fixed: paper; 20,000 mmf; 2,000 vdcw; Mallory No. 0T464 (connect two in series for correct capacity of 10,000 mmf). (See par. 51b.)	Tuning capacitor.
C7	3K4510221	CAPACITOR, fixed: mica; 1,000 mmf; 2,500 vdcw	Peak voltage limiter.
C38	3K5051222	CAPACITOR, fixed: mica; 5,100 mmf; 2,500 vdcw	Spark suppressor.

57. Motor Amplifier, Output Stage (Contd.)

Ref symbol	Signal Corps stock number	Name of part and description	Function
T6	3C323–81A	COIL, AF: choke; impedance matching filter; T. T. E. No. 90–06–05.	Matching filter coil.
	3Z9824–27	SWITCH, push: Mallory No. 2006	Start motor.
	2Z8678.60	SOCKET, tube: 8-contact, loktal; Cinch No. 6969 (2 required).	Tube socket.

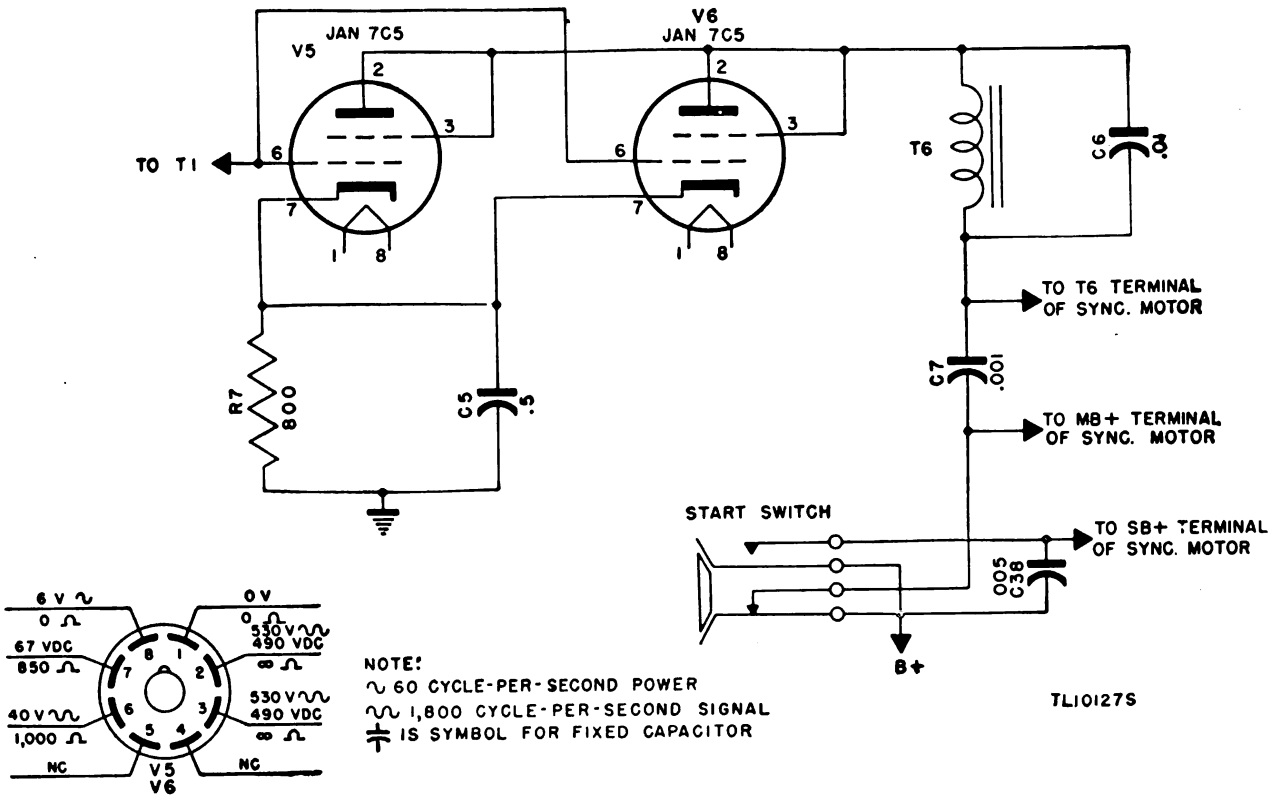


Figure 22. Motor amplifier, output stage.

58. Voltage Regulator, Output Stage (fig. 23)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V7	2J7C5	TUBE: JAN–7C5	Ballast.
V8	2J7C5	TUBE: JAN–7C5	Ballast.
	2Z8678.60	SOCKET, tube: 8-contact; loktal; Cinch No. 6969 (2 required).	Tube socket.

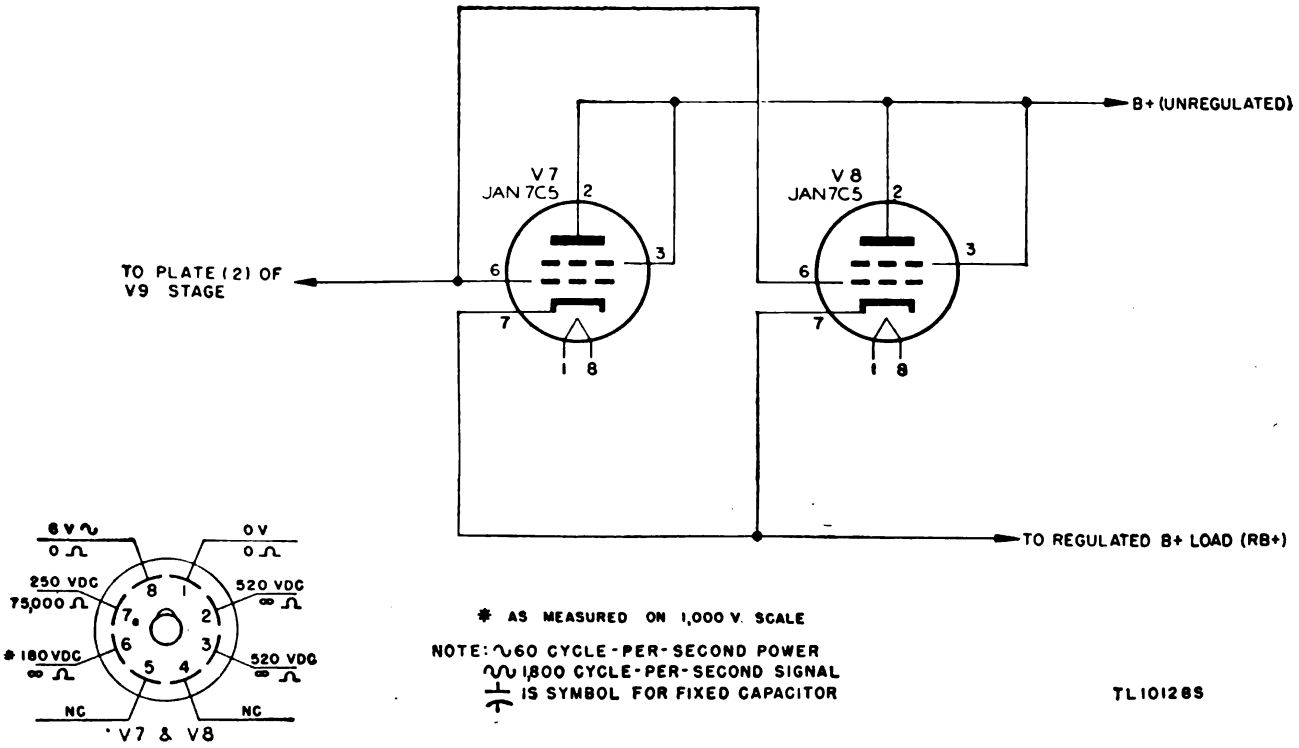


Figure 23. Voltage regulator, output stage.

59. Voltage Regulator, Control Stage (fig. 24)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V9	2J7L7	TUBE: JAN-7L7	Controller tube.
R1	3RC30BF513J	RESISTOR, fixed: carbon; 51,000 ohms, ±5%; 1-w	Voltage divider.
R2	3RC31BF153K	RESISTOR, fixed: carbon; 15,000 ohms, ±10%; 1-w	Voltage divider.
R3	3RC21BE205J	RESISTOR, fixed: carbon; 2 meg, ±10%; ½-w	Cathode resistor.
R4	3RC21BE205J	RESISTOR, fixed: carbon; 2 meg, ±10%; ½-w	Screen-grid resistor.
R5	3RC21BF105K	RESISTOR, fixed: carbon; 1 meg, ±10%; ½-w	Plate resistor.
C1	3DB1-106	CAPACITOR, fixed: paper; 1.0 mf; 1,000 vdcw; C-D No. TLA100101. Original was 4mf; 600 vdcw. (See par. 51*b*.)	Unregulated B+ filter capacitor.
C2	3DA500-37	CAPACITOR, fixed: paper; 500,000 mmf, 400 vdcw	Stabilizer capacitor.
C3		See paragraph 47*d*	Regulated B+ filter capacitor.
	2Z5889-9	LAMP: neon; voltage regulator; 1B46. Original was R1160, R1160A, or ¼-w neon. (See par. 47*a*.)	Maintain constant cathode bias voltage on V9.
	2Z8678.60	SOCKET, tube: 8-contact; loktal; Cinch No. 6969	Tube sockets.

60. Signal Amplifier, First Stage (fig. 25)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V10	2J7C7	TUBE: JAN-7C7	Voltage amplifier.
R14	3RC21BF302J	RESISTOR, fixed: carbon; 3,000 ohms, ±10%; ½-w	Cathode resistor.
R15	3RC21BF105K	RESISTOR, fixed: carbon; 1 meg, ±10%; ½-w	Screen-grid resistor.
R16	3RC21BF244J	RESISTOR, fixed: carbon; 250,000 ohms, ±10%; ½-w	Plate resistor.
R17	3RC21BF104K	RESISTOR, fixed: carbon; 100,000 ohms, ±10%; ½-w	Decoupling resistor.
C9	3DA10-276.1	CAPACITOR, fixed: paper; 10,000 mmf; 600 vdcw	Screen-grid bypass.
C10	3DA500-37	CAPACITOR, fixed: paper; 500,000 mmf; 400 vdcw. Original was 10 mf electrolytic. (See par. 44*b*.)	Cathode bypass.
C11	3DA500-37	CAPACITOR, fixed: paper; 500,000 mmf; 400 vdcw. Original was 4 mf electrolytic.	Decoupler capacitor.
C12	3D9250-13	CAPACITOR: fixed; mica; 250 mmf; 500 vdcw	Coupling capacitor.
	2Z8678.60	SOCKET, tube: 8-contact; loktal; Cinch No. 6969	Tube socket.

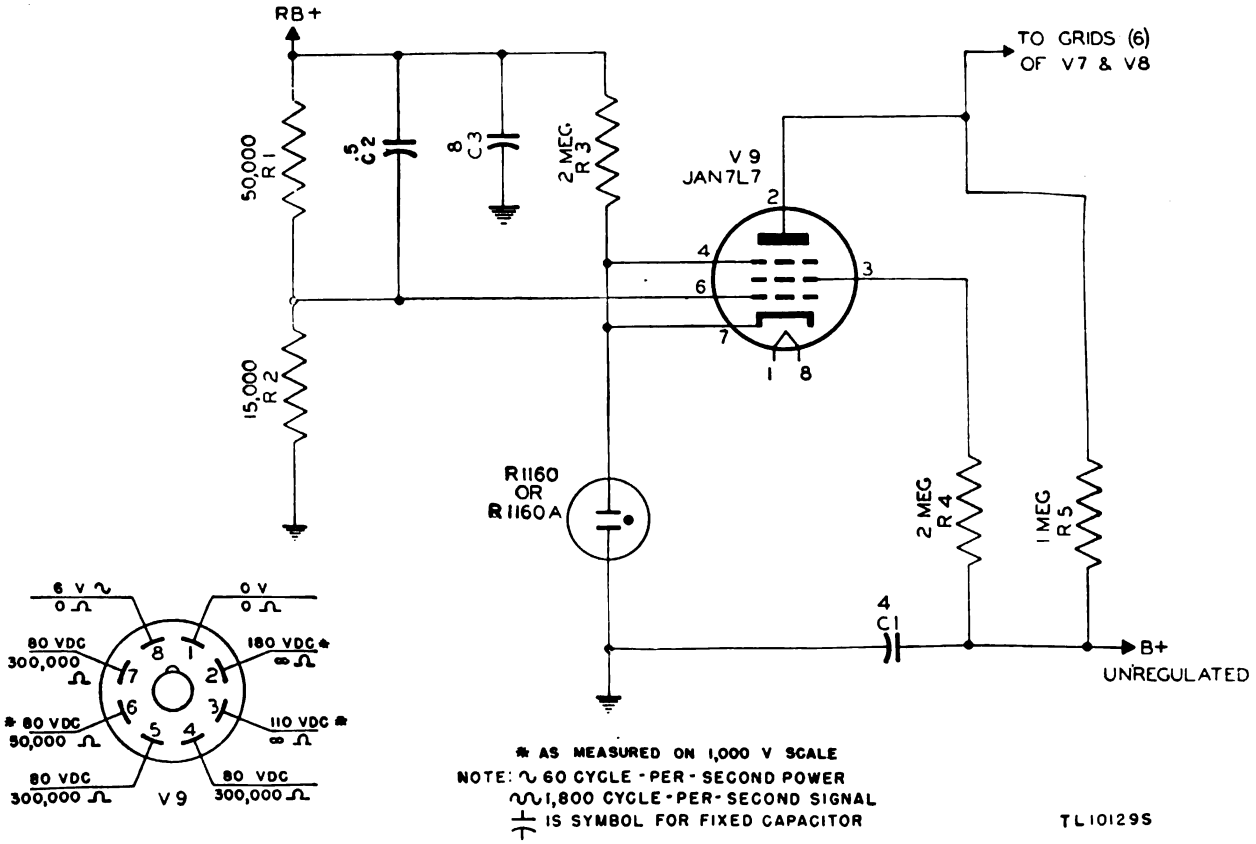


Figure 24. Voltage regulator, control stage.

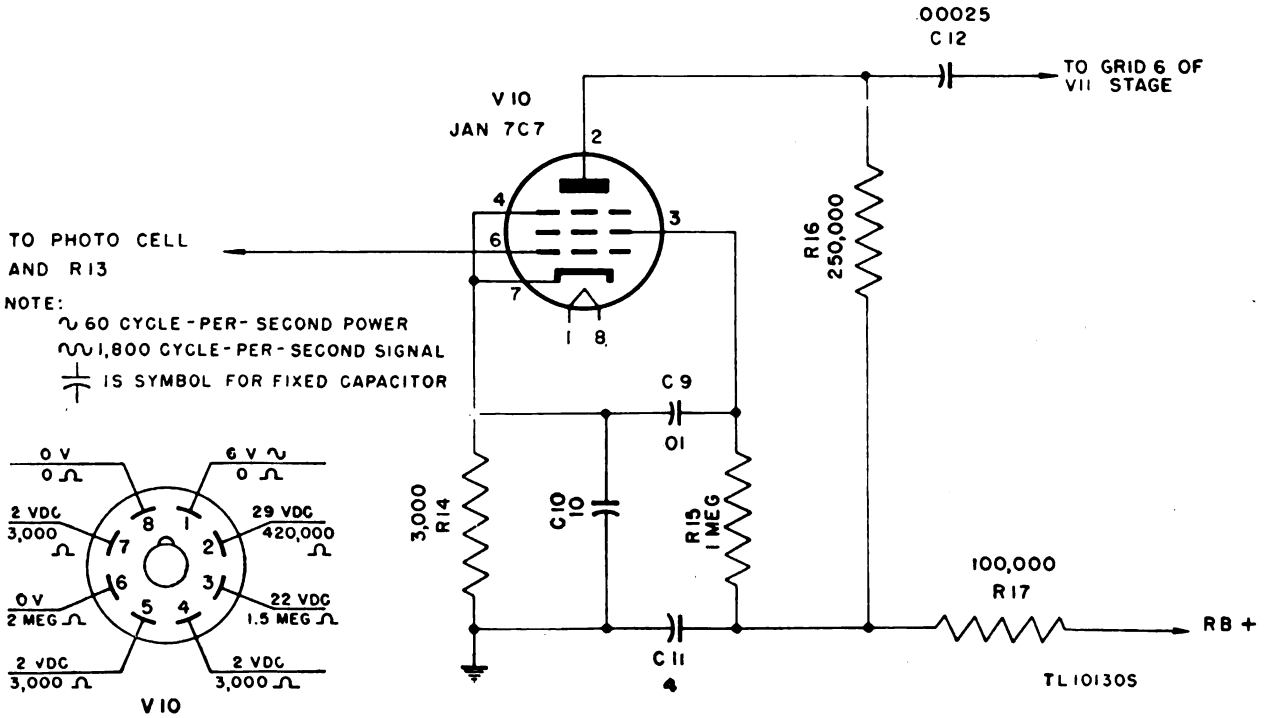


Figure 25. Signal amplifier, first stage.

61. Signal Amplifier, Second Stage (fig. 26)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V11	2J7L7	TUBE: JAN-7L7	Voltage amplifier.
R18	3RC21BF244J	RESISTOR, fixed: carbon; 250,000 ohms, ±5%; ½-w	Grid resistor.
R19	3RC21BF182K	RESISTOR, fixed: carbon; 2,000 ohms, ±5%; ½-w	Cathode resistor.
R20	3RC21BF514J	RESISTOR, fixed: carbon; 500,000 ohms, ±10%; ½-w	Screen-grid resistor.
R21	3RC21BF154K	RESISTOR, fixed: carbon; 150,000 ohms, ±10%; ½-w	Plate resistor.
C13	3DA500-37	CAPACITOR, fixed: paper; 500,000 mmf; 400 vdcw. Original was 10 mf electrolytic. (See par. 51b.)	Cathode bypass.
C14	3DA10-276.1	CAPACITOR, fixed: paper; 10,000 mmf; 600 vdcw. Original was 50,000 mmf.	Screen-grid bypass.
C15	3D9500-18	CAPACITOR, fixed: mica; 500 mmf; 500 vdcw	Coupling capacitor.
C16	3K3020222	CAPACITOR, fixed: mica; 2,000 mmf; 500 vdcw	Coupling capacitor.
	2Z8678.60	SOCKET, tube: 8-contact; loktal; Cinch No. 6969	Tube socket.

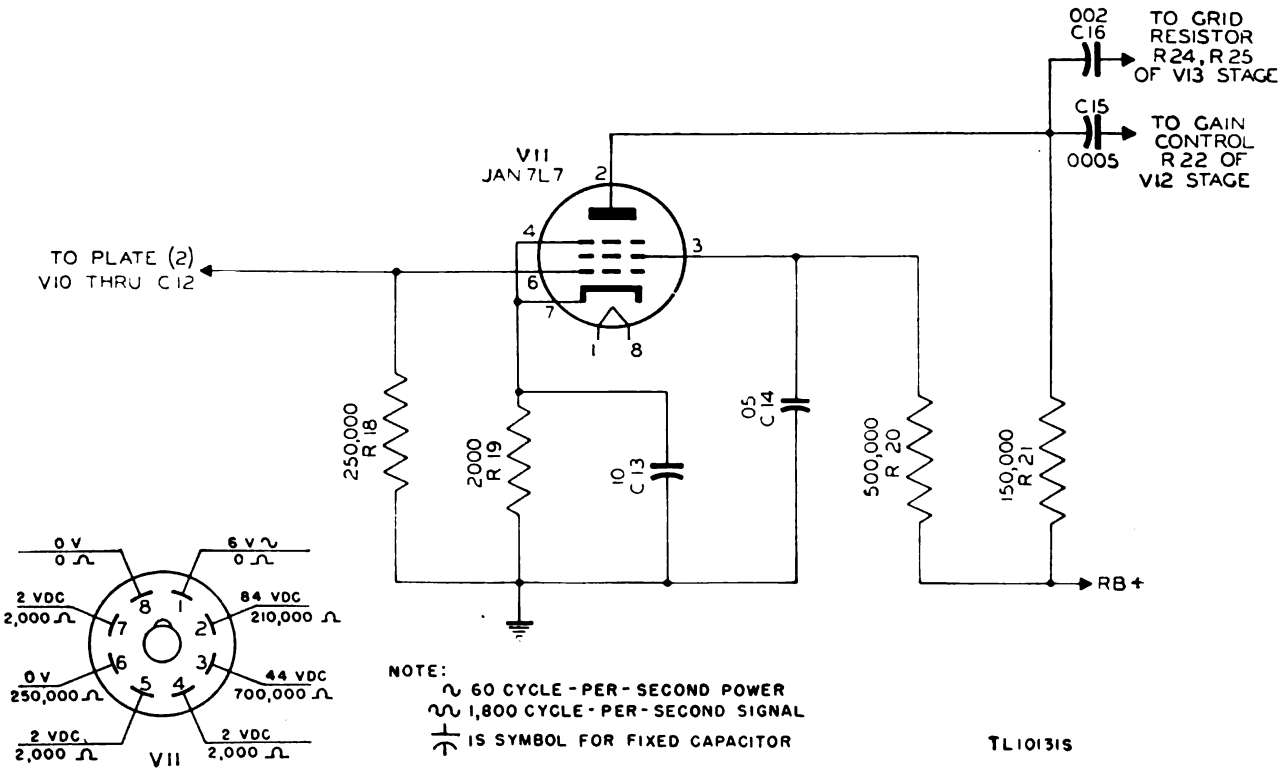


Figure 26. Signal amplifier, second stage.

62. Signal Amplifier, Third Stage, Transmit Output, Record Photo (fig. 29)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V12	2J7C5	TUBE: JAN-7C5	Power output tube.
R22	2Z7286.1	RESISTOR, variable: composition; dual; sec. No. 1, 500 ohms; sec. No. 2, 250,000 ohms; 1-w; Clarostat No. K5158. Sec. No. 1 is R58. Sec. No. 2 is R22.	Gain control.
R27	3RC21BF105K	RESISTOR, fixed: carbon; 1 meg, ±10%; ½-w	Grid resistor.
R28	3RC21BE621J	RESISTOR, fixed: carbon; 600 ohms, ±10%; ½-w	Cathode resistor.
R29	3RC21BF513J	RESISTOR, fixed: carbon; 50,000 ohms, ±5%; ½-w	Meter multiplier.
R56	3RC21BF105K	RESISTOR, fixed: carbon; 1 meg, ±10%; ½-w	Trimmer for R29.
C17	3DA500.37	CAPACITOR, fixed: paper; 500,000 mmf; 400 vdcw. Original was 10 mf electrolytic.	Cathode bypass.

62. Signal Amplifier, Third Stage, Transmit Output, Record Photo (Contd.)

Ref symbol	Signal Corps stock number	Name of part and description	Function
T2	2Z9632.222	TRANSFORMER, A-f: output; T. T. E. No. 90–11–01. (See par. 51c(2).)	1. Transmit output transformer. 2. Driver transformer for V14.
	2Z5534A.1	JACK, meter: Mallory No. 702A	External meter connection.
	3F3307.12–3	METER: power level; db scale −10 to +6 at 6 mw, 500 ohms; Weston model 61, case type 506. Adapter ring required. Original was Weston model 60, case type 301.	Indicate signal level.
	3F2–24	ADAPTER RING: bakelite; fitted with mounting screws.	Fits to Weston type 506 case. Ring mounts in cut-out for type 301 case.
	3Z9825–52	SWITCH, rotary: 5 position; 5 double sections, 10 circuit; T. T. E. No. 80–00–85.	Switch circuits for following conditions: TRANSMIT, SET RANGE, STANDBY, RECORD PHOTO, RECORD DIRECT.
	2Z8678.60	SOCKET, tube: 8-contact; loktal; Cinch No. 6969	Tube socket.

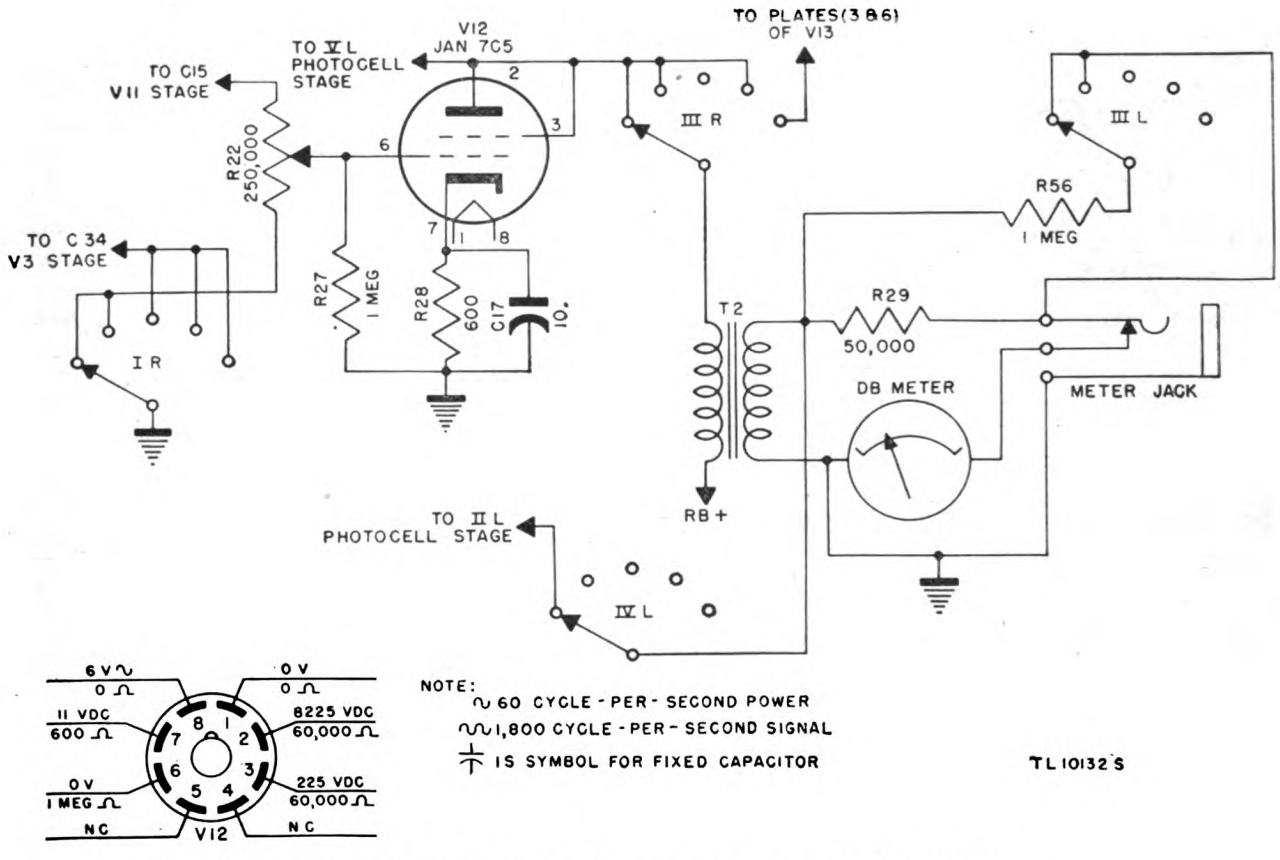


Figure 27. Signal amplifier, third stage, transmit output, RECORD PHOTO.

63. Record Direct, Driver Stage (fig. 28)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V13	2J7N7	TUBE: JAN-7N7	Replaces V12 to improve contrast for record direct.
R24	3RC21BF514J	RESISTOR, fixed: carbon; 500,000 ohms, +5%; ½-w	Grid current limiter.
R25	3RC21BF105K	RESISTOR, fixed: carbon; 1 meg, ±10%; ½-w	Grid resistor.
R26	3RC21BF152K	RESISTOR, fixed: carbon; 1,500 ohms, ±10%; ½-w	Cathode resistor.
C18	3DA500-37	CAPACITOR, fixed: paper; 500,000 mmf; 400 vdcw. Original was 10 mf electrolytic. (See par. 51*b*.)	Cathode bypass.
	2Z8678.60	SOCKET, tube: 8-contact; loktal; Cinch No. 6969	Tube socket.

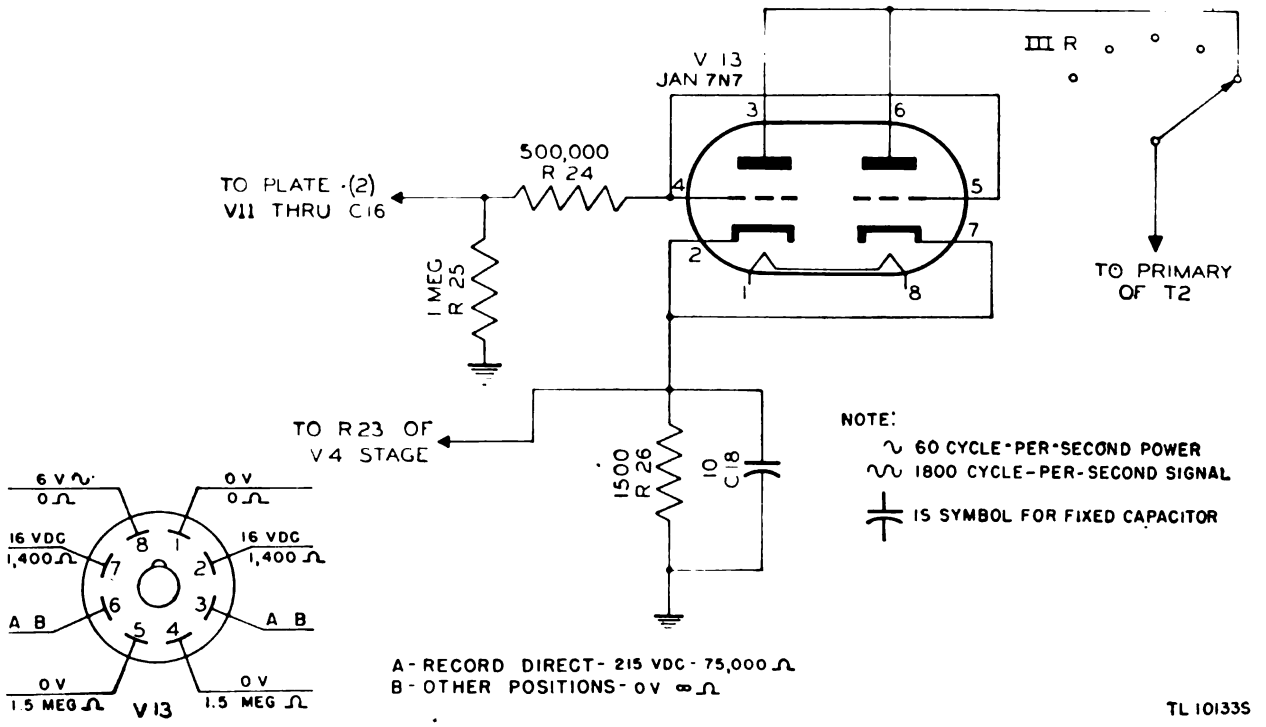


Figure 28. RECORD DIRECT, driver stage.

64. Signal Amplifier, Output Stage, Record Direct, and Record Photo (fig. 29)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V14	2J6AC5G	TUBE: JAN-6AC5G	Zero bias power amplifier.
C19	3D9250	CAPACITOR, fixed: mica; 250 mmf; 500 vdcw	High-frequency suppressor.
T3	2Z9632.13	TRANSFORMER, A-f: stylus input; T. T. E. No. 90-11-02.	Voltage step-up transformer for recording stylus.
T7	3C368	CHOKE, R-4: 10 mh. (See par. 44*d*.)	High-frequency suppressor.
	2Z5890-11	LAMP: glow; Sylvania R1130B. Replaces R1130 and R1130A. (See par. 51*e*.)	Illuminate spot for photographic recording.
		STYLUS. (See par. 86 and fig. 50.)	
	2Z8650.1	SOCKET, tube: octal; Cinch No. 9919	Tube socket.

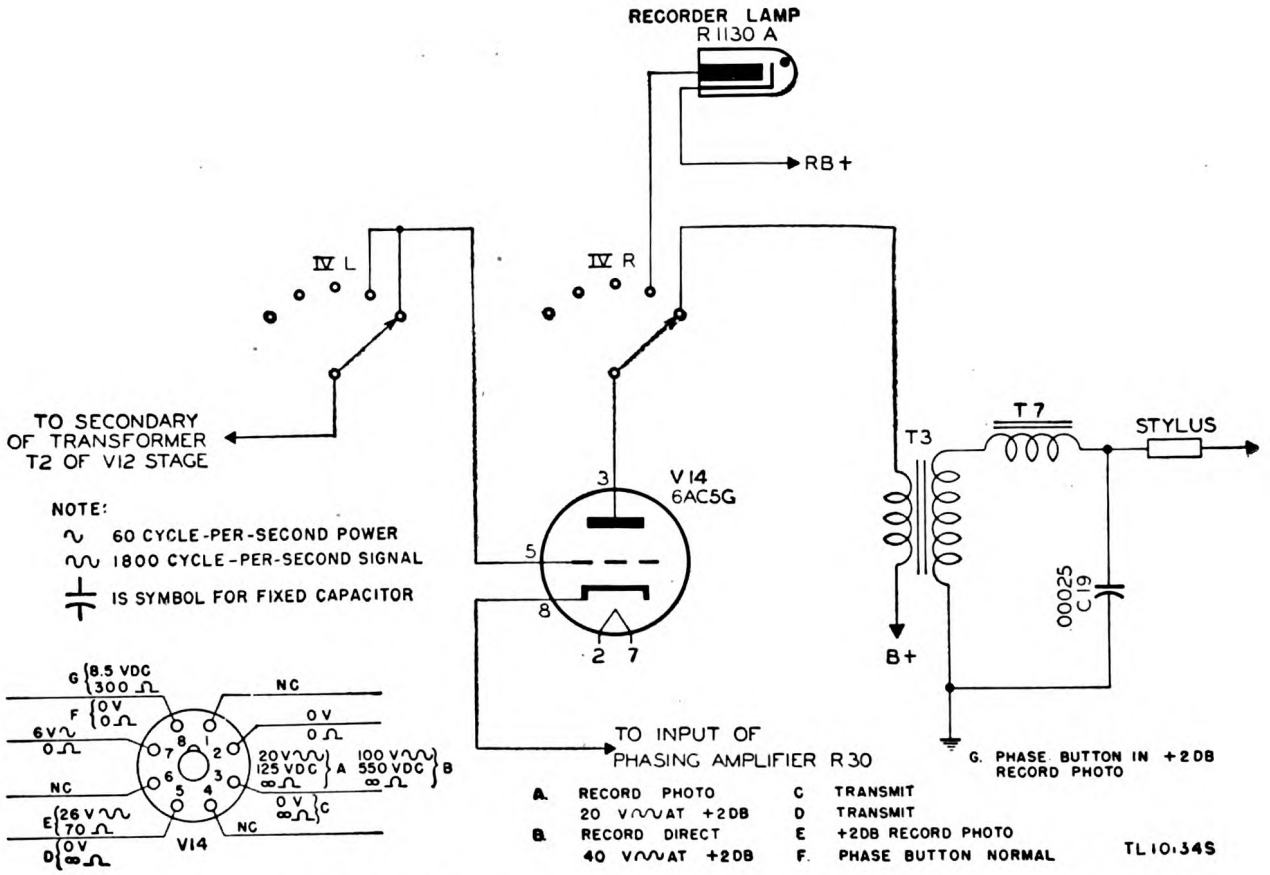


Figure 29. Signal amplifier, output stage, RECORD DIRECT, and RECORD PHOTO.

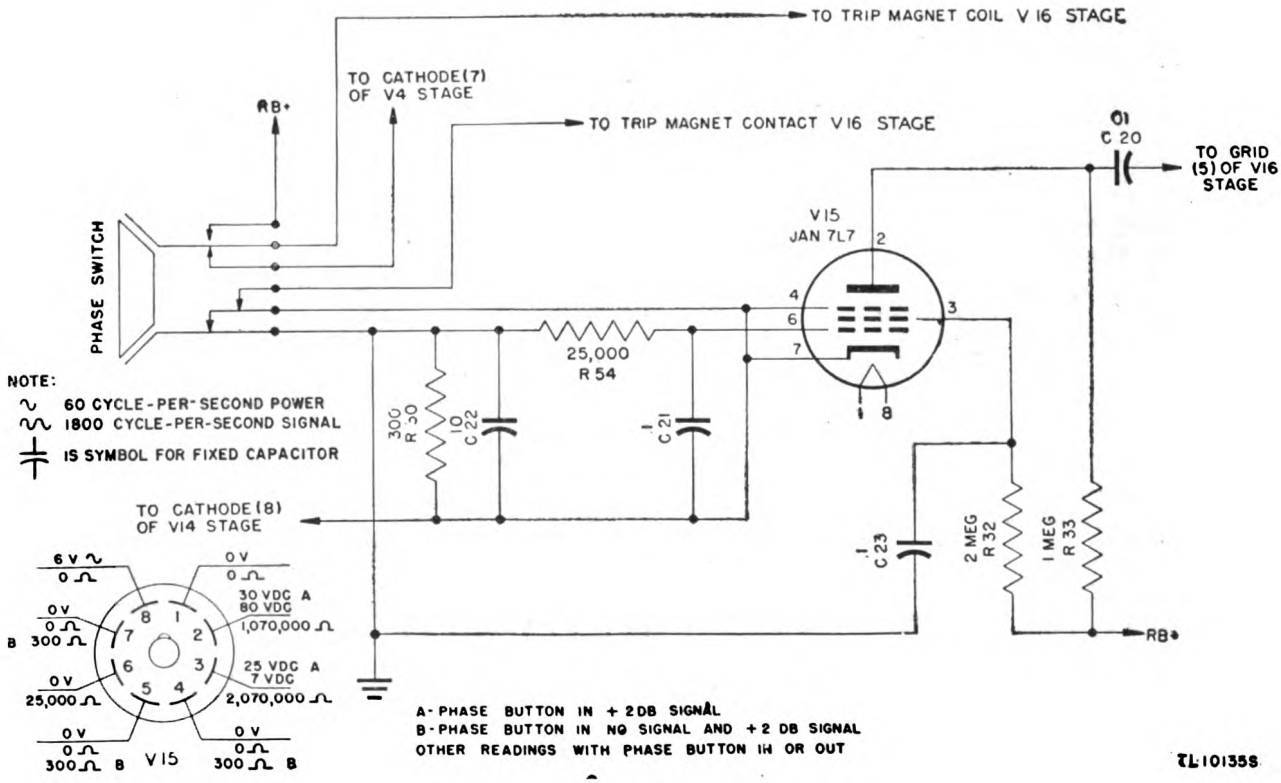


Figure 30. Phasing circuit voltage amplifier.

65. Phasing Circuit, Voltage Amplifier (fig. 30)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V15	2J7L7	TUBE: JAN-7L7	Voltage amplifier.
R30	3Z6030-49	RESISTOR, fixed: wire-wound; 300 ohms, ±10%; ½-w	Cathode follower resistor.
R32	3Z5100	RESISTOR, fixed: carbon; 2 meg, ±10%; ½-w	Screen-grid resistor.
R33	3RC21BF185K	RESISTOR, fixed: carbon; 1 meg, ±10%; ½-w	Plate resistor.
R54	3RC21BF243J	RESISTOR, fixed: carbon; 25,000 ohms, ±10%; ½-w	Low-pass filter series impedance.
C20	3DA10-16	CAPACITOR, fixed: paper; 10,000 mmf; 400 vdcw	Coupling capacitor.
C21	3DA100-94	CAPACITOR, fixed: paper; 100,000 mmf; 600 vdcw	Low-pass filter shunt impedance.
C22	3DB50-6	CAPACITOR, fixed: electrolytic; 50 mf; 25 vdcw. (See par. 42b.)	Low-pass filter shunt impedance.
	3Z9824-26	SWITCH: push-button; phasing; Mallory No. 2006 modified, B116479 sub 2.	Switch connections to phase drum.
	2Z8678.60	SOCKET, tube: 8-contact; loktal; Cinch No. 6969	Tube socket.

66. Phasing Circuit, Output Stage (fig. 31)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V16	2J884	TUBE: JAN-884 (VT-222)	Control trip magnet.
R34	3RC21BF105K	RESISTOR, fixed: carbon; 1 meg, ±10%; ½-w	Grid resistor.
R35	3RC21BF185K	RESISTOR, fixed: carbon; 2 meg, +5%, ½-w	Bleeder resistor.
R36	3RC21BF274K	RESISTOR, fixed: carbon; 250,000 ohms, ±10%; ½-w	Cathode bias control when plate current is cut off.
R37	3RC21BF683K	RESISTOR, fixed: carbon; 75,000 ohms, +5%; ½-w	Cathode resistor.
C24	3DA500-37	CAPACITOR, fixed: paper; 500,000 mmf; 400 vdcw. Original was 2 mf.	Cathode bypass.
C36	3D9500-18	CAPACITOR, fixed: mica; 500 mmf; 500 vdcw	Stabilize V16 operation.
	2Z8650.1	SOCKET, tube: octal; Cinch No. 9919	Tube socket.

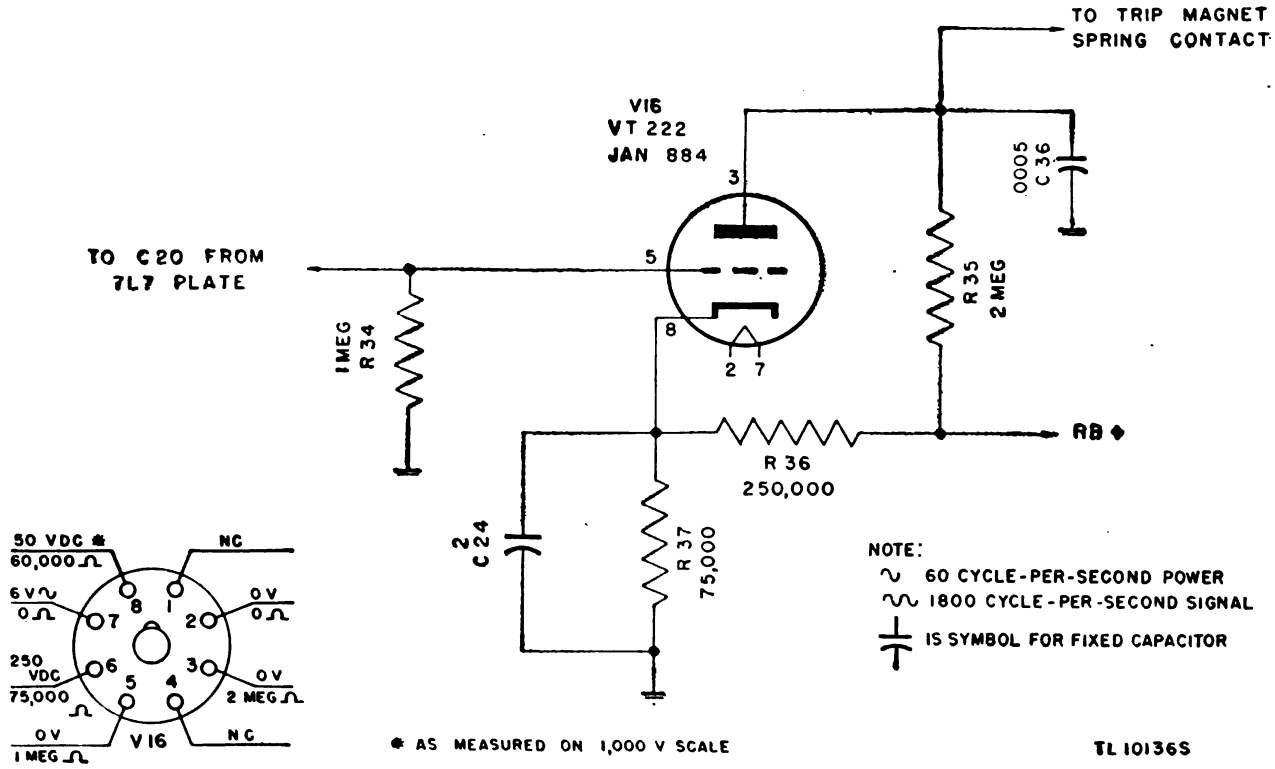


Figure 31. Phasing circuit, output stage.

67. Exciter Lamp Supply, Input Stage (fig. 32)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V17	2J7S7	TUBE: JAN–7S7. Original was 7J7	Variable gain amplifier.
R71	3RC21BF102K	RESISTOR, fixed: carbon; 1,000 ohms; ±10%; ½-w	Cathode resistor.
R72	3RC21BF105R	RESISTOR, fixed: carbon; 1 meg, ±10%; ½-w	Screen-grid resistor.
R73	3Z6713–1	RESISTOR, fixed: carbon; 130,000 ohms, ±10%; ½-w	Voltage divider.
R74	3RC21BF393K	RESISTOR, fixed: carbon; 40,000 ohms, ±10%; ½-w	Voltage divider.
R75	3RC21BF105K	RESISTOR, fixed: carbon; 1 meg, ±10%; ½-w	Suppressor grid resistor.
R76	3RC21BF514J	RESISTOR, fixed: carbon; 500,000 ohms, ±5%; ½-w	Plate resistor.
R91	2Z7281.51	RESISTOR, variable: wire-wound; 50,000 ohms; 3-w	Input potentiometer.
C51	3DA5–38	CAPACITOR, fixed: mica; 5,000 mmf; 500 vdcw	Coupling capacitor.
C52	3DA5–38	CAPACITOR, fixed: mica; 5,000 mmf; 500 vdcw	High-frequency suppressor.
C53	3DA10–276.1	CAPACITOR, fixed: paper; 10,000 mmf; 600 vdcw	Coupling capacitor.
	2Z8678.60	SOCKET, tube: 8-contact; loktal; Cinch No. 6969	Tube socket.

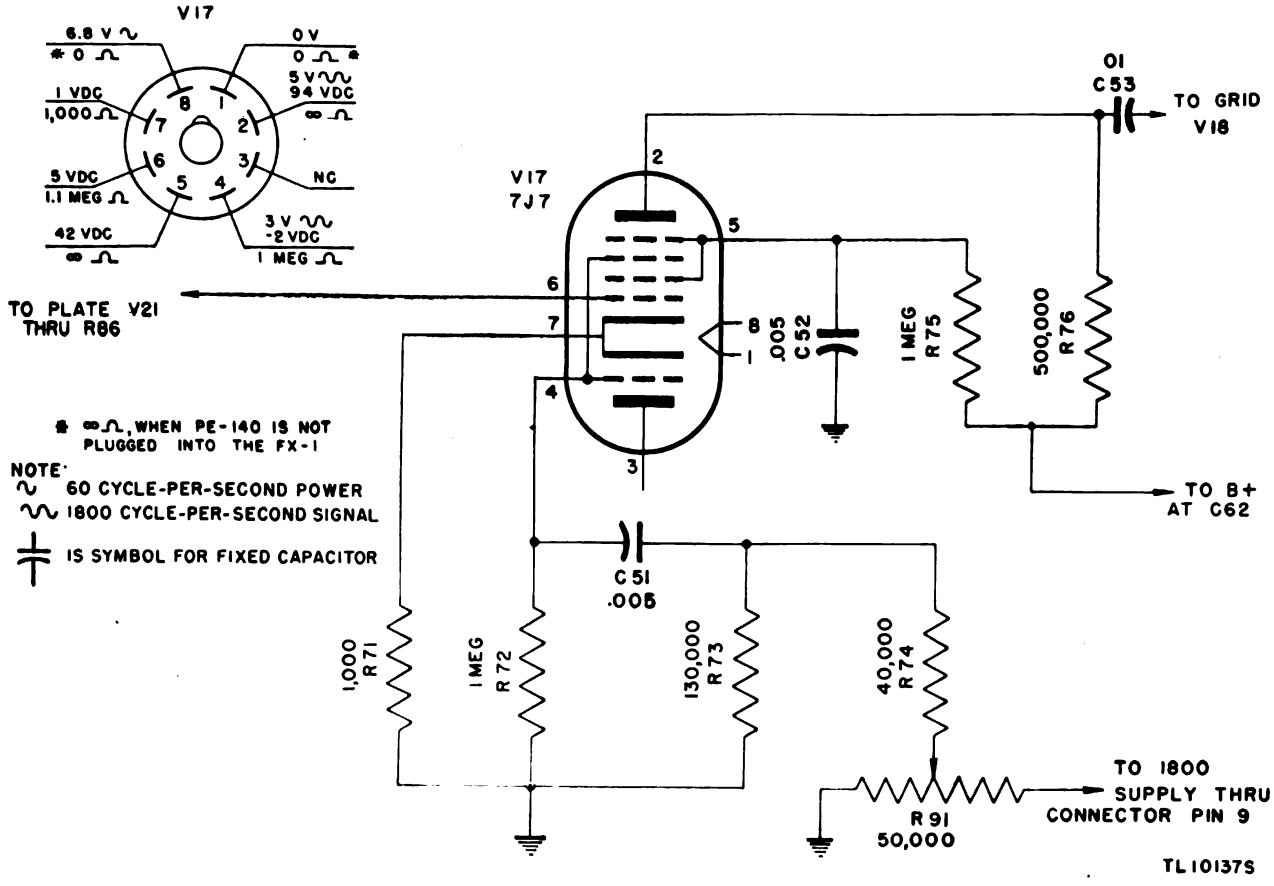


Figure 32. Exciter lamp supply, input stage.

68. Exciter Lamp Supply, Driver and Rectifier Stage (fig. 33)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V18	2J7N7	TUBE: JAN–7N7	Amplifier and rectifier.
R77	3RC21BF514J	RESISTOR, fixed: carbon; 500,000 ohms, ±5%; ½-w	Grid resistor.
R78	3RC21BE302J	RESISTOR, fixed: carbon; 3,000 ohms, ±10%; ½-w	Cathode resistor.
C54	3DA2–71	CAPACITOR, fixed: mica; 2,000 mmf; 500 vdcw	High-frequency suppressor.
C55	3DA100–94	CAPACITOR, fixed: paper; 100,000 mmf; 600 vdcw	Cathode bypass.
T14	2Z9633.4	TRANSFORMER, A-f: driver; T. T. E. No. 90–11–00	Class B coupling transformer.
	2Z8678.60	SOCKET, tube: 8-contact; loktal; Cinch No. 6969	Tube socket.

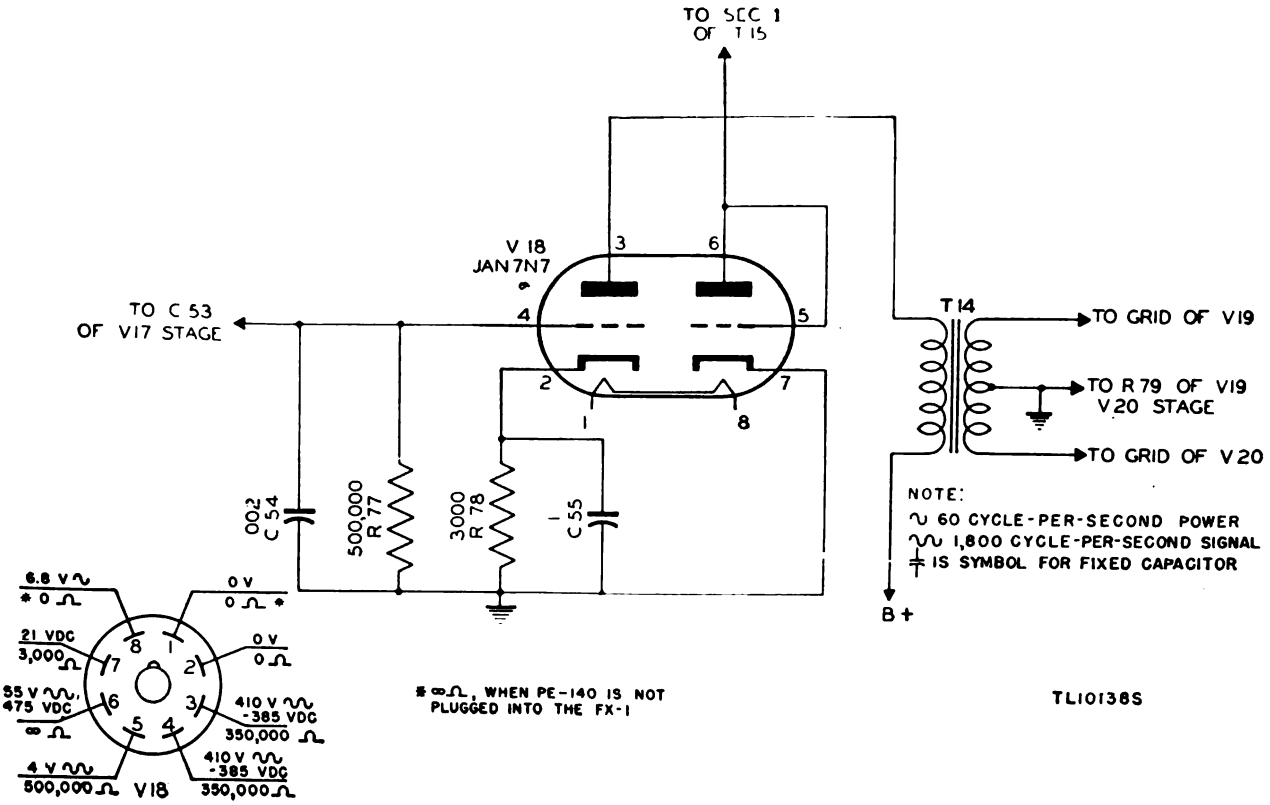


Figure 33. Exciter lamp supply, driver and rectifier stage.

69. Exciter Lamp Supply, Output Stage (fig. 34)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V19	2J7C5	TUBE: JAN–7C5	Power amplifier.
V20	2J7C5	TUBE: JAN–7C5	Power amplifier.
R79	3Z6030–64	RESISTOR, fixed: wire-wound; 300 ohms ±10%; 10-w	Cathode resistor.
C56	3K4510221	CAPACITOR, fixed: mica; 1,000 mmf; 2,500 vdcw	Suppressor for peak voltages.
T15	2Z9635.3	TRANSFORMER, A-f: push-pull output; T. T. E. No. 90–11–10.	1. Output to rectifier for avc. 2. Output to load.
	2Z8678.60	SOCKET, tube: 8-contact; loktal; Cinch No. 6969 (2 required).	Tube socket.

70. Exciter Lamp Supply, Voltage Regulator Detector Stage (fig. 35)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V21	2J7L7	TUBE: JAN–7L7	Regulate control grid (6) bias of stage V17.
	2Z5889–9	LAMP, neon: voltage regulator; 1B47. Original was R1160, R1160A, or ¼-w neon. See paragraph 49*a*.	Maintain constant cathode bias voltage on V21.
R80	3RC21BF273K	RESISTOR, fixed: carbon; 25,000 ohms, ±10%; ½-w	Low-pass filter impedance.
R81	3RC21BF154K	RESISTOR, fixed: carbon; 150,000 ohms, ±10%; ½-w	Voltage divider.
R82	2Z7281.51	RESISTOR variable; wire-wound; 50,000 ohms; 3-w; Clarostat No. P58–50,000; 3 terminals.	Voltage divider.
R83	3RC21BF274K	RESISTOR, fixed: carbon; 250,000 ohms, ±10%; ½-w	Voltage divider.
R84	3RC21BF393K	RESISTOR, fixed: carbon; 40,000 ohms, ±10%; ½-w	Grid current limiter.
R85	3RC21BF105K	RESISTOR, fixed: carbon; 1 meg, ±10%; ½-w	Oscillation suppressor.
R86	3RC21BF105K	RESISTOR, fixed: carbon; 1 meg, ±10%; ½-w	Oscillation suppressor.
R87	3RC21BF393K	RESISTOR, fixed: carbon; 40,000 ohms, ±10%; ½-w	Plate resistor.

70. Exciter Lamp Supply, Voltage Regulator Detector Stage (Contd.)

Ref symbol	Signal Corps stock number	Name of part and description	Function
R88	3RC21BF105K	RESISTOR, fixed: carbon; 1 meg, ±10%; ½-w	Screen-grid resistor.
R89	3RC21BF105K	RESISTOR, fixed: carbon; 1 meg, ±10%; ½-w	Cathode resistor.
C57	3DA100–307	CAPACITOR, fixed: paper; 100,000 mmf; 600 vdcw. Original was 500,000 mmf.	Low-pass filter capacitor.
C58	3DA50–1	CAPACITOR, fixed: paper; 50,000 mmf; 400 vdcw. Original was 40,000 mmf.	Oscillation suppressor.
C59	3DA250–30	CAPACITOR, fixed: paper; 250,000 mmf; 400 vdcw	Smoothing capacitor.
	2Z8678.60	SOCKET, tube: 8-contact; loktal; Cinch No. 6969	Tube socket.

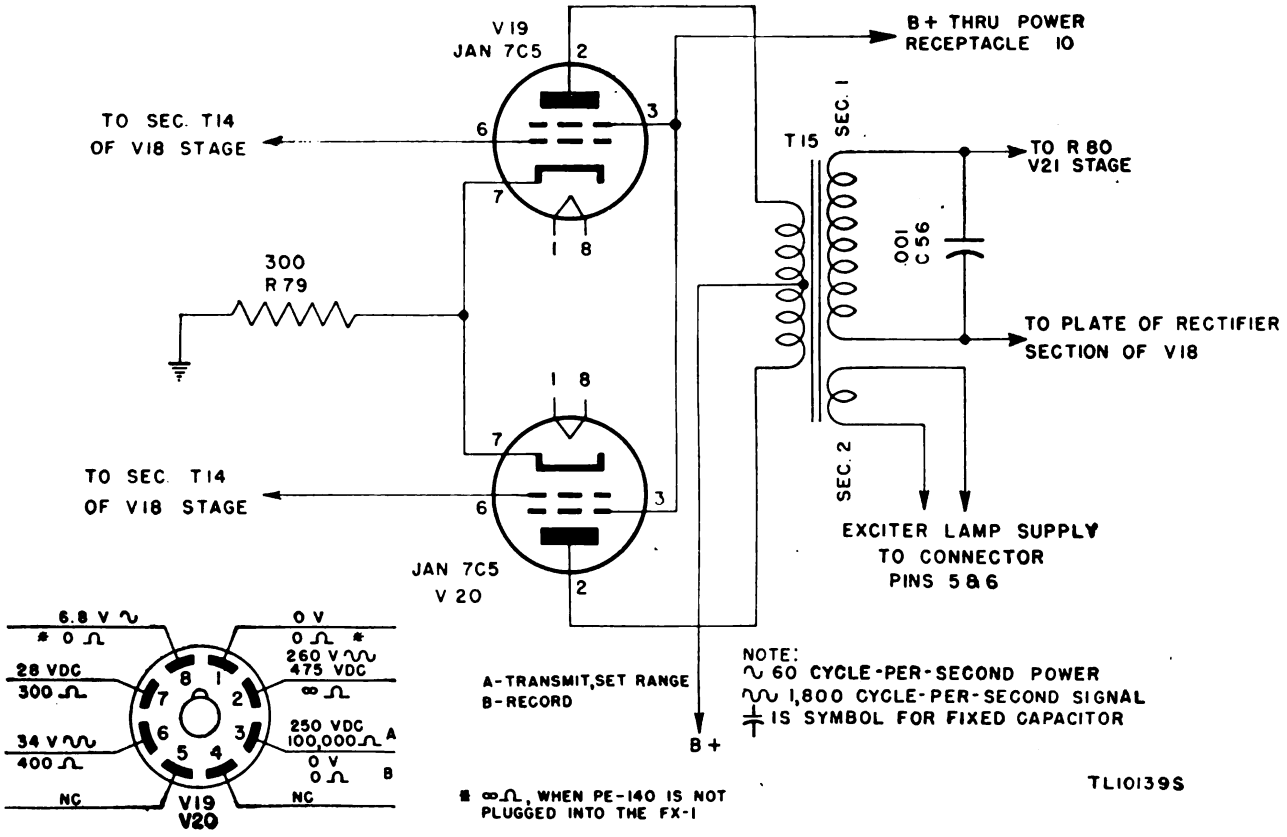


Figure 34. Exciter lamp supply, output stage.

71. Rectifier Power Supply (fig. 36)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V22	2J5Z3	TUBE: JAN–5Z3 (VT145)	Power rectifier for high voltage.
R92	3Z6640–2	RESISTOR, fixed: carbon; 40,000 ohms, ±10%; 1-w	Decoupler resistor.
C60, C61, C62.	3DB2.21	CAPACITOR, fixed: paper; 2 mf; 1,000 vdcw; C–D No. TLA–10020. Original was 4 mf; 600 v. (See par. 51*b*.)	Smoothing filter capacitor.
T11	2Z9613.8	TRANSFORMER: power; filament and plate; T. T. E. No. 90–11–07. (See par. 48*a*.)	Power transformer, high voltage, and filament.
T12	3C369	COIL, A-f: choke; swinging; T. T. E. No. 90–11–08	Swinging choke.
T13	3C369–1	COIL, A-f: choke; filter; T. T. E. No. 90–11–09	Smoothing choke.
	3Z2605.2	FUSE: 5-amp; 250-v; Littelfuse No. 3AG	A-c line fuse.
	3Z3275–10	FUSE POST: extractor; Littelfuse No. 1075–S	Fuse holder.
	2Z8659–5	SOCKET, tube: 4-prong; Amphenol No. MIP–4M	Tube socket.
		PLUG: Jones. (See par. 72.)	
		CONNECTOR: power line cord. (See par. 72.)	

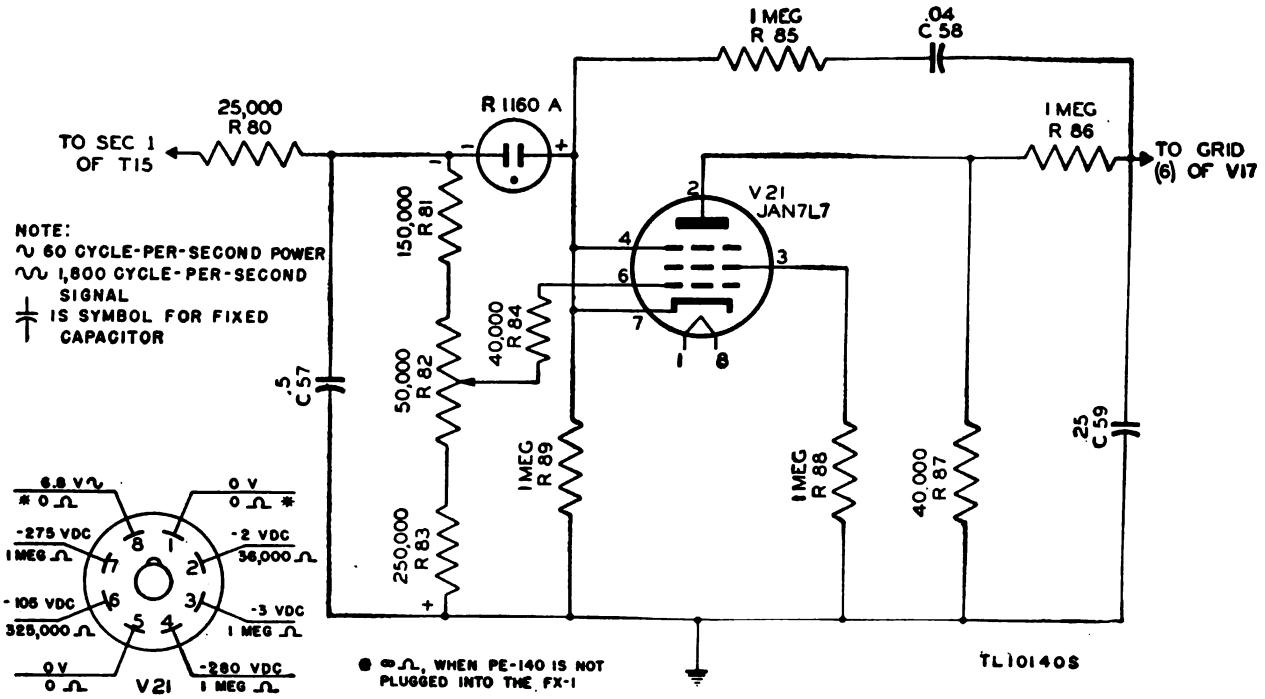


Figure 35. Exciter lamp supply, voltage regulator detector stage.

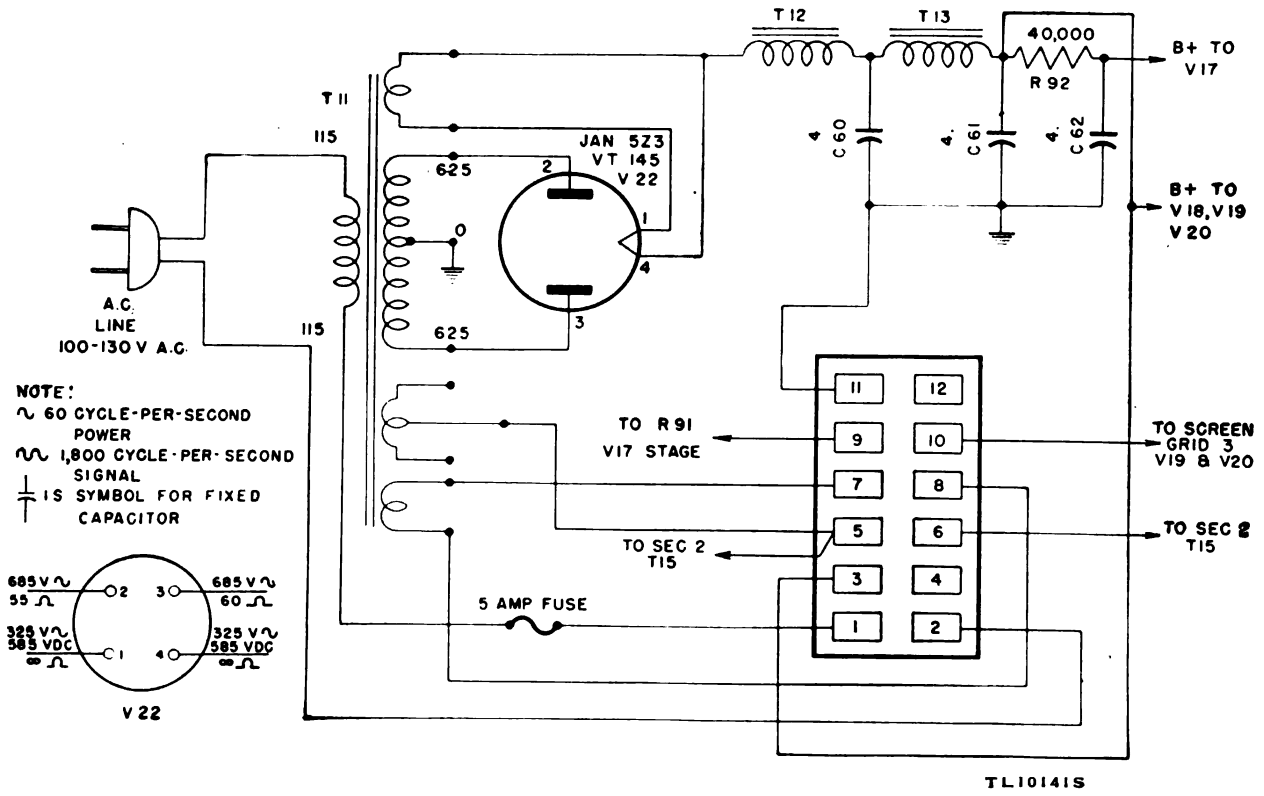


Figure 36. Rectifier power supply.

72. Connector Plug to Rectifier Power Supply and Exciter Lamp Supply (fig. 37)

Ref symbol	Signal Corps stock number	Name of part and description	Function
	3E90939–3	CORD: 34″ lg; 12-conductor; T. T. E. No. 90–15–08 (power cord attached to power supply complete with 12-contact female Jones plug).	Connector line to facsimile transceiver.
		TERMINAL STRIP: T. T. E. No. 90–15–10	Power cord terminal block.
		TIE LUG: T. T. E. No. 90–15–23	A-c power cord connector block.
		CORD: a-c power	A-c line connector cord.

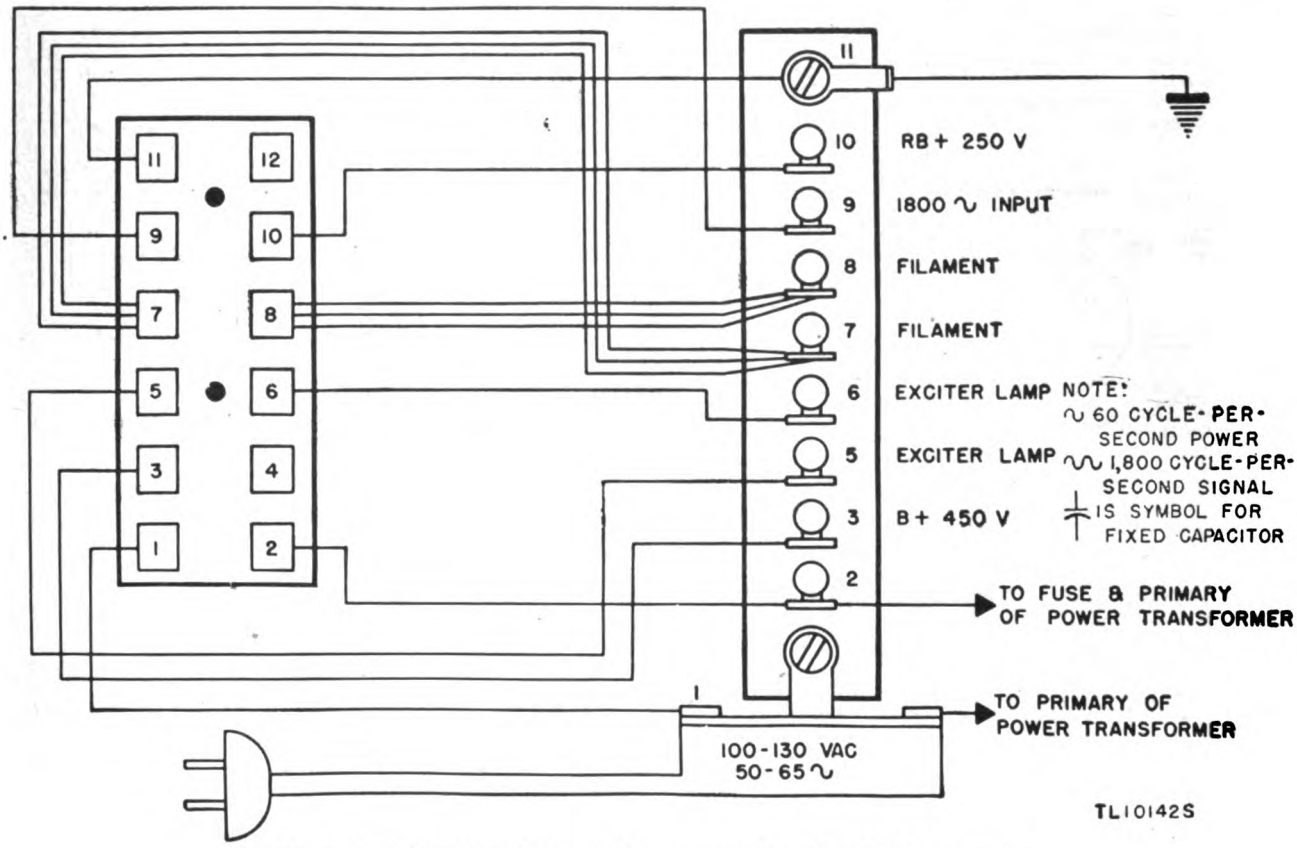


Figure 37. Connector plug to rectifier power supply and exciter lamp supply.

73. Photocell Bridge Circuit (fig. 38)

Ref symbol	Signal Corps stock number	Name of part and description	Function
	2J1645	PHOTOCELL: JAN–1645; special; T. T. E. No. 90–01–12.	Control signal from reflected scanning beam.
R8, R12	3RC21BE511J	RESISTOR, fixed: carbon; 510 ohms, ±5%; ½-w	Voltage divider.
R9	3RC21AE510J	RESISTOR, fixed: carbon; 50 ohms, ±10%; ½-w	Voltage divider.
R10	3RC21AE510J	RESISTOR, fixed: carbon; 50 ohms, ±10%; ½-w	Voltage divider.
R11	2Z7299–50	RESISTOR, variable: noninductive, wire-wound; 50 ohms; 5-w; Clarostat No. G3912–B.	Balance bridge.
R13	3RC21BF185K	RESISTOR, fixed: carbon; 2 meg, ±5%; ½-w	Grid resistor.
R58		(See R22, par. 62.)	Receive gain control.
C8		CAPACITOR: (see par. 43*c* and *d*.)	Trimmer.
C35	3DA250–30	CAPACITOR, fixed: paper; 250,000 mmf; 400 vdcw	Blocking capacitor.
C39	3D9100–24	CAPACITOR, fixed: mica; 100 mmf; 500 vdcw	Feedback capacitor.
	2Z7255–11	CONNECTOR, fema' , GE No. 1347; T. T. E. No. 90–00–93.	Feed coil jack.

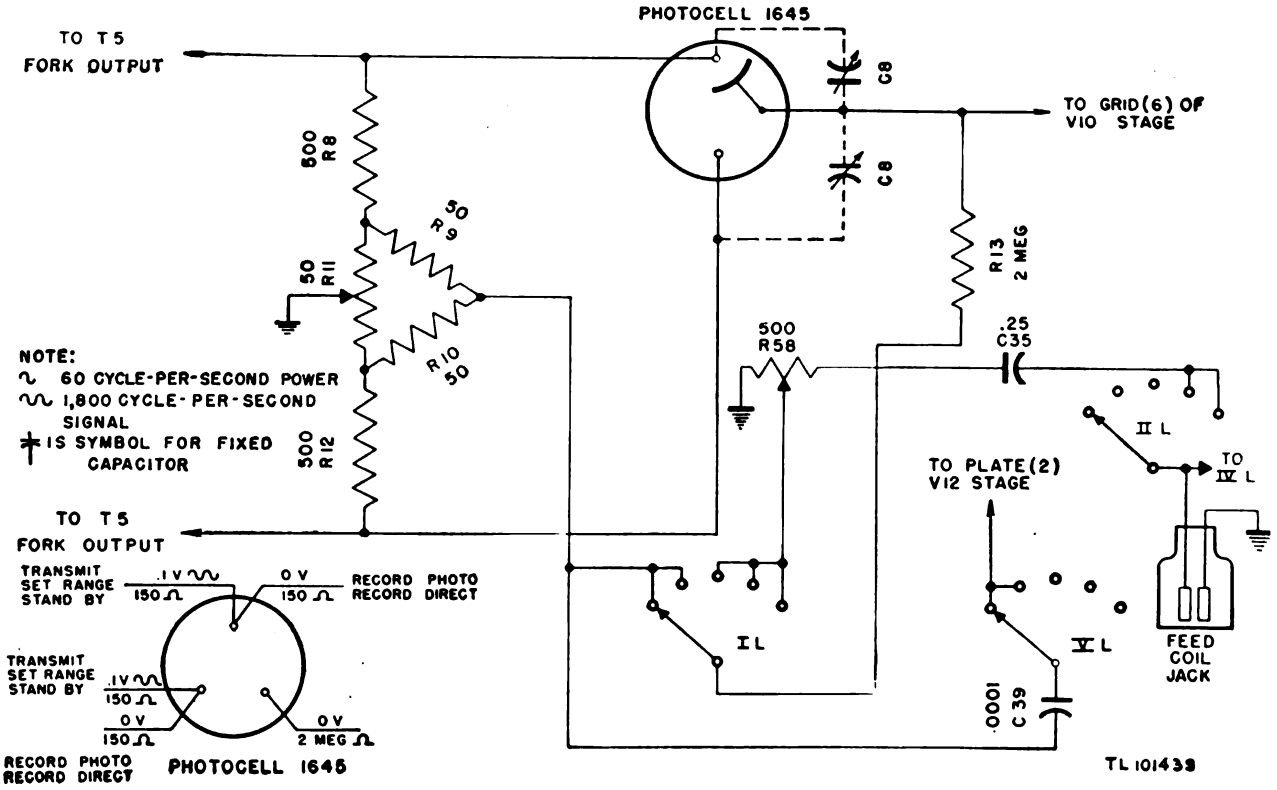


Figure 38. Photocell bridge circuit.

74. Coupling Coils and Cords (fig. 39)

Ref symbol	Signal Corps stock number	Name of part and description	Function
A	6C25–120/C5	COIL: coupling; model KC; T. T. E. No. 90–10–00	Induction coupler to telephone receiver.
B	6625–120/C8	COIL: coupling; model UC; T. T. E. No. 90–09–00	Induction coupler to telephone receiver.
C	3E4039–2	CORD: line-connector; 5'6"; 2-conductor; T. T. E. No. 90–37–02.	Line connector.
D	2Z9637.5	TRANSFORMER, line-coupling; T. T. E. model LT; impedance 600 ohms pri; 600 ohms secondary.	Induction coupler to line.

75. Dynamotor (fig. 40)

Ref symbol	Signal Corps stock number	Name of part and description	Function
A	3H1505–2	DYNAMOTOR: input 5.5-v d-c; output 400-v d-c; 0.15 amp; Carter No. 415-v.	High-voltage plate supply.
B	3H1505–2/B4	BRUSH: Carter type G–48–A	High-voltage brush.
C	3H1505–2/B3	BRUSH: Carter type 556	Low-voltage brush.
D	3H1505–2/C1	CAP: brush; T. T. E. No. 90–39–02	Brush cap holder positive.
E	3H1505–2/C2	CAP: brush; ground; T. T. E. No. 90–39–08	Brush cap holder negative.
F	6L31113	STUD: dynamotor mounting; T. T. E. No. 90–39–03	Mounting stud for dynamotor.
G	2Z8502–3	SHOCK MOUNT: T. T. E. No. 90–39–04	Resilient mounting for dynamotor.
H	6L75034–1	SHOCK MOUNT WASHER: T. T. E. No. 90–39–05	

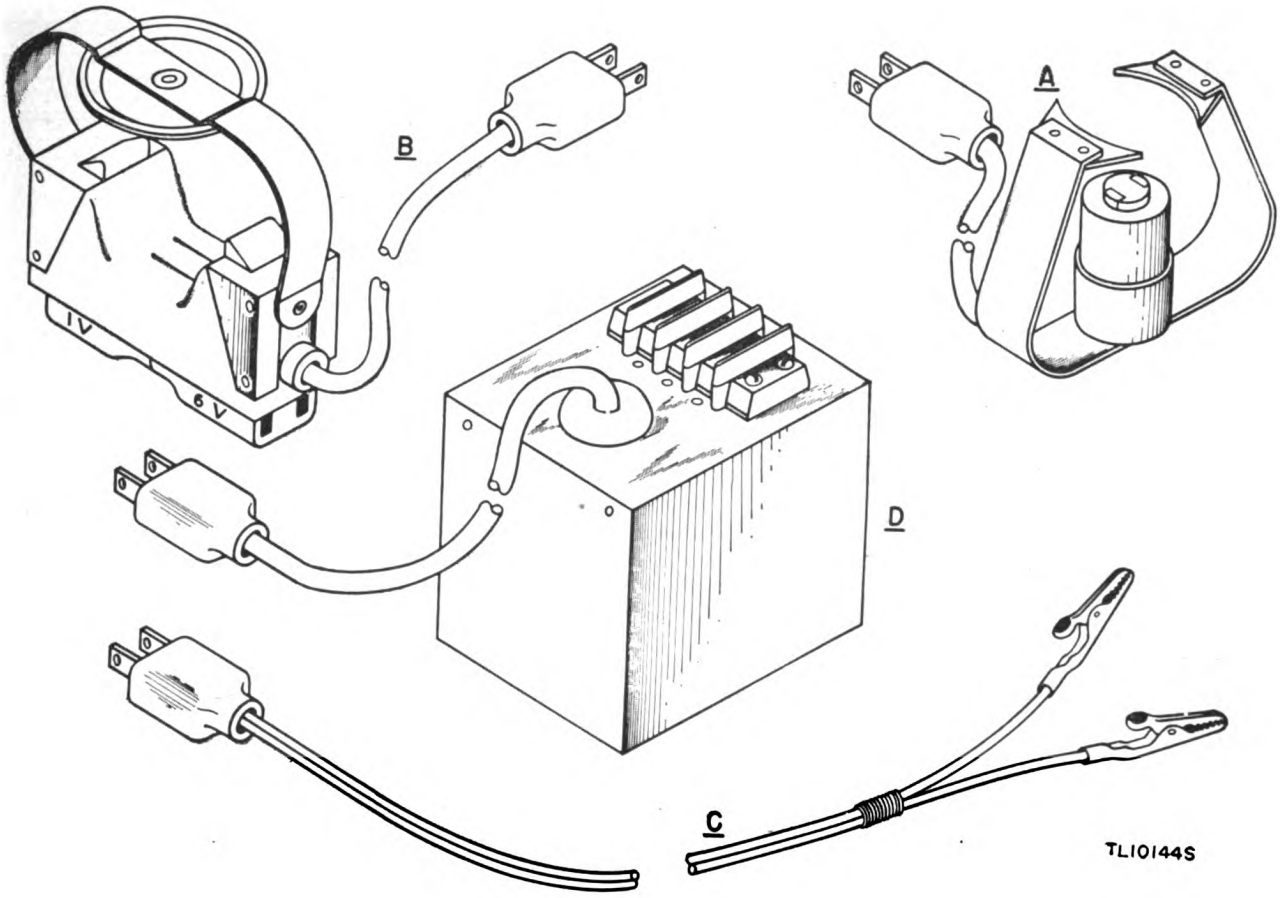


Figure 39. Coupling coils and cords.

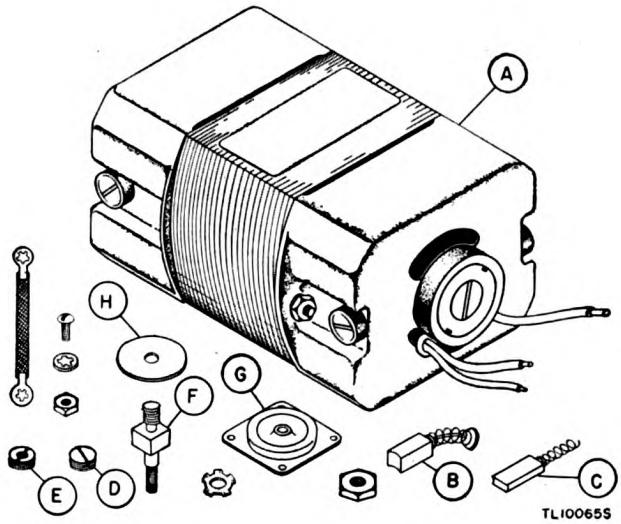


Figure 40. Dynamotor.

76. Synchronous Motor (fig. 41)

Ref symbol	Signal Corps stock number	Name of part and description	Function
	6C25–1/M3	MOTOR: 1,800 cycle synchronous; geared to 60 rpm for FX–1; T. T. E. No. 90–06.	Driver for drum.
A	(*)	WICK: felt	Oil reservoir.
B	(*)	BEARING: Compo, 5/16"; T. T. E. No. 90–06–01–12	Top bearing.
C	(*)	BEARING: Compo, 3/16"; T. T. E. No. 90–06–01–22	Lower bearing.
D	(*)	BEARING: Compo, 5/16"; T. T. E. No. 90–06–01–42	Synchronous rotor bearing.
E	(*)	COMMUTATOR	Commutator.
F	(*)	COILS: field, 125 ohms each; T. T. E. No. 90–06–01–25	Synchronous motor field coils.
G	(*)	BRUSH ASSEMBLY: (see par. 78)	Motor brushes.
H	(*)	GEAR: 20T, 40P; T. T. E. No. 90–06–03–2 for FX–1	Reduction gear.
I	(*)	SHAFT: synchronous motor; start motor; worm; T. T. E. No. 90–06–01–31.	Motor shaft and worm.
J	(*)	ARMATURE: series type; T. T. E. No. 90–06–01–5	Start armature.
K	(*)	COILS: series field; 2 ohms each; T. T. E. No. 90–06–01–15.	Start motor field coil.
L	(*)	SPRINGS: synchronous rotor coupling; T. T. E. No. 90–06–01–45.	Couple rotor to shaft.
M	(*)	SHAFT: drive; T. T. E. No. 90–06–03–1	Drive clutch assembly.
N	(*)	BEARINGS; ball: Norma Hoffman No. 7007; T. T. E. No. 90–06–03–10.	Drive shaft bearings.
O	(*)	PLATE: bottom; T. T. E. No. 90–06–01–63	Thrust bearing retainer.
P	(*)	RUBBER: synthetic Hycar; T. T. E. No. 90–06–01–61	End thrust decoupling.
Q	(*)	PLATE: thrust; T. T. E. No. 90–06–01–62	Thrust ball retainer.
R	(*)	BALL: steel 1/8"	Thrust bearing.
R39	3Z5475–9	RESISTOR, fixed: wire-wound; 7,500-ohms; 10%; 20-w; Ward Leonard Type 2T. (See par. 51*f*.)	Voltage-dropping resistor.
S	(*)	COLLAR: thrust; and SPRING ANCHOR: T. T. E. No. 90–06–01–44.	Thrust collar and spring anchor.
T	(*)	PIN: taper; 7/0	Pin spring anchor to shaft.
U	(*)	WASHER: bakelite thrust; T. T. E. No. 90–06–01–64	Thrust bearing for synchronous rotor.
V	(*)	WASHER: felt thrust; T. T. E. No. 90–06–01–65	Thrust bearing for synchronous rotor.
W	(*)	ROTOR: synchronous; T. T. E. No. 90–06–01–4	Synchronous rotor.
X	(*)	BALL: thrust; steel; 1/8" dia.	Thrust bearing for shaft assembly

*Not stocked by depots.

77. Trip Magnet (fig. 42)

Ref symbol	Signal Corps stock number	Name of part and description	Function
	(*)	TRIP MAGNET ASSEMBLY: T. T. E. No. 90–06–04	Phase drum.
A	(*)	ARMATURE: T. T. E. No. 90–06–04–3	Armature and stop latch.
B	(*)	SCREW: back stop; T. T. E. No. 90–06–04–10	Armature back stop adjustment.
C	(*)	COIL & CORE: 3,000 ohms; T. T. E. No. 90–06–04–7	Electromagnet.
D	(*)	SCREW: core locating; 6–32	Core position adjustment.
E	(*)	SCREW: set; 8–32	Setscrews for locking core in place.
F	(*)	PIVOT: T. T. E. No. 90–03–02–3	Fixed armature fulcrum pivot.
G	(*)	PIVOT: T. T. E. No. 90–06–04–9	Adjustable armature fulcrum pivot.
H	(*)	SPRING: T. T. E. No. 90–06–04–4	Armature return spring.
J	(*)	SLIDE ROD	Close contacts K when armature is in position for phasing.
K	(*)	CONTACTS	Break plate circuit of V15 after phasing.
L	(*)	SPRING	Return slide rod to normal position.
M	(*)	PUSH BUTTON, insulated	Transfer motion of slide rod J to contacts K.

*Not stocked by depots.

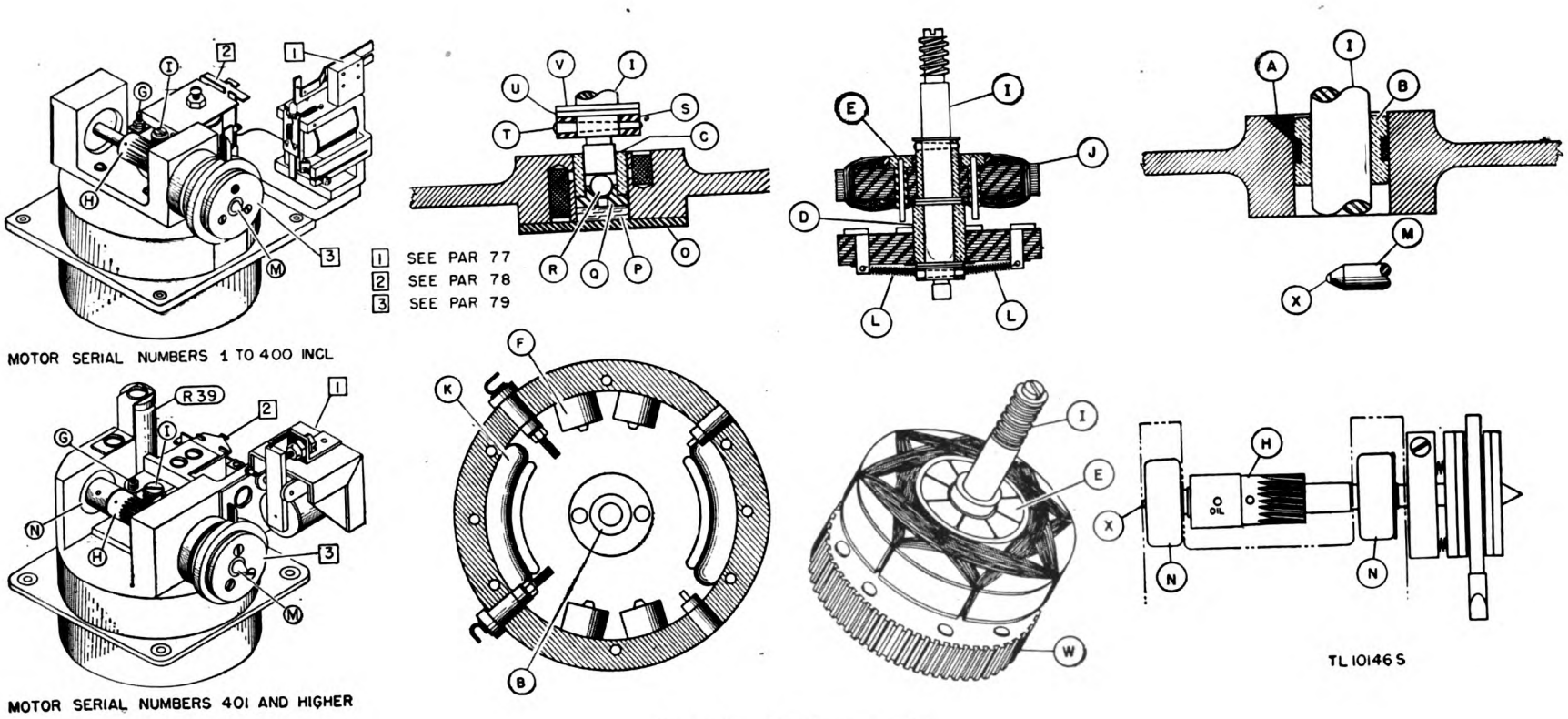
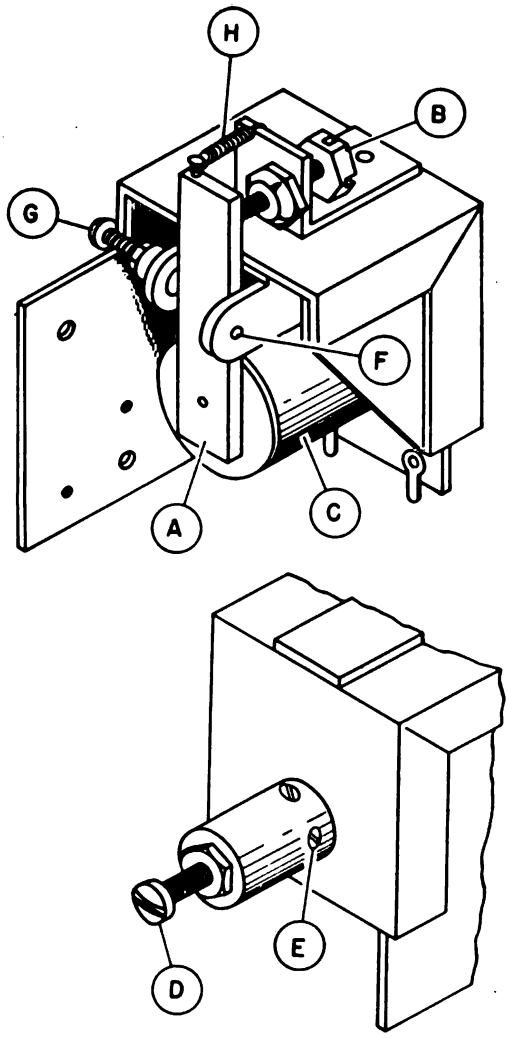
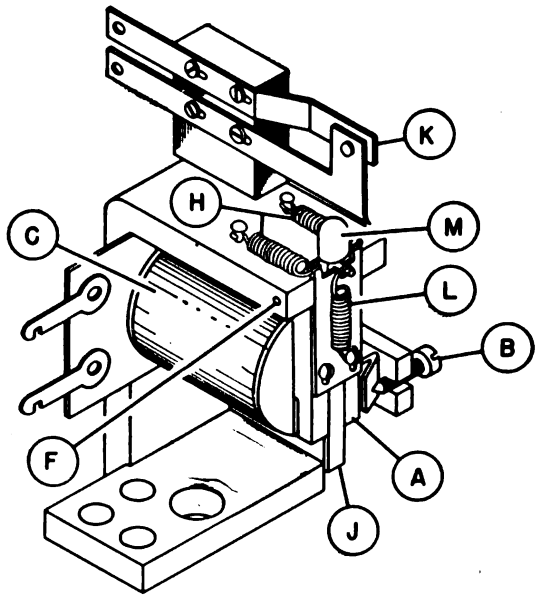


Figure 41. Synchronous motor.



MOTOR SERIAL NUMBERS 401 AND HIGHER



MOTOR SERIAL NUMBERS 1 TO 400 INCL

TL10147S

Figure 42. Trip magnet.

78. Start Magnet (fig. 43)

Ref symbol	Signal Corps stock number	Name of part and description	Function
	(*)	START MAGNET ASSEMBLY: T. T. E. No. 90–06–02	Move brushes in contact with commutator.
A	(*)	ARMATURE EXTENSION: T. T. E. No. 90–06–02–3	Brush actuator.
B	3H526	BRUSH ASSEMBLY: motor; T. T. E. No. 90–06–02–04; includes brushes, sleeves, springs, brush arms, and nuts.	Brush and brush holder.
C	3H3115/B3	BRUSH: T. T. E. No. 90–06–02–44	Commutator brush.
D	(*)	SPRING: brush; T. T. E. No. 90–06–02–43	Brush pressure control.
E	(*)	SPRING: armature	Armature return spring.
F	(*)	BACK STOP: armature	Armature back stop.
G	(*)	SCREWS: armature extension	Remove brush assembly for replacement.
H	(*)	SCREWS: binding head	Brush pigtail connector.
I	(*)	NUTS: 2/56	Hold brush assembly in place.
J	(*)	COIL: 3,000 ohms; ±10%	Actuate armature.
K	(*)	ARMATURE	Actuate brushes.

*Not stocked by depots.

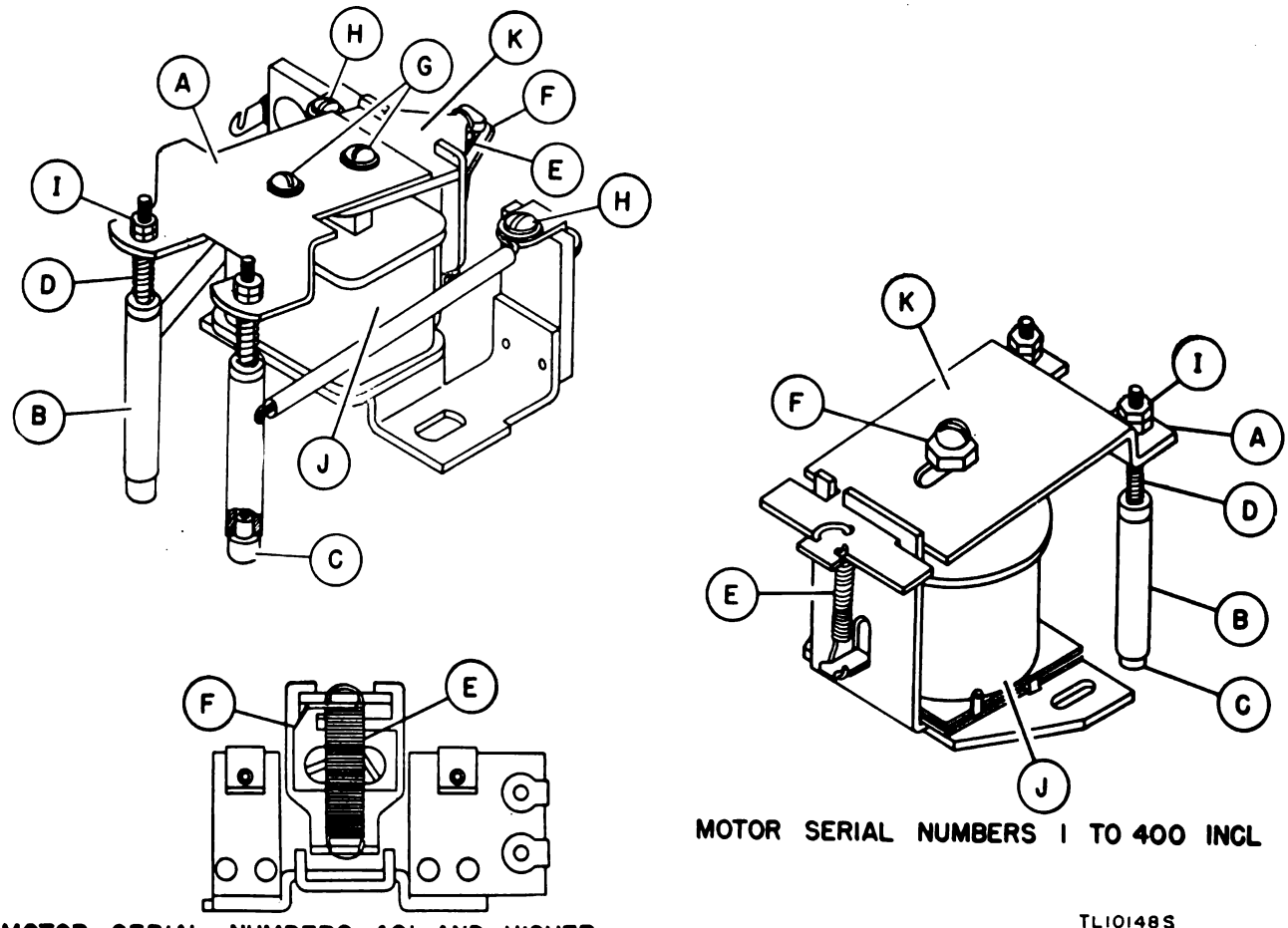


Figure 43. Start magnet.

79. Clutch (fig. 44)

Ref symbol	Signal Corps stock number	Name of part and description	Function
	(*)	CLUTCH ASSEMBLY: part of countershaft Drive Assembly T. T. E. No. 90–06–03.	Hold back drum while phasing.
A	(*)	ARM: stop; T. T. E. No. 90–06–03–82	Stop arm and driver for lead-screw dog.
B	(*)	CLUTCH: ring; T. T. E. No. 90–06–03–81	Retainer for friction drive plugs.
C	(*)	RINGS: Compo, clutch plates; T. T. E. No. 90–06–03–9	Driving part of clutch.
D	(*)	PLUGS: Compo, clutch plugs; T. T. E. No. 90–06–01–72.	Driven part of clutch.
E	(*)	SPRINGS: T. T. E. No. 90–06–03–5	Clutch pressure springs.
F	(*)	RETAINER: spring; T. T. E. No. 96–06–03–4	Retainer for clutch pressure springs.
G	(*)	SCREW: clamp; 3–32	Clamp spring retainer to shaft.
H	(*)	RETAINER: clutch assembly; T. T. E. No. 90–06–03–7.	Clutch assembly retainer and clutch plate driver.
I	(*)	BEARING: clutch; T. T. E. No. 11–06–03–3	Hub for clutch assembly.
J	(*)	PIN: taper 7/0	Pin clutch bearing to drive shaft.
K	(*)	SCREWS: 4-40 flathead	Hold clutch retainer to clutch bearing.
L	(*)	PLATE: pressure; T. T. E. No. 90–06–03–6	Transfer spring pressure to clutch.
M	(*)	SHAFT: drive. (See par. 76.)	

*Not stocked by depots.

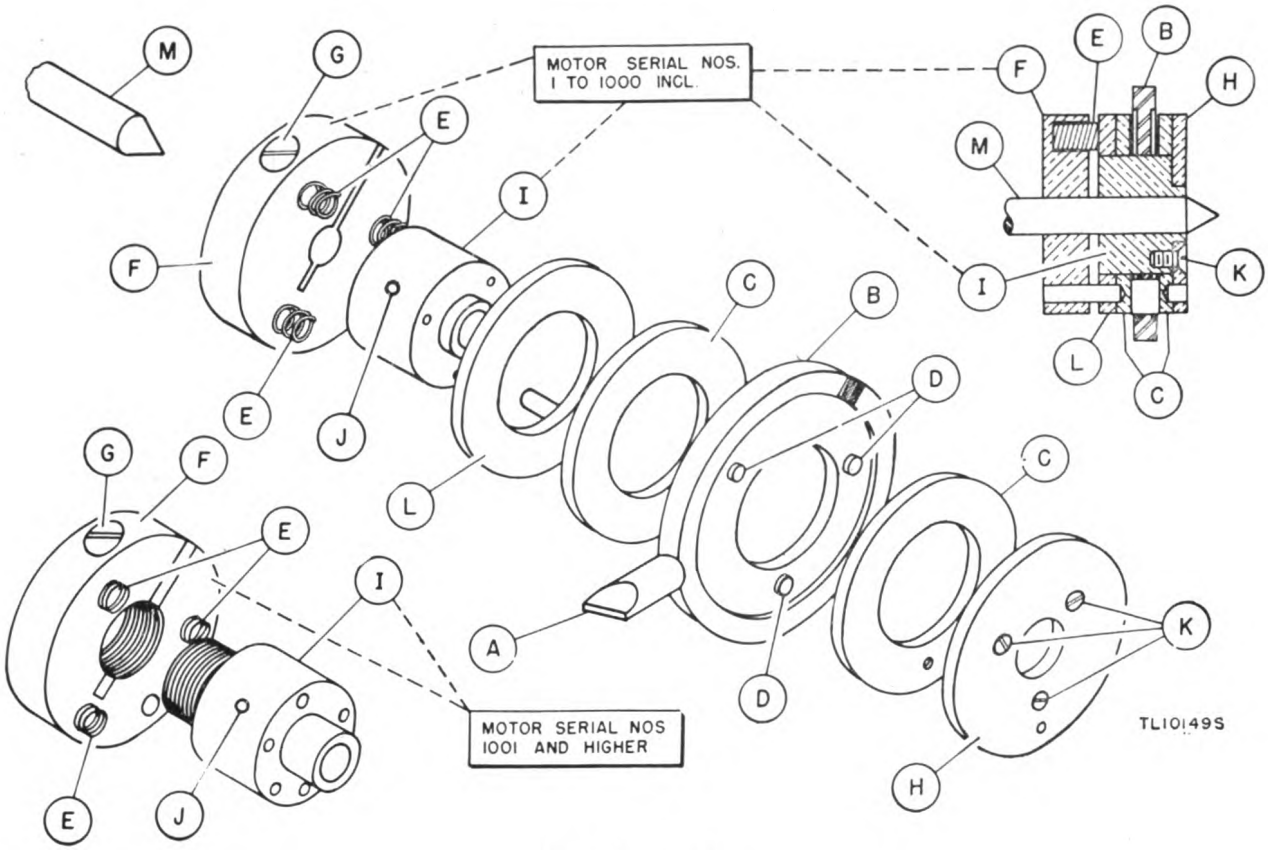


Figure 44. Clutch.

80. Leadscrew, Dog, and Bearing (fig. 45)

Ref symbol	Signal Corps stock number	Name of part and description	Function
A	6C25–1/S5	LEADSCREW: stainless steel; T. T. E. No. 90–04–00	Rotate and feed drum assembly.
B	(*)	KEY-WAY	Drive drum.
C	(*)	COLLAR: drum stop; T. T. E. No. 90–04–00–61. Not required with drums originally supplied with FX–1.	Limit drum travel.
D	(*)	SETSCREW: 6–32; 60° point; T. T. E. No. 90–04–00–62.	Lock collar in place.
E	6C25–1/D5	DOG: drive; leadscrew; T. T. E. No. 90–04–00–5	Leadscrew drive dog.
F	(*)	PLUNGER AND THRUST BALL: T. T. E. No. 90–04–00–3.	Take up end play.
G	(*)	SPRING: T. T. E. No. 90–04–00–2	End thrust pressure.
H	(*)	WICK: felt; T. T. E. No. 90–04–00–4	Oil retainer.
I	6C25–1/B6	BEARING ASSEMBLY: leadscrew; T. T. E. No. 90–07–00.	Bearing for leadscrew.
J	(*)	SCREW: 10–32	Fasten bearing assembly.
K	(*)	BALL: thrust; steel; 1/8" diameter	Thrust bearing.

*Not stocked by depots.

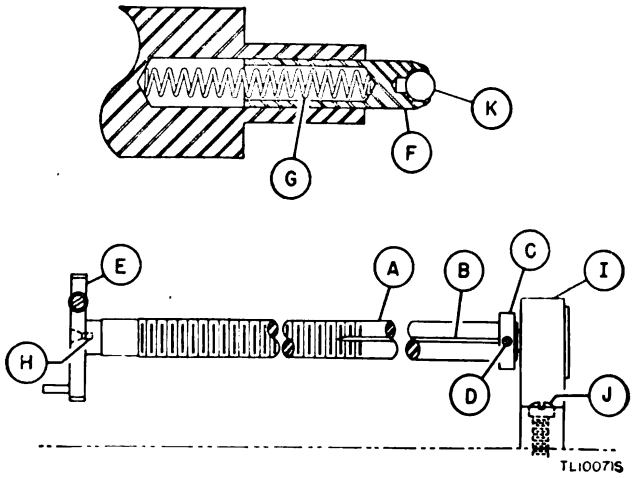


Figure 45. Leadscrew, dog, and bearing.

81. Drum (fig. 46)

Ref symbol	Signal Corps stock number	Name of part and description	Function
	6C25–1/D8	DRUM: T. T. E. No. 90–08–00. 80 series, 80–08–00 originally supplied with equipment. Depots are supplied with 90 series for replacements.	
A		DRUM SLEEVE	Carrier for transmitting subject or recording paper.
B	(*)	KEY: T. T. E. No. 90–08–01–51. 80 series, 80–08–01–51.	To drive drum through contact with keyway in leadscrew.
C	(*)	BEARING SUPPORT AND DECOUPLING ANCHOR, INCLUDING KEY RETAINER: T. T. E. No. 90–08–01–5.	Retainer for key, anchor for decoupler spring F and mount for bearing D.
D	(*)	BEARING: ball; T. T. E. No. 90–08–01–32	Bearing support for drum sleeve.
E	(*)	SLEEVE: bearing; T. T. E. No. 90–08–02–2	Bearing support for drum sleeve.
F	(*)	DECOUPLER SPRING: T. T. E. No. 90–08–01–55	Resilient drive coupling for drum sleeve.
G	(*)	NUT, for paper clamp screw: T. T. E. No. 90–08–01–82	Fasten screws for paper clamp.
H	(*)	COUNTERBALANCE: T. T. E. No. 90–08–01–4	Balance weight of drum clamp.
I	(*)	PHASING RING: T. T. E. No. 90–08–01–9	
J	(†)	HALF NUT: T. T. E. No. 90–08–03–2	Feed drum along leadscrew.
K	(*)	CAM PLATE AND KNURLED RING: T. T. E. No. 90–08–04.	Relieve half nuts from leadscrew.
L	(*)	TAPER PIN: T. T. E. No. 90–08–03–22	Transfer cam motion to half nuts.
M	(*)	HALF NUT SPRINGS: T. T. E. No. 90–08–03–3	Press half nuts into engagement with leadscrew.
N	(*)	RETAINER PLUG: half nut; T. T. E. No. 90–08–03–4	Retainer for spring M.
O	2Z8877–7	GARTER SPRING: T. T. E. No. 90–08–07	Fasten direct recording paper to drum.
P	6C25–1/C5	FILM CLAMP: T. T. E. No. 90–08–06–1	Clamp film or paper onto drum.
Q	(*)	HALF NUT RETAINER: T. T. E. No. 90–08–03–1	Mounting for half nuts and left-hand end drum support.

*Not stocked by depots.
†Stock number not assigned at time of manuscript writing.

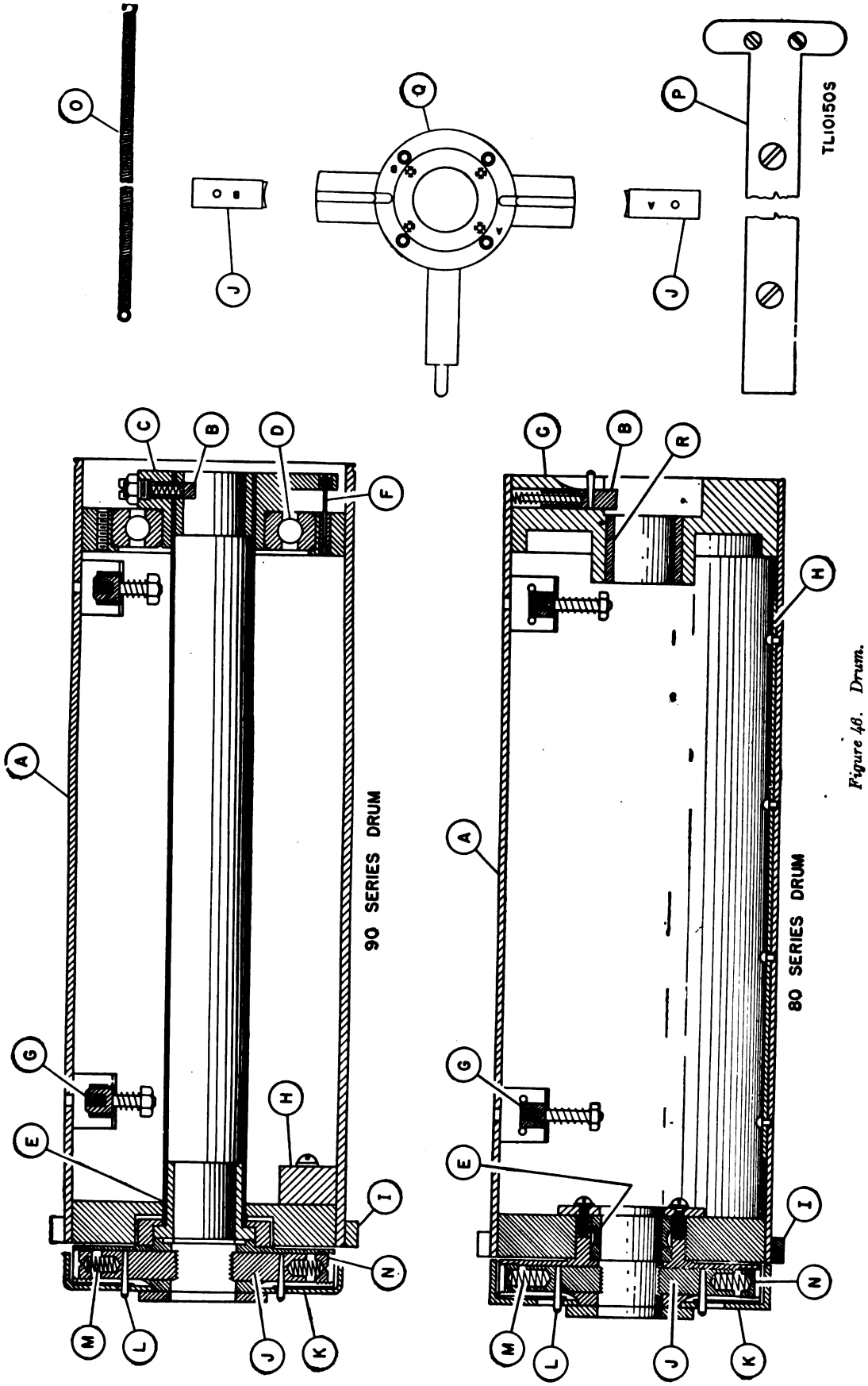


Figure 46. Drum.

82. Transmitter Optical System, 80 Series, Part of Original Equipment (fig. 47)

Ref symbol	Signal Corps stock number	Name of part and description	Function
		TRANSMITTER OPTICAL SYSTEM: T. T. E. No. 80–01.	Scan subject matter for transmission.
A		OBJECTIVE LENS. Replace with 90 series. (See par. 83.)	
B		CONDENSER LENS ASSEMBLY. Replace with 90 series. See paragraph 83.	
C	2Z5936.3	EXCITER LAMP: 6-v; 2 amp; GE 1129. (Bayonet pins must be removed.)	Illuminate spot to be scanned.
D	(*)	BLOCK COVER	Cover for photocell chamber.
E	2Z9403	TERMINAL STRIP: 3-terminal lugs; 2 lug mounting	Mount resistors of bridge circuit.
F	6C25–1/R9	RING: retainer. Not recommended as replacement part because of fitting difficulties.	Clamp photocell in place.
G	2Z3600–5	CUSHION: sponge rubber; T. T. E. No. 80–01–02	Top cushion for photocell.
H	2Z3600–6	CUSHION: sponge rubber; T. T. E. No. 80–01–01	Bottom cushion for photocell.
I	6C25–1/N5	NUTS, lens: T. T. E. No. 80–01–21	Retainer for objective lens.
J	6C25–1/P15	POST, lamp: T. T. E. No. 80–01–12	Support lamp clamp P.
K	6C25–1/H7	HOUSING, photocell: T. T. E. No. 80–01–00	Housing for photocell and support for optical system.
N	6C25–1/H5	HOLDER, exciter lamp: bakelite clamp; T. T. E. No. 80–01–15.	Clamp exciter lamp in place.
O	6L7030–10S	SCREW: standard 10-32 x 5/8" iron filister-head	Pinch clamp P.
P	6C25–1/C6	CLAMP: brass; T. T. E. No. 80–01–13	Adjustable support between post J and lamp holder N.
R	6L6436–10.1S	SCREW: standard 4-36 x 1/2"; filister-head; iron	Clamp lens barrel lock.
U		INDICATOR SPOT	Indicate UP position of lens barrel.
V		PHOTOCELL AND GRID CONNECTOR SHIELD. Replace with 90 series. (See par. 83.)	
W	6L50208–2	BUSHING, insulated: bakelite shoulder washer; T. T. E. No. 90–01–09.	Insulate photocell housing from chassis.
X	(*)	SPACER: 6–32 internal thread; external projection threaded 6–32.	Raise photocell housing.
Z	6C25–1/B3	BARREL, objective lens; T. T. E. No. 80–01–26	Mount objective lens and aperture plate (not shown).
R8, R9, R10, R12.		See paragraph 73.	

*Not stocked by depots.

83. Transmitter Optical System, 90 Series for Replacements (fig. 48)

Ref symbol	Signal Corps stock number	Name of part and description	Function
	6C25–1B/L1	TRANSMITTER OPTICAL SYSTEM: T. T. E. No. 90–01–00.	Scan subject matter for transmission.
A	6C25–1/L7	OBJECTIVE LENS: T. T. E. No. 90–01–10; Bausch & Lomb No. 31–61–80.	Focus image of scanned spot on aperture.
B	6C25–1/M5	CAPACITOR LENS ASSEMBLY: T. T. E. No. 90–01–02.	Focus light from exciter lamp onto spot to be scanned.
C	6Z6806.8	EXCITER LAMP: T. T. E. No. 90–01–13; GE No. 1129 Mazda 6-volt, 21 cp auto lamp.	Illuminate spot to be scanned.
D	(*)	BLOCK COVER: T. T. E. No. 90–01–01–3	Cover for photocell chamber.
E	(*)	CELL EJECTOR: T. T. E. No. 90–01–01–4	Remove photocell.
F	(†)	ADJUSTING SCREW (eccentric): T. T. E. No. 90–01–04–3.	Adjust vertical position of exciter lamp.
G	(†)	ADJUSTING SCREW (eccentric): T. T. E. No. 90–01–04–3.	Adjust horizontal position of exciter lamp.

83. Transmitter Optical System, 90 Series for Replacements (Contd.)

Ref symbol	Signal Corps stock number	Name of part and description	Function
H		CENTER OF ROTATION FOR VERTICAL ADJUSTING CAM SCREW.	
I		CENTER OF ROTATION FOR HORIZONTAL ADJUSTING CAM SCREW.	
J	(*)	EXCITER LAMP ADJUSTING PLATE: T. T. E. No. 90-01-04-1.	Mount exciter lamp to cell block.
K	(*)	CELL BLOCK: T. T. E. No. 90-01-01-1	Mount optical system and support photocell.
L	(†)	LEAF COMPRESSION SPRINGS: T. T. E. No. 90-01-04-9.	Press exciter lamp adjusting plate against cell block.
M	(†)	ADJUSTING PLATE WASHER: T. T. E. No. 90-01-04-4.	
N	(*)	SOCKET HOLDER: T. T. E. No. 90-01-04-5	Mount exciter lamp socket to permit vertical adjustment of socket and adjustment of distance between exciter lamp and capacitor lens.
O	(*)	LOCKING SCREW: T. T. E. No. 90-01-04-7	To lock socket holder in correct focusing position.
P	(†)	SOCKET: T. T. E. No. 90-01-04-6; Culver-Stearns #AG-135.	Lamp socket.
R	(*)	CLAMP: T. T. E. No. 90-01-01-6	Clamp lens barrel.
S	(*)	LENS BARREL FOCUS ADJUSTMENT SCREW: T. T. E. No. 90-01-01-8.	
T	(*)	CLAMP: T. T. E. No 90-01-01-7	Transmit motion from adjustment screw S to lens barrel Q.
U		INDICATOR SPOT	Indicate UP position of lens barrel.

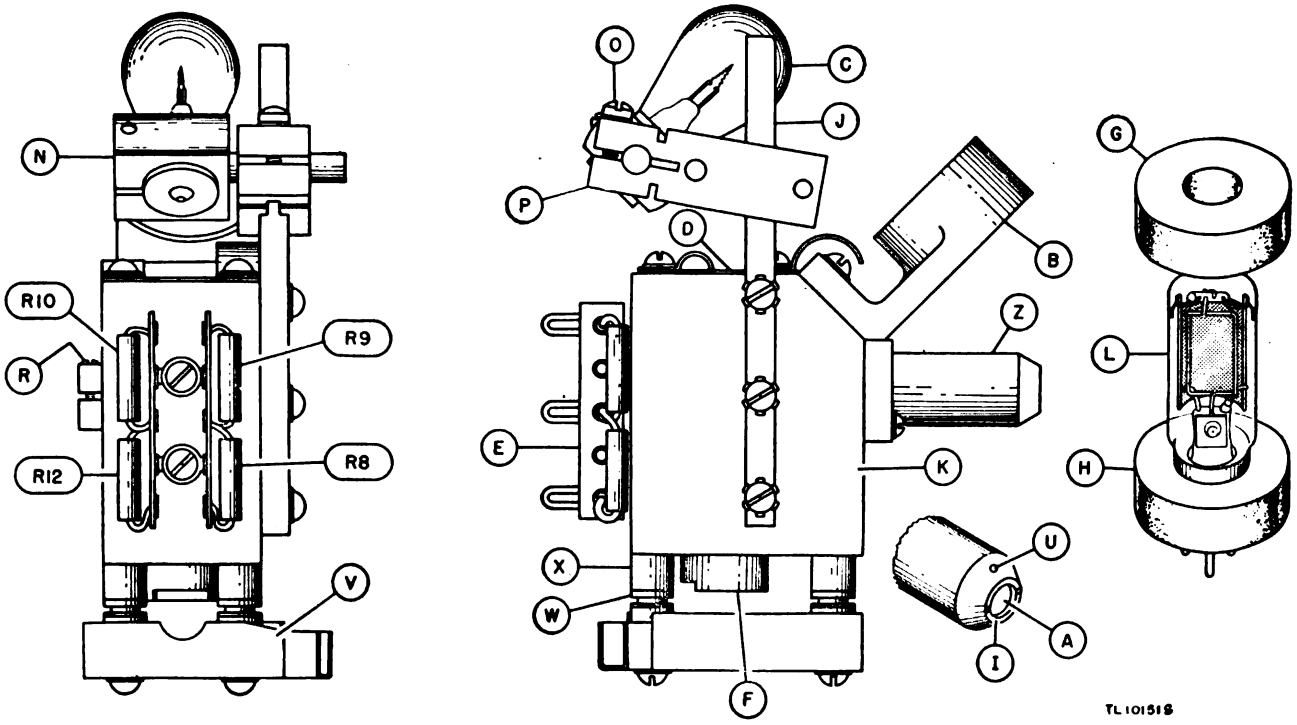


Figure 47. Transmitter optical system, 80 series, part of original equipment.

83. Transmitter Optical System, 90 Series for Replacements (Contd.)

Ref symbol	Signal Corps stock number	Name of part and description	Function
V	(*)	PHOTOCELL AND GRID CONNECTION SHIELD: T. T. E. No. 90-01-90-11.	
W	(*)	SOCKET PLATE ASSEMBLY: T. T. E. No. 90-01-01-2 including socket T. T. E. No. 90-01-01-23.	Photocell socket and mounting plate.
Z	(*)	LENS BARREL ASSEMBLY: T. T. E. No. 90-01-03	To scan area of predetermined size (elemental area) passing light through aperture to photocell.

*Not stocked by depots.
†Stock number not assigned at time of manuscript writing.

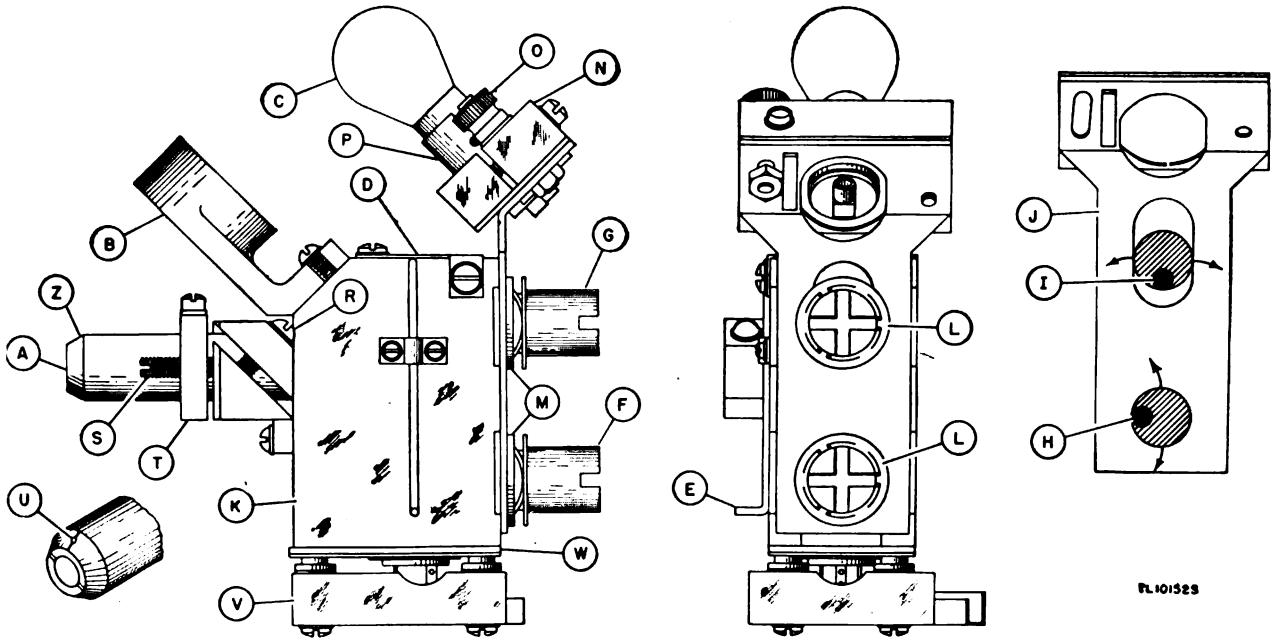


Figure 48. Transmitter optical system, 90 series for replacements.

84. Recorder Optical System (fig. 49)

Ref symbol	Signal Corps stock number	Name of part and description	Function
A	2Z5890-11	LAMP RECORDER: Sylvania No. R1130A or No. R1130B; T. T. E. No. 90-02-06.	Convert signal to light.
B	(*)	SCREW: 3/8" x 6-32; 4 required	Fasten pressure plate.
C	(*)	PLATE: pressure; T. T. E. No. 90-02-02-2	Clamp for lamp base sleeve.
D	(*)	SLEEVE: lamp base; T. T. E. No. 90-02-02-9	Clamp recorder lamp in place.
E	6C310-1/L7	LENS: objective; planoconvex; Hastings Triplet 10X T. T. E. No. 90-02-5.	Focus light passing through aperture onto drum.
F	6C310-1/H1	HOUSING: lamp: T. T. E. No. 90-02-02	Main assembly barrel.
G	(*)	KNURLED RING: T. T. E. No. 90-02-03-12	Adjust lens barrel.
H	6C310-1/B4	BARREL SUB ASSEMBLY: lens; T. T. E. No. 90-02-03-1.	Mount and shield objective lens.
I	(*)	NUT, collet: T. T. E. No. 90-02-03-3	Locknut.
J	6C310-1/L3	LENS: planoconvex, 18-mm, focal length; T. T. E. No. 90-02-04.	Field lens.
K		APERTURE PLATE: T. T. E. No. 90-02-02-7	Light aperture.
L	2Z2650.8	CLAMP: lamp recorder: T. T. E. No. 90-02-01	Support lamp housing.
N	2Z3600-10	SNUBBER	Prevent vibration of lens barrel.

*Not stocked by depots.

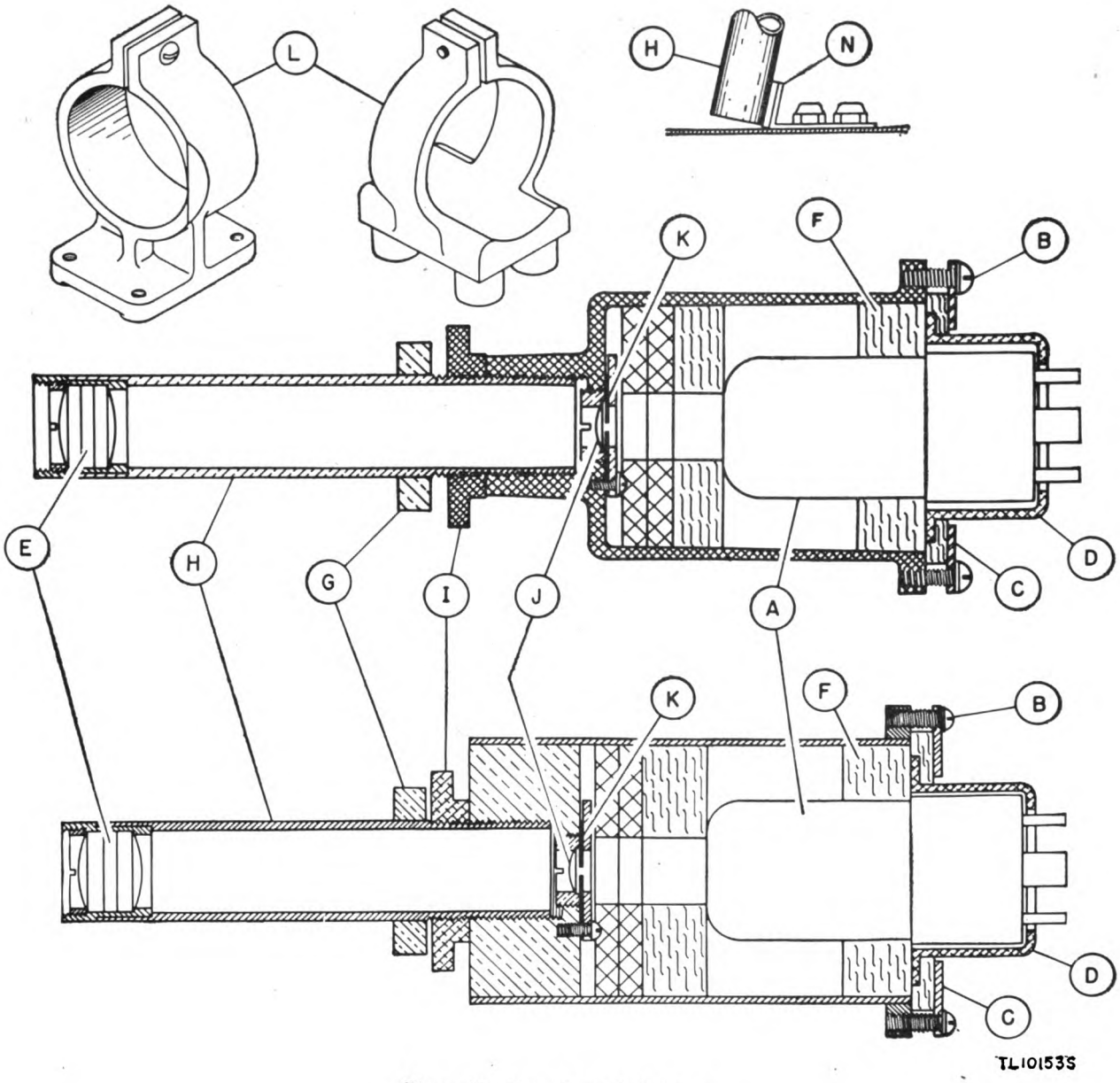


Figure 49. Recorder optical system.

85. Stylus Holder Assembly (fig. 50)

Ref symbol	Signal Corps stock number	Name of part and description	Function
	6C25–1/S21	STYLUS ASSEMBLY: T. T. E. No. 90–03–01	Support stylus needle.
A	6C25–1/S20	STYLUS: T. T. E. No. 90–03–04	Conduct high voltage to recording paper.
B	(*)	STYLUS HOLDER: T. T. E. No. 90–03–01–3	Holder for stylus A.
C	(*)	SCREW: 2-56 x ¼"; RK Brass	Clamp stylus in holder.
D	(*)	FIXED PIVOT: T. T. E. No. 90–03–02–3	Left-hand pivot for stylus shaft.
E	(*)	ADJUSTABLE PIVOT: T. T. E. No. 90–03–02–4	Right-hand pivot for stylus shaft.
F	(*)	BRACKET SPRING: T. T. E. No. 90–03–02–2	Spring support for adjustable pivot.
G	(*)	BRACKET ASSEMBLY: T. T. E. No. 90–03–02 including fixed pivot T. T. E. No. 90–02–03–3.	Support pivots.
H	(*)	STYLUS SHAFT LEVER: T. T. E. No. 90–03–01–2	Rotate stylus shaft to remove needle from drum.
I	(*)	SPRING: T. T. E. No. 90–03–01–6	Rotate stylus shaft to bring stylus in contact with drum; electrical connection between stylus holder and connecting terminal.
J	(*)	FEEDTHROUGH INSULATOR: T. T. E. Nos. 90–03–05–1 and 90–03–05–2.	Insulate connection to terminal lug.
M	(*)	STYLUS SHAFT: T. T. E. No. 90–03–01–1	Support needle holder.

*Not stocked by depots.

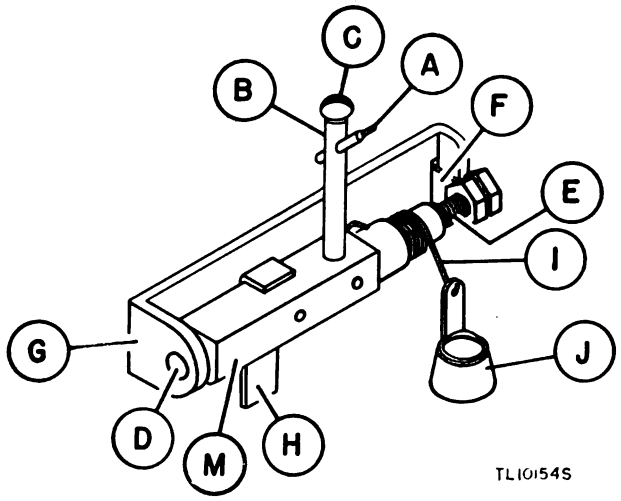


Figure 50. Stylus holder assembly.

86. Miscellaneous Accessory Equipment (fig. 51)

Ref symbol	Signal Corps stock number	Name of part and description	Function
A	6M1550–1	TAPE: Minnesota Mining and Mfg. Co. #135	Secure transmission copy to drum.
B	3B2227/1	CASE, hydrometer: paper tube with metal caps	
C	3B2227	HYDROMETER: Electric Storage Battery Co. Type AS–2E float.	Measure battery charge.
D	6R36921	LIFTER, tube	Assist removal of loktal tubes.
E	2Z7255–13	PLUG, phone: Utah Model No. 2	Connect external meter.
F	6C25–1/S20	STYLUS, needle: tungsten wire in brass sleeve	Conduct current to direct recording paper.
G	3E4020–1	CABLE, battery connector: T. T. E. No. 90–41–00	Connect FX–1 to storage battery.

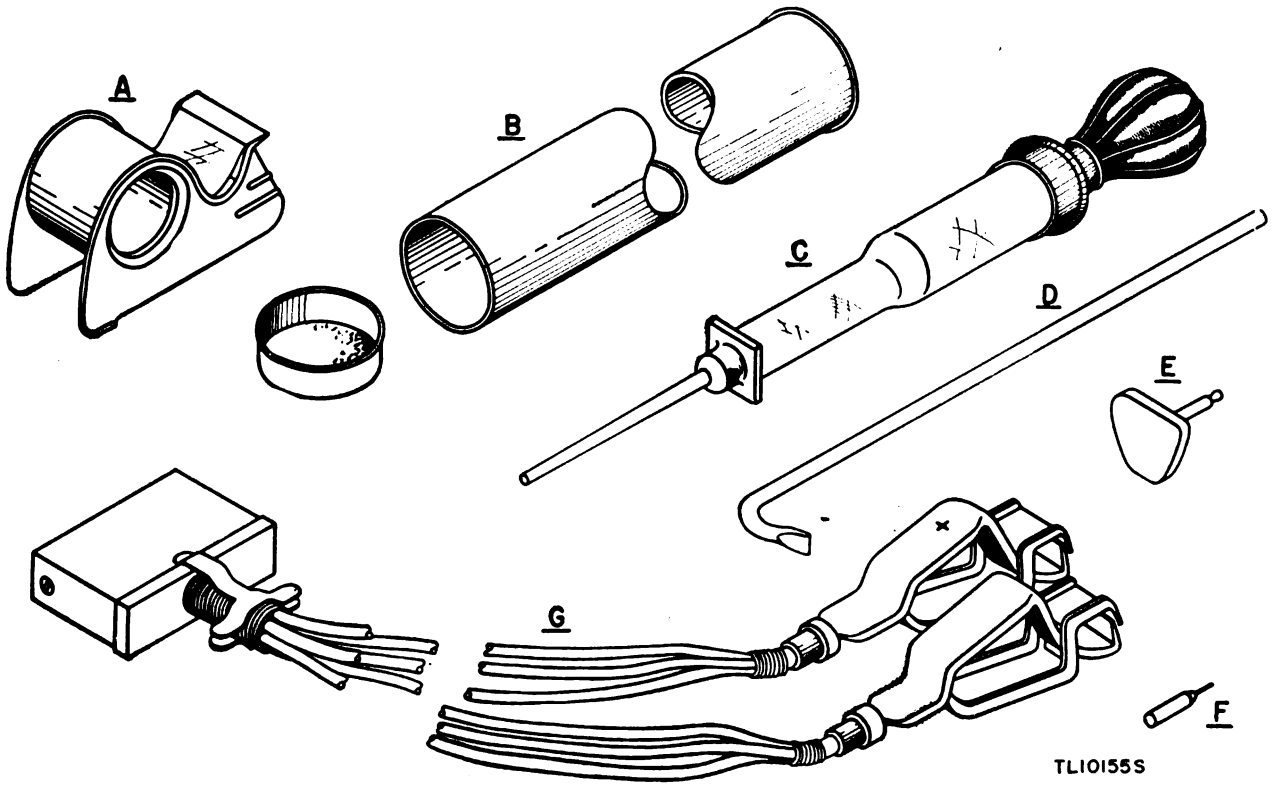


Figure 51. Miscellaneous accessory equipment.

SECTION VIII
FINAL TESTING

87. Recheck of Individual Unit Performances

a. GENERAL. After the set has been repaired and is ready for operation, a final check shall be made of all the major individual units to see that they all meet the minimum performance requirements.

b. INDIVIDUAL UNITS TESTS (TRANSMIT). Table III shows the measurements when the set is operating as a transmitter.

Table III. Signal measurements (TRANSMIT)

Test	Requirements
Fork frequency. TRANSMIT position. Transceiver meter set at approx 0 db.	1 cycle per minute maximum deviation as compared to a standard. (See par. 21*a*.)
Contrast wedges. TRANSMIT position.	20-db min wedge for both positive and negative settings. (See par. 43*c*.)
Power pack regulation. TRANSMIT position. Balance on black and shine light on white. Transceiver meter set at approx 0 db when light is shining on white.	1-db maximum deviation of transceiver meter while varying power line voltage from 100 v alternating current to 130 v alternating current at the rate of about one cycle per second.
Feed coil output into 600-ohm load. TRANSMIT position. Transceiver meter set at +2 db.	Voltage measured across 600-ohm load resistor: Minimum 14 v alternating current. Maximum 17 v alternating current.

c. INDIVIDUAL UNIT TESTS (RECEIVE). Table IV shows the measurements when the set is operating as a receiver.

Table IV. Signal Measurements (RECEIVE)

Test	Requirements
Fork beat. RECORD PHOTO position. Gain dial set above 75. Input signal 0.002–0.003 v alternating current 1,800 cps. (See par. 44*b*.)	Transceiver meter should show beat of less than 1 db (par. 44*b*).
Feed coil input 0.002 volt, 1,800 cps. RECORD PHOTO position. Gain dial set at 100.	Transceiver meter should read minimum +1 db, maximum +4 db. Recorder lamp current minimum 28 ma direct current; maximum 33 ma direct current (d-c milliammeter connected in series with recorder lamp).
Motor action. RECORD PHOTO position. Drum cam disengaged (cam knob away from operator).	Set power line voltage at 100 v alternating current. Press START button until motor speed is slightly above synchronous speed and release button. Motor should lock into synchronous speed at an average of 4 times out of 5. After several trials, press PHASE button while motor is running. Drum should stop without stopping motor. (If drum does not rotate when PHASE button is released though motor is running, rotate drum manually toward front panel about ½ inch and release. If clutch tension is too tight or motor current is too low, the motor will stall.) Repeat above operations at 115 and 130 v alternating current.
RECORD DIRECT. RECORD PHOTO position. Transceiver meter set at +2 db. (Approximately 0.005 v alternating current, 1,800-cycle into feed coil jack.) Fasten a sheet of Teledeltos on drum. Start motor and engage drum. Turn selector switch to RECORD DIRECT.	Stylus should contact drum and continuously record at least a dark grey.

SECTION IX
SUPPLEMENTARY DATA

88. General

In addition to the normal repair work, there will be emergency conditions when deviations from conventional test and repair work will have to be made. Personnel assigned to testing and repairing may have to assist with installation and operating problems. This section covers in a general way information required for operation under emergency conditions and information pertaining to installation and operation which is not covered in TM 11-375. If the facsimile transceiver does not meet the minimum requirements as a transmitter, as specified in paragraph 22, certain allowances can be made when necessary. Any equipment set up for operation which does not meet all requirements of section VIII should be so marked. If special operating instructions are required, the instructions should be written and attached to the set.

89. Emergency TRANSMIT Allowances

a. The specified requirements for contrast call for a 15-db difference between black and white. In an emergency, a range as low as 4-db will make it possible for the receiving station to obtain intelligible copy. The transmitting copy must, under such conditions, have extreme contrast between black and white so that the transmitted signal will have the maximum possible range. If the recording is to be made on film, the receiving station can help by setting for its minimum signal at a point 1 or 2 db above the customary setting. The film should be developed in a developer D-72 instead of DK60A. A high-contrast printing paper such as Azo No. 5 will aid in correcting the deficiencies.

b. Under most operating conditions, the facsimile transceiver will deliver a signal strong enough to feed a line or radio set, even though the signal level at the output of the transceiver is considerably less than the rated minimum. The receiving operator will, in most cases, be able to make up for a low level transmitted signal by the adjustment of his GAIN control.

Caution: If there is danger of causing crosstalk into another circuit, do not put more signal into the line than necessary. The 1-volt receptacle of the UC feed coil will not give excessive signal. Never put more than 0-db signal into a line feeding a carrier system, unless there is loss in the line between the facsimile transceiver and the carrier equipment. For example, if the line loss is 10 db, a +10 db output of the transceiver will not overload the carrier equipment.

Note. In transmitting to a nearby receiving stations over a line having very little loss, the transmitting station can reduce the signal by readjusting the GAIN control to give a low meter reading (say −10 db for maximum signal) *after* the contrast adjustments have been made.

90. Emergency RECORD PHOTO Allowances

a. Paragraph 22 indicates that the transceiver must be capable of producing a +2-db meter reading with a line signal input of 0.002 volt. Under fixed conditions where it is known that the available signal is considerably above 0.002 volt, the equipment may be put in service even though it does not meet this sensitivity requirement.

b. If the phasing system does not operate over the range of normal GAIN control settings, the receiving operator can sometimes obtain satisfactory operation by adjusting the GAIN adjustment to the point where the phasing system operates properly and then returns the GAIN adjustment to the point determined to be satisfactory for recording. If it is essential that the equipment be used at a time when the phasing system is inoperative, it is generally possible to obtain intelligible copy by recording on direct recording paper and cutting the paper at the proper phasing position. If the recording must be made on film, remove the clamp bar and fasten the film on the drum with transparent scotch tape. Remove all the scotch tape before developing the film. With a little skill and practice, the drum can be hand-phased. To do this, hold the drum by hand (motor running) with the paper overlap or film clamp directly in front of the lens system. Watch or listen for the phasing pulse and release the drum at the instant the pulse is received.

c. If the recorder lamp becomes weak and a replacement lamp is not available, satisfactory results may sometimes be obtained by using a faster recording film or faster paper. A satisfactory film is Super Speed Ortho or Portrait Pan. Care will have to be taken to avoid fogging this film. A paper which will give the effect of 2 or 3 db more signal level is Eastman Kind 797. This paper will not give the contrast of the Royal Bromide F1. The lack of contrast can be compensated for by having the transmitting operator transmit a signal of

greater range between black and white. If the low density of the recording is the result of fogging of the recording lamp, the fog or sputter can sometimes be partially removed by heating the end of the tube in a flame. The heating must be done by bringing the temperature up gradually. Cooling must also be gradual. The heat distills the deposited coating.

91. Emergency RECORD DIRECT Allowances

a. If there is no supply of stylus needles, ordinary steel phonograph needles may be used. They must be replaced often. Steel spring wire having a diameter of approximately 0.010 inch may be used in emergency. If the stylus holder has become damaged beyond repair, a light steel spring may be mounted in a fixed position to serve as a stylus.

b. If Teledeltos or Timefax paper is not available, readable copy can be made on the black interleaving paper used in the packing of transmission film.

92. Radio Interference (TRANSMIT)

Under some conditions, there are cases where a radio transmitter will feed back into a facsimile transceiver when the transceiver is set for TRANSMIT. This feedback condition may occur when the facsimile set is close to the radio transmitter. The cause may be circulating currents through the ground system or in the signal line connections. The feedback is indicated by a short contrast range when the radio set is turned on. Do not attempt to operate when there is an indication of radio feedback. It must be cleaned out. There is no fixed rule for accomplishing this. In extreme cases, it may be necessary to operate the FX–1 from a storage battery rather than the power line circuits. In most cases, proper isolation may be secured after trying different coupling circuits and grounding systems between the facsimile transceiver and the radio modulator input circuit.

93. Radio Interference (RECORD DIRECT)

The sparking at the recorder stylus sometimes causes radio interference. The added suppressor resistor referred to in paragraph 44*d* will, in many cases, do much to reduce radio disturbances. Interference in radio reception may be reduced by the use of proper grounding system. It is sometimes necessary to use a common ground for the radio receiver and the facsimile transceiver.

94. Field Wire Operational Troubles

The signal attenuation over field wire such as W110b is very high as compared with commercial telephone circuits. If there is only one circuit involved, make the line connection to the feed coil jack. This will permit the satisfactory transmission of signals over approximately 25 miles of field lines. If there are adjacent circuits, it may not be possible to operate directly from the feed coil jack because the facsimile signal will produce crosstalk. The next best method of feeding the line is to use the UC feed coil and connect the line to the 6-volt receptacle.

Caution: Never connect a commercial telephone circuit to the line jack.

95. Loaded Cable Circuit Operational Troubles

Telephone circuits carried in cables usually have loading coils inserted in the cable at regular intervals to improve the voice transmission characteristic. The insertion of the loading coils produces a distortion effect which is quite noticeable in some of the older type commercial circuits. If the received copy shows an out-of-focus or stutter effect, this degradation will, in many cases, be traced to the telephone transmission line. Under normal operating conditions, nothing can be done to correct this trouble. The only remedy is to obtain a better circuit or to transmit copy having no fine lines.

96. Timefax Recording

a. When multiple copies of direct recording are required, Timefax recording paper is used. This paper contains a dye in the undercoating, which transfers to the gelatine pad in the hectograph method of duplicating. The Timefax paper is use in the same manner as the Teledeltos. It is important, however, not to attempt to make dense recordings. A strong current at the stylus will burn away the dye in the undercoating. To judge whether the recording signal has been too strong, hold the received copy up to the light with the backside of the copy to the observer. If the copy appears to be perforated, the recording density is excessive.

b. In making multiple copies from the Timefax recording, the gelatine pad must be carefully prepared. If the moisture content is too low, the dye will not transfer. If the pad is too moist, the gelatine may peel off when the Timefax copy is stripped from the pad. There is no way of conveniently measuring the condition of the pad. It must be determined by experience. By touching

the pad with the finger tips, an operator soon becomes acquainted with the requirements. The Timefax copy must be left in contact with the pad 1 or 2 minutes before stripping it off. If it is not left on long enough, there will not be sufficient transfer of the dye. If it is left on too long, there may be a tendency for the background (unrecorded portions) to bleed through. Normally, 10 to 15 satisfactory copies can be made from one impression of the original copy. If additional copies are required, one or more additional impressions may be made from the recorded Timefax copy.

97. Recording Paper Substitutes

If Royal Bromide F1 paper is not available, the recordings should be made on film and contact prints made from the film. If the time required for this process is excessive, bromide enlarging papers may be used. Fairly good results may be obtained from photostat paper. Experiments will have to be made to determine the correct db meter reading for proper exposure. Most papers will require a higher signal level than Royal Bromide F1. If it is necessary to go up to +4 or +5 db for recording, do not attempt to handle half tone copy, since the shadows will be badly flattened because of the overloading of the amplifier.

98. Preparing Facsimile Transceiver FX–1 for Shipping

a. Facsimile Transceiver FX–1 and its power Supply PE–140 are provided with carrying cases. In an emergency, where weight and space are important factors, the carrying case may be omitted.

b. Do not remove the tubes in the fork unit when shipping. The other tubes in the PE–140 unit may be removed, if the tubes are properly packed for shipment with the equipment.

c. Slide the drum to the extreme left end of the leadscrew, disengage the half nuts and chock the drum with a wooden block, as shown in figure 70. The shipping chock keeps the drum from sliding, without having to put the load on the half nuts. If the traveling conditions are not going to be severe, the chock may be omitted. When shipping without the chock, move the drum to the right as far as it will go, then engage the half nuts to keep the drum in place.

d. Check the list of accessories (pars. 74 and 86) belonging to the equipment. See that each accessory is in its proper place and properly packed before shipping. Where more than one set of units is involved, pair the serial numbers of the FX–1 and PE–140 units.

99. Voltage and Resistance Chart

Figures 52 to 57 inclusive supply correct voltage and resistance measurements made from the bottom of the chassis with a 1,000-ohm-per-volt meter. Measure the resistances after removing the tubes from their sockets. Disconnect the power cord from the line.

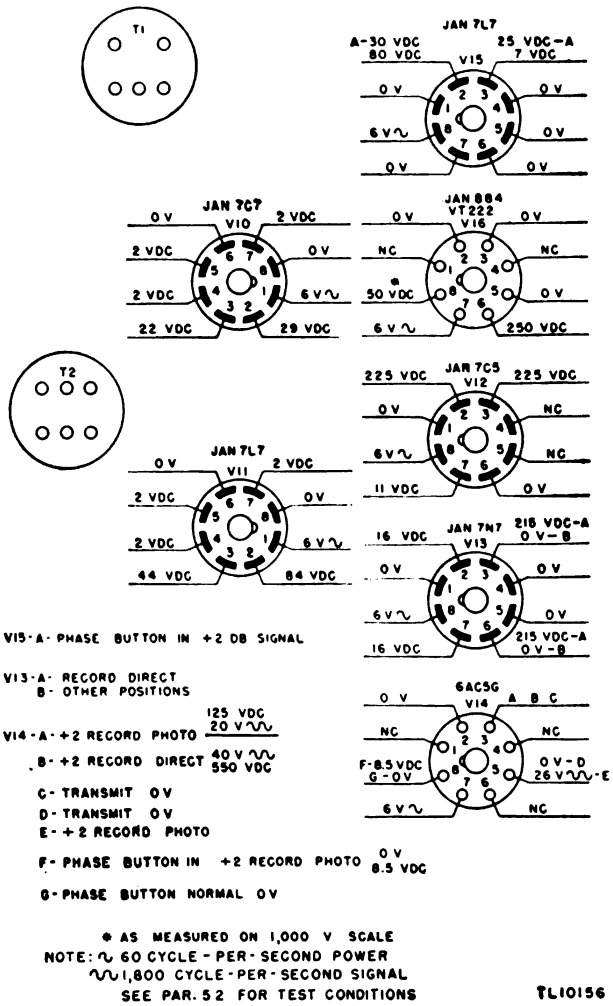


Figure 52. Voltage measurement chart.

100. Moistureproofing, Fungiproofing, and Refinishing

After Facsimile Transceiver FX–1 and Power Supply PE–140 have been repaired and are functioning properly, they should be moistureproofed and fungiproofed in accordance with Signal Corps Specifications JAN–T–152. If the transceiver or power supply cases have been scarred or chipped, remove any rough spots with No. 00 or No. 000 sandpaper and apply paint to spots with a small brush. If the cases are sufficiently scarred and scratched to warrant complete refinishing, remove chassis from cases, and remove all dirt and rust

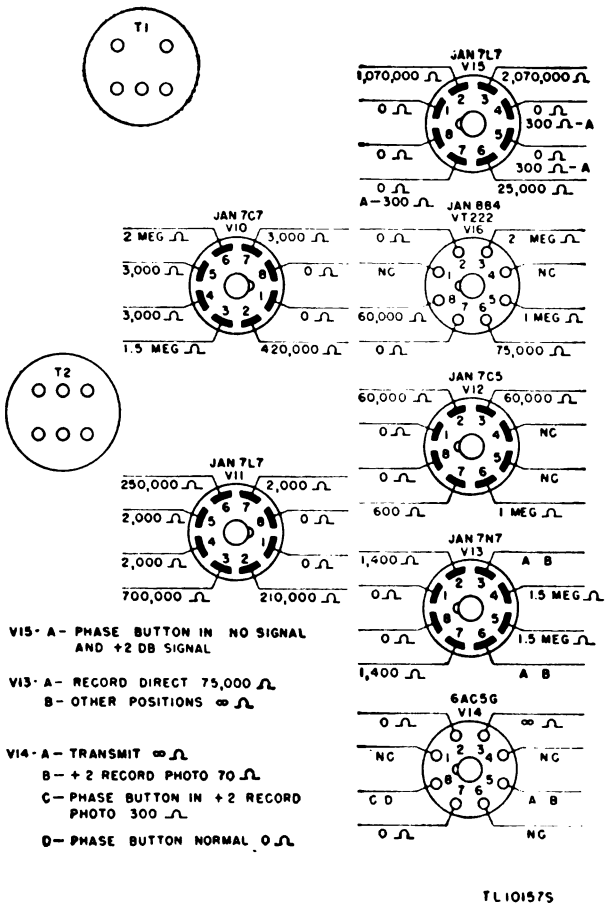


Figure 53. Resistance measurement chart.

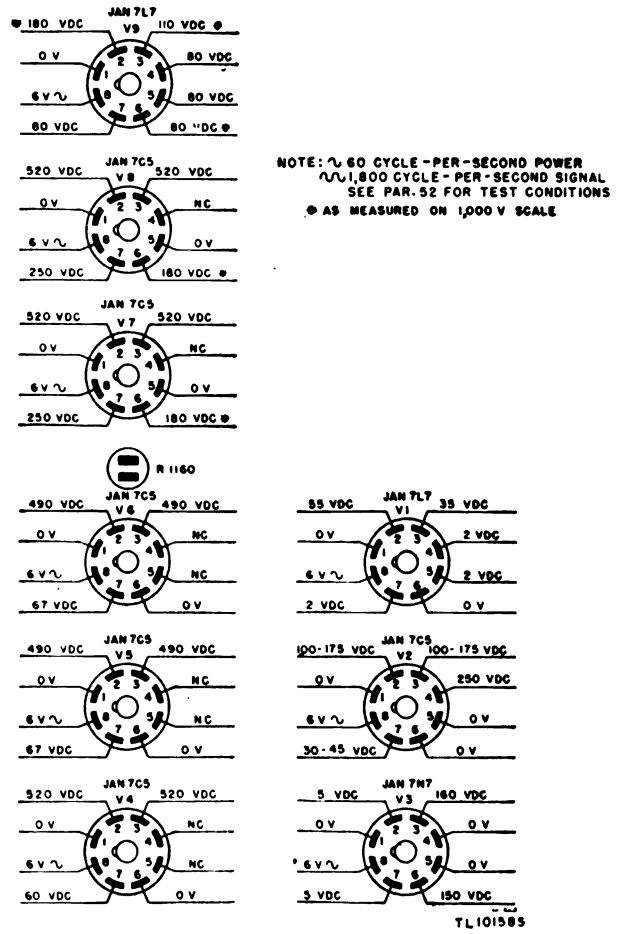


Figure 54. Fork and regulator panel voltage measurements.

with kerosene when necessary. Spray entire case with the proper paint authorized by existing regulations.

101. Nomenclature

Certain terms and descriptions appearing in this manual may bear different nomenclature in other publications. Several of the terms used in this manual are derived from colloquial expressions, used by personnel working with facsimile equipment, which have a broader meaning than is immediately apparent. Some of the common terms and expressions are clarified below:

a. AN/TXC–1. The nomenclature AN/TXC–1 is sometimes used in describing the Facsimile Transceiver FX–1, modified for 12- by 18-inch copy. Correctly used, the term AN/TXC–1 applies only to a more recent design.

b. COMPO. Compo is a trade name for a powdered bronze which is formed into bearings and other parts by means of pressure and heat. There are other types of this form of material referred to as sintered bronze. Other types of sintered bronze may be used for bearings but not for the friction plates or plugs described in paragraph 79.

c. CONTRAST. The db difference between maximum and minimum or white and black signals in this manual is referred to as contrast. Some publications use the term wedge for contrast. The term wedge is derived from photographic nomenclature.

d. FACSIMILE. In some technical literature, the term facsimile systems is used to describe systems capable of handling black and white copy only. The term facsimile as now defined includes also the handling of half-tone photographic copy.

e. ENGAGING KNOB. The engaging knob on the drum is sometimes referred to in other publications as the knurled knob. The engaging knob or knurled knob is attached to the cam plate which is sometimes referred to as the knurled ring.

f. FEED COIL JACK. The feed coil jack is referred to in other publications as line jack.

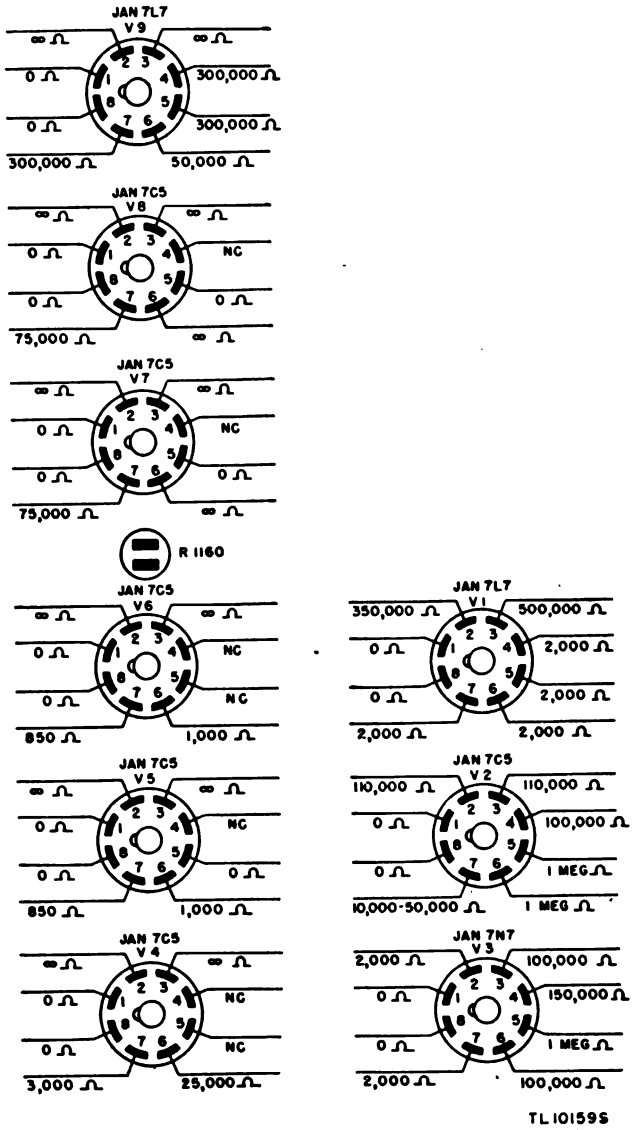


Figure 55. Fork and regulator panel resistance measurements.

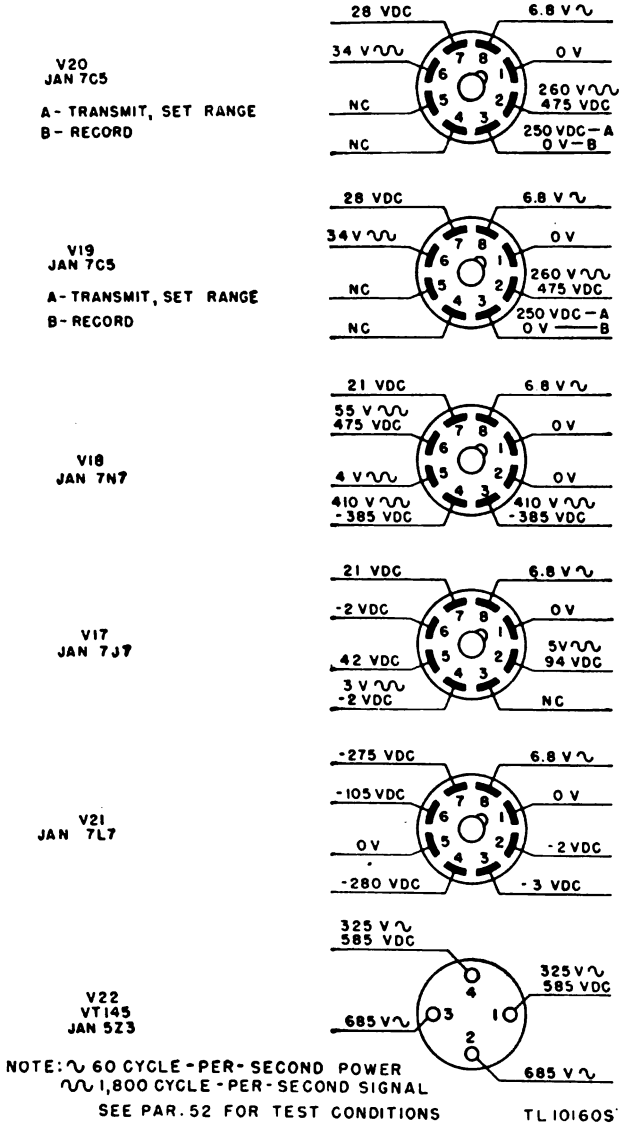


Figure 56. Rectifier power supply voltage measurements.

g. FORK OSCILLATOR. Correctly used, the term fork oscillator includes the tuning fork, drive coils, and associated amplifier circuits.

h. GE PLUG. Other publications refer to the GE plug. This plug is the General Electric 1347 female or 1348 male connector.

i. RECTIFIER POWER SUPPLY. The term rectifier power supply is now used to describe the unit which was formerly referred to as the power pack.

j. REGULATOR PANEL. The term regulator panel is used to describe the bracket and tube assembly which includes the voltage regulator system and motor amplifier tubes. The transformer and choke included in the amplifier are mounted on the main chassis.

k. SYNCHRONOUS MOTOR. The term synchronous motor, in most cases, applies to the complete assembly shown in figure 41. This includes the synchronous motor, the start motor, reduction gear system, clutch assembly, start magnet, and trip magnet.

l. 884. The tube in stage V16 is a type 884 gas-filled triode frequently called a thyratron.

m. TRIP MAGNET. The trip magnet referred to in this manual is generally called phase magnet in other publications.

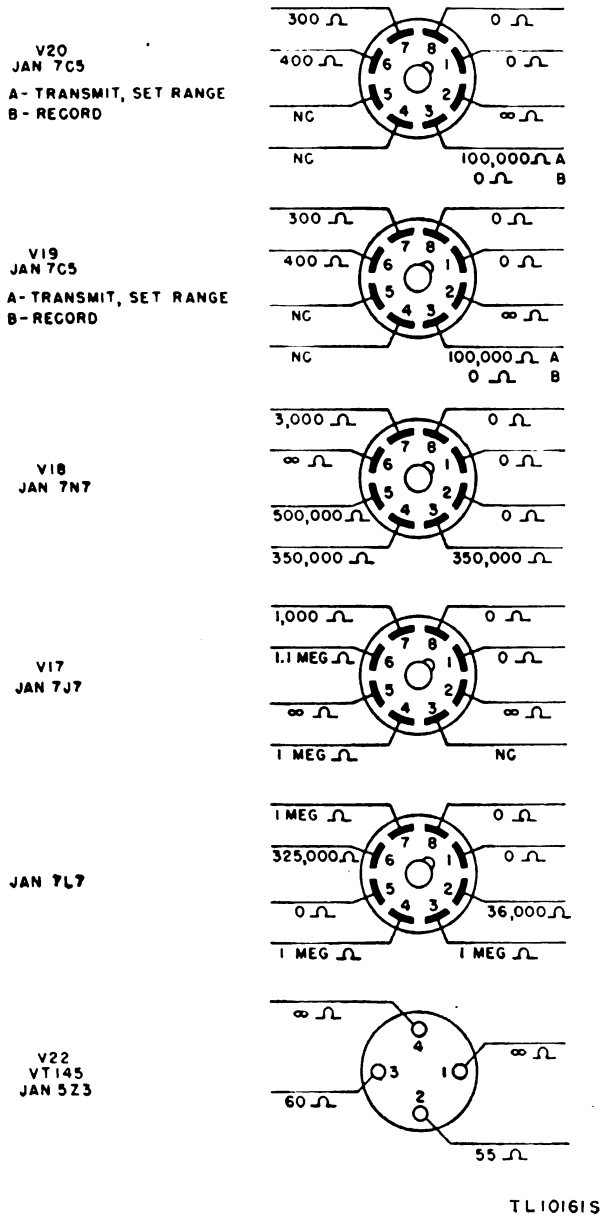


Figure 57. Rectifier power supply resistance measurements.

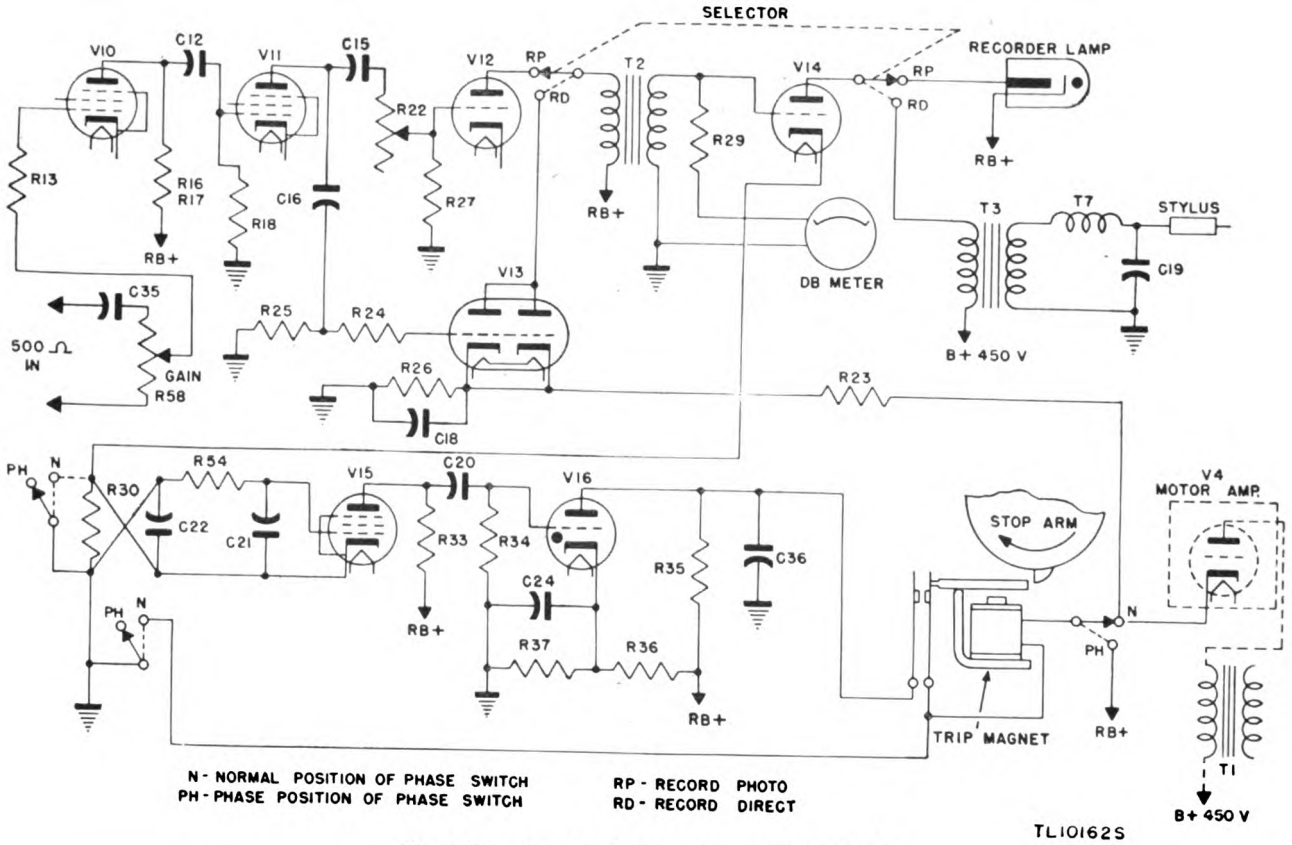


Figure 58. Simplified stage schematic, RECEIVE.

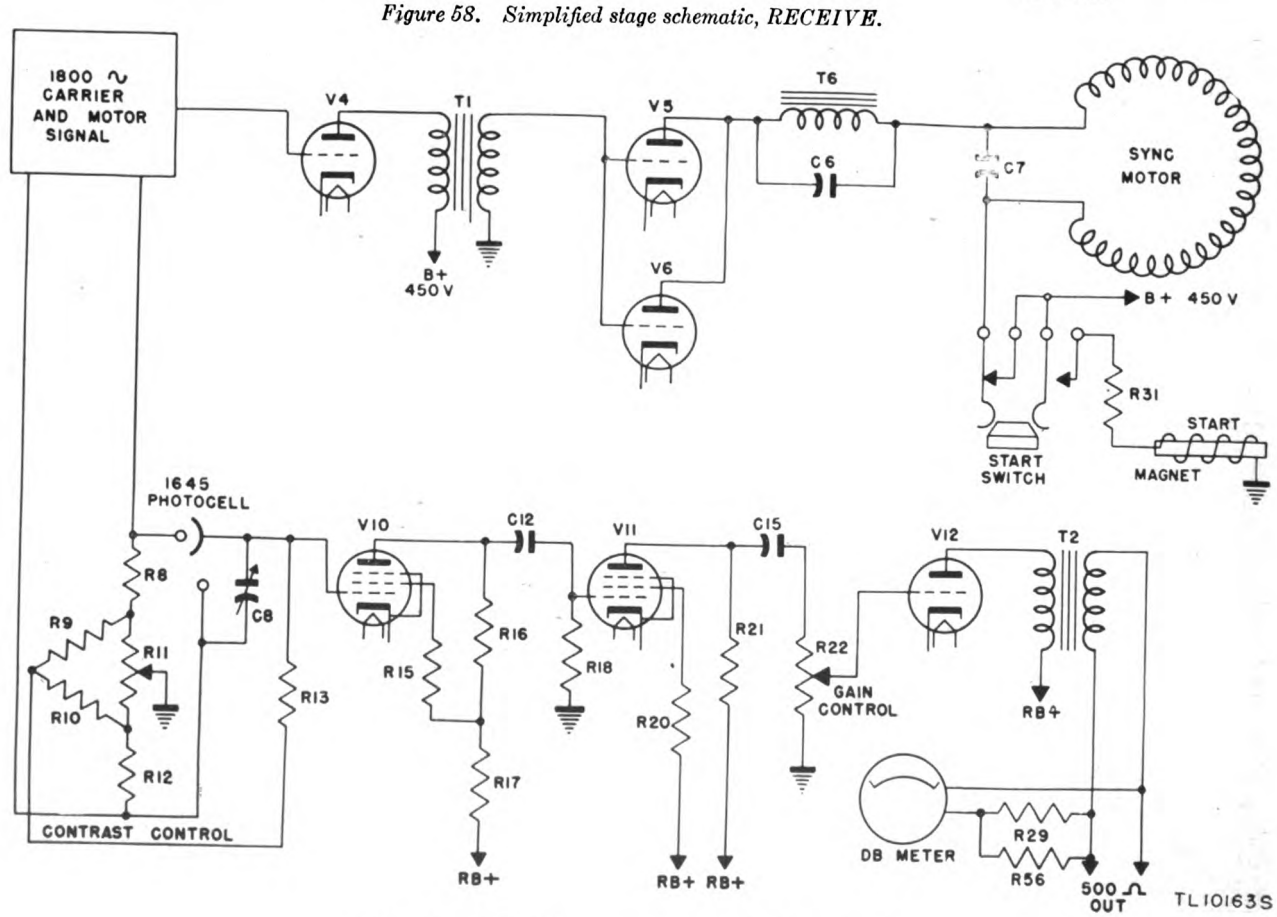


Figure 59. Simplified stage schematic, TRANSMIT.

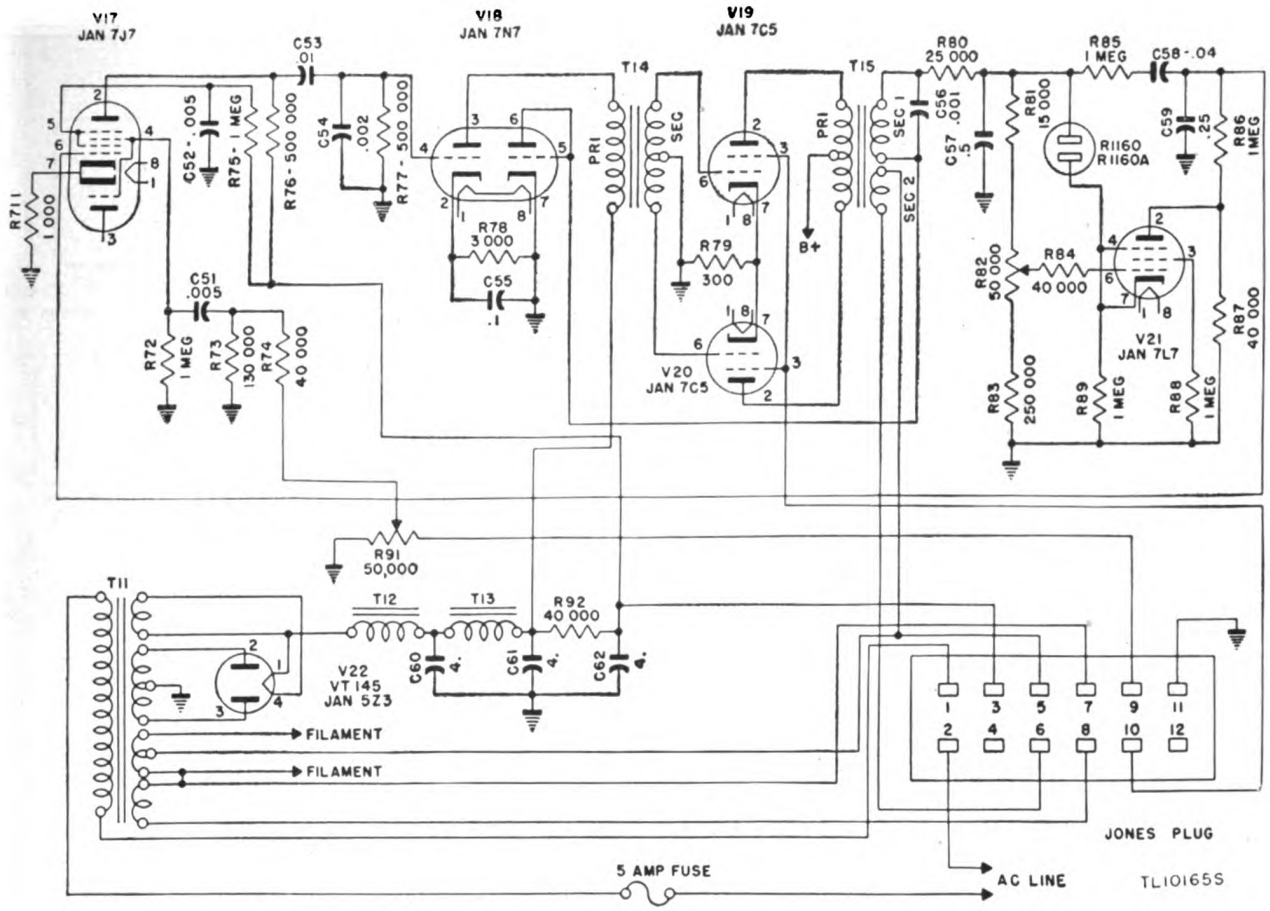


Figure 60. Rectifier Power Supply PE–140, schematic diagram.

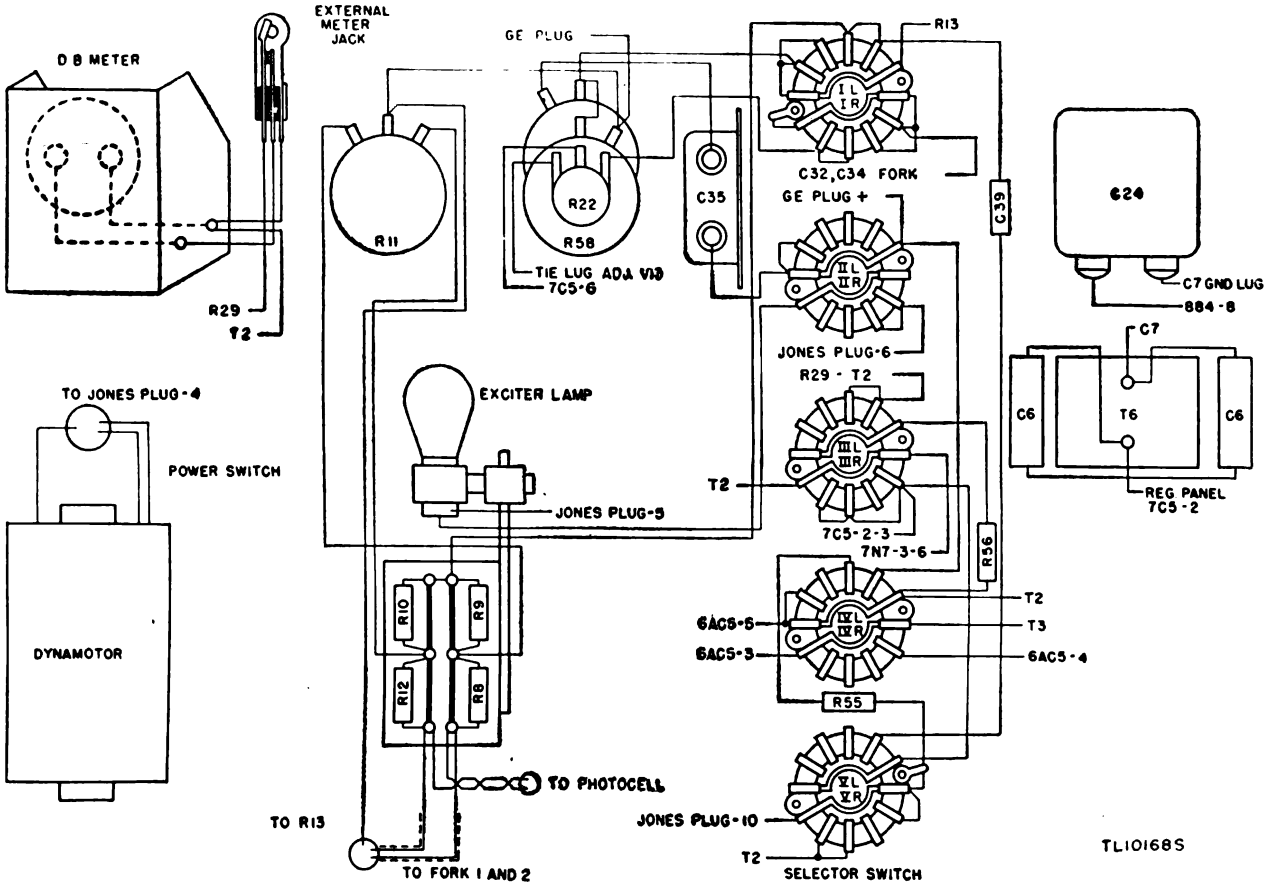


Figure 61. Facsimile Transceiver FX–1, front panel, wiring diagram.

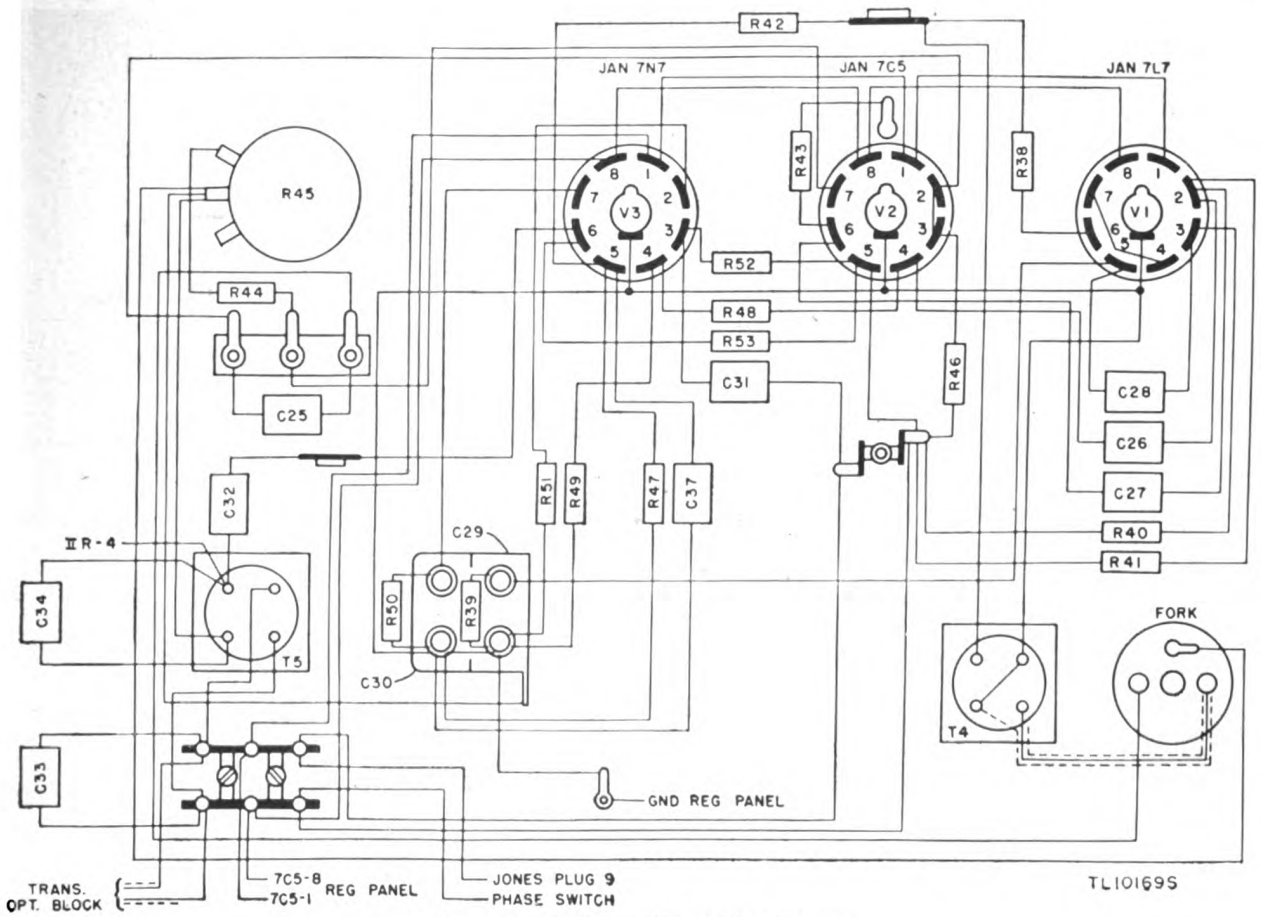


Figure 62. Fork amplifier, wiring diagram.

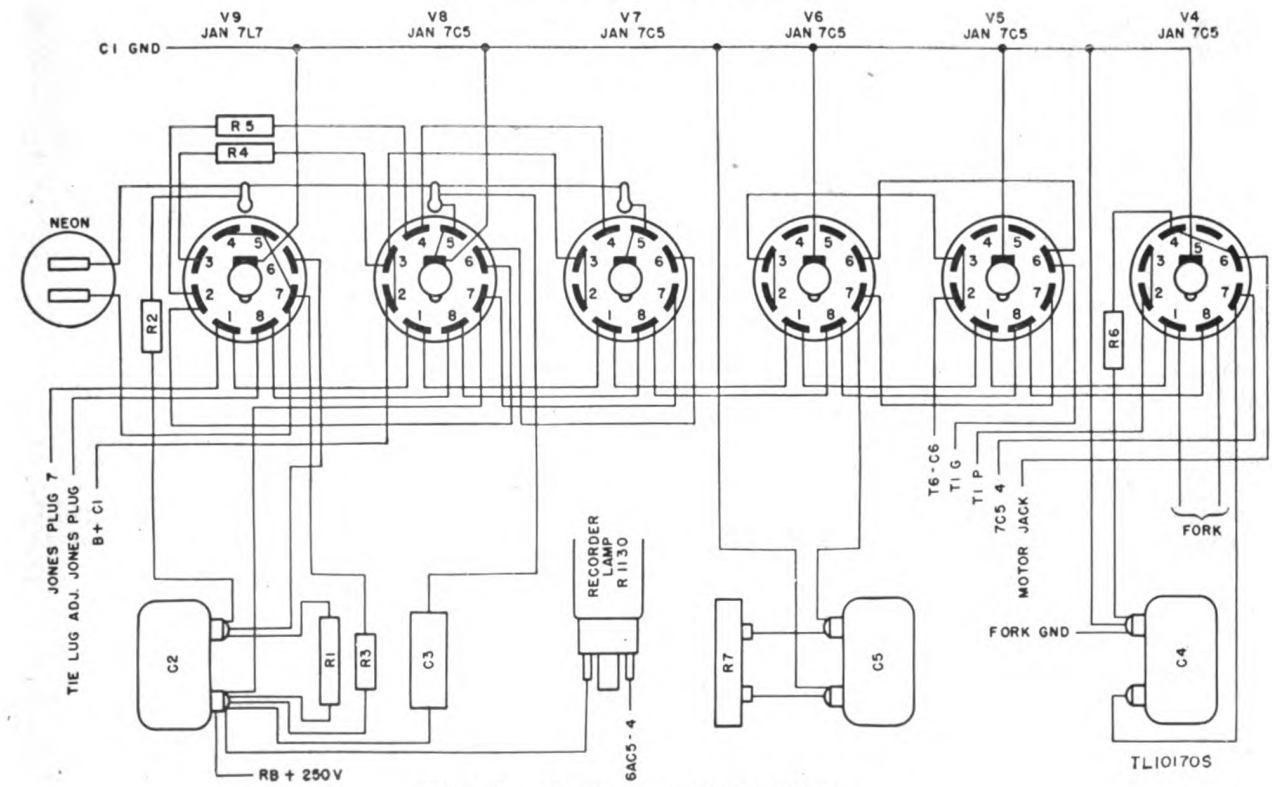


Figure 63. Regulator panel, wiring diagram.

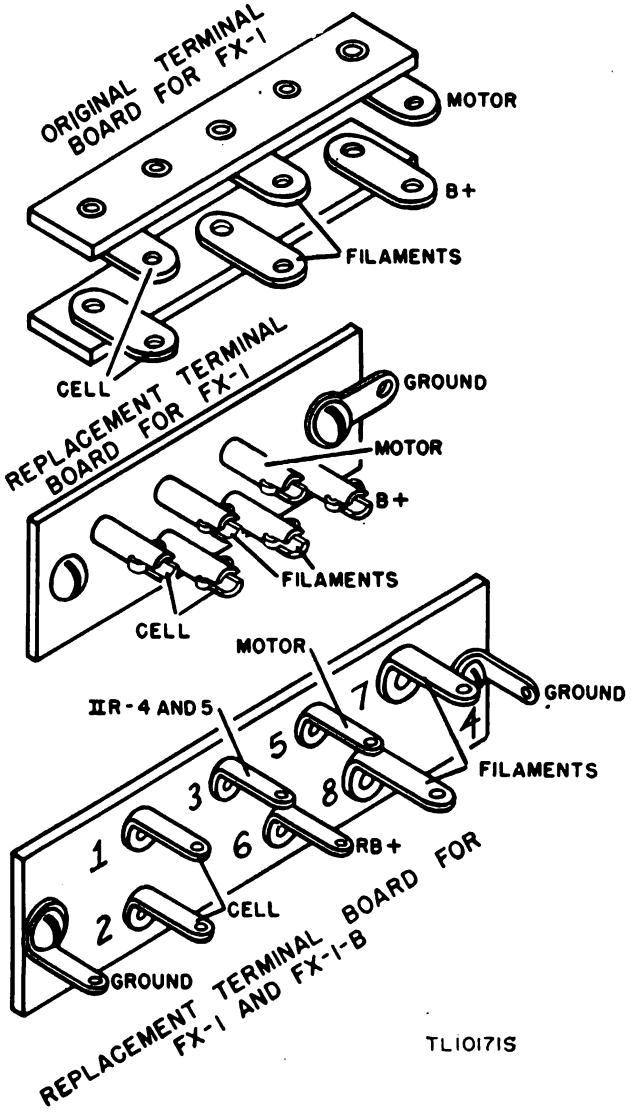


Figure 64. Fork oscillator terminal boards.

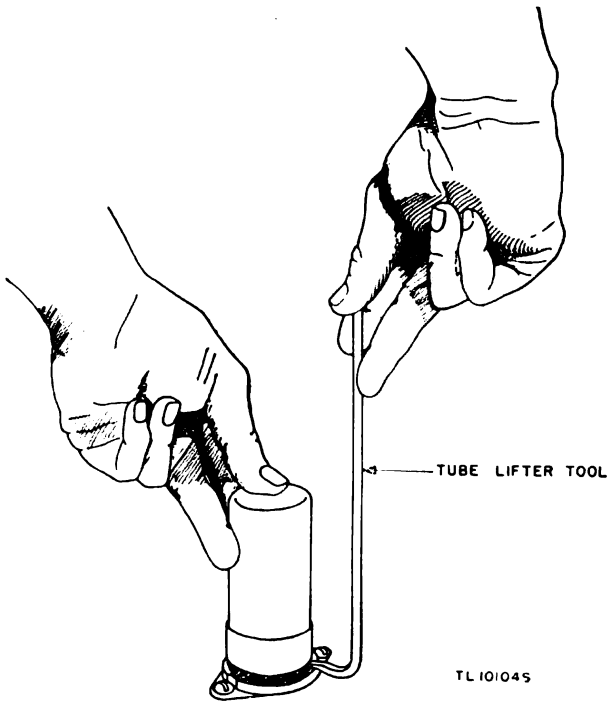


Figure 65. Use of tube lifter.

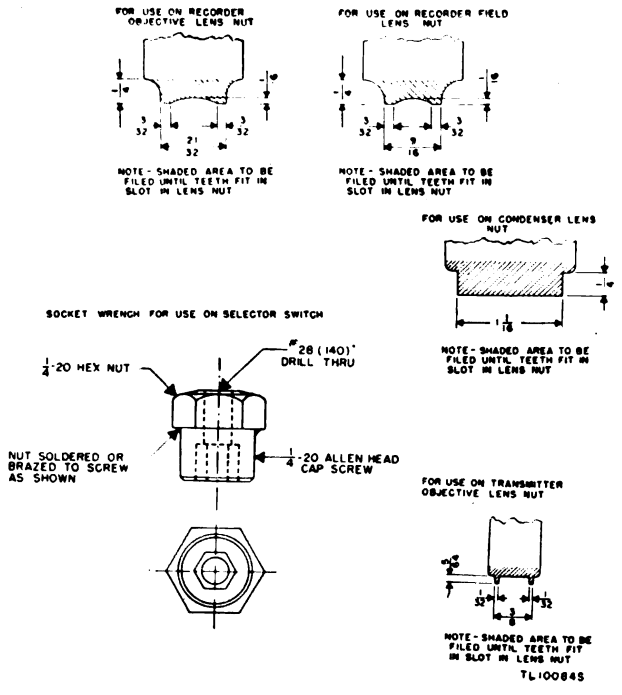


Figure 66. Special tools.

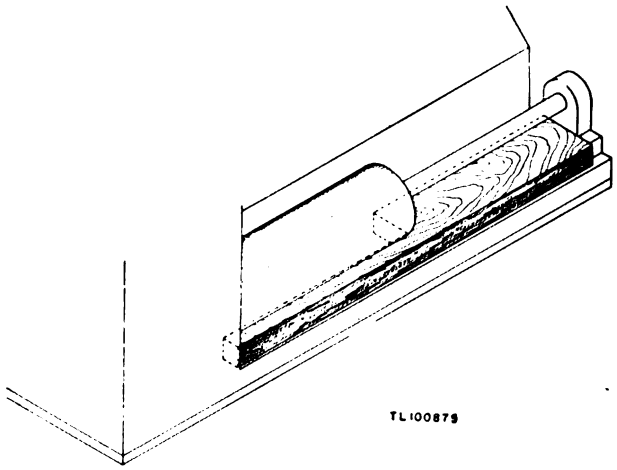


Figure 67. Drum shipping chock.

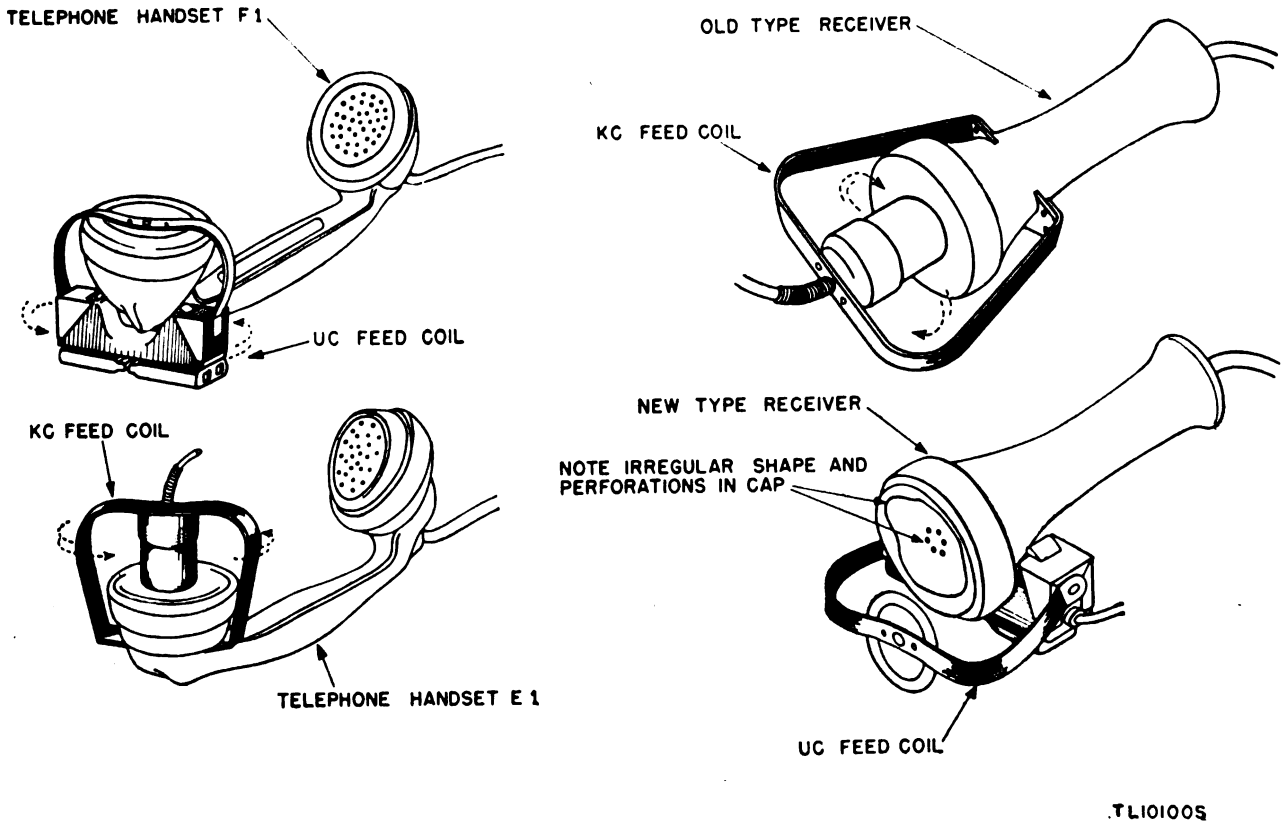


Figure 68. Coupling coils attached to phone sets.

Figure 69. Set-up for photographic reception, battery operation, using portable dark tent.

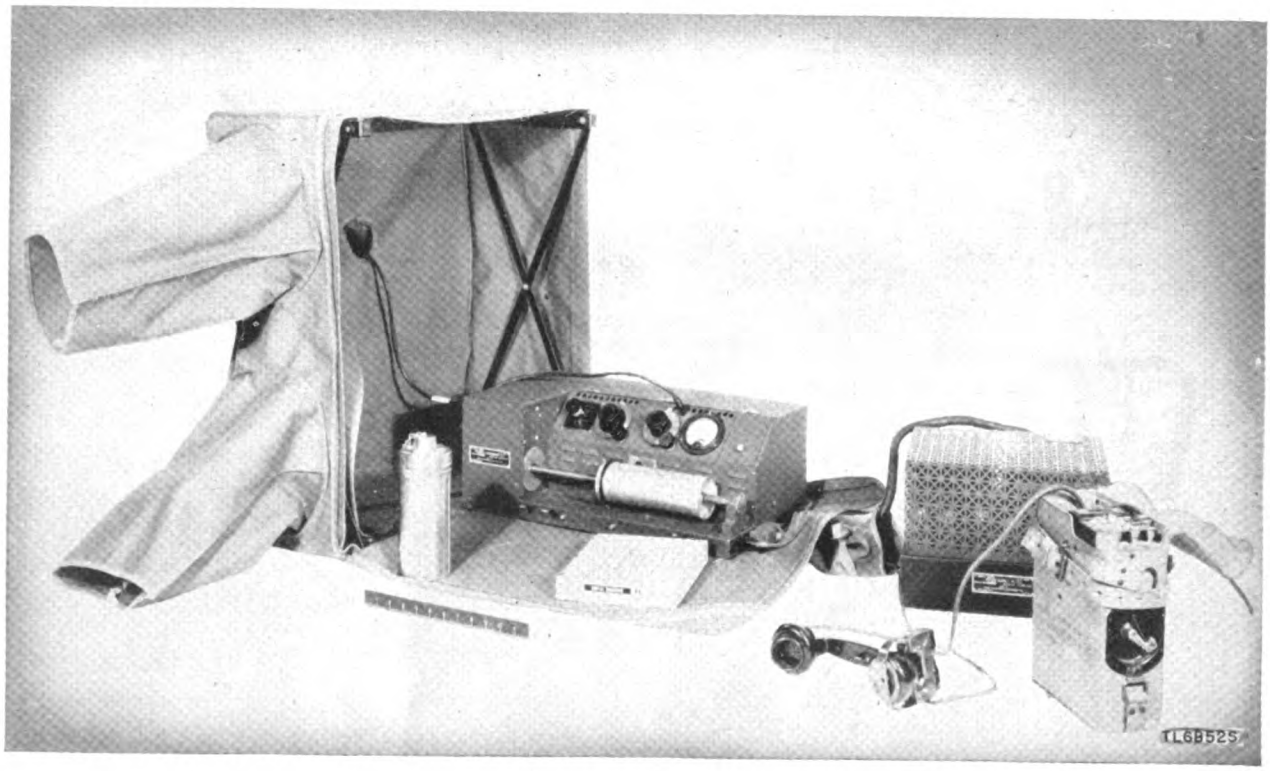


Figure 70. Set-up for photographic reception, a-c operation, using portable dark tent.

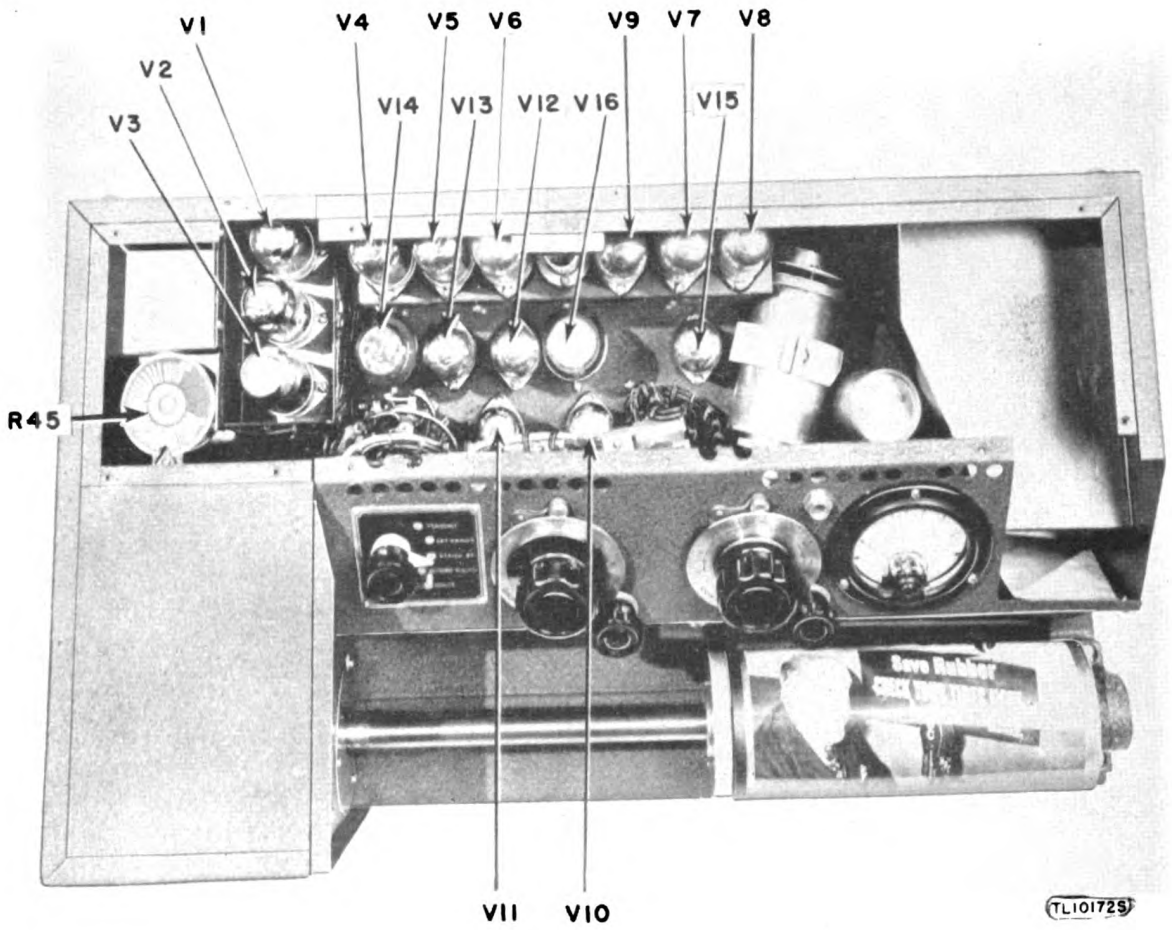


Figure 71. Facsimile Transceiver FX–1, top view showing tube placement.

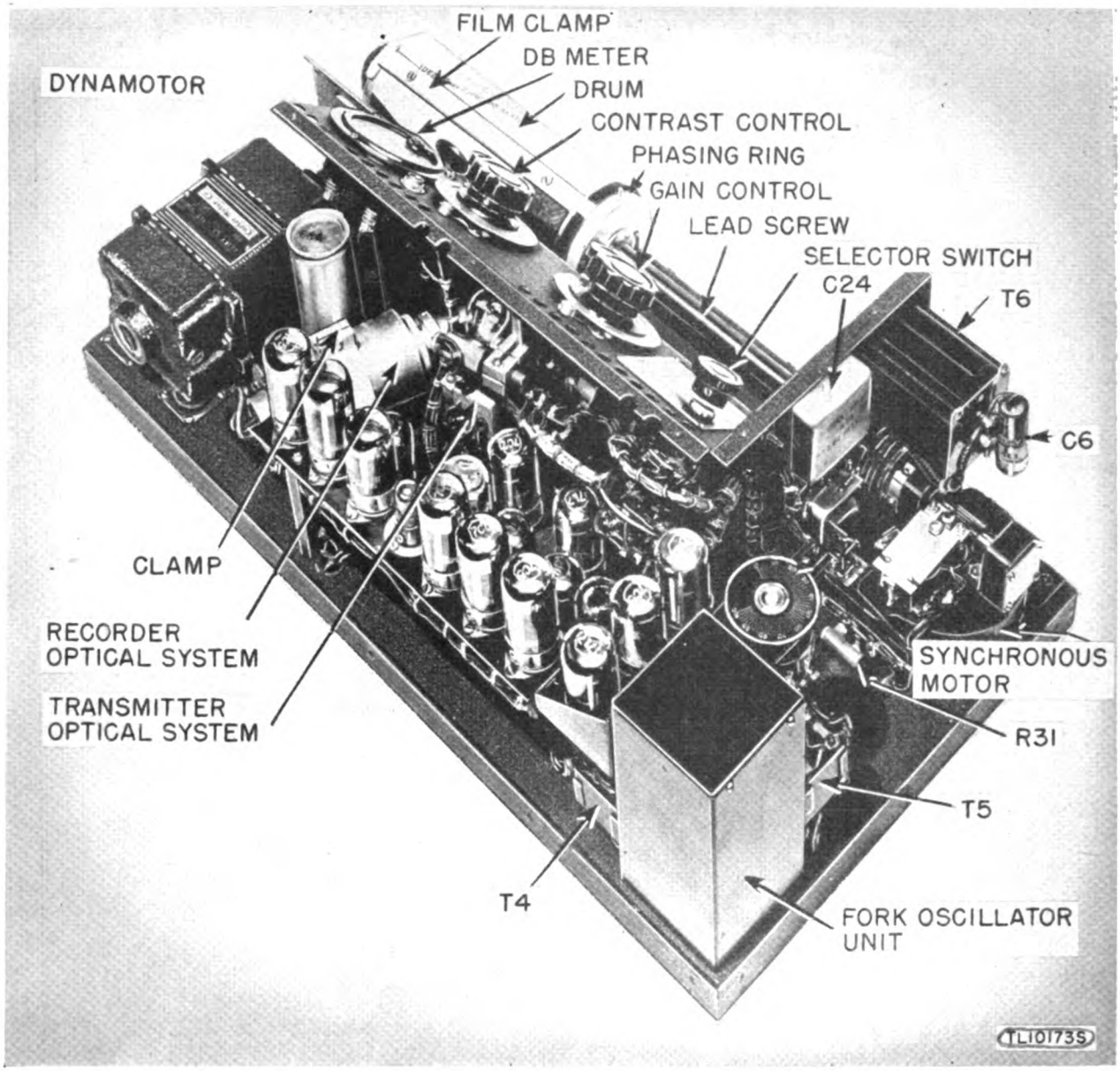


Figure 72. Facsimile Transceiver FX–1, rear quarter view with covers removed.

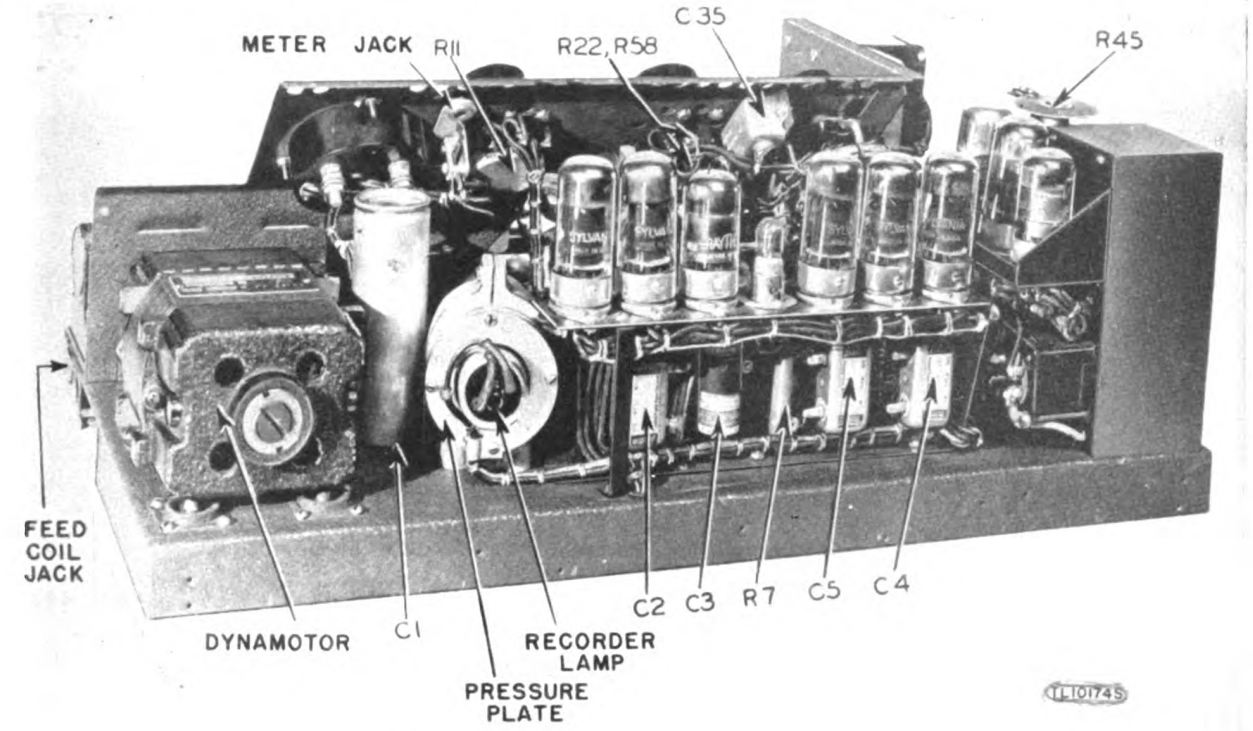


Figure 73. Facsimile Transceiver FX–1, rear view with covers removed.

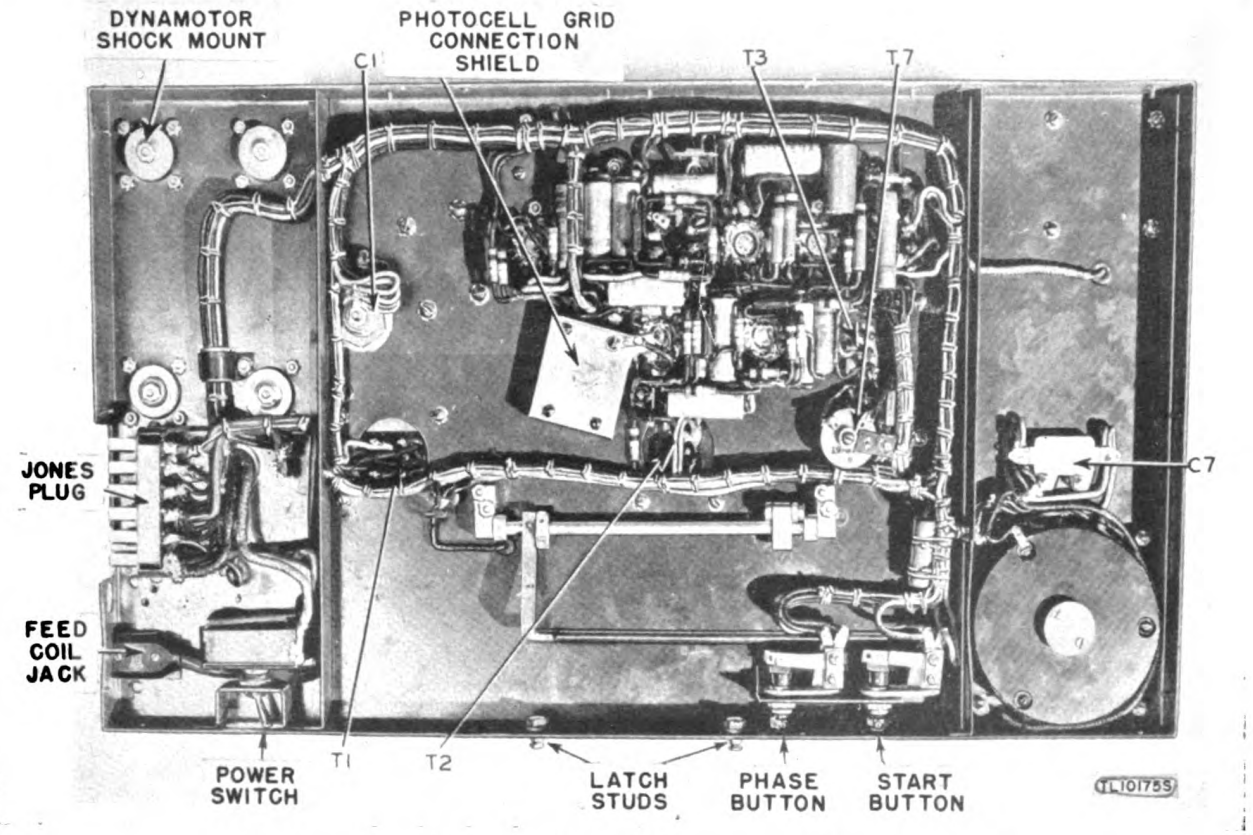


Figure 74. Facsimile Transceiver FX–1, bottom view with bottom plate removed.

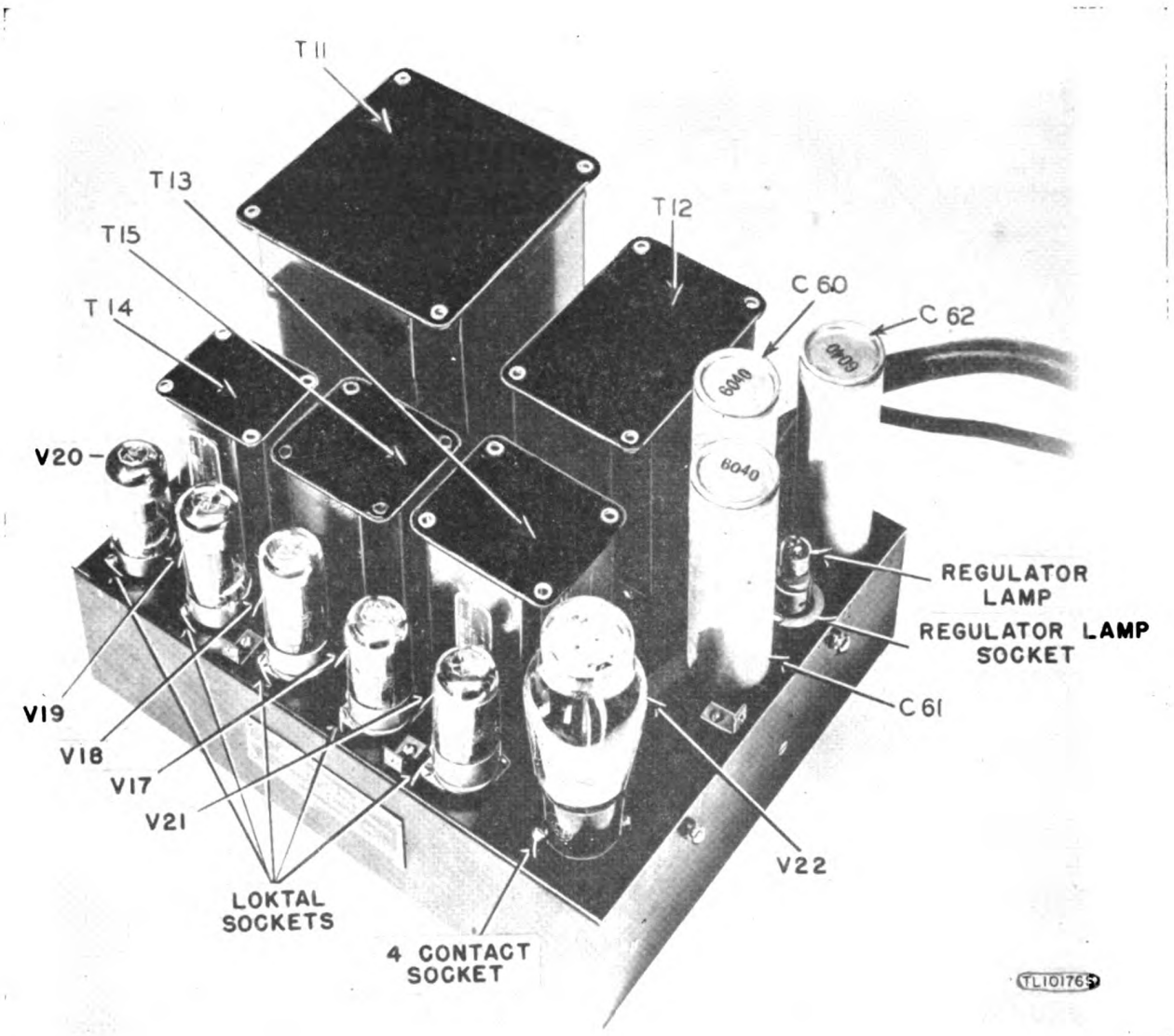


Figure 75. Rectifier Power Supply PE-140, top view of chassis.

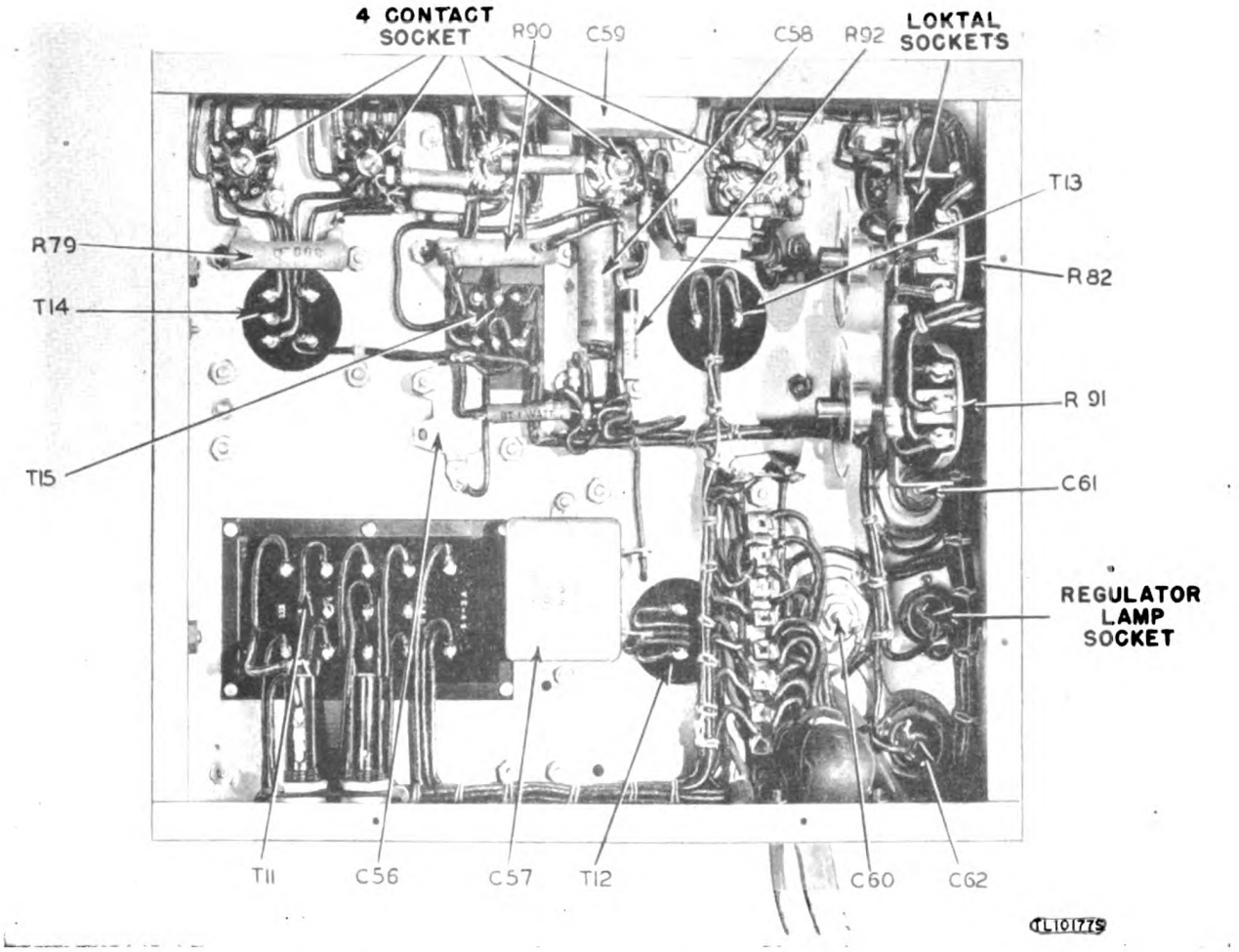


Figure 76. Rectifier Power Supply PE–140, bottom view with bottom plate removed.

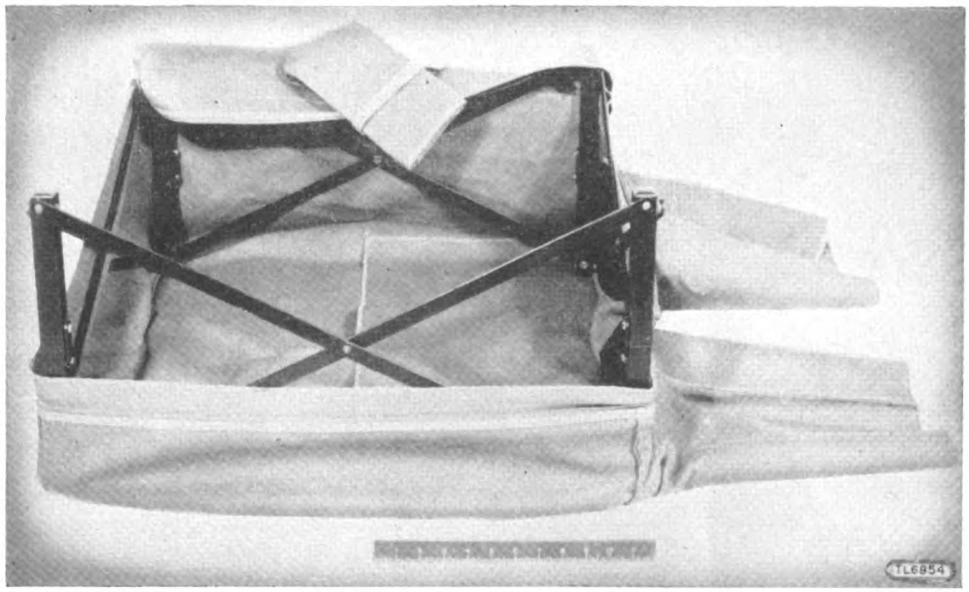


Figure 77. Method of assembling portable dark tent.

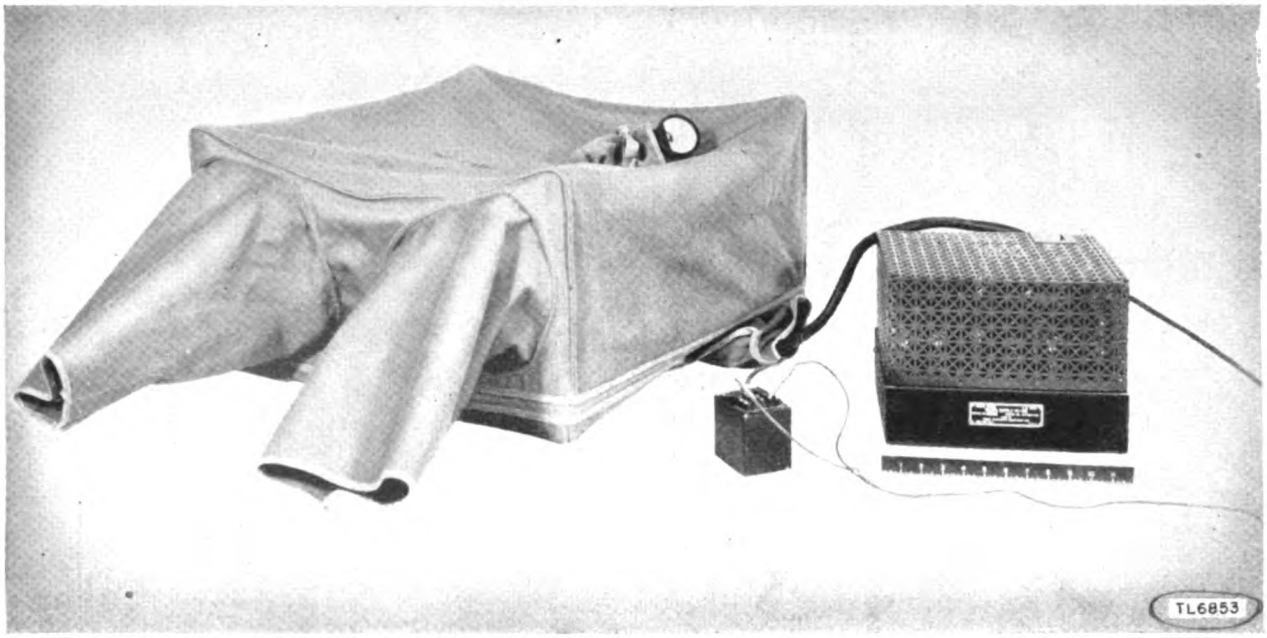


Figure 78. Facsimile Transceiver FX–1 set up for photographic reception with Rectifier Power Supply PE–140, line transformer, and portable dark tent.

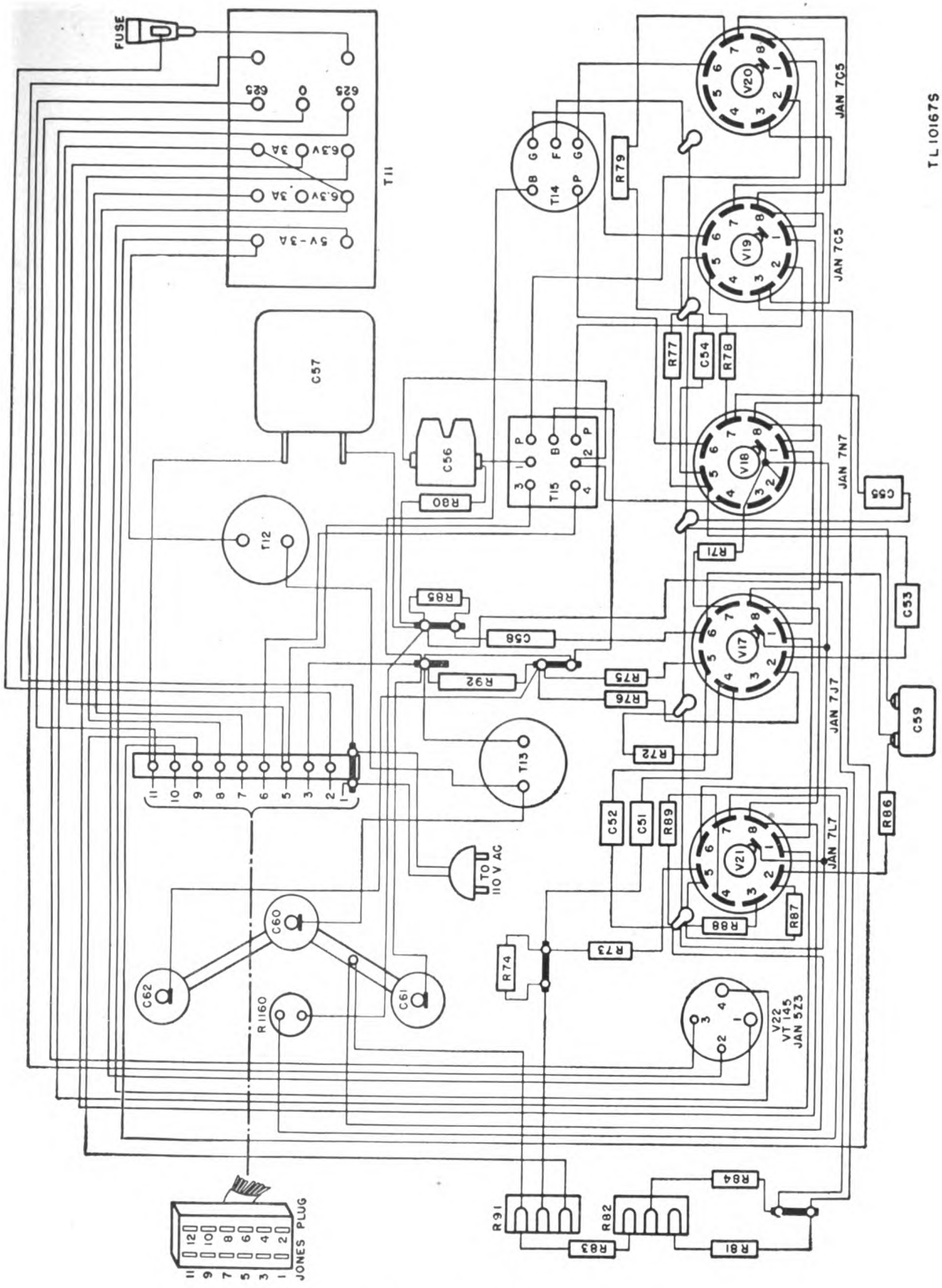


Figure 79. Rectifier Power Supply PE–140, wiring diagram.

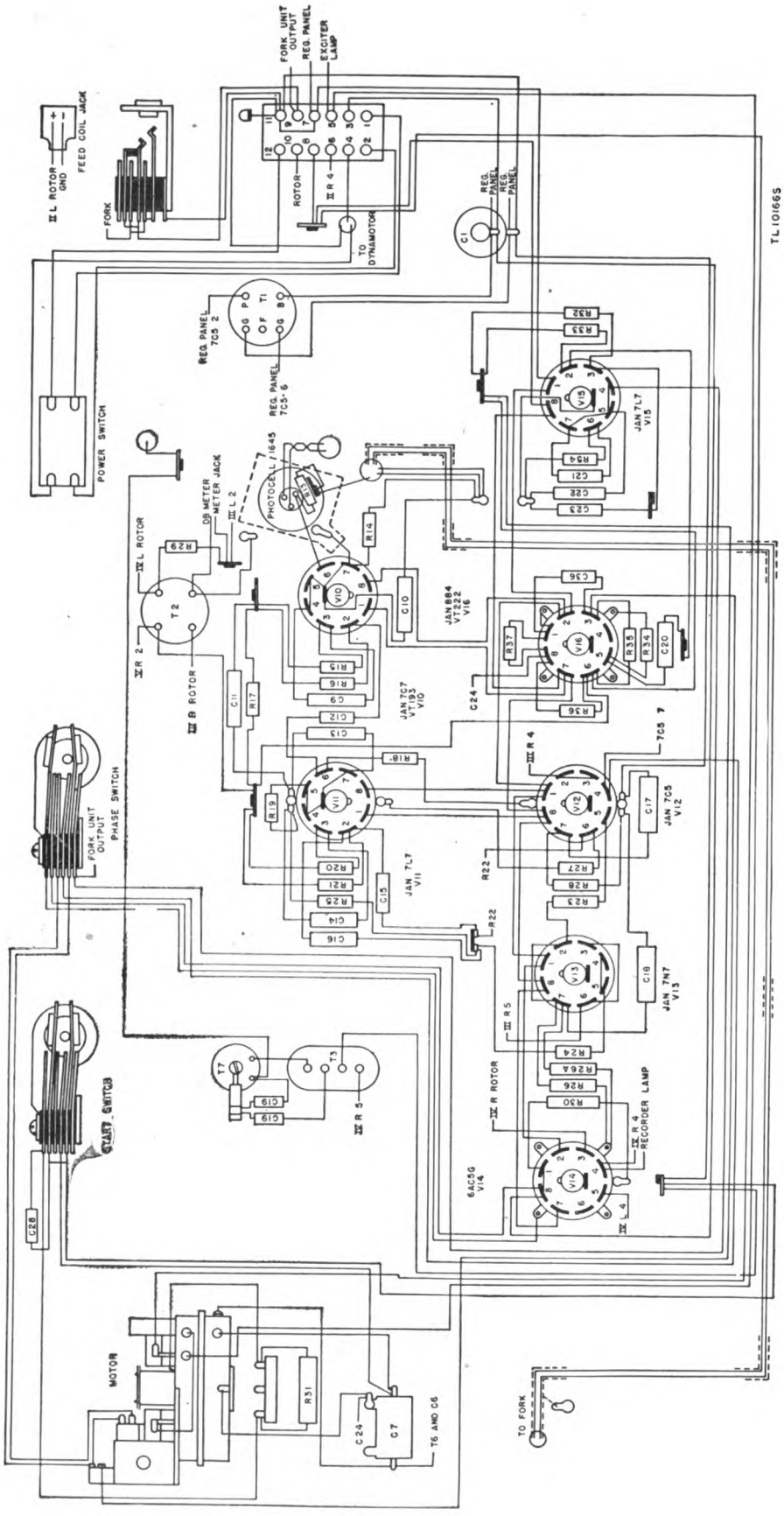


Figure 80. Facsimile Transceiver FX–1, wiring diagram.

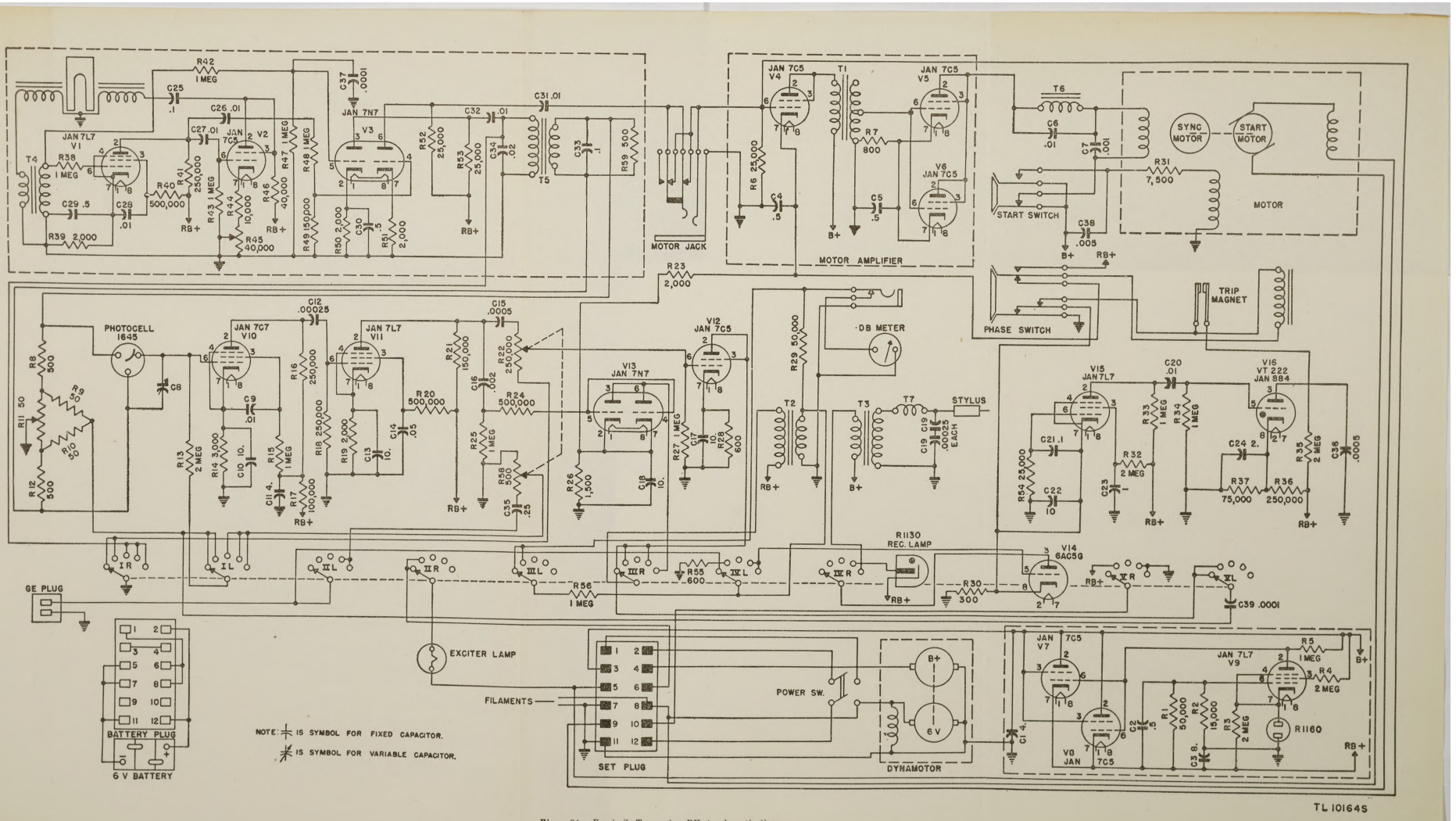


Figure 81. Facsimile Transceiver FX–1, schematic diagram.