LATITUDE 75°N

STARS	ALPHERATZ			POLARIS			ALDEBARAN			CAPELLA		
	Dec.	SHA		Dec.	SHA		Dec.	SHA		Dec.	SHA	
	28°47'N	358°38'		88°59'N	333°52'		16°24'N	291°50'		45°56'N	281°53'	
LHA ARIES	Hc	Ho	E	Hc	Ho	E	Hc	Ho	E	Hc	Ho	E
0°	43°47'			75°54'			21°25'			46°59'		
30	41 37			76 00			27 54			54 31		
60	35 41			75 50			31 14			59 54		
90	28 04			75 26			30 13			60 29		
120	20 53			74 55			25 14			55 54		
150	15 45			74 26			17 56			48 36		
180	13 47			74 06			10 24			41 04		
210	15 26			74 00						35 01		
240	20 18			74 10						31 32		
270	27 22			74 33						31 12		
300	35 01			75 03						34 04		
330	41 12			75 33			13 44			39 39		

Altitudes are based on Declination and SHA in the May-August 1943 American Air Almanac

RESTRICTED

Figure 132—Computed Altitudes, Form B **(Page 25 of 30 pages)**

LATITUDE 75°N

STARS	POLLUX			REGULUS			DUBHE			BENESH		
	Dec.	SHA		Dec.	SHA		Dec.	SHA		Dec.	SHA	
	28°10'N	244°33'		12°15'N	208°40'		62°04'N	194°57'		49°36'N	153°40'	
LHA ARIES	Hc	Ho	E	Hc	Ho	E	Hc	Ho	E	Hc	Ho	E
0°	20°58'						47°25'			35°49'		
30	28 18						50 08			34 38		
60	35 50			11°29'			55 17			36 35		
90	41 27			19 03			62 13			41 23		
120	43 07			24 54			69 54			48 16		
150	40 05			27 15			76 03			55 57		
180	33 39			25 16			76 03			62 22		
210	25 58			19 40			69 55			64 33		
240	19 04			12 10			62 14			61 04		
270	14 28						55 18			54 06		
300	13 13						50 09			46 27		
330	15 33						47 25			39 59		

Altitudes are based on Declination and SHA in the May-August 1943 American Air Almanac

Figure 132—Computed Altitudes, Form B (Page 26 of 30 pages)

LATITUDE 75°N

STARS	ARCTURUS			VEGA			ALTAIR			DENEB		
	Dec.		SHA	Dec.		SHA	Dec.		SHA	Dec.		SHA
	19°29'N		146°44'	38°44'N		81°14'	8°43'N		62°59'	45°05'N		50°07'
LHA ARIES	Hc	Ho	E	Hc	Ho	E	Hc	Ho	E	Hc	Ho	E
0°	06°47'			39°26'			15°13'			53°15'		
30				32 05			07 39			45 41		
60	05 59			26 33						38 24		
90	10 51			23 53						32 56		
120	17 57			24 36						30 16		
150	25 35			28 33						30 50		
180	31 45			35 00						34 32		
210	34 27			42 39			09 11			40 45		
240	32 41			49 38			16 36			48 19		
270	27 08			53 30			21 59			55 31		
300	19 38			52 26			23 42			59 47		
330	12 16			46 57			21 10			58 51		

Altitudes are based on Declination and SHA in the May-August 1943 American Air Almanac

Figure 132—Computed Altitudes, Form B (Page 27 of 30 pages)

LATITUDE 79°N

STARS	ALPHERATZ			POLARIS			ALDEBARAN			CAPELLA		
	Dec.		SHA	Dec.		SHA	Dec.		SHA	Dec.		SHA
	28°47'N		358°38'	88°59'N		333°52'	16°24'N		291°50'	45°56'N		281°53'
LHA ARIES	Hc	Ho	E	Hc	Ho	E	Hc	Ho	E	Hc	Ho	E
0°	39°47'			79°54'			20°12'			47°07'		
30	38 16			80 00			24 54			52 33		
60	34 02			79 50			27 17			56 15		
90	28 28			79 26			26 33			56 38		
120	23 07			78 55			23 58			53 32		
150	19 16			78 26			17 39			48 18		
180	17 47			70 06			12 04			42 41		
210	19 01			78 00						38 05		
240	22 41			78 10						35 24		
270	27 57			78 33						35 08		
300	33 33			79 03						37 20		
330	37 59			79 33			14 33			41 27		

·Altitudes are based on Declination and SHA in the May-August 1943 American Air Almanac

Figure 132—Computed Altitudes, Form B (Page 28 of 30 pages)

LATITUDE 79°N

STARS	POLLUX			REGULUS			DUBHE			BENESH		
	Dec.	SHA		Dec.	SHA		Dec.	SHA		Dec.	SHA	
	28°10'N	244°33'		12°15'N	208°40'		62°04'N	194°57'		49°36'N	153°40'	
LHA ARIES	Hc	Ho	E	Hc	Ho	E	Hc	Ho	E	Hc	Ho	E
0°	23°01'						51°21'			39°33'		
30	28 28						53 31			38 37		
60	33 58			11°46'			57 34			40 08		
90	37 58			17 19			62 55			43 51		
120	39 08			21 34			68 30			49 04		
150	37 00			23 15			72 29			54 42		
180	32 23			21 50			72 29			59 08		
210	26 45			17 47			68 31			60 34		
240	21 36			12 17			62 56			58 16		
270	18 09						57 35			53 22		
300	17 12						53 32			47 42		
330	18 57						51 21			42 46		

Altitudes are based on Declination and SHA in the May-August 1943 American Air Almanac

Figure 132—Computed Altitudes, Form B (Page 29 of 30 pages)

LATITUDE 79°N

STARS	ARCTURUS			VEGA			ALTAIR			DENEB		
	Dec.	SHA		Dec.	SHA		Dec.	SHA		Dec.	SHA	
	19°29'N	146°44'		38°44'N	81°14'		8°43'N	62°59'		45°05'N	50°07'	
LHA ARIES	Hc	Ho	E	Hc	Ho	E	Hc	Ho	E	Hc	Ho	E
0°	10°12'			39°34'			13°33'			51°24'		
30				34 05						45 55		
60				29 53						40 27		
90	13 13			27 51						36 17		
120	18 30			28 23						34 13		
150	24 06			31 24						34 39		
180	28 33			36 16						37 30		
210	30 28			41 55			9 07			42 13		
240	29 13			46 55			14 34			47 51		
270	25 13			49 35			18 28			52 59		
300	19 44			48 51			19 42			55 53		
330	14 16			45 02			17 53			55 15		

Altitudes are based on Declination and SHA in the May-August 1943 American Air Almanac

Figure 132—Computed Altitudes, Form B (Page 30 of 30 pages)

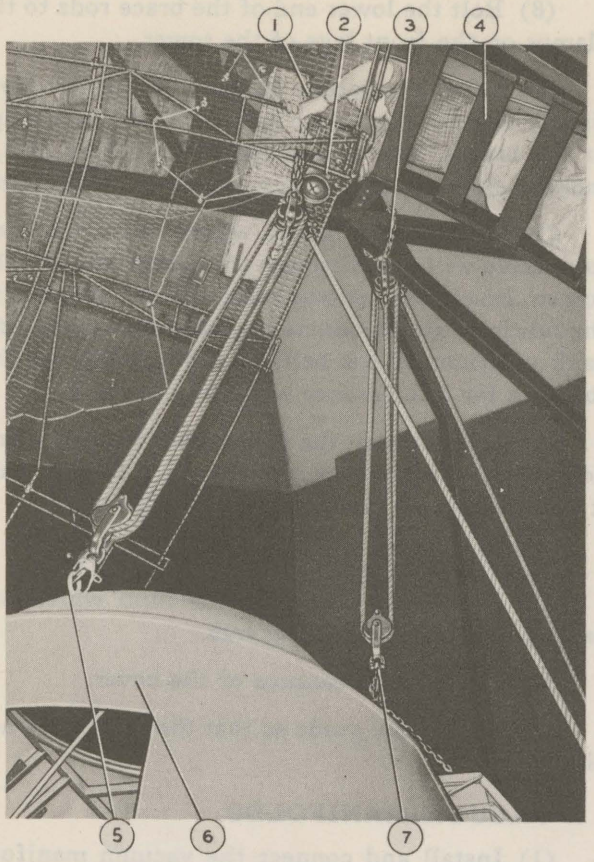


Figure 133—Hoisting the Fuselage

1. *Chain Attached to Trusswork*
2. *Opening in Wire Netting*
3. *Chaining Attached to Trusswork*
4. *Work Bridge*
5. *Front Eye Bolt*
6. *Fuselage*
7. *Rear Eye Bolt*

(8) Attach the fuselage leveling device cables to the four fuselage brackets and tighten. (See figure 21.)

(9) Mount the four main bellows. (See figure 72.) The two side bellows are attached directly to the fuselage frame and are connected to brackets on the carriage by cables. The front bellows is bolted inside the tower with its cable running down to a pulley, and from there to the forward end of the fuselage. The rear bellows is attached by a rod to the rear of the fuselage and to a bracket on the rear leg of the tower. The bellows sizes are as follows:

Bellows	*Size*
Front	11-1/2 in. x 16 in.
Rear	13-1/2 in. x 18 in.
Side (2)	11-1/2 in. x 15 in.

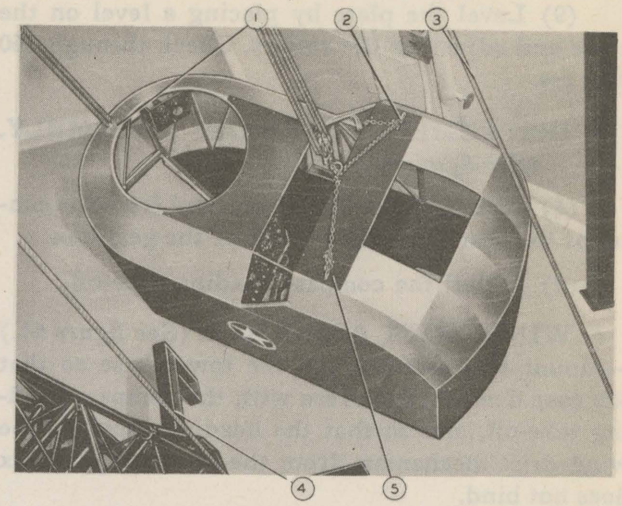


Figure 134—Hoisting the Fuselage

1. *Front Lifting Eye*
2. *Rear Lifting Eye*
3. *Hoisting Cable*
4. *Hoisting Cable*
5. *Rear Lifting Eye*

(10) Install the tower locking device. (See figure 76.)

d. TERRAIN MECHANISM.

(1) Center the azimuth rail by means of the east-west and north-south lines marked on floor simultaneously with step No. 4 of installing the base.

(2) When correctly positioned, mark on the floor the position for the hold-down lag (rawl) bolts, located from the three large untapped holes in the rail.

(3) Remove the rail and drill for hold-down bolts simultaneously with step No. 6 of installing the base.

(4) Replace rail and level by means of the six bolts in the tapped holes on either side of the three hold-down bolts. Use a carpenter's level as a reference. Place the plates beneath the leveling screws.

(5) Set up the hold-down bolts without disturbing the adjustment.

(6) Install the carriage after raising the wheels so they will clear the rail.

(7) Check tightness of all gear setscrews, and lock nuts.

(8) Insert a plate on the carriage and by raising the carriage rollers, adjust until the top surface of the plate is approximately 1/4 of an inch from the bottom of the collector ring assembly.

(9) Level the plate by placing a level on the plate and adjusting the rollers. Check through 360 degrees.

e. INSTRUMENT TAKE-OFF ASSEMBLY. (*See figure* 81.)

(1) Install the heading input rod from the center of the bearing to the bottom of the gear box.

(2) Install the compass heading take-off.

f. WIND DRIFT ASSEMBLY. (*See figure* 61.) —Mount this assembly on the tower base so that the case does not interfere with the compass heading take-off, and so that the heading input to the wind drift mechanism from the heading gear box does not bind.

g. TERRAIN PROJECTION SCREEN. (*See figure* 71.)

(1) Place the terrain screen frame on the floor of the Trainer building and mount the seven horizon curtain upright tube supports at points around the top side edge of the frame, indicated by the tapped screw holes, using the proper adapters and screws to make them secure.

(2) To the top of these uprights, mount the four tube supporting rails, securing them by means of the adapters and caps provided.

(3) Hang the black horizon curtain from the supporting rail using the steel wire clips in the top edge of the curtain.

(4) Tighten and tie securely the draw cord which is sewed into the bottom edge of the curtain so that the curtain completely encloses the front and two sides of the screen frame and is held in place under the bottom edges.

NOTE

Care should be taken when the projection screen has been raised into place and fastened to the tower, that the horizon curtain and supports clear the celestial dome with the Trainer in any attitude.

(5) Measure the position of the front bellows cable with reference to the tower, and disconnect.

(6) Insert the four bolts in the screen frame and bolt on the brace rods.

(7) Carefully hoist the screen into place and bolt the rear mounting eyes to the tower mounting braces.

(8) Bolt the lower end of the brace rods to the clamps on the front legs of the tower.

(9) Level the screen by placing a spirit level lightly against the fabric and shifting the clamps or the braces. The screen fabric should be 30-3/4 inches below the center line of the universal joint.

(10) Locate the point where the front bellows cable will pass through the screen and cut the screen. Insert the bellows cable and reconnect. Cut the fabric to accommodate the maximum pitch and bank positions of the bellows cable, being careful to check for interference with the screen.

(11) Disconnect the front bellows cable and dope the reinforcement ring to the screen so that it centers around the travel of the cable.

h. CLOUD PROJECTOR. (*See figure* 80.)

(1) Install the lens and the bulb which are packed in the main bearing hub.

(2) Check the clearance of the cover.

(3) Adjust the guide so that the plate does not bind.

i. VACUUM MANIFOLDS.

(1) Install and connect the vacuum manifold from the turbine to the rear leg of the tower. (See figures 58 and 61.)

(2) Connect the high vacuum line from the altitude pump to the manifold and from the manifold to the rear leg of tower. (See figure 58.)

(3) Install the connection from the high vacuum and the low vacuum supply from the top of the tower to the fuselage.

(4) Cut the fabric away from the supply holes in the bellows and shellac the elbows in place at the proper angle.

(5) Install the vacuum lines from the main valves to the main bellows. (See figure 72.)

(6) Install the turning motor vacuum supply lines from the rudder valve to the top of the tower and from the bottom of the tower to the anti-turn mechanism valve. (See figure 83.)

5. RADIO AND EQUIPMENT.
(*See figures* 84, 135, *and* 136.)

a. Mount the rectifier on the wind drift platform directly behind the wind drift mechanism.

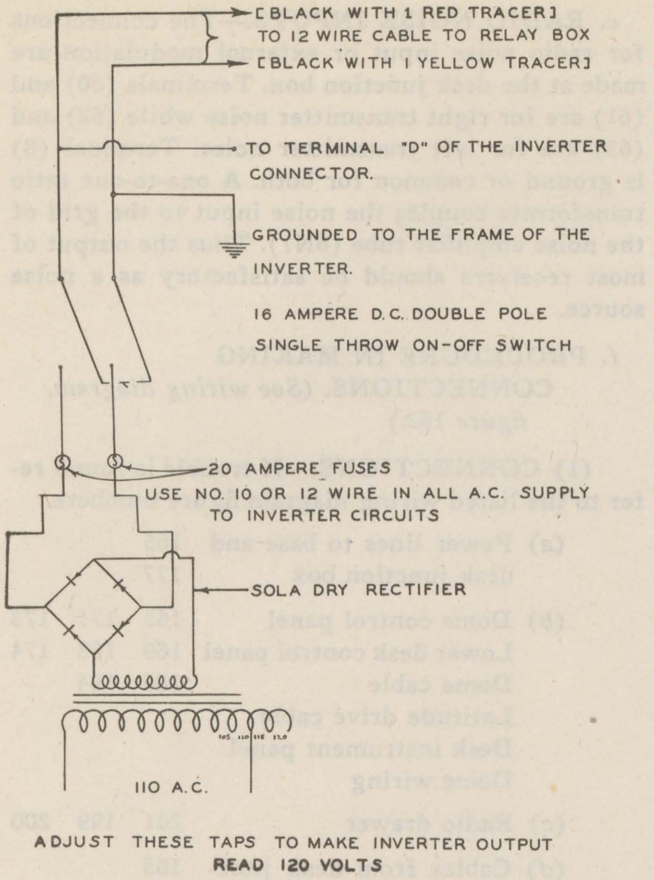


Figure 135—Wiring Diagram, Power Supply

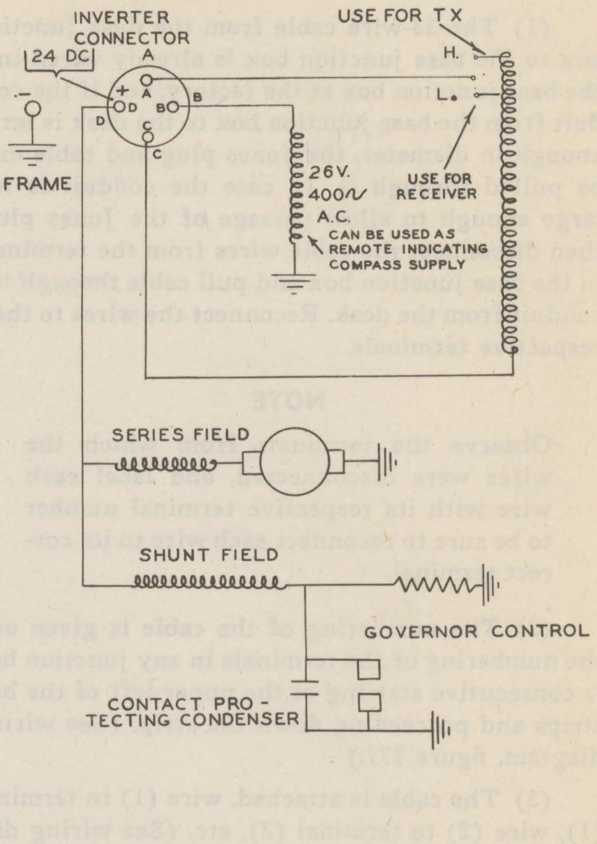


Figure 136—Wiring Diagram, Inverter

b. The SCR-269-A receiver and the inverter (or Navy DZ-2) are mounted in place at the factory and are shipped that way. (See figure 61.)

6. ELECTRICAL INSTALLATION.

(*See figure* 159.)

a. POWER.—Power for the Trainer is fed into the system in two places.

(1) The 110-volt supply must be connected to the near side of the fuse plugs in the desk junction box. The line is fused for 30 amperes at this point.

(2) The 220-volt supply must be connected to the two main (left side) fuses in the base junction box. This power is for the turbine and is fused for a 20-ampere current.

(3) Both these lines are from the main building fuse box. General lighting power is also taken from this box.

b. CONNECTION.—Most of the connections necessary from one unit of the Trainer to another are made with plugs. However, there are several connections which necessarily will have to be made in the field. All the plugged connections are so made that there is no possibility of ambiguity with one exception. This is on the radio control chassis. In this case the male and female Jones plugs are color coded showing the proper connections. By reference to the general schematic wiring diagram (figure 162) all the plugged connections which are to be made can readily be identified.

NOTE

Since the tower cable runs down through one of the legs of the tower, extreme care must be used in erecting the tower or this cable may be damaged. The basic part of any Jones plug is a fairly fragile bakelite molding. Always be careful not to subject this type of plug to rough handling. Do not unsolder connections on Jones connectors as it is difficult to resolder them. One poor connection thus made may cause considerable trouble.

c. WIRE CABLE CONNECTIONS.

(1) The 33-wire cable from the desk junction box to the base junction box is already wired into the base junction box at the factory, and if the conduit from the base junction box to the desk is large enough in diameter, the Jones plug and cable may be pulled through it. In case the conduit is not large enough to allow passage of the Jones plug, then disconnect the cable wires from the terminals in the base junction box and pull cable through the conduit from the desk. Reconnect the wires to their respective terminals.

NOTE

Observe the terminals from which the wires were disconnected, and label each wire with its respective terminal number to be sure to reconnect each wire to its correct terminal.

(2) The numbering of the cable is given and the numbering of the terminals in any junction box is consecutive starting at the upper left of the box strips and proceeding down the strip. (See wiring diagram, figure 177.)

(3) The cable is attached, wire (1) to terminal (1), wire (2) to terminal (2), etc. (See wiring diagram, figure 175.)

d. LUG CONNECTIONS.

(1) Connections will have to be made from the star lamps and collimators to the busses on the dome hub. The connections are lugs which are secured by screws into tapped holes on the busses.

(2) The coding of the busses is as follows: black—collimators, white—recognition, yellow—ground, red—miscellaneous, and green—constellations. The busses from top to bottom are: collimators, recognition, constellation, miscellaneous and ground. Thus connections should be made as follows: from top to bottom, black, white, green, red and yellow. The wire mesh is a common ground for all stars and collimators. (For connections from slip rings to transformers and busses if trouble is encountered here, see wiring diagram, figure 174.)

(3) The bomb hit timer will also have to be connected. This is done in the following manner. The cable from the tower base junction box is "BX" and will come with lug termination. (The color coding and wiring connections are given in wiring diagrams, figures 181 and 183.) The bomb hit projector plugs into the cloud projector assembly.

e. RADIO NOISE INPUTS.—The connections for radio noise input or external modulation are made at the desk junction box. Terminals (60) and (61) are for right transmitter noise while (62) and (63) are for left transmitter noise. Terminal (8) is ground or common for both. A one-to-one ratio transformer couples the noise input to the grid of the noise amplifier tube (6N7). Thus the output of most receivers should be satisfactory as a noise source.

f. PROCEDURE IN MAKING CONNECTIONS. (*See wiring diagram, figure* 162.)

(1) CONNECTIONS.—If trouble is found refer to the listed wiring diagram figure numbers.

(*a*)	Power lines to base and desk junction box	165 177		
(*b*)	Dome control panel	165	171	173
	Lower desk control panel	169	168	174
	Dome cable	166	164	
	Latitude drive cable			
	Desk instrument panel			
	Dome wiring			
(*c*)	Radio drawer	201	199	200
(*d*)	Cables from desk junction box to base junction box	165 177		
(*e*)	Base junction box to base Slip rings	165 177	179	
	Mike cable from desk junction box to base slip rings			
(*f*)	33-wire cable from base slip rings to tower junction box	179 181		
(*g*)	Wind drift and hit projector	181		
	Check equipment associated with tower junction box	182		
(*h*)	Terrain plate drive and base light	177 178		
(*i*)	33-wire cable, tower junction box to fuselage junction box No. 1	186 181		
(*j*)	Fuselage junction box No. 1 to navigator's panel	186 189		
	Two 12-wire cables			

(*k*) 33-wire cable from fuselage junction box No. 1 to pilot's instrument panel — 186, 187

(*l*) Fuselage junction box No. 3 to fuselage power supply, 12-wire cable — 196, 197

Connect telegon oscillator

(2) CHECKS.—As the above connections are made, it is suggested that the following checks be made:

(*a*)	Proper fusing
(*b*)	Dome drives, lighting instruments.
(*c*)	Upon completion of wiring installation, check functioning of radio and interphone completely.
(*d*) through (*k*)	Check terrain carriage drives. Wind drift track and ground speed. Cloud and hit projectors. Vacuum pump. Turbine. Bomb hit timer. Antiturn solenoid. Heading teletorque. Altitude and air-speed transmitters. Ground projector.

7. PROTECTION AGAINST CORROSION.

a. The following parts are to be painted after assembly of the Trainer.

(1) Mounting bolts for the latitude drive assembly

(2) Mounting for the dome rail hanger

(3) Mounting for the dome rail fork and bracket

(4) Mounting bolts for the counterweight bracket

(5) Mounting bolts for the upper dome electric cable pulley bracket

(6) Mounting bolts for the counterweight cable pulley bracket

(7) Base bolts—lag screws—leveling screws

(8) Counterweight sector assembly bolts

(9) Counterweight sector pivot shaft and collars

(10) Block on the end of the latitude cable

(11) End of the wind drift mechanism

(12) Touch up the celestial dome

(13) Touch up the tower

SECTION V
PREPARATION FOR USE

1. ALIGNMENT.

a. CELESTIAL DOME.—With the dome at the zenith position, insert the dome center-locating fixture in the lower end of the dome shaft and from the hole in the center of this fixture suspend a plumb bob to the floor of the building. Rotate the dome through 360 degrees. The plumb bob should remain stationary over one spot.

b. FLOOR.

(1) Mark the point on the floor directly beneath the plumb bob as point (A).

(2) From the center of the under side of the north end of the dome rail suspend a plumb bob to the building floor. Mark this point (B). Draw a fine straight north and south line through points (A) and (B).

(3) From any point on an outside lower dome ring, suspend a plumb bob to the building floor. Rotate the dome until the plumb bob point is on the north-south line (A)-(B) at the south side of the building. Set the desk LHA Aries indicator at 90 degrees and rotate the dome until the desk LHA Aries indicator registers zero degrees. After the plumb bob has come to rest, mark the point on the floor under the plumb bob as point (C). Through points (A) and (C) draw a fine straight east-west line.

(4) With the dome at the zenith suspend a plumb bob with the line passing through the plumb bob mount on the Polaris collimator mounting bracket. Adjust the Polaris plumb bob mount so the plumb bob line remains in the center of the hole as the dome is rotated through 360 degrees. Tie a knot in the line above the Polaris plumb bob mount, then cut the line just above this knot so the plumb bob will be suspended from the mount. Rotate the dome through 360 degrees and the plumb bob should remain stationary; if the plumb bob should move, re-center the Polaris plumb bob mount until the plumb bob remains stationary as the dome is rotated.

(5) The Polaris collimator may now be mounted. (See figure 130.)

c. BASE.—Install the main bearing center-locating fixture in the terrain projection lens tube, and move the Trainer base so that the center of this fixture is directly under the dome center plumb bob point. The Trainer base leg which carries the base junction box must be toward the west. Rotate the counterbalance frame and main bearing hub through 360 degrees, and throughout the full rotation the plumb bob point should remain directly over the small hole in the center-locating fixture. If the main bearing is not exactly centered in the fixture hole, or moves in a circle as the carriage is rotated, move the base slightly so that the center of this arc or circle will be directly under the plumb bob point.

(1) SECURE BASE.—Drill the floor and secure the base legs to the floor by the use of square-head bolts and expansion shields placed in the holes in the floor.

(2) LEVEL BASE.—Using a spirit level across the top of the main bearing hub, adjust the base leveling cap screws in the base foot plates until the top of the main bearing hub is level.

(3) TOWER LOCKING DEVICE.—With the Trainer carriage locked on an east heading suspend a plumb bob to the floor from the center of the east end of the carriage. Slightly loosen the cap screws which secure the locking strike to the southwest base leg, and move the carriage and locking strike in the slotted holes until the plumb bob point is on the east-west line (A)-(C). Tighten the locking strike to the base leg.

d. TOWER.

(1) From the center point of the top of the fuselage mounting pad suspend a plumb bob to the bottom of the tower.

(2) With the counterbalance frame and tower locked on an east heading, shift the tower mounting pads on the carriage in their slotted holes until the point of the plumb bob falls on the longitudinal center line of the counterbalance frame. The distance between this plumb line and the dome center plumb line should be 48 inches. Secure the tower mounting pads to the frame. If the correct distance cannot be obtained in the above manner, either

shim between the mounting pads and the frame, or adjust the tower tie rods to obtain 48 inches between the two plumb lines, with the tower plumb bob remaining on the frame longitudinal center line.

e. FUSELAGE.

(1) By means of the turn-buckles, adjust the length of each cable so that the fuselage is held level when the level-locking device is cranked as far as it will go in a clockwise direction.

(*a*) Use a machinist's level on the pitch and bank limit stop plate to determine if the fuselage is level.

(*b*) Check that the tension is equal on all four cables.

(2) Release the level-locking device slightly and loosen the fuselage mounting bolts slightly at the fuselage mounting pad, and by means of a drift or a "C" clamp, shift the fuselage slightly on the mounting pad until the plumb bob from the dome center is at the mid-point of the distance between the longitudinal edges of the steel frame of the bombardier's window. Tighten the fuselage mounting bolts.

(*a*) Crank up the fuselage locking device and re-level the fuselage.

1. Recheck that the tension is equal on all four level-locking cables.

2. Back off the leveling device one-fourth turn.

(*b*) Adjust the stop nut on the fuselage level-locking device worm shaft so that the lock nut is against the stop nut.

f. TERRAIN ASSEMBLY.

(1) AZIMUTH RAIL.—The azimuth rail is to be installed so that the north-south lines on the floor pass through 0° and 180° azimuth rail marks respectively, and the east and west lines pass through the 90° and 270° azimuth rail marks respectively. Point (A) on the floor will be at the center of the azimuth rail.

(*a*) Drill holes in the cement floor and install the hold-down bolts with expansion shields. Secure the azimuth rail to the floor in the above position.

(*b*) By means of a level and the leveling screws, level the azimuth rail.

(2) TERRAIN BASE FRAME AND CARRIAGE.

(*a*) Level the terrain base on the azimuth rail by vertical adjustment of the four terrain base leg bolts.

(*b*) Level the terrain plate carriage by adjusting the four eccentrics on the four carriage rollers (two beveled and two flat).

g. PROJECTION SCREEN.

(1) Adjust the tube support clamps on the front tower legs up or down, and adjust the rear screen bolts in the vertical slotted holes. By means of a level, level the screen.

(2) Adjust the rear screen bolts in the horizontal slots so that the screen will clear the dome in all positions.

(3) Adjust the horizon curtain frame so it will not strike the stair landing or the dome.

2. PRELIMINARY ELECTRICAL CHECK.

a. Check the turbine fusing—20 amperes.

b. Check the base junction box fusing—20 amperes.

c. Check the telegon oscillator fusing—30 amperes.

d. Check the desk junction box fusing—30 amperes.

3. FINAL ADJUSTMENTS.

NOTE

Any Trainer unit that has been shipped from the factory as an assembly or subassembly has been carefully adjusted and cross-checked, either one against the other, or checked against a known unit. Consequently, extreme care should be taken to determine whether these units need readjustment in the field. Until definite proof has been established that readjustment is necessary, leave the unit alone.

a. MAIN BELLOWS.

(1) The left and the right banking bellows are adjusted so that the bellows are one-half collapsed when the Trainer is locked level and the turbine is on. This is accomplished by measuring the bellows when fully collapsed and when fully extended, then adjusting the cable length at the eye bolts attached to the sides of the counterbalance frame.

(2) The front and rear pitching bellows are adjusted so that the bellows are one-half collapsed when the Trainer is locked level and the turbine is on. To accomplish this, measure the rear bellows when fully collapsed and when fully extended, then adjust the nuts on the U-bolt attached to the rear bellows tower hanger.

b. TURBINE AND ALTITUDE PUMP.—Before operating the turbine or the altitude pump, carefully inspect the wiring for correct connections. Inspect the bearings for proper lubrication. Look for foreign matter which may have entered the turbine during shipment. Using a vacuum gage, adjust the regulator valve on the vacuum pump to 14 inches Hg.

c. TURNING MOTORS.—Adjust the tension on the turning motor belts so that the Trainer will respond promptly to the rudder controls. New belts will require frequent adjustment of the belt tightener at first, and possibly shortening if the stretching is excessive. Tighten all setscrews and hose clamps. With the turn indicator roughly adjusted, check the smoothness of operation of the turning motor in both directions at one-half standard rate turn. Oscillation of the needle should not be more than 1/32 of an inch. (Adjust as necessary, according to section VII, par. 4*e*.)

d. BASIC ADJUSTMENTS TO LINKAGE.—Use the following adjustments to the linkages to position all the walking beams vertically with the Trainer locked level.

(1) BANK ACTION WALKING BEAM.—Clamp the rudder pedals in neutral. Adjust the link rod from the bank action shaft to the universal joint pedestal to bring all bell cranks on the bank action shaft to vertical. Adjust the linkage from the rudder bar to the lower end of the bank action shaft walking beam to bring this walking beam to vertical position. The vertical position of all units should be verified by use of a spirit level.

(2) AILERON VALVE WALKING BEAM.—With the rudder pedals clamped in neutral and the bank action walking beam vertical, adjust the link from the bank action walking beam to the automatic bank shaft so that the bell cranks on the shaft are vertical. With the aileron control centered, adjust the link rod from the aileron slipstream simulator to the lower end of the aileron valve walking beam so that the walking beam is vertical.

NOTE

The radius of the automatic bank shaft arm governs the amount of the automatic bank with turn, and is initially set at the factory.

(3) PITCH ACTION WALKING BEAM.—Set the pitch action arm to vertical by adjusting the arm on the universal joint pedestal by means of the mounting bolt holes. Check that when the climb and dive valves are closed, the pitch action walking beam is approximately vertical.

NOTE

Check for interference between the actuating arm and the roller.

e. MAIN VALVES AND CONTROLS.

(1) RUDDER VALVE.—With the Trainer locked level, ignition switch "on," vibrator motors "on," tower locking device disengaged and control column forward, disconnect the rod from the bank action walking beam to the rudder valve at the valve. Turn the rough air mechanism "on."

(*a*) Adjust the top half of the rudder valve for equal changes of heading, using the directional gyro. Adjust for zero trend through six pairs of alternate rough air yawing impulses.

(*b*) With the rough air "off," adjust the length of the rod to the rudder valve for slide fit into actuating arm on the top half of the rudder valve.

(*c*) Recheck the yawing trend with the rough air "on."

(2) TURN TIGHTENING VALVE.—With the Trainer locked level and the rudder pedals clamped in neutral, adjust the length of the turn-tightening valve actuating rod to bring the turn-tightening actuating arm on the top half of the valve in line with the center line of the valve assembly.

(3) AILERON VALVE.—With the control wheel centered, slack off the leveling device cables slightly.

(*a*) Fly the Trainer by positioning the control column to level the Trainer with reference to its longitudinal axis. Use a spirit level on the pitch and bank action limit stop plate.

(*b*) Back off the lock nut of the ball joint on the link rod from the walking beam to the top half of the aileron valve, and adjust its length to bring the Trainer to a lateral level position.

(*c*) Set up the lock nut and recheck for level floating.

(4) ELEVATOR VALVE.—Fly the Trainer to floating level condition (leveling cables slackened) by reference to a spirit level on the pitch and bank action plate, with rudder pedals locked and rough air "off."

(*a*) Back off the ball joint lock nut of the elevator valve rod at the control column.

(*b*) Rotate the top half of the elevator valve by moving the control column to float the Trainer level along the longitudinal axis.

(*c*) Adjust the length of the rod to bring the column vertical without disturbing the valve, and set up the lock nut. Recheck for floating level.

f. DIFFERENTIAL PRESSURE REGULATOR.—The operation is checked by use of a vacuum gage. The adjustment is made by adjusting the spring tension so that the pressure differential between the vacuum side and the atmospheric side is 2 inches ± 1/4 inch Hg.

g. LEAK TEST.—Set the altimeter to zero feet and fly the Trainer up to + 2000 feet. Lock the Trainer level and inspect the climb and dive valves to be sure both are closed against stops, turn the Trainer ignition switch "off" (vibrators "on"). The altimeter should not indicate a loss of over 100 feet in altitude in 5 minutes. If loss of altitude exceeds this tolerance, inspect all plumbing connections and bellows of the altitude system for leaks.

h. CLIMB AND DIVE VALVES.

(1) Adjust the climb limit valve as follows: With the Trainer ignition switch "off," altimeter at zero feet, vibrators "on," and normal atmospheric pressure in the altitude tank and the throttle fully advanced, zero the vertical speed indicator. Then turn on the ignition and turbine switches and put the Trainer in a full climb. The vertical speed indicator should indicate 2000 feet ± 100 feet per minute ascent as the altimeter passes the indicated 2000-foot level. Using the proper size screw driver to prevent damage, adjust the climb limit valve to come within this tolerance.

(2) Adjust the dive limit valve as follows: with the ignition and the turbine switches "on," vibrators "on," fly the Trainer from zero feet altitude to a point where the altimeter registers at least 4000 feet. Close the throttle fully, put the Trainer in a full dive position, and the vertical speed indicator should indicate 2000 feet ± 100 feet per minute descent as the altimeter passes the indicated altitude of 2000 feet. Using the proper size screw driver to prevent damage, adjust the limit valve to come within tolerance.

i. VERTICAL SPEED.—Zero the vertical speed indicator as before, and with the altimeter set to zero and normal atmospheric pressure in the altitude tank, turn on the ignition and the turbine switches. With the throttle fully forward and the Trainer locked level, the vertical speed indicator should indicate 600 feet ± 50 feet per minute climb, as the altimeter passes the indicated 1000 feet altitude. Adjustment is brought within tolerance by adjusting the length of the throttle link rod to the pitch action walking beam.

j. LIMITING REGULATOR BELLOWS.

(1) With a suitable vacuum gage connected to the outlet of the manifold pressure limiting regulator bellows, adjust the knurled nut on the eyebolt controlling the spring tension on the bellows until the vacuum gage registers 4-1/4 inches ± 1/4 inch Hg.

(2) Adjust the tachometer limiting regulator bellows using the same method and the same tolerances.

NOTE

There are bleed holes in the elbows leading from the limiting regulator bellows to the manifold and tachometer regulating bellows and the sizes are as follows: tachometer .025 inches, manifold pressure indicator .020 inches.

k. MANIFOLD PRESSURE.

(1) SEA LEVEL.—With the Trainer locked level, the throttle in cruising position (climb-dive valves closed), the manifold pressure gage should indicate 29.5 inches ± 1 inch Hg. With full open throttle (locked level), the manifold pressure gage should indicate 38.5 inches ± 1 inch Hg. The indication with the throttle fully closed should be 12 inches ± 2 inches Hg.

(2) 10,000 FEET OF ALTITUDE.—With the Trainer locked level and the throttle in cruising position, the manifold pressure gage should indicate 24 inches ± 1 inch Hg. With full open throttle, the indication should be 33.5 inches ± 1 inch Hg.

(3) ADJUSTMENT. — The adjustment for manifold pressure indications is made by moving the collar on the spring link rod to the manifold

pressure regulating bellows. Lowering the collar will increase the indication (greater spring tension). The range is adjusted by varying the spring characteristics. The bleed hole in the line adjacent to the instrument is .015 of an inch.

l. TACHOMETER.—With the Trainer locked level, throttle in cruising position (climb-dive valves closed), propeller pitch control in full high pitch (full back), the tachometer should indicate 1900 rpm ± 50 rpm. Under the same conditions, with the governor controls in full low pitch (full forward), the tachometer should indicate 2400 rpm ± 50 rpm. With the throttle fully closed and the governor control in full high pitch, the tachometer should indicate 500 rpm ± 50 rpm. The adjustment for tachometer indications is made similarly to those for manifold pressures. The bleed hole for the tachometer is .025 of an inch.

m. INDICATED AIR-SPEED CONTROL.—With oscillator "on" and the Trainer ignition switch "off," turn the indicated air-speed control until the air-speed indicator is on zero. Set the indicated air-speed control dial so that it reads zero with the control positioned as above. Adjust the stop to position the control at zero.

n. AIR SPEED.

(1) With the indicated air-speed control set to zero, the following conditions should be set up with the Trainer locked level. With the throttle at cruising (climb-dive valves closed), the air-speed indicator should read 160 units per hour ± 3 units per hour. Adjust by means of the knurled nut on the eyebolt on the reversing air-speed spring lever.

(2) With the throttle fully open, the air-speed indicator should read from 180 units to 200 units per hour. Adjust by changing the spring characteristics. To decrease the range, stretch the spring; to increase the range, shorten the spring.

NOTE

Use extreme care when changing the spring characteristics.

(3) With the throttle fully closed, the air speed should indicate 50 units per hour ± 10 units per hour. The capillary tube is .025 inches in diameter and approximately 1/4 inch in length. The bleed hole diameter is .020 of an inch.

o. TURN AND BANK INDICATOR.—Insert a connector "T" and a vacuum gage into the line between the turn and bank regulating bellows and the turn and bank indicator, and adjust the knurled nut on the spring eyebolt until the vacuum gage indicates 2 inches ± 1/4 inch Hg. Turn on the ignition and the turbine switches and with the Trainer locked level, after running for five minutes, set the directional gyro. Place a block under the tower locking plunger shaft lever to keep the plunger from striking the locking socket, and apply right rudder until the turn indicator shows the standard rate of turn established at 180 degrees per minute. Hold this standard rate of turn constant, using a stop watch to time the turns with reference to the directional gyro. Use the same procedure for timing turns to the left. Adjust the knurled nut on the turn and bank regulating bellows to adjust the vacuum until the stop watch registers 58 seconds to 62 seconds for a 180-degree turn in either direction.

NOTE

The higher the vacuum the faster the turn and bank gyro rotates. The faster the gyro rotates, the more sensitive it is, or the greater the indication on the instrument for a given rate of turn.

p. DIRECTIONAL GYRO. (Standard Air-Craft Instrument.)

(1) Using "T" connections and a vacuum gage, adjust the knurled nut on the spring eyebolt until the vacuum gage registers 4 inches + 1/4 inch Hg.

(2) Set the directional gyro at four cardinal points of the compass and test for precession. It should be limited to an average of 3 degrees over all headings, and a maximum of 5 degrees on any one heading, in 15 minutes.

q. ARTIFICIAL HORIZON.—Unlock the pendulums and fill the dashpots 7/8 full of castor oil. With the Trainer locked level, adjust for level indication by moving the sliding brass bar.

r. WIND DRIFT MECHANISM.

(1) Inspect the wiring and tighten any loose connections. Synchronize the wind speed by centering the wind pivot over the center of the wind bar, then disconnect the flexible drive from the wind speed control, set the wind drift control indicator to zero, and reconnect. The centers are checked by revolving the wind direction control through 360 degrees and checking for possible movement of the ground speed pinion. There should be no movement. The stop nuts should stop

the wind velocity at zero units and at 60 units per hour.

(2) Synchronize the wind direction input by aligning the wind bar with the wind triangle rack so that it lies beneath the wind triangle rack with the Trainer locked on an east heading, and with maximum wind velocity. Disconnect the wind direction control, rotate the control indicator to read 270 degrees and reconnect the flexible drive.

(3) With the indicated air-speed density control on "0" and with a true air speed of 160 units per hour, the air-speed slide should be 15/16 inch ± 1/32 inch from the stop collar. Adjust by rotating the air-speed receiver teletorque in the mounting collar. Check the air-speed follow-up motor for operation. The contact pressure on the rotary switch may be varied by changing the spring tension. If the contact binds on the notch, it is possible to use a fine emery paper to smooth the contact. If the follow-up motor hunts slightly, the teletorque should be set to average the hunting.

NOTE

Use extreme caution in all adjustments to the rotary switch, and avoid excessive or rapid hunting.

(4) The track transmitter teletorques will be synchronized when shipped and should not require adjustment. If necessary to synchronize the transmitters, disconnect one teletorque mechanically, and, with the power on, permit them to come into alignment. When synchronized, reconnect the teletorques.

(5) With zero wind velocity and 160 units per hour true air speed, the ground speed take-off wheel should be approximately 1.5 inches from the center of the rubber ground speed plate, with the center line of the ground speed teletorque arm beneath the pointer. The adjustment is made by changing the length of the link rod from the ground speed rack to the teletorque carriage.

s. TERRAIN MECHANISM.

(1) TERRAIN PROJECTOR ASSEMBLY.

(*a*) Remove the projection lens and adjust the vertical position of the bulb so that the filament image will come in the center of the top condensing lens.

(*b*) Adjust the lateral position of the bulb so that the filament image will come in the center of the top condensing lens.

(*c*) Adjust the position of the projector bulb so the distance between the bulb and the first condensing lens is about 1 inch.

(*d*) Adjust the distance between the spherical reflector and the bulb so as to see clearly the crossed filament image in the center of the top condensing lens.

(*e*) Replace the projection lens. The center point of the top condensing lens should be approximately under the center point of the projection lens in the hub.

(*f*) Adjust the projector assembly laterally, longitudinally, and if necessary, tilt the projector until maximum coverage and maximum light is attained on the screen (no dark spots or rainbow effects), with the azimuth pointer at any point on the 360 degrees of azimuth rail.

(*g*) Insert a projection plate and focus the projection lens for clearest definition by observation from the fuselage. Use the special wrench supplied with the Trainer for focusing the lens.

(2) TERRAIN PROJECTOR ASSEMBLY. Alternate Method of Adjusting. (*See figure* 137.)

(*a*) Remove the bearing hub projector lens and insert a sheet of paper 6 inches to 7 inches above the top condensing lens.

(*b*) Insert a cardboard shield between the reflector and the projection bulb.

(*c*) Focus the bulb by moving the bulb case so that the filament of the bulb appears on the paper as a clear image.

(*d*) Remove the screen in front of the reflector and adjust the reflector so that a second image of the filament, crossed over the first, appears on the paper.

(*e*) Adjust the projector assembly in the base carriage so that the center point of the top condensing lens is under the center of rotation (center point of the bearing hub projector lens tube).

(*f*) Replace the ground projector lens.

(*g*) Check that there is maximum coverage and maximum illumination of the screen.

(3) PROJECTION PLATE DRIVES.

(*a*) Adjust the pressure of the plate drive wheels against the plate by adjusting the limiting nuts on the plate depressor. With the depressor re-

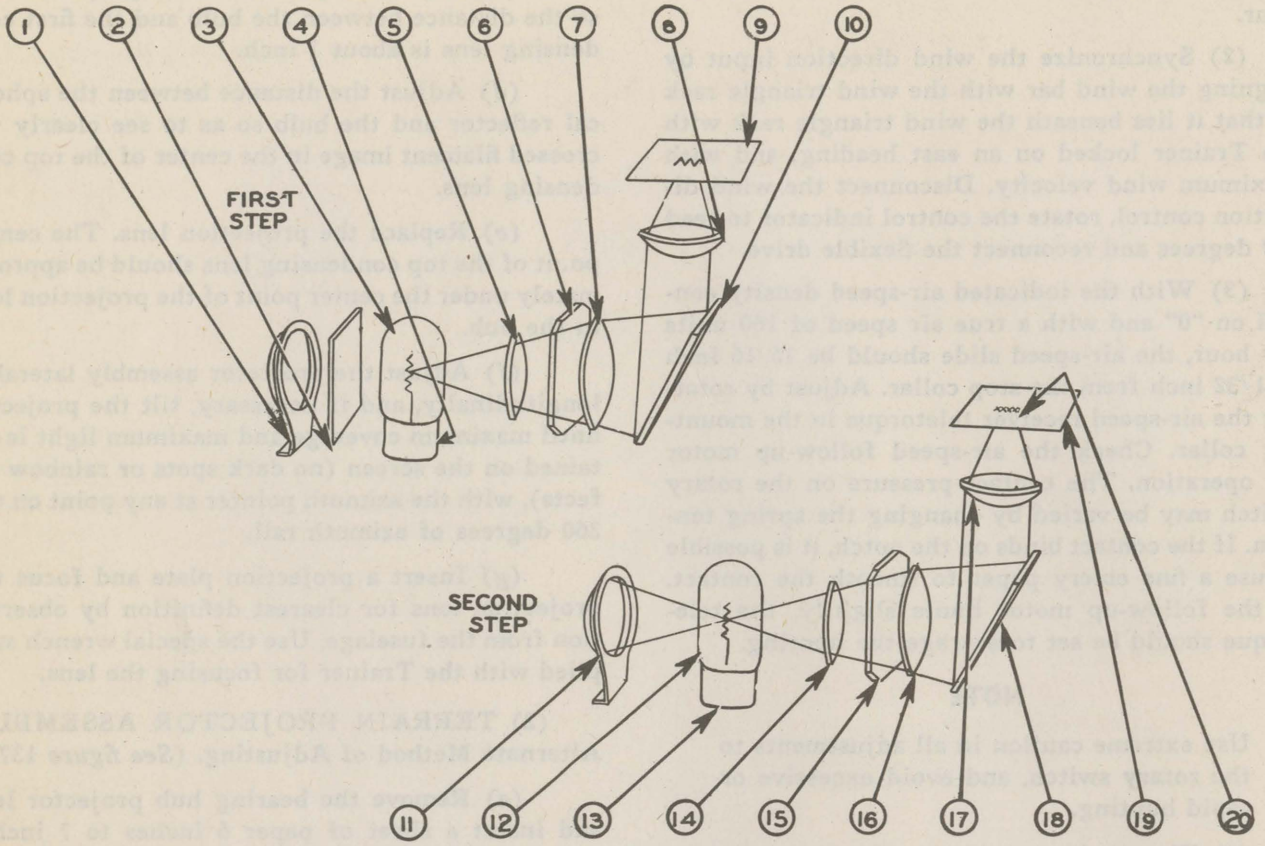


Figure 137—Adjustment of Terrain Projector

1. *Reflector*
2. *Cardboard (to Shield Reflector)*
3. *Bulb Filament*
4. *Bulb*
5. *Condensing Lens*
6. *Heat Absorbing Lens*
7. *Condensing Lens*
8. *Condensing Lens*
9. *Sheet of Paper (replaces objective Lens)*
10. *45° Mirror*
11. *Reflector*
12. *Bulb Filament*
13. *Bulb*
14. *Condensing Lens*
15. *Heat Absorbing Lens*
16. *Condensing Lens*
17. *Condensing Lens*
18. *45° Mirror*
19. *Sheet of Paper*
20. *Filament Image*

leased, the rubber wheels should extend 1/32 inch above the under side of the plate, or compress just enough to prevent slippage of plate against the rubber drive wheels. With the drive wheels depressed, there should be a 1/16- to 3/32-inch clearance between the top of the rubber drive wheels and the under side of the plate.

(*b*) Check the alignment of the plate drive wheels. With the Trainer locked on an east heading, the azimuth rail pointer on 270 degrees and the master switch "on," align the plate drive wheels longitudinally to the nearest electrical notch, set the plate end scale to (8) and turn the navigation switch "on." Adjust the track teletorque locating arm on the azimuth rail until the plate travels its full length with a maximum side movement of 1/8 inch measured on the end scale of the carriage.

(*c*) Electrical alignment of the terrain track teletorque is obtained by mechanically disengaging the teletorques, turning on the master switch so that the teletorques will align electrically, and then mechanically re-engaging the gears and securing the teletorques in the mountings.

(*d*) Check the alignment of the projection plate rollers. These are adjusted by means of the eccentric mountings, after putting a plate on the carriage. First adjust the third roller from each

end, then bring all other rollers up to the plate. The distance between opposite rollers should be 20 inches + 1/32 inch — zero inches. The size of the plate is 20 inches + zero inches — 3/64 of an inch. These rollers are very carefully adjusted at the factory by use of a fixture, and it should be unnecessary to readjust the rollers in the field.

(*e*) Remove the ground projector lens in the main bearing hub and insert the main bearing center-locating fixture and plumb bob for determining the center of rotation above the projection plate. By means of masking tape attach two threads to a plain glass projection plate in such a manner that one thread is parallel to the longer edge of the plate and the other thread is parallel to the shorter edge or end of the plate. Insert the plate in the plate carriage and adjust the plate so the thread which is parallel to the end of the plate passes through the center of rotation of the Trainer (under the center point of the projection lens tube). Adjust the plate so that the other thread which is parallel to the side edge of the plate passes through the center of rotation of the Trainer, and adjust the end scale index pointer on the terrain base frame to coincide with the thread on the plate.

(4) PROJECTION PLATE AND RECORDER RATE OF TRAVEL.

(*a*) The ratio of the rate of travel of the projection plate to the rate of travel of the recorder is 5 to 2. With the master switch "on," insert an insulator between the contacts of the air-speed freezing relay. Rotate the pinion gear on the air-speed follow-up motor until the distance between the stop collar and the air-speed slide is 15/16 of an inch.

(*b*) Secure a transparent rule to a blank projection plate, so that the rule will be parallel to the long side of the plate. Secure a thread to the cloud plate and secure the cloud plate in the guides so that it will not rotate. Adjust the cloud plate so that the thread will be projected laterally across the screen near the west end of the screen. Move the projection plate so that the zero mark of the transparent rule is projected on the screen and coincides with the line from the cloud plate. Set the desk clock so it indicates an integral hour, and turn on the navigation switch. This will start the clock recording time, and also move the projection plate. At the end of ten minutes turn off the navigation switch. The projection plate travel should be 8.45 inches, and the recorder travel should be 3.38 inches with a statute mile ground speed take-off wheel used in the wind drift mechanism. If a nautical miles per hour take-off wheel is used in the wind drift, then in ten minutes the projection plate travel should be 9.718 inches and the recorder travel should be 3.887 inches.

(*c*) Adjust by changing the length of the link rod from the ground speed rack to the ground speed transmitter teletorque carriage, shifting the take-off wheel with relation to the drive wheel.

NOTE

Check that the proper take-off wheel for the air-speed units desired is used.

(*d*) Simultaneously check the distance of recorder travel with the projection plate distance of travel. With the master switch "on," connect the Jones plug to the recorder. Align the drive wheels of the recorder to agree with the Trainer heading to the nearest electrical notch, loosen the thumb screw on the top of the recorder controlling the clutch on the recorder track teletorque, and align wheels to agree with the heading. Tighten the thumb screw and place the recorder with the rear edge parallel to the latitude lines on the graticule (Lambert Conformal projection). Check the recorder distance of travel under the same conditions as for projection plate travel. If the projection plate travels 8.45 inches in 10 minutes, the recorder distance of travel should be 3.38 inches in the same length of time.

(*e*) Should the recorder travel be too great and the plate travel below the desired amount, check the plate rubber wheels to be sure there is no slippage between the plate and wheels. To correct this condition, adjust the nuts and lock nuts which control the height of the plate drive autosyns. If the plate and recorder travel are both short of the desired amount, be sure there is no slippage between the rubber surfaced ground speed plate (in the wind drift mechanism) and the ground speed take-off wheel. If there is slippage at this point, increase the tension on the spring which keeps the take-off wheel engaged against the ground speed plate.

(*f*) Adjustment should be made so as to obtain correct recorder rate of travel; then, if necessary, adjust the plate drive wheels up or down to obtain the correct plate rate of travel. This will cause a slight change in the rubber drive wheel diameters, producing a small change in rate of travel.

(5) WIND SPEED AND DIRECTION CHECK.—Check the projection plate and recorder rates of travel for various wind velocities and wind directions. Use wind velocities from zero units to 60 units per hour in 15-unit increments, and wind direction from zero degrees to 360 degrees in 45-degree increments.

t. CLOUD PROJECTOR.—Check for maximum illumination, as was done for the terrain mechanism. Adjust the focus for maximum realism of cloud appearance. Adjust the cloud plate to prevent binding in the guides.

u. AIR-SPEED CALIBRATION. — The air-speed system has been adjusted to give the correct rate of travel at 160 units per hour. With the density controls on zero and zero wind speed, check the rate of plate and recorder travel at indicated air speeds from 120 units to 200 units per hour in 10-unit increments. Calculate the actual air speed from the plate and recorder travel in 10 minutes and make out an instrument calibration card. The error should not exceed 3 to 4 units per hour.

v. AIR-SPEED DENSITY CONTROL CALIBRATION.

(1) INDICATED AIR-SPEED CONTROL. —With the Trainer locked level, the climb and dive valves closed, zero the indicated air-speed control and check the indicated air speed. (It should read 160 units per hour.) If the cruising condition is satisfactory, calibrate the density control dial by noting the indicated air speed for each division on the density dial. Make out a calibration card.

(2) TRUE AIR-SPEED CONTROL.—With the Trainer locked level and on an east heading, density controls on zero, set up cruising conditions and check the projection plate as in calibrating the air-speed indicator. If cruising conditions are satisfactory, check the plate travel (10-minute minimum) for each division on the control dial. Make out a calibration card.

w. MAGNETIC COMPASS.

(1) Project a compass rose from the terrain mechanism on the projection screen so that the center of the compass rose will coincide with the center of rotation of the screen. The compass rose may be either a photographic negative, or threads fastened with masking tape to a blank terrain projection plate. The east-west lines of the compass rose should be perpendicular to the sides of the projection plate and the north-south lines parallel to the sides of glass plate. The terrain carriage azimuth pointer should be set to north or zero degrees.

(2) Apply a thread to the cloud plate by using masking tape and wedge the cloud plate in the guide so that the plate will not revolve. Adjust the plate so the line of the thread is projected longitudinally through the center of rotation on the screen.

(3) With the Trainer locked on an east heading set the projection plate so that the center of the rose falls on the center of rotation, and so that one line of the projected compass rose coincides with the longitudinal line projected from the cloud projector. True heading for each 30 degrees can now be obtained by rotating the Trainer until the longitudinal lines superimpose consecutively on each line of the compass rose. Lock the rudder pedals with two short boards, one on the front and one on the rear of the rudder pedals, secured with a "C" clamp. Rotate the Trainer by hand to eliminate the error in compass reading due to northerly-turning-error compass magnets being energized.

(4) Adjust the compass compensating screws to neutral position (dot to dot), and with variation control on zero, disconnect the flexible compass drive shaft. With the Trainer locked on east heading and all electrical equipment turned "on," rotate the shaft by hand until the compass reads east, or 90 degrees. Reconnect the flexible compass drive and recheck that the compass still reads 90 degrees.

(5) Check the deviation on all four cardinal points and adjust the north-south compensating screw to halve the deviation on north and south. Then adjust the east-west compensating screw to halve the deviation on east and west.

(6) Swing the Trainer through 360 degrees, noting the compass reading at each even 30-degree interval. From the indicated readings make out a deviation card.

(7) Check the deviation using several variations. Since deviation is the difference between the compass heading and the magnetic heading, the following procedure must be followed:

(*a*) Set the variation control to the variation desired.

(*b*) Set the azimuth pointer on the terrain carriage to the same reading without disturbing previous plate setting and swing as before.

EXAMPLE

Set 10 degrees east variation on variation control, set azimuth pointer to 10 degrees east. If the deviation does not change for changes in variation, only one deviation card will be necessary.

x. RADIO DIRECTION FINDING ADJUSTMENTS.

(1) ADJUSTMENT OF THE TRANSMITTER GONIOMETER UNITS.

(*a*) Place the azimuth control of each transmitter unit on zero and check the mechanical stop position. The control should be rotatable from zero around and slightly throug zero. If not, loosen the Briston setscrew fastening the azimuth control to the shaft, and rotate the control until the above is true.

(*b*) With the azimuth control on zero, loosen the Briston setscrew fastening the goniometer rotor to the rotor shaft, and rotate the goniometer rotor until it lines up with the longitudinal stator coils of the unit. Retighten the setscrew on the goniometer shaft. Care should be taken not to allow the connections of the rotor to be stressed.

(c) Set the left transmitter on a frequency of 200 kc and the right transmitter on a frequency of 400 kc. Set the radio up for range. An "on-course" signal is preferable, although an "A" signal on one transmitter and an "N" signal on the other transmitter may be desired for differentiation between stations. At either the navigator's or the radio operator's radio receiver control box, push the button to give that box control, turn up the volume to about the three-quarter point, turn the multi-throw antenna switch control knob to comprehensive position, and turn the frequency dial to about 200 kc. Tune until the meter shows a maximum, and note the reading on the radio compass indicator where the compass pointer stops.

(*d*) Tune the receiver to the frequency of the other station (400 kc) and again note the reading on the radio compass where the compass pointer stops.

(*e*) With the azimuth setting of the 400 kc station still on zero, loosen the setscrew fastening the transmitter gonio rotor to the shaft and rotate the rotor on the shaft until the radio compass needle stops at the same point as it did in the case of the 200 kc station. Fasten the gonio rotor to the shaft. Both transmitter gonio units are now synchronized with each other.

(2) SYNCHRONIZING THE PICK-UP GONIOMETER UNIT WITH TRAINER HEADING AND RADIO COMPASS INDICATORS USING THE SCR-269-A RECEIVER.

(*a*). With the Trainer locked on an east heading and both radio transmitters set at an azimuth of zero degrees, mechanically disengage the receiver goniometer teletorque gear being careful to hold the receiver goniometer rotor from turning. Place the radio antenna selector switch on loop position, and by operating the loop drive switch on the radio receiver control box to right or left, drive the loop until the radio compass needle is on 270 degrees. Re-engage the teletorque gear and secure the teletorque. Change the radio antenna selector switch to comprehensive position and the radio compass needle should stop at about 270 degrees. If the needle does not stop at 270 degrees exactly, loosen the setscrew which holds the goniometer receiver rotor on the shaft, and turn the rotor slightly until the radio compass needle does stop on 270 degrees. Fasten the rotor to the shaft.

(*b*) With the Trainer still locked on an east heading and the radio tuned to a frequency of 200 kc and both transmitters set at an azimuth of zero degrees, put the antenna selector switch on the loop position and with headphones plugged in, turn the loop drive control to drive the loop either to left or right. As the radio compass pointer moves slowly around the dial, listen for a null which should be heard when the radio compass needle is at 270 degrees. Use the same procedure to check the null at 270 degrees on the 400 kc frequency station.

NOTE

If the null does not come on 270 degrees, inspect the instrument drive assembly, instrument drive take-off gear box, connectors, and receiver goniometer unit for backlash or bind.

(*c*) With the Trainer locked on an east heading, set both transmitter station azimuths to 90 degrees. With the radio tuned to 200 kc and antenna switch on comprehensive position, the radio compass pointer should stop on zero. Tune to the 400 kc station and the radio compass needle should stop on zero.

(*d*) If, in both the above cases, the radio compass pointer stops on 180 degrees instead of zero degrees, simply rotate the pick-up goniometer teletorque 180 degrees. The same effect may be obtained, if desired, by rotating the teletorque in the instrument drive assembly. However, if only one transmitter unit is out of phase by 180 degrees, the faulty unit is corrected by changing the direction of the loop current by rotating the gonio loop 180 degrees on its shaft. In case the direction of teletorque rotation is wrong, it may be corrected by reversing connections No. 2 and No. 3 on either the instrument drive assembly teletorque, or the receiver goniometer teletorque. The receiver goniometer rotor should rotate in the same direction as the Trainer.

(*e*) It may be found that radio bearings taken with the radio compass may differ a few degrees from the correct relative bearing on azimuth and heading combinations other than the Trainer heading and azimuth control used in synchronizing the transmitter and receiver goniometer units; that is: 90 degrees Trainer heading, zero degrees transmitter azimuth.

1. In order to eliminate this error a correction table may be determined giving the azimuth setting for the desired true bearing. The table may be constructed as follows. The following figures were taken from an actual installation:

LEFT TRANSMITTER		RIGHT TRANSMITTER	
Desired Azimuth	*Azimuth Setting*	*Desired Azimuth*	*Azimuth Setting*
0°	02°	0°	0°
10	12	10	10
20	22	20	20
30	32	30	30
40	43	40	40
340	339	340	340

2. In order to calculate the transmitter goniometer azimuth error, we must have a known Trainer heading. Therefore, lock the Trainer on an east heading. Then it is apparent that with the transmitter azimuth set to zero, the radio compass indicator would read 270 degrees and the station would be north, relative to the Trainer.

3. The transmitter azimuth control is set to read the true bearing of the station **from** the plane.

4. The radio compass needle indicates the relative bearing of the station **from** the plane.

5. The following method is used to make a transmitter azimuth correction card:

a. Set the left transmitter azimuth control to zero and notice what bearing the pilot's radio compass indicates. It should indicate 270 degrees. If it does not indicate 270 degrees, turn the transmitter azimuth control slightly until the desired radio compass reading is obtained. Note the transmitter azimuth reading which corresponds to the 270 degrees desired reading on radio compass.

b. Set the transmitter control to 10 degrees, and check the reading on radio compass. It should indicate 280 degrees. If it does not indicate 280 degrees, turn the azimuth control slightly until the radio compass indicates a bearing of 280 degrees. Note the transmitter azimuth setting necessary to get the desired 280 degrees indication on the radio compass.

c. Repeat this procedure for each 10 degrees, for the entire 360 degrees of transmitter azimuth. Make up a correction card giving transmitter azimuth setting for any desired radio compass indication.

d. Repeat the above procedure for the right transmitter.

6. An alternate method is to prepare a small compass rose of azimuth settings necessary to obtain desired readings on the radio compass, and mount this card under the azimuth pointer replacing the transmitter azimuth scale. This will make it unnecessary for the operator to use a correction table.

(3) MODIFICATIONS FOR ADJUSTMENT AND SYNCHRONIZATION OF THE NAVY DZ-2 RECEIVER.

(*a*) GENERAL. — Navy Trainers are equipped with a type DZ-2 receiver rather than the Army SCR-269-A receiver. As the DZ-2 is not an automatic direction finding type radio, some modifications in Trainer parts are necessary in its installation.

(*b*) LOOP DRIVE.—The loop drive is manual on this installation and consists of a loop azimuth control at the radio operator's desk, drive shafts to the instrument drive assembly, and a gear on this shaft which drives one side of the loop differential in the instrument drive assembly.

(*c*) INSTRUMENT DRIVE ASSEMBLY.—Since there is a manually driven loop in the DZ-2, installation fittings in the instrument drive assembly are modified to receive the flexible drive cable from the radio operator's control panel, rather than the loop drive motor and remote indicator magnesyn of the SCR-269-A receiver.

(*d*) ANTENNA SYSTEM.—To obtain the proper balance between omni-directional antenna signal strength and loop signal strength in the DZ-2 installation, it is necessary to couple the loop leads through a 5000-ohm resistor at the receiver goniometer chassis. One resistor is placed in each lead. Proper adjustment of the receiver sensitivity (loop and omni-directional) controls is also necessary.

(*e*) SYNCHRONIZATION.—Synchronization of the DZ-2 equipment is similar to that of the SCR-269-A, except that the loop drive shaft from the fuselage to the instrument take-off may be uncoupled after a null is obtained and the loop azimuth control rotated to the correct reading. If the shaft is now recoupled, synchronization between null, heading, and relative bearing has been achieved. The transmitter azimuth control correction card may be made out in the same manner as for the SCR-269-A, using manual loop control to set the desired relative bearing and rotating the transmitter azimuth control to achieve this bearing. Sensing may be properly synchronized by 180-degree rotation of the receiver loop rotor while the teletorque is de-energized.

4. FINAL INSPECTION.

a. FUSELAGE.

(1) INTERPHONE TEST.

(*a*) Turn on the fuselage power supply.

(*b*) Turn the fuselage interphone volume up to three-fourths full travel.

(*c*) Turn the outside air temperature control on the fuselage power supply panel.

(*d*) Check that this control operates the outside air temperature gage on the navigator's panel.

(*e*) Turn the instructor's interphone station switch to "crew."

(*f*) Turn the radio operator's and pilot's interphone station toggle switches to "interphone." (Use two microphones and head sets known to be good.)

(*g*) Check the communication between pilot and instructor.

(*h*) Check the communication between instructor and radio operator.

(*i*) Check the communication between instructor and navigator.

(*j*) Check the operation of the fuselage interphone volume control. (See that it controls the volume of voice with communication between the radio operator and the instructor.)

(*k*) Check the operation of the interphone signal lamps (signal from all stations, and note operation of signal lamp on the interphone amplifier.)

(2) SIGNAL TEST.

(*a*) Turn the flap switch to "up." Check that the green "flaps-up" indicator lamp lights.

(*b*) Turn the flap switch to "down." Check that the red "flaps-down" indicator lamp lights.

(*c*) Turn the landing gear switch to "down." Check that the green "landing-gear-down" lamp lights.

(*d*) Turn the landing gear switch to "up." Retard the throttle fully.

(*e*) Check that the red "landing-gear-up" lamp lights.

(*f*) Check that the warning buzzer operates.

(*g*) Advance the throttle to "cruising." Check that the warning buzzer does not operate.

(*h*) Check that the red landing gear lamp does not light.

(3) ELECTRICAL OPERATION CHECK.

(*a*) Check that only the master switch is "on" during these tests.

(*b*) Check that the "rough air" drive motor operates.

(*c*) Check that the differential pressure vibrator motor runs.

(*d*) Check that the vibrator motor and switch on the pilot's instrument panel operates—"on" and "off."

(*e*) Check that the vibrator motor and switch on the navigator's instrument panel operates—"on" and "off."

(*f*) Check that the vibrator motor and switch on the air-speed and altimeter transmitter panel operates—"on" and "off."

(*g*) Turn the "collimator - recognition" switch to "recognition." Check that the relay in the desk junction box energizes.

(*h*) Turn the switch to "collimator"; check that the relay is de-energized.

(*i*) Check that the pilot's fluorescent lamp operates.

(*j*) Check that the navigator's fluorescent lamp operates.

(*k*) Check that navigator's desk lamp variable control regulates the lamp intensity.

(*l*) Check the pilot's signal lamp—"on" and "off." Check that the variable control regulates the lamp intensity.

(*m*) Check the fuselage dome light—"on" and "off."

(*n*) Check the operation of the automatic electric door lock:

1. Push the micro-switch; check that the door lock solenoid is energized and that the door is unlocked.

2. Release micro-switch; check that the door lock solenoid is de-energized and that the door is locked.

(4) CLOCKS.

(*a*) Set the pilot's and the navigator's clocks to an even hour, minute, and second. Turn the master, navigation and time switches to the "on" position.

(*b*) Check that both clocks run one minute in one minute as checked against stop watch.

(*c*) Turn the time switch "off."

(5) LEVELING DEVICE.

(*a*) Check that the stop on the leveling device crank rod is correctly adjusted for locked position.

(*b*) Check that the cables have equal tension with the Trainer locked level.

(*c*) Check that the Trainer remains "locked level" when the weight of the tester or inspector is shifted from one crew position to another.

(6) CONTROLS AND MAIN VALVES.

(*a*) SIMULATORS.

1. Check that there is no play or jerkiness at start of movement.

2. Check that there is no play or lost motion in ball joint connectors.

(*b*) WHEEL CONTROL.

1. Check that the wheel motion is free and smooth.

2. Check that it has the same "feel" as actual aircraft.

3. Check that when the wheel column is pushed all the way forward, the stop prevents it from hitting the instrument panel.

(7) RUDDER CONTROL.

(*a*) Check that the pedal motion is free and smooth.

(*b*) Check that the pedals have the same "feel" as in actual aircraft.

(8) THROTTLE.

(*a*) Check the throttle for full movement.

(*b*) Check that the throttle has no excess play or lost motion; that movement is not stiff or "jerky."

(*c*) Check that the throttle has the same "feel" as in actual aircraft.

(9) PROPELLER PITCH CONTROL.

(*a*) Check the propeller pitch control for full movement.

(*b*) Check that the propeller pitch control has no excess play or lost motion; that movement is not stiff or "jerky."

(*c*) Check that the propeller pitch control has the same "feel" as in actual aircraft.

(10) PILOT'S PANEL.

(*a*) Check that the interphone indicator bulb is in place and that the socket is tight.

(*b*) Check that the visual marker bulb is in place and that the socket is tight.

(*c*) Check that the bomb release indicator bulb is in place and that the socket is tight.

(11) DIFFERENTIAL PRESSURE REGULATOR.

(*a*) Check that the unit is securely mounted.

(*b*) Check that the tubing, fittings and connectors are not damaged.

(12) AIR-SPEED REGULATOR BELLOWS ASSEMBLY.

(*a*) Check that the unit is securely mounted.

(*b*) Check that the guide rollers turn freely and do not bind on the bellows rod.

(13) ALTITUDE TRANSMITTER.—Check that the unit is securely mounted under the radio operator's desk.

(14) AIR-SPEED TRANSMITTER.

(*a*) Check that the unit is securely mounted under the radio operator's desk.

(*b*) Check that the tubing, fittings, and connectors are not damaged and do not leak.

(15) CLIMB-DIVE VALVE ASSEMBLY.

(*a*) Check that the unit is securely mounted.

(*b*) Check that the connections are tight.

(16) ALTITUDE COMPENSATOR.—Check that the unit is properly mounted. It must be solid, but have no excessive play in linkages or pivots.

(17) INSTRUMENT CHECKS. (Trainer locked level.)

(*a*) Check that all tubing, fittings and connectors show no sign of damage or leaks.

(b) Check size of the air-speed bleed hole—.020 of an inch.

(*c*) Check size of the tachometer bleed hole—.025 of an inch.

(*d*) Check size of the manifold pressure bleed hole—.015 of an inch.

(*e*) Check that the bell crank at the pitch action shaft is vertical.

(*f*) Check that the pitch action walking beam is vertical (climb and dive valves closed).

b. COUNTERBALANCE FRAME.

(1) TURBINE.

(*a*) Turn on the master switch, ignition switch and the turbine switch.

(*b*) Check that the motor runs without excessive vibration.

(*c*) Check that there is no excessive sparking at the brushes.

(*d*) Turn the turbine switch "off"; check that the turbine is off.

(2) ALTITUDE PUMP.

(*a*) Check that the motor runs without excessive vibration.

(*b*) Turn off the ignition switch; check that the altitude pump is off.

(3) CLOUD PROJECTOR.

(*a*) Check that the motor runs without excessive vibration (fan tight on shaft, in balance).

(*b*) Turn on the cloud projector switch (lower left desk drawer).

(*c*) Check that the cloud density control variac controls the cloud projector lamp intensity ("0" minimum light, "110" maximum light).

(*d*) Turn the variac down to approximately "50." Turn off the cloud projector switch. Check that the light goes out.

(4) BOMB HIT TIMER CIRCUIT.

(*a*) Check that the bomb hit timer, anti-turn solenoid, hit projector and bomb release switch relay are connected electrically.

(*b*) Set the bomb hit timer on 30 seconds.

(*c*) Operate the bomb release switch relay.

(*d*) Check that the anti-turn solenoid operates.

(*e*) Check that the air-speed freezing relay operates (solenoid energized, up in core).

(*f*) Check the bomb hit projector for a 2-second flash at the end of the 30-second timed interval.

c. TERRAIN MECHANISM.

(1) Turn the ground projector switch "on" (lower left desk drawer).

(2) Check that the ground density control variac controls the intensity of light of the ground projector (from "0" to "110" maximum).

(3) Check that the blower fan operates (master and ground projector switches "on").

(4) Check that the teletorques and autosyn motors on the terrain drive and direction units are in phase electrically.

(5) Turn the variac down to approximately "50." Turn off the ground projector switch. Check that the light goes out.

(6) Turn off the master and navigation switches.

d. DESK.

(1) Check that the key fits and operates the lock in the center drawer.

(2) Check that all drawers run smoothly.

(3) Check that the desk instruments are mounted in their proper position, and that all mounting screws are in place and tight.

(4) Check that all instrument panel mounting screws are tight.

(5) Check that the dome control panel (upper left drawer) fits the drawer and can be removed and replaced. Check that the hold-down screws go in place and are tight.

(6) Check that the control unit in the lower left drawer fits properly and that the top panel is secure. This unit is not fastened to the drawer.

(7) Check that the radio control units fit the center drawer, and may be removed and replaced readily.

(8) Check that all plug connectors in the control panels and behind the instrument panel are tight.

e. DESK RADIO.

(1) Desk lamp should operate when the switch on the desk instrument panel is operated.

(2) Turn on the desk radio master switch.

(3) Check the telegon oscillator. The output voltage should be between 70 volts and 90 volts. Check the voltage.

(4) Turn the visual marker, keyer, code and aural marker "off."

(5) Plug in the desk head set and microphone.

(6) Push the control chassis radio interphone switch "in."

(7) Turn the instructor's interphone station switch to "operator."

(8) Check the interphone signal lamp on the desk instrument panel. (It should be "on.")

(9) Check the interphone communication between the desk and the instructor's station.

(10) Check the control chassis interphone volume control.

(11) Turn the visual marker switch "on."

(12) Check the visual marker push button. (The visual marker lamp on the pilot's panel should light when the button is pressed.)

(13) Turn the aural marker switch "on."

(14) Turn the marker beacon volume up to about three-fourths full volume. Leave the visual marker switch "on."

(15) Turn the marker selector switch to the desired positions.

(16) Check for reception of "Z," "F1," "F2," "F3" and "F4," aural marker signals at the desk and in the fuselage.

(17) Check for the action of the visual marker beacon on the pilot's panel.

(18) Place the code switch "on."

(19) Check the transmission of code from the desk to the fuselage and from the fuselage to the desk.

(20) Check the frequency of the note by ear. (3000-cycle.)

(21) Turn the aural and visual marker switches "off" and place the marker selector switch on "off."

(22) Place the interphone-radio switch on "radio" (pull out).

(23) Put the pilot's voice-simultaneous-range switch on "range."

(24) Place the left and right transmitter modulation selectors on "range."

(25) Place the left transmitter frequency control on 400 kc and the right transmitter frequency control on 200 kc.

(26) Place both transmitter volume controls on "50."

(27) Use the omni-directional antenna on the receiver.

(28) Check the reception of both transmitter signals and the frequency of each.

(29) Place the beam shift controls on "0."

(30) Check the movement in either direction necessary to detect an "A" or an "N" signal. (Not less than one division or more than three. "A" and "N" to be audible within the same division on either side of the center.)

(31) Check extreme positions for an "A" or "N" with no background.

(32) Check all identification signals.

(33) Check the voice-range transmission between the radio operator and the desk. (Range should come in over voice. Control is in "simultaneous" position at the pilot's control box.)

(34) Check voice only.

(35) Check range only.

(36) Check voice transmission on both transmitters for a readable but not clear signal.

(37) Check the amount of 700- and 400-cycle hum. (Should not be excessive.)

(38) Check the "right" transmitter frequency on 200 kc, 300 kc and 400 kc. (It should be within ± 10 kc.)

(39) Check "left" transmitter frequency on 200 kc, 300 kc, and 400 kc. (It should be within ± 10 kc.)

(40) Put the left and right transmitter modulation selectors on "instrument landing."

(41) Right transmitter (800-cycle note).

(42) Left transmitter (400-cycle note).

(43) Turn the code switch "on."

(44) Check the transmission of code from the desk to the fuselage and fuselage to the desk (right transmitter only, 800-cycle note).

(45) Put the left modulation selector on 278 kc.

(46) Check the frequency setting of the receiver for 278 kc ± 2 kc.

(47) Check voice transmission for a readable but not clear signal.

(48) Put the left modulation selector on "range" and the right modulation selector on "278" kc.

(49) Check the amount of 700-cycle and 400-cycle hum (level should not be excessive).

(50) Check voice transmission for a readable but not clear signal.

(51) Put the right transmitter modulation selector on "range" and turn to 278 kc.

(52) Check that the two transmitter signals are at least 10 kc apart.

(53) Check the localizer for adjustment (desk power supply control to instrument on pilot's panel.)

f. OPERATION TEST. (Trainer locked level.)

(1) Turn on the telegon oscillator supply. Connect the Trainer voltage supply. Turn on the pilot's, navigator's, altimeter and air-speed transmitter vibrator motors. Do not turn on the ignition switch, altitude tank must have no vacuum.

(2) Set the altimeters (pilot's and navigator's) to "0." Check that the barometric scale setting is "29.92."

(3) Set the indicated air-speed control knob to zero.

(4) Check that the pilot's and navigator's air-speed indicators read zero.

(5) Turn on the ignition and turbine switches.

(6) Advance the throttle fully (climb the Trainer).

(7) Check that the indicated vertical speed is 600 feet per minute, ± 50 feet per minute as the Trainer passes 1000 feet altitude.

(8) Fly the Trainer to 2000 feet above sea-level.

(9) When the altimeter indicates 2000 feet above sea-level, set the throttle to cruising (climb and dive valves closed). Turn the ignition switch off.

(10) Check that the altimeters do not lose more than 100 feet in 5 minutes.

(11) Turn the ignition switch on.

(12) Retard the throttle fully and fly the Trainer to sea-level (zero altitude).

(13) Set the throttle at cruising (climb and dive valves both closed).

(14) Set the indicated air-speed knob to zero.

(15) Check that the air speed is 160 mph ± 3 mph.

(16) Check that the manifold pressure is 29 inches Hg ± 1 inch Hg (sea level).

(17) Pull the propeller pitch control all the way back.

(18) Check that the tachometer indicates 1900 rpm ± 50 rpm.

(19) Push the propeller pitch control all the way forward.

(20) Check that the tachometer indicates 2400 rpm ± 50 rpm.

(21) Advance the throttle fully (all the way forward).

(22) Check that the indicated air speed is 180 mph to 200 mph.

(23) Check that the indicated manifold pressure is 38.5 inches Hg ± 1 inch Hg (sea level).

(24) Retard the throttle fully (within 1/16 inch).

(25) Check that the indicated air speed is 50 mph ± 10 mph.

(26) Check that the indicated manifold pressure is 12 inches ± 2 inches Hg (sea level).

(27) Pull the propeller pitch control all the way back; leave the throttle fully retarded.

(28) Check that the tachometer indicates 500 rpm ± 50 rpm.

(29) Note the air-speed indication. Turn the indicated air-speed control knob. Check that the air speed decreases.

(30) Advance the throttle; set it so that the vertical speed indicator shows a rate of climb of exactly 500 feet per minute.

(31) Starting at 500 feet above sea level, check the altimeter gain against a stop watch. It should increase 500 feet per minute ± 100 feet per minute. Check up to 2500 feet above sea level.

(32) Retard the throttle; set it so that the vertical speed indicator shows a dive of exactly 500 feet per minute. Make the same check as above (from 2500 feet to 500 feet above sea level).

(33) Check that the altimeter indication changes are smooth; hands should not move intermittently.

(34) Advance the throttle fully. Fly the Trainer to 10,000 feet above sea level.

(35) Check that the manifold pressure indication is 5 inches Hg to 6 inches Hg less than that indicated at sea level (fully advanced throttle). (Indications will be between 31.5 inches Hg and 34.5 inches Hg, but must be checked against those of the sea level test.)

(36) Set the throttle to cruising (climb and dive valves closed).

(37) Check that the manifold pressure indication is 5 inches Hg to 6 inches Hg less than indicated at sea level. (Indications will be between 22 inches Hg and 25 inches Hg, but must be checked against sea level test.)

(38) Retard the throttle; allow the altitude to return to sea level while making the remaining checks.

(39) Using the mercury column and fittings provided, check that the altitude pump is supplying 14 inches Hg vacuum ± 1/2 inch Hg.

(40) Check that the turn and bank instrument regulator bellows is set for 2 inches Hg ± 1/4 inch Hg vacuum.

(41) Check that the directional gyro regulator bellows is set for 4 inches Hg ± 1/2 inch Hg vacuum.

g. FLIGHT TEST.

(1) FUSELAGE LEVELING DEVICE.

(*a*) Unlock the Trainer; turn the leveling device crank counterclockwise until the stop is reached. **Do not jam against the stop!**

(*b*) Check that the crank and worm gearing operates easily (no binds).

(*c*) Check that when "unlocked" the leveling device and cables allow full movement of the Trainer in all directions. (This should move the circular stop against the fuselage mounting column in all directions. A full crew of four should be in their proper positions during this check.)

(2) CONTROLS AND MAIN VALVES.

(*a*) Check that the aileron valve is centralized (no bank with wheel neutral).

(*b*) Check that the elevator valve is centralized (no pitch with control column neutral).

(*c*) Check that the rudder valve is centralized (no turn with rudder pedals neutral).

(*d*) Rotate the wheel clockwise; check that the Trainer banks to the right.

(*e*) Rotate the wheel counterclockwise; check that the Trainer banks to the left.

(*f*) Push the right rudder pedal; check that the Trainer turns right.

(*g*) Push the left rudder pedal; check that the Trainer turns left.

(*h*) Pull the wheel column back; check that the "nose" of the Trainer pitches upward.

(*i*) Push the wheel column forward; check that the "nose" of the Trainer pitches downward.

(3) AUTOMATIC FEATURES.

(*a*) Rotate the wheel clockwise (rudder pedals neutral); check that the Trainer turns right as it banks right.

(*b*) Rotate the wheel counterclockwise (rudder pedals neutral); check that the Trainer turns left as it banks left.

(*c*) Push the right rudder pedal (wheel neutral); check that the Trainer banks right, nose drops, and turns right.

(*d*) Push the left rudder pedal (wheel neutral); check that the Trainer banks left, nose drops, and turns left.

(*e*) Make a banked right turn (wheel column neutral); pull the column back; check that the rate of turn increases.

(*f*) Make a banked left turn (wheel column neutral); pull the column back, check that the rate of turn increases.

(4) ROUGH AIR.

(*a*) Turn on full rough air.

(*b*) Check that the Trainer banks right and left; pitches "nose up" and "nose down"; and turns right and left (minimum of 5 degrees).

(5) INSTRUMENTS.

(*a*) Fly the Trainer to 2000 feet above sea level.

(*b*) Close the throttle; push the wheel to "full dive."

(*c*) Check that the air speed is at 190 mph, ± 5 mph.

(*d*) Check that the vertical speed is 2000 feet ± 100 feet per minute.

(*e*) Before making the following check on the turn and bank indicator, the Trainer turbine must have been running for at least 10 minutes.

1. Check that the ball is centered (Trainer level).

2. Push right rudder until the turn indicator is steady at one needle width. By reference to the directional gyro and a stop watch, check that the Trainer turns 180 degrees, ± 5 degrees in one minute.

3. Check the number of degrees to the right in one minute.

4. Check the number of degrees to the left in one minute.

h. WIND DRIFT, TERRAIN PROJECTION PLATE AND RECORDER TEST.

(1) Make certain that all electrical and mechanical connections necessary to check these units are made.

(2) Turn on the master, navigation and ignition switches. Turn off the turbine switch. The air-speed and altimeter transmitter panel vibrator motor must be running, and the fuselage locked level.

(3) Turn the indicated air-speed control to zero.

(4) Turn the true air-speed control to zero.

(5) Set the throttle at cruising (climb and dive valves closed).

(6) Check that the air speed is at 160 mph.

(7) Check that the air-speed rack in the wind drift assembly is 15/16 of an inch ± 1/32 inch from the stop.

(8) Check that the ground speed take-off wheel is approximately 1-1/2 inches from the center of the rubber faced ground speed plate. (Use 1-1/2 inch wheel during these tests.) Advance throttle, set air speed at 180 mph.

(9) Turn the true air-speed control to + 20. Check that the air-speed rack is 1-9/16 inches ± 1/32 inch from the stop.

(10) Turn the air-speed control back to zero. Close the throttle. Check that the air-speed rack is against the stop.

(11) Advance the throttle; set the air speed at 180 mph. Check that the air-speed rack is 1-1/4 inches ± 1/32 inch from the stop.

(12) Check that the follow-up motor does not oscillate excessively after changes in air speed.

(13) Set the air speed back to 160 mph, the indicated and true air-speed controls at zero.

(14) Set the wind speed to zero. Revolve the wind direction input through 360 degrees. Check that the wind triangle pinion does not turn more than one-half tooth.

(15) Crank in 60 mph wind speed. Crank the wind direction input to 270 degrees (Trainer locked on east heading).

(16) Check that the wind bar aligns with the air-speed bar.

(17) Crank the wind speed back to zero.

(18) Set the terrain mechanism base pointer to "0" or "180" on the azimuth rail scale.

(19) Place the terrain projection plate on the carriage; align the drive wheels parallel to the side of the plate, so that the plate will be driven straight along its length.

(20) Check that the drive wheels are parallel to each other, and that both contact the plate.

(21) Position the carriage so that the carriage end scale pointer is on an even graduation.

(22) Run the projection plate from one end to the other. Check that the side travel of the carriage does not exceed 3/16 of an inch.

(23) Leave the drive wheels aligned parallel to the edge of the plate; set the projection plate to an even graduation of the side scale on the plate.

(24) Set the recorder on the desk; make the proper electrical connections (Trainer locked on east heading, air speed "160," wind velocity zero, and navigation switch "off").

(25) Turn on the navigation switch; run the plate exactly 10 inches. Check that the recorder is driven 4 inches ± 5/64 of an inch.

(26) Turn the Trainer to the right 360 degrees; run the plate and recorder for 10 minutes on a locked east heading. Note the track.

(27) Turn the Trainer to the left 360 degrees; run the plate and recorder for ten minutes on a locked east heading. Note the track.

(28) Check that the lines drawn by the recorder during the two foregoing ten-minute tests are parallel to each other within 2 degrees.

i. BASE.

(1) Check that all bolts are in place and tight on the base assembly.

(2) Check for maximum pull necessary to move the Trainer through 360 degrees. With the belts removed, turn through 360 degrees to the right and left. The maximum allowable pull is 5 pounds.

(3) Check that all turbine mounting bolts are in place and tight.

j. TURBINE.

(1) Check that the turbine is properly lubricated with special turbine grease.

(2) Check that the vacuum hose coupling is connected properly and that both clamps are in place and tight.

k. ALTITUDE PUMP.

(1) Check that the altitude pump mounting bolts are in place and tight.

(2) Check that the guard is securely mounted.

(3) Check that the oil reservoir is full.

(4) Check that the relief valve is properly set and locked. If not, have it reset to 14 inches Hg with the mercury column, and locked.

(5) Check that all connections are tight.

(6) Check that the pressure relief valve on the oil filter housing is adjusted to indicate 2 inches Hg and locked.

l. CLOUD PROJECTOR.

(1) Check that the cloud projector cover fits properly.

(2) Check that the hold-down bolts are in place and tight.

(3) Check that the idler wheel is free.

(4) Check that the mirror is clear and uncracked.

(5) Check that the lenses are not damaged.

(6) Check that the cloud plate rotates easily and without bind.

(7) Replace the focus lens. Check that the focus lens cover is in place.

m. BOMB HIT PROJECTOR.

(1) Check that the bomb hit projector bolts (hold-down) are tight.

(2) Check that the adjusting springs are not broken or damaged.

(3) Check that the springs are under slight tension.

n. BOMB HIT TIMER.

(1) Check that the bomb hit timer is securely mounted.

(2) Check that the control knob is tight.

o. ANTI-TURN SOLENOID.

(1) Check that the anti-turn solenoid is securely mounted.

(2) Check that the spring tension returns the plunger after the relay has operated.

(3) Check the plunger movement. (It must move at least 5/8 of an inch.)

(4) Check that the hoses to the anti-turn unit are in place. (Clamps in place and tight.)

p. TURNING MOTORS.

(1) Remove the covers.

(2) Check that the mounting bolts are tight.

(3) Check that the gears have been lubricated.

(4) Check that the gears mesh properly, and set screws are tight.

(5) Check that all hoses are correctly placed (all clamps in place and tight).

(6) Check that the bellows connecting rods, nuts and fixtures are not damaged.

(7) Check that the valves are graphited.

(8) Check for sufficient clearance between all operating parts and hoses, covers, etc.

(9) Replace the covers.

(10) Check that the belts are not damaged and are under proper tension.

(11) Check that the belt hooks are fastened to the belt properly and are not cracked or damaged.

(12) Check that both belt tighteners are properly and securely mounted.

q. TOWER LOCKING DEVICE.

(1) Check that the locking device plunger moves without bind.

(2) Check that the guide brackets are mounted securely.

r. TERRAIN MECHANISM.

(1) Check that the azimuth rail is level.

(2) Check that the base and carriage are level.

(3) Check that the carriage rails are straight and level.

(4) Check that the carriage rollers are free of binds.

(5) Check that the carriage touches both stops, each side.

(6) Check that the projection plate support and guide rollers are free of binds.

(7) Check the plate adjustable support rollers with a straight edge (all rollers must touch the straight edge within +.000 inches and —.002 inches.

(8) The straight edge must be level.

(9) Check the clearance between the terrain plate and the center of the condenser lens. It should be 3/32 of an inch to 1/8 inch.

(10) Check the depressor level and mechanism.

(11) Drive the mechanism down. The rubber drive wheels should clear the plate by 1/16 of an inch to 3/32 of an inch.

(12) Drive the mechanism up. The rubber drive wheels should contact the plate with positive pressure, but should not lift the plate off the support rollers.

(13) Check that the rubber drive wheels are aligned with each other.

(14) Check to see that all three markers are in place:

(*a*) Projection plate side marker.

(*b*) Projection plate carriage end scale marker.

(*c*) Azimuth rail pointer.

(15) Check that all screws, bolts and nuts on entire unit are in place and tight.

(16) Check that the rubber drive wheels are not cut or damaged.

(17) Remove the focus lens; hold a sheet of paper approximately 6 inches above the condenser lens. Move the paper up or down until a clear, distinct filament image is seen.

(18) Check that the direct and reflected filament images cross each other, and are clear and distinct. (The reflected filament image should be as nearly superimposed on the direct image as possible.)

(19) Rotate the carriage through 360 degrees; check that the filament image remains centered.

(20) Replace the objective lens. Put the projection plate in place; check that a clear, sharp focus can be obtained (ground variac at "75").

(21) Remove the plate; leave the objective lens in place; focus unchanged. Rotate the carriage through 360 degrees; check the screen for maximum light. (It should have full bright coverage, no rainbows or dark spots along the edges.)

SECTION VI
OPERATION

1. INTRODUCTION.

a. REPRESENTATIVE PROBLEM. — A representative problem requiring crew coordination will be described to illustrate the operation of the Trainer and the kind of practice possible.

(1) The pilot, navigator, radio operator, and bombardier are to carry out a simulated bombing mission to city "B." They are to arrive just after daybreak, bomb city "B," and return to their base.

(2) The operator sets up the mechanism according to the instructions given to him by the instructor on the operation forms, so that all the conditions which are to be encountered during the flight will be satisfied. Included in this category are such items as time, date, latitude and longitude of the point departure, variation, wind direction and speed, local hour angle of Aries, radio transmitting stations available, etc.

(3) A low layer of clouds and fog lies over their field but, since all instruments perform in a manner similar to those in an actual aircraft, the Trainer simulates a climb through the clouds to an altitude of 10,000 feet where the Trainer has sufficient height to clear the overcast. During this climb, they are proceeding toward their destination on the heading supplied by the navigator.

(4) The Trainer operator, sitting at his control desk in the operator's booth, observes the simulated position of the Trainer as indicated by the automatic recorder in terms of latitude and longitude, and controls the movement of the dome so that its position agrees with the position of the Trainer.

(5) The navigator, using a sextant, now proceeds to take sights on one or more of the twelve navigational stars provided, and, by use of tables works out the position of the Trainer in terms of latitude and longitude. Sometime later, he takes another set of observations and again works out the position. He determines that he is ten miles north of the desired track, and asks the pilot to correct his heading.

(6) As daylight begins to approach, the operator slowly starts to increase the variac setting on the terrain projector so as to bring up the image of the ground on the screen in view of the navigator. The problem calls for broken clouds at this point, so the operator turns on the cloud projector and slowly increases the variac setting. The navigator now being able to see the ground proceeds to navigate by dead reckoning and air pilotage (map reading) to the objective. Because of the clouds, the navigator finds added difficulty in checking his dead reckoning by land marks.

(7) On approaching the objective, the bombardier takes drift sights and computes the wind speed and direction. He then makes the necessary adjustments on the bomb sight for drift, altitude, etc., so that upon arrival he can bomb immediately.

(8) Arriving at "B," the bombing is accomplished. The instructor can observe the results by noting where the bomb hit projector indicates the hits. The mission accomplished, the Trainer starts its return flight for the home base. Flying by dead reckoning, it soon runs into the overcast again. When the navigator has reached his own territory and it is safe to use the radio, he asks for bearings, or takes his own bearings with the automatic radio compass.

(9) From this sample problem, it can be seen that various units such as the dome, terrain projector, and radio facilities must be kept synchronized with the Trainer's position on the earth.

(10) The operator's desk serves as the nerve center of the Trainer. By means of various switches, variacs, and indicators, the desired effects may be obtained and controlled throughout a problem.

(11) Proper use of the available controls and an understanding of the function of each control are essential for successful use of the Trainer.

b. CONTROLS.—The controls which must be used in operation of the Trainer, with a brief description of their function, follow:

(1) DOME CONTROL PANEL. (*See figure* 94.)

(*a*) THE MASTER SWITCH.—The master switch should be turned on and off only upon entering and leaving the building. It controls the

power supply to the electrical units in the complete Trainer assembly.

(*b*) THE NAVIGATION SWITCH.—This switch controls all of the drives once the master switch is turned on. These drives include all motors in the dome, fuselage, tower, and base except the turbine, altitude pump, clutch motor, and dome reset motor.

(*c*) THE CONSTELLATION SWITCH.—This switch turns on the constellations in the dome. Included in this circuit are the collimators (or their recognition star lamps) and all of the stars of the first and second magnitudes.

(*d*) THE COLLIMATOR-CONSTELLATION SWITCH.—This switch serves as a selector switch for the collimators alone (or their recognition star lamps depending upon the position of the "collimator-recognition" switch on the navigator's instrument panel) or the entire group of constellations, including the collimated stars.

(*e*) THE MISCELLANEOUS STARS SWITCH.—This switch turns on all the remaining stars which include stars of the third and fourth magnitudes.

(*f*) THE CLUTCH CONTROL.—With the clutch control switch in the "normal" position (as shown) and signal lamp No. 7 lighted, the dome may be rotated by means of the "time" switch No. 10 or the "longitude" switch No. 11 or both. With the clutch control in "neutral," both clutches in the dome gear box are disengaged and the dome is free to rotate by hand. In this position, lamp No. 8 will light. By placing the clutch control switch in "reset" position the reset clutch becomes engaged, and the dome may be rotated by means of the reset motor. With the clutch in this position, lamp No. 9 will light.

(*g*) THE TIME SWITCH.—This switch controls the time motor. With the navigation and master switches "on," the position of this switch will determine whether or not the time motor runs.

(*h*) THE LONGITUDE SWITCH.—This switch, which is a three-way selector switch, controls the longitude drive motor. When placed in the position marked "W," the dome will revolve in the correct direction for westerly travel of the Trainer; conversely, on "E," the dome rotation is correct for easterly Trainer travel. The central switch position is "off."

(*i*) THE LATITUDE INTERMITTENT SPEED CONTROL.—This switch controls the percentage of time, over a period of time, for which the latitude motor circuit will be closed. It provides the wide range of coverage speeds necessary for correct operation of the latitude drive.

(*j*) THE LONGITUDE INTERMITTENT SPEED CONTROL.—This switch is similar to that for the latitude circuit except that it operates the longitude drive.

(*k*) THE LATITUDE VARIAC.—This variac controls continuously the speed of the latitude drive motor within a limited range. In conjunction with the intermittent speed control, it provides continuously variable average speeds for the latitude drive from very low speeds to relatively high speeds.

(*l*) THE LONGITUDE VARIAC.—This is similar to the latitude variac except that it controls the longitude drive motor.

(*m*) THE RESET VARIAC.—This variac is the only speed control for the reset motor.

(2) PROJECTION CONTROL PANEL. (*See figure* 93.)

(*a*) GROUND "ON-OFF" SWITCH.—This switch turns the terrain projector on or off.

(*b*) STAR "ON-OFF" SWITCH. — This switch turns the stars on or off. The effect of this switch is, of course, dependent on the position of the star switches in the dome control panel.

(*c*) CLOUD "ON-OFF" SWITCH. — This switch turns the cloud projector on or off.

(*d*) GROUND DENSITY VARIAC.—This variac controls the average illumination of the projected image on the screen.

(*e*) CLOUD DENSITY VARIAC.—This variac controls the density of the projected clouds. (The percentage of overcast, or cloud formation, is changed by changing cloud plates.)

(*f*) STAR DENSITY VARIAC.—This variac controls the brilliance of the stars.

(3) RADIO CONTROLS. (*See figure* 95.)

(*a*) The transmitter unit controls are shown on each transmitter, one of which is located on each side of the control chassis.

(*b*) The central panel shows the controls for units in the radio control chassis. It is in this chas-

sis that modulation signals are made, amplified and switched.

(4) WIND CONTROLS. (*See figure* 59.)

(*a*) The wind speed control is graduated from zero to 60 units of wind speed (either knots or statute miles per hour depending on the ground speed wheel used in the wind drift mechanism).

(*b*) The wind direction control is graduated in 360 degrees. The setting of this control determines the direction from which wind is simulated.

(5) MAGNETIC VARIATION CONTROL. (*See figure* 61.)—This control is a variable coupling (graduated to read in degrees east or west) in the heading drive to the artificial north bar over the compass transmitter unit. The bar may be set by means of this control to introduce from zero to 180 degrees variation, either east or west.

(6) AIR-SPEED CONTROLS. (*See figure* 27.)

(*a*) INDICATED AIR-SPEED CONTROL.—This control rotates the case of the air-speed telegon transmitter. In this manner, the indicated air speed may be made smaller than the true air speed (controlled by a teletorque whose position is not disturbed by this control).

(*b*) TRUE AIR-SPEED CONTROL.—This control rotates the shell of the air-speed transmitter teletorque, and thus controls the air-speed input to the wind drift. In this manner, different Trainer attitudes may be required to achieve the same true air speed with the same engine power under varying conditions of load or air density (and resultant change of skin friction on the plane).

(7) AIR TEMPERATURE CONTROL. (*See figure* 27.)—This control is located on the radio operator's control panel and it governs the indication of outside air temperature on the navigator's instrument panel.

(8) BOMB "TIME OF FALL" CONTROL.—This control is located on the front of the bomb hit timer and its setting determines the time interval between the hit flash and the time at which the bomb release switch was closed. The setting should never be less than 5 seconds, nor greater than 55 seconds.

(9) LATITUDE RESET CONTROL. (*See figure* 8.)—This control is located at the control panel mounted on the north structural column. It may be used to rapidly change the position of the dome along the rail.

2. OPERATION FOR CELESTIAL NAVIGATION.

a. THE POSITION OF THE DOME.

(1) GENERAL.—The desk instruments indicate the position of the dome and the time. For example, a problem is to be started at latitude 42° 38′ N, longitude 86° 41′ W and, as the date used for the problem is March 25, 1942, the Greenwich Civil Time is 06-06-44. Thus from the Air Almanac, the LHA Aries indicator should read approximately 187° 18′.

(2) READING THE INDICATORS.

(*a*) LOCAL HOUR ANGLE OF ARIES INDICATOR. (*See figure* 110.)

1. The reading, 187° 18′, is obtained by adding the short hand indication (180 degrees) to the intermediate hand indication (7 degrees) to obtain the total number of degrees (187 degrees), and the minutes reading is indicated by the sweep hand (18 minutes).

2. The setting knob, when pulled out, is used to manually set the hands to agree with the dome.

(*b*) LONGITUDE INDICATOR. (*See figure* 109.)

1. When the short needle is on the red half of the scale, longitude is measured west; when it is on the white half of the scale, longitude is measured east. The sum of the readings of the short and intermediate hands is the total reading in degrees. (As illustrated: short hand, 60 degrees; intermediate hand, 26 degrees; total 86 degrees.) Minutes are read by the long "sweep hand." (As illustrated: 41 minutes.) When the short hand reads west, the intermediate and sweep hands are read on the red scale. If the short hand indicates east, the other two hands are read on the white scale. In the example shown, the solid hands indicate west 86° 41′, and the dotted hands indicate east 86° 41′.

2. The setting knob, when pulled out, is used to manually set the hands to the longitude of the problem being set up.

(*c*) LATITUDE INDICATOR. (*See figure* 108.)

1. The wide hand indicates degrees and the narrow hand indicates minutes.

2. With the dome at the zenith (against the stops), the indicator is set to read 90 degrees plus the error taken from the latitude correction card for the desired latitude. The dome is then run down until the indicator reads the desired latitude, in this case 42° 38′ N.

(*d*) CLOCKS. (*See figure* 111.)

1. Turning on the time switch will start the clocks if the master switch is "on" and the navigation switch is "on." The time motor is a 110-volt, 60-cycle synchronous motor which drives the dome through use of a gear train. The time motor operates on mean solar time and the gear train changes it to sidereal time, thus the dome is driven at the sidereal time rate. There is a time transmitter teletorque on the dome and receiver teletorques at each of the three clocks. Another gear train in the clocks changes the time from sidereal back to mean solar time, so that the clocks will indicate mean solar time.

2. The setting knob is used to manually set the time.

b. POSITION OF THE RECORDER ON THE DESK GRATICULE.

(1) The desk graticule will be either a Lambert conformal conic projection for latitudes below 60 degrees or an azimuthal equidistant polar projection for latitudes above 60 degrees. In either case the chart will show convergency depending upon the mid-latitude of the chart. Since track angle is always measured at the meridian of the plane, track angle in this case is measured at the meridian of the inking wheel. The track of the recorder is dependent on the Trainer heading, air speed, and wind velocity as transmitted from the wind drift mechanism to the recorder. The track, thus applied, is measured from the center line (front to back) of the recorder itself. Thus, it is apparent that this center line must at all times be parallel to the meridian of the inking wheel in order for the recorder to trace the track angle properly. That is, the recorder will not indicate track properly on a graticule unless its center line, front to back, is parallel to the inking wheel meridian. This means that the operator may have to realign the recorder with respect to the graticule several times during a flight covering considerable difference of longitude.

(2) If at any time the recorder track is within two degrees of the correct track the error is within the limits of allowable error, especially when the 2-degree error is averaged out during any complete flight. On this basis, it becomes necessary to change the recorder orientation for every four degrees of convergency (convergency correction angle is one-half convergency). The following table is derived on that basis.

Mid-Latitude	*Difference of Longitude*
30°	8.0°
40	6.2
50	5.2
60	4.6
70	4.2
80	4.1

(3) In order for the track angle errors to cancel out during a given flight, it is necessary to set the recorder center line parallel to the mid-meridian of each interval for which the recorder is not to be realigned.

(4) If the mid-latitude of the flight was 50 degrees, the starting longitude 90 degrees west, and the longitude of destination 60 degrees west, the recorder would be handled as follows: From the table, the necessary change frequency is every 5.2 degrees. For convenience, a change will be made every 5 degrees. The recorder is aligned to start the problem with longitude 87° 30′ or with a convenient parallel of latitude at the point when it intersects the 87° 30′ west meridian. The recorder need not be touched now until it reaches longitude 85° 00′ west. At this point, the recorder will again be aligned (the rear edge parallel with a parallel of latitude 2° 30′ **ahead** of the recorder). A total of six changes will be necessary on this flight which covers 30 degrees of longitude.

c. CONTROL SETTINGS.

(1) GENERAL.—The control settings will be determined and stated on the operation forms at the start of the problem. As the problem starts, the dome will be controlled as indicated by the position and track of the recorder inking wheel. Other controls such as the variation control will be set according to the operation forms. These settings vary during the problem and according to the type of problem.

(2) SPECIFIC.—An outline of the control settings from the start of celestial navigation problem to the end follows:

(*a*) DOME MOVEMENT.

1. The master switch is turned on and the Trainer is locked on an east heading. Turn the hand

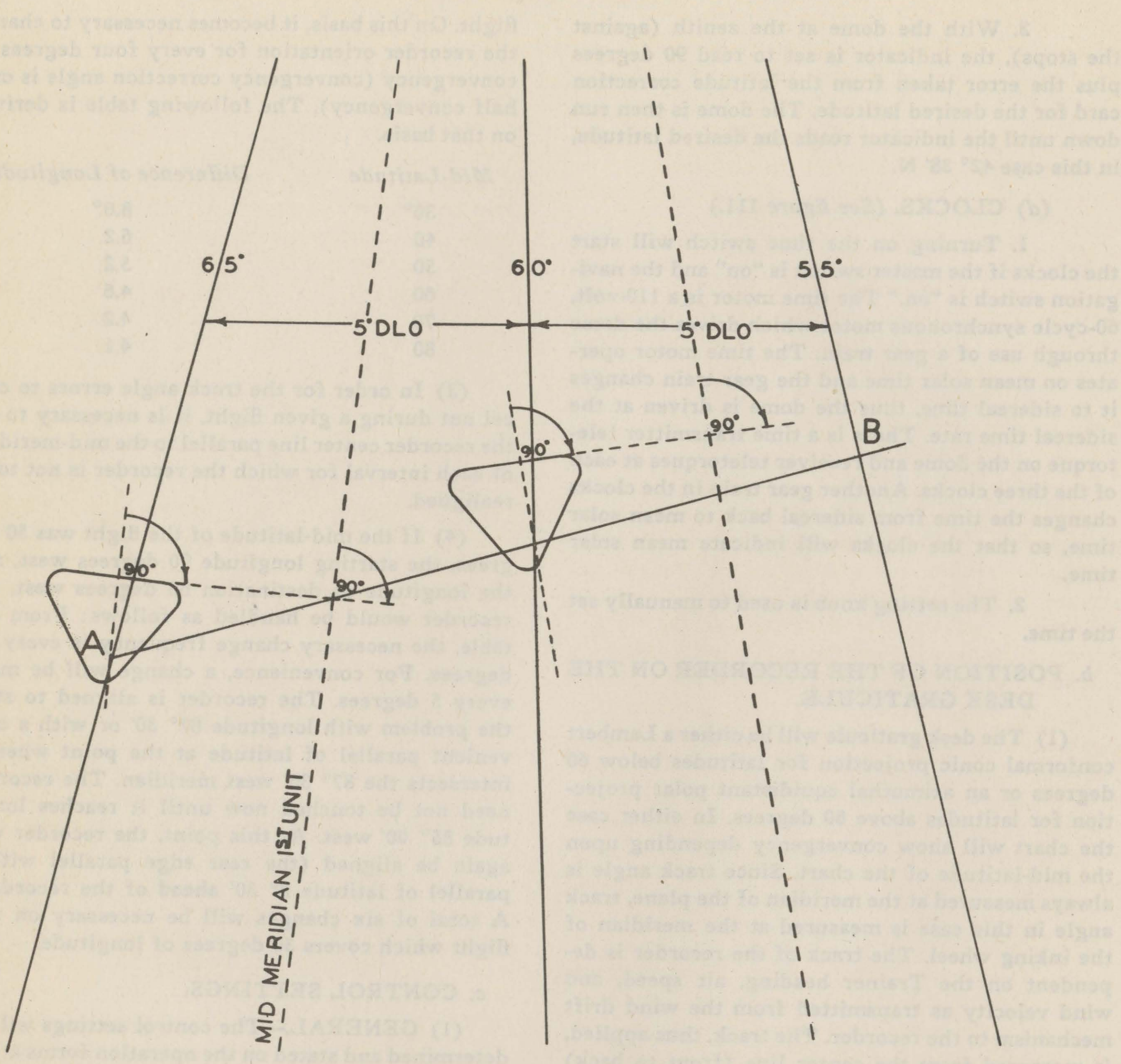


Figure 138—Proper Recorder Setting on Graticules Showing Convergency

crank to allow the dome gear box to move up the rail until the gear box is against the stop on the south dome rail bracket.

NOTE

The latitude drive crank should be turned slowly, keeping enough tension on cables so that the dome gear box safety pawls remain disengaged. As the gear box nears the zenith position, the crank should be turned very slowly. This will prevent damage to the gear box mechanism as the gear box strikes the stop.

2. With the gear box at the zenith and against the stop, reset the desk latitude indicator to 90 degrees. In the lower desk drawer, turn on the star switch and turn the variac up to about "85." In the top desk drawer, put the constellation

switch in the "on" position. In the top desk drawer, put the clutch control switch in the "neutral" position.

3. Rotate the dome by hand until the LHA Aries projector image aligns with the center of the target on the west wall, and then reset the desk LHA Aries indicator to 180 degrees and put the dome clutch switch in the "normal" position.

4. Assume the point of departure of the problem is an air-field at a latitude of 42° 30′ north, longitude 76° 5′ west at 06-10-00 G.C.T. on 12/1/42. The operation form will show that the LHA Aries under these conditions should read 85° 53′. (GHA Aries from the Almanac equals 161° 58′ minus west longitude 76° 05′, yields 85° 53′.)

5. With the dome at 90 degrees and the master switch "on," the clutch control switch on the reset position, the reset variac on about "75," and the reset switch in "—" position, drive the dome and turn off the reset switch to stop the dome at the point when the desk LHA Aries shows 85° 53′. (The instructor will determine this value and the operator will find it on the operation form.)

6. If the problem is to start at 42° 30′ north and terminates at 47° 30′ north, then 45° 00′ would be the mid-point of latitude covered by the problem. By referring to the latitude correction chart, the latitude correction factor for 45° 00′ might be found to be 20′. In this case, the 20′ correction factor is added by resetting the desk latitude indicator from 90° 00′ to 90° 20′, while the dome gear box is still at the zenith.

7. Use the latitude drive and reset hand crank to bring the dome down the rail until the desk latitude indicator registers approximately the correct latitude for the start of the problem. If the nearest figure to the 42° 30′ north latitude point that can be obtained by use of the hand crank is 42° 35′ on the desk indicator, then, with the master switch "on" and the latitude speed switch on the No. 7 position, put the north-south latitude switch on the "S" position, and turn on the navigation switch. Turn off the navigation switch to stop the dome when the desk indicator shows 42° 30′. Reset the latitude intermittent speed switch to zero position, and reset the latitude switch to neutral position.

8. In the case of a problem covering 20 degrees of latitude, as from 40° 00′ north to 60° 00′ north, the difference between the latitude correction factors for the stated latitudes might be as much as 12′. In order to keep errors to a minimum, it is essential that this difference be proportional over the entire range of latitude. Four corrections over the entire range of latitude would necessitate a correction of 3 minutes for every change of 5 degrees in latitude. The operator should set in the latitude corrections factor for 40 degrees at the beginning of the problem. As the problem progresses and the recorder inking wheel is crossing the 45° 00′ north line of latitude, the operator could set back the desk latitude indicator about 3 minutes, from 45° 00′ north to 44° 57′ north; again, as the recorder inking wheel passed the 50° 00′ north line. Thus, the desk indicator would be set back about 3 minutes each time. If the problem course were southerly it would be necessary to set the latitude indicator ahead every two or three degrees. By handling latitude correction factor in this manner, providing the dome is kept synchronized with the recorder on the graticule, the error in altitudes of collimated stars should be under 3 minutes at any time during the problem.

(*b*) STARS.

1. STAR SWITCHES.—In setting the star controls for a celestial problem, the star density variac should be set to zero. The star switches necessary to give the desired combination of stars are turned on. With the crew in the fuselage and the building lights turned out, the star density variac is turned up to about "100," during the next 15 to 20 minutes. As the navigator's eyes become accustomed to the darkness, the operator should gradually reduce the star density variac setting to about "85."

2. STAR DENSITY VARIAC.—With the star density variac set anywhere from "80" to "115," the star switch in the lower desk drawer turned on, and the master switch turned on, the main groups of star combinations are controlled as follows:

a. COLLIMATORS OR RECOGNITION LIGHTS ONLY.—The "collimator-constellation" switch is placed on "collimator" position and the "constellation" switch turned "on." The "collimator-recognition" switch on the navigator's panel is placed in "collimator" position to see the collimated stars, and on "recognition" position to see the recognition stars.

b. CONSTELLATIONS, INCLUDING COLLIMATOR OR RECOGNITION STARS.—The "collimator-constellation" switch is placed on

"constellation." All other switches are placed as in paragraph a.

c. CONSTELLATION, COLLIMATED OR RECOGNITION STARS, AND MISCELLANEOUS STARS.—The miscellaneous star switch is turned "on." All other switches are placed as in paragraph b.

3. OPERATION FOR CONTACT FLIGHT AND D.R. NAVIGATION.

a. PROJECTION PLATE POSITION.

(1) PROCEDURE WHEN STARTING A PROBLEM.

(*a*) During contact flight, the position of the Trainer is determined, as far as the crew is concerned, by objects on the terrain directly below the Trainer (center of rotation). If this condition is to be simulated correctly, the coordinates (latitude and longitude) of the point projected from the plate to the screen must agree with the coordinates on the graticule underneath the recorder inking wheel.

(*b*) Coordinates in latitude and longitude cannot be shown across the image area of the projection plate, so a scale along one edge of the plate and a scale along one end of the plate carriage are used as references for indexing the plate position correctly. In order to transfer latitude and longitude as read from the inking wheel position to the side and the end scale readings, it is necessary to use the name print. This print is a positive print of the same area as the projection plate with which it is to be used. Reference lines of latitude and longitude are drawn across this print and labeled. In addition, a side and an end scale appears on the print. Thus the print may be placed on a board in the booth and the coordinates (latitude and longitude) of any point on the print may be picked out. The correct plate scale settings can be determined for this point by placing the T-square on the board so that it intersects the point, marking the T-square at the point of intersection and noting the side and end scale readings.

(*c*) The desk graticules are made in several strips; one strip of graticule covers a certain strip of terrain projection plate. The outlines, geographically correct and to scale, of the strip of plate image areas covered by a particular graticule are marked centrally along the graticule. Each plate area shown is marked with a number starting at the southerly end of the strip with the numeral one and running consecutively through two, three, etc., to the most northern area of the strip. Thus, if a problem is to be run using strip "1" of the plates, the graticule marked strip "1" would be chosen for use on the desk. The starting point of the problem will be marked on the graticule and from this it can be seen which area is to be used first. If the point is in area "1" of the strip, the name print and projection plate marked strip 1, area 1, would be chosen and placed on the name print board and plate carriage respectively. Next, determine the side and end scale settings for the plate from the name print and the given coordinates of the starting point. With the ground speed wheels of the plate drive depressed, set the plate to the correct side and end scale readings and release the drive. In order to orient the plate correctly for azimuth, it will be necessary to read the azimuth number on either the plate or name print of that area and set the terrain base frame index pointer to the azimuth number on the azimuth rail. In order that the plate will always be in the plate carriage correctly, and not backwards or upside down, always set the plate in the carriage from the end scale end of the carriage with the side scale of the plate to the left and the zero end of the plate toward the Trainer base.

(2) PROCEDURE FOR USING TWO OR MORE PROJECTION PLATES OF A STRIP IN SEQUENCE.

(*a*) Suppose a problem involves contact flight, and departure is from an airfield of latitude 39° 30′ north, longitude 75° 30′ west (strip 1, area 1) and the destination of the flight is a landing field at latitude 41° 10′ north, longitude 75° 15′ west (strip 1, area 2).

(*b*) The operator should put the proper graticule (strip 1) with a sheet of transparent paper on the desk.

(*c*) The recorder Jones plug is then connected and the recorder is put on the transparent paper in such a manner that the inking wheel will be on that point of the graticule marked as latitude 39° 30′ north and longitude 75° 30′ west.

(*d*) The recorder is lined up on the graticule so that the rear edge of the recorder is parallel to the lines of latitude at the mid-meridian point of the problem. Throughout the problem the rear edge of the recorder is always kept parallel to the latitude lines since the change in longitude for the

problem is less than that which would cause an appreciable track error due to convergency.

(*e*) The operator should then place a name print of strip 1, area 1, in the proper position and fasten the print securely to the top of the name print table in the operator's booth. Using the grid on the name print and the latitude and longitude ticks at the edges of the name print, the operator will locate on the name print the point which presents the location of the airfield of departure. After locating this point, the operator should use a T-square to determine the side scale and end scale coordinates of this point by placing the T-square so that one edge intersects the point, reading the side scale, marking the point on that edge of the T-square where the intersection occurs, then sliding the T-square to the end scale and reading the end scale at the marked point.

(*f*) Depress the plate drive wheels and then insert the projection plate of strip 1, area 1, in such a manner in the projection plate carriage that the side scale and end scale pointer readings coincide with the side and the end scale coordinates taken from the name print.

(*g*) Release the projection plate drive wheel depressor and rotate the base frame to read the plate azimuth number on the azimuth rail.

(*h*) The projection plate and recorder are now synchronized, and turning on the navigation and time switches will start the problem.

(*i*) With the flight in progress, as the center of the recorder wheel on the graticule reaches a point about 1/2 inch from the line on the graticule denoting the end of the projection plate of area 1, gradually turn on clouds and turn down the ground density until there is a solid overcast on the screen.

(*j*) Determine at about what point on the graticule the recorder wheel will enter the next area of the strip. Put the name print of this next area on the table and, again using a T-square, determine the side and end scale coordinates of a point at least one inch inside the edge of the plate (as shown on the graticule) and on the anticipated recorder track.

(*k*) The coordinate of the side scale which is used must always be between 2 and 31, and the coordinate of the end scale must always be between 3 and 17.

(*l*) While the terrain is obscured by clouds or solid overcast, the operator should remove the strip 1, area 1, projection plate and insert the next following area plate, in this case, strip 1, area 2.

(*m*) This plate is then adjusted on the rollers and the carriage is also adjusted to the end scale and side scale coordinates of the point on the anticipated recorder inking wheel path about one inch inside the edge of plate.

(*n*) When the center point of the recorder inking wheel reaches the point anticipated and set on the plate, the operator should raise the projection plate depressors and gradually turn down the cloud density. At the same time, gradually turn up the ground density.

(*o*) If the Trainer heading is such that the projection plate drive wheels tend to drive the plate carriage against the stops, then the drive wheels will slip and the terrain image on the screen will not simulate ground speed. Just before this happens, the operator should turn down the ground density, increase the cloud density to a solid overcast, and depress the plate drive wheels. If the pilot changes heading so the recorder indicates the Trainer is again back on the area, then the operator, by using the name print, T-square, and side and end scale coordinates of recorder position on the graticule, can reset the plate and carriage, then release the plate drive wheel depressor and gradually increase the ground density and decrease the clouds.

b. CONTROLS.

(1) VARIATION CONTROL.

(*a*) GENERAL.—The variation control is located on a shaft between the instrument take-off and the tower transmitter compass. A magnetized bar is mounted above the remote indicating compass (transmitter) and is connected to the Trainer heading drive (at the base of the Trainer tower) through a system of rigid and flexible couplings, which enables it to remain pointing in the same direction (artificial magnetic north) throughout Trainer rotation.

(*b*) ADJUSTMENT.—A vertical scale is provided for east or west variation from zero degrees to 180 degrees, graduated in units of 36 degrees, and also a horizontal circular scale for east or west variation from zero degrees to 36 degrees. The variation control is set to the desired variation by unlocking the knurled locking screw and turning the body of the variation control until the scale reads the desired variation, then locking it at that

position by tightening the knurled locking thumb screw. Readings above the zero horizontal line on the sleeve indicate westerly variation, and readings below indicate easterly variation. This is clearly marked by the letters "W" or "E" above and below this line.

(*c*) SETTINGS.—For take-off and climb to operating altitude, the "spot" or actual variation of the vicinity should be used. However, as it would be impractical for the operator to continually reset variation consistently over the route, it is suggested that, after leveling off, the mean variation for 300 miles in advance of the recorder be used. If the leg is shorter than 300 miles, then the mean variation for the length of the leg should be used.

(*d*) POLAR FLIGHTS.—An exception to the use of mean variation setting for length of leg, or for 300 miles ahead of the recorder, is found in the case of polar flights where variation changes rather rapidly. The variation control should be reset often enough to prevent over 2 degrees of error when converting headings from magnetic to true values.

(2) WIND DIRECTION AND WIND SPEED CONTROLS.

(*a*) ADJUSTMENT.—The wind direction (0-360) and speed (0-60) controls are located in the base of the tower where they may be adjusted during "flight" by the operator, from information furnished on the operator's form sheet. These controls are specifically located on the wind drift remote control panel on the north-west side of the Trainer as the Trainer is locked on an east heading. The control crank to the east is the wind speed control and the operator can set this to simulate any desired wind speed from zero to a wind of sixty units per hour. The wind direction control crank can be set so that the projection plate travel and recorder travel will simulate the effect of wind from any direction.

(*b*) SETTINGS.—While under actual flight operations wind may change at any time, it is suggested that average winds be used for different weather zones. Thus, for a climb, an average local wind is used to give the desired actual track, while on long flights the route is divided into zones. The average wind for each zone is to be set in by the operator when (and if) the recorder enters that zone.

(3) INDICATED AIR-SPEED CONTROL.

(*a*) GENERAL.—This control is mounted on the radio operator's table and it is the control nearest the side of the fuselage. As this control is moved away from the zero stop, it causes the air-speed indicator to indicate a lower air speed. This does not change the rate of travel of the projection plate or the recorder with an indicated air speed of 160 units per hour with no wind, and the ground speed take-off wheel 1.5 inches from the center of the rubber ground speed plate. Setting the indicated air-speed control knob on "5" will reduce the indicated air speed from 160 to 155 units per hour, but the ground speed take-off wheel will maintain at the 1.5 inch setting and the recorder and plate travel will be 160 units per hour.

(*b*) SETTING FOR CLIMB.—The indicated air-speed control will be set to read the same number of units as the differential which exists between the desired indicated air speed and the resultant true air speed under a given set of density (pressure altitude and temperature) conditions at the surface, and will be changed as density varies. Thus the control would be varied evenly during a climb from the differential setting at the surface to the required differential setting at flight altitude.

(*c*) SETTING AT LEVEL OFF.—Upon leveling off, the indicated air-speed control will be immediately set to the differential existing between the required indicated cruising air speed and the true air speed existing under the predetermined conditions of pressure altitude and temperature (density). This may be conveniently accomplished while the pilot is adjusting the controls. The IAS control setting remains constant for level flight under these conditions.

(*d*) EXAMPLES.

1. The required indicated air speed is 140 units during a climb to a pressure altitude of 13,000 feet. The surface temperature is + 30° C. (86° F.) and the temperature at flight altitude is + 3° C. (37° F.). The true air speed at the surface is 143.5 units and the differential of 3.5 units is set on the control. On reaching flight altitude the true air speed will be 175 units, and thus the differential setting is 35 units. Thus, the control must be varied from a setting of 3.5 units to 35 units over the entire climb at an approximate rate of 2.5 units per thousand feet.

2. Indicated Cruising Speed at flight altitude is 160 units, pressure altitude 13,000 feet and

temperature + 3° C. (37° F.). Referring to a computer, the true air speed obtained will be 200 units, thus a differential of 40 units is set on the indicated air-speed control.

NOTE

In some instances Trainers have been modified by placing the indicated air-speed control on the wind drift platform near the wind speed and direction controls. In this case, the operator will adjust these controls according to information furnished on the operator's form sheet.

(4) TRUE AIR-SPEED CONTROL.

(*a*) GENERAL.—This control is mounted on the radio operator's desk. It is the control knob nearest to the radio operator. If the indicated air speed is 160 units per hour with no wind, and the ground speed take-off wheel is 1.5 inches from the center of the ground speed plate, and if the true air-speed control is set on "5," the air speed indicator will still indicate 160 units per hour, but the plate and recorder rate of travel will simulate an air speed of 165 units per hour.

(*b*) SETTINGS.—The true air-speed control will remain on a zero setting until it is desired to simulate some unusual condition; whereupon, it will be increased or decreased as desired. At the same time, regardless of original setting, the indicated air-speed control must be raised or lowered exactly the same number of units.

(*c*) EXAMPLES.

1. An aircraft whose fuel consumption is 200 gallons per hour, gains in true air speed at the predetermined rate of 2 units per hour. Original setting of TAS control is zero, that of IAS control is 40. At the end of the first hour of flight the TAS control setting is + 2, and IAS control **is** − 38, while at the end of 5 hours the settings would be + 10 and 30 respectively. (An increase in reading of IAS control value decreases IAS, and vice versa, thus the differential between IAS and TAS has remained 40 units.)

2. The releasing of a bomb load is determined to cause an immediate increase in TAS of 20 units. Original setting of TAS control is zero, while that of IAS control is 30. Upon release of load the TAS setting is immediately changed to + 20, while the IAS control is placed at 10. Note that the density differential is still 30 units.

3. It is predetermined that a plane encountering icing conditions shall lose 30 units of TAS in, say, 6 minutes. Original setting of TAS is zero while that of IAS is 30. In the 6-minute interval the TAS control is varied to read 30, while the IAS control is varied at the same rate to read 60. Again the density differential remains as originally set.

NOTE

In some instances, the true air-speed control has been relocated in the same manner as the indicated air-speed control.

(5) AIR TEMPERATURE CONTROL SETTING.

(*a*) GENERAL.—This unit is located on the right-hand side of the interphone power supply panel in the fuselage. Turning this knob in a clockwise direction causes the air temperature gage on the navigator's panel to increase its reading.

(*b*) SETTINGS FOR CLIMB.—The temperature settings should be varied during a climb from predetermined surface temperature to the selected temperature at flight altitude, so that an average temperature is maintained for purposes of computation.

(*c*) EXAMPLE.—The predetermined surface temperature at the point of departure is + 30° C. (86° F.), and the selected operational altitude is 13,500 feet. Using the average lapse rate of 2° C. (3.5° F.) per 1000 feet, a temperature drop of 27° C. (49° F.) is expected. Thus the temperature at flight altitude would be + 3° C. (37° F.). During the climb, the temperature setting is varied from + 30° C. (86° F.) to + 3° C. (37° F.) at a rate of change of 2 degrees per 1000 feet.

NOTE

The temperature control may also have been relocated to a position on the wind drift platform. In this case, the operator will adjust the settings according to information on the operator's form sheets.

(6) BOMB HIT TIMER CONTROL.—This unit is located on the panel near the wind speed direction controls. The bomb hit timer is an electrical timing device and can be set from 5 seconds "time of fall" to 55 seconds "time of fall" of the bomb. The timer mechanism operates the bomb hit projector, which projects a small circle of light on the image on the terrain screen, indicating the spot

where the bomb would have hit under the conditions imposed by the bombardier and pilot.

(7) CLOCKS.—The clocks are synchronized by pulling out the reset knob and turning the hands to the desired time, then restoring the reset knob to its original position.

(8) ALTIMETERS.—The altimeters are adjusted to read the known field elevation of any desired airport by means of the zero setting knob. In addition, desired altimeter settings may be placed on the barometric scale without disturbing the altitude reading. To accomplish the latter, the captive screw adjacent to the zero setting knob is loosened, pressed upward and outward to release the knob. The zero setting knob is then pulled outward and turned until the desired altimeter setting is obtained. This setting should be checked before each

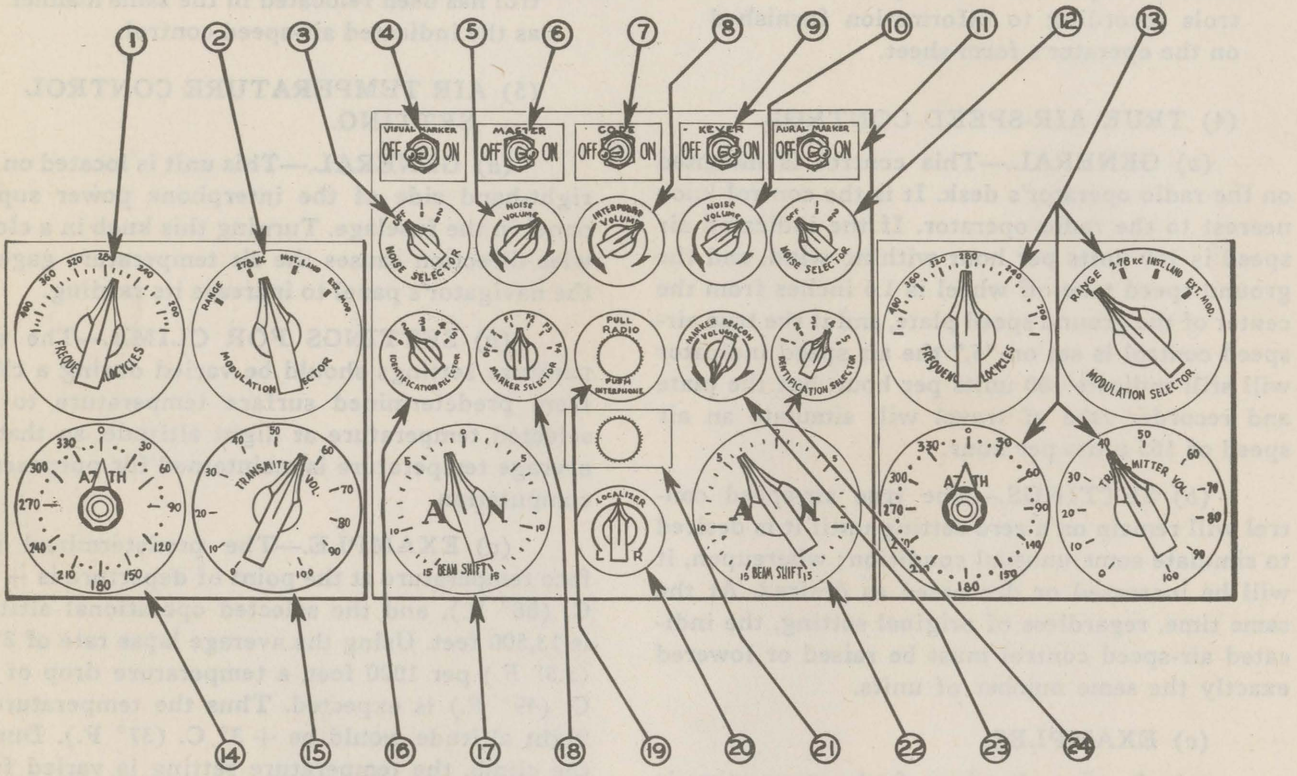


Figure 139—Radio Control Chassis

1. *Control the frequency in kilocycles of the "left" transmitter.*
2. *Select type of signal to modulate the "left" transmitter.*
3. *Select noise or interference from external source to be fed through "left" transmitter.*
4. *Turn on visual marker relay amplifier.*
5. *Control amount of noise, broadcast or interference imposed on "left" transmitter signal.*
6. *Turn on power to radio system.*
7. *Connect manual code keys for manual keying.*
8. *Control interphone volume—use moderate volume.*
9. *Start automatic keyer.*
10. *Control amount of noise broadcast, noise or interference superimposed on "right" transmitter signal.*
11. *Turn on aural marker signals.*
12. *Select noise interference or broadcast signals from external source for "right" transmitter.*
13. *"Right" transmitter controls used the same as those on "left" transmitter.*
14. *For DR and RDF by adjusting to radial degree line figures on desk chart.*
15. *Control transmitter power output—use moderate volume.*
16. *Select range call letters for "left" transmitter.*
17. *Control A-N, twilight and on-course signals according to position of inking wheel, being careful to simulate exact signals as heard in actual radio range flight.*
18. *Select either "Z" or fan markers.*
19. *Pull for radio or voice on beam, and push for interphone.*
20. *Runway localizer control.*
21. *Visual marker push button switch.*
22. *"Right" transmitter beam shift control. Operate same as "left."*
23. *Control marker beacon volume.*
24. *Select range call letters for "right" transmitter.*

flight, and both the pilot's and navigator's instruments should be synchronized.

4. OPERATION FOR RADIO NAVIGATION.

a. INTRODUCTION.—The radio direction finding controls are operated to maintain the relative positions of the Trainer and the radio station. By proper use of the azimuth, frequency, and volume controls, a radio station at a specified position may be simulated. The desk radio provides transmitters and controls for simulation of reception signals from either one of two transmitters of a different frequency at any time. Range and various standard markers used as radio aids to navigation ("fan," "Z," and "M") are available. Voice or range, control tower frequency, and call letters for five different stations are supplied, as well as provision for code, by use of a key. A standard hand microphone and head set is supplied for the desk operator to allow two types of communication to the crew in the Trainer. By use of the radio interphone switch, either radio communication with the radio operator and the pilot, or interphone communication to the instructor's position may be made available.

b. DESCRIPTION OF CONTROLS.

(1) RADIO CONTROL CHASSIS. (*See figure* 139.)

(*a*) The master switch controls the power supply which furnishes operating voltages for the various units of the radio control chassis and transmitters.

(*b*) The keyer switch controls the code keying device motor which operates the keyer cams that produce the keyed signals which are fed into the transmitters.

(*c*) The identification selector switch is for selecting a choice of any one of the five available sets of station call letters. There are two selector switches, the "left" one is used in selecting call letters for the "left" transmitter, and the right one is used in selecting call letters for the "right" transmitter.

(*d*) The interphone-radio push-pull switch, while in the "radio" or "up" position, makes it possible for the operator to talk over the beam signals usually spoken of as "simultaneous-voice-range." In the depressed or "interphone" position, only interphone with the instructor in the fuselage is available. The instructor must have his interphone switch on the "operator" position before conversation can be established.

(*e*) The interphone volume control, as the name implies, controls the desk interphone volume.

(*f*) The aural marker switch controls the aural marker signals. The interphone circuit is dead during the time the aural marker switch is on.

(*g*) The marker selector switch is for selecting either the "Z" marker or any one of the four "fan" marker signals.

(*h*) The marker beacon volume controls the volume of the marker station power output.

(*i*) The visual marker push-button flashes the marker beacon signal lamp on the pilot's instrument panel.

(*j*) The visual marker "on-off" switch energizes the visual marker relay amplifier circuit, and thus energizes the visual marker relay according to the aural marker signal being transmitted. The aural marker volume control must be at least one-quarter "on" to supply enough signal to operate the relay. With this switch "on," visual indications of the aural markers will be available automatically.

(*k*) The noise selector switches are used to select one of the available "static" interference or radio broadcast signals which are received from external radio sources, properly connected into the control chassis and superimposed on the regular range station signals.

(*l*) The code switch should be turned on when manual keying is desired by either the desk operator or the radio operator in the fuselage.

(*m*) The A-N beam shift controls the A-N signals from the radio range station. "Zero" position gives an "on-course" signal effect which is graduated into a pure "A" or "N" signal as the pointer is moved toward the extreme left or right respectively. A reasonable amount of "twilight" effect prevails until the pointer passes the approximate ten-division mark where a clean "A" or "N" starts to break in, simulating mid-quadrant signals.

(2) RADIO TRANSMITTERS.

(*a*) FREQUENCY KILOCYCLES.—This control is used in setting the transmitter frequency in kilocycles to any desired frequency between 200 kc and 400 kc. Never use two stations less than 10 kc apart, to prevent inter-action between the transmitters, resulting in a "squealing" emission.

(*b*) MODULATION SELECTOR SWITCH.—This switch is used to select the type of modulation or audible signal to be transmitted with a choice of radio range, 278-kc voice frequency (control tower), instrument landing, or externally modulated signals such as the output of an ordinary household radio receiver fed into the transmitter to simulate a broadcast station.

(*c*) TRANSMITTER VOLUME. — This controls the output volume or power of the station being simulated.

(*d*) AZIMUTH CONTROL.—This control is used to control the transmitter's directive qualities in such a manner that correct bearings can be taken from the Trainer on the radio station or from the radio station on the Trainer. Radial lines on the graticules guide the operator in keeping the azimuth control constantly adjusted to the correct number of degrees shown on the chart with respect to the position of the recorder inking wheel. That is, if the recorder is crossing the radial line labeled 280°, the transmitter azimuth control should be set to read 280°, etc., following, with the azimuth indicator, the exact position of the recorder inking wheel as it moves in relation to the station azimuth lines.

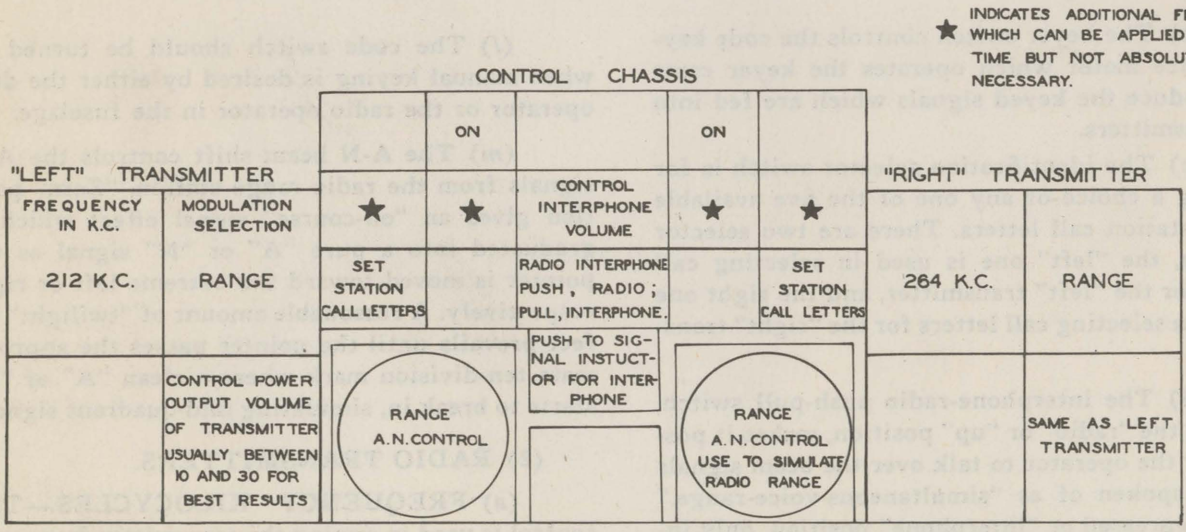
(3) OPERATION OF DESK CONTROLS. (*See figure* 139.)—Operation of the desk radio controls becomes comparatively simple by the use of charts showing the necessary control settings to produce a given effect. It will be noted that there are two types of controls; namely, switches which are set to specified positions before starting an exercise, with possible changes necessary during the exercise, and then the variable controls which for the most part have to do with signal strength or volume. However, there are exceptions, such as the transmitter azimuth control. It controls the true bearing of the station **from** the Trainer for radio direction finding purposes and must be carefully manipulated in order that accurate radio fixes may be obtained when relative bearings are taken by the radio operator.

c. CONTROL SETTINGS. (*See figure* 140.)

(1) RADIO RANGE SIMULATION.—The following procedure is recommended. Let the left transmitter be (A) and the right transmitter (B).

(*a*) The frequencies of the two range stations which are to be simulated are chosen and set on the transmitter frequency controls. [There should be at least a 10 kc difference in frequency between (A) and (B).]

(*b*) The modulation selector switches of (A) and (B) are placed on "range."



SHOWS SWITCH POSITION AND VARIABLE CONTROLS USED TO SIMULATE TWO SEPARATE RADIO RANGE STATIONS. NOTE: WHERE CONTROLS ARE DUPLICATED THE ONE ON THE "LEFT" IS FOR THE "LEFT" TRANSMITTER AND ONE ON "RIGHT" FOR "RIGHT" TRANSMITTER.

Figure 140—Radio Range Control Settings

(*c*) The identification selector switches are placed in the position which will associate the proper call letters with each station.

(*d*) The transmitter volume controls are set to simulate the signal strength of each range in the neighborhood of the Trainer.

(*e*) The A-N mixer controls are set to simulate the position of the Trainer with respect to the range quadrant.

(*f*) The code, marker selector, aural marker, and visual marker switches should be in the "off" position.

(*g*) The master switch and code-keyer switch are turned "on" and the interphone-radio switch is placed in the "radio" (pulled out) position.

(*h*) If it is desired to introduce interference into either range system, the noise receivers are tuned to the desired type of interference and the noise selector switches are placed in the position which will place the desired noise on each range. The signal to noise ratio is controlled by the noise volume control adjacent to each noise selector switch.

(*i*) When it is desired to produce "Z" or "fan" marker signals, the aural marker switch is placed in the "on" position and the marker selector switch is turned to the type of signal desired. For aural marker signals not available on the marker selector switch, place the marker selector switch in the "Z" position, and the code switch in the "on" position. The desired signal may then be produced with the key. The volume of the signal is controlled by the marker beacon volume control. If visual marker indications are desired, the visual marker switch is turned on and the marker selector switch is placed in the desired position. For visual markers, other than those available from the marker selector switch, the marker selector switch should be placed in the "off" position and the visual marker push-button keyed in the desired manner.

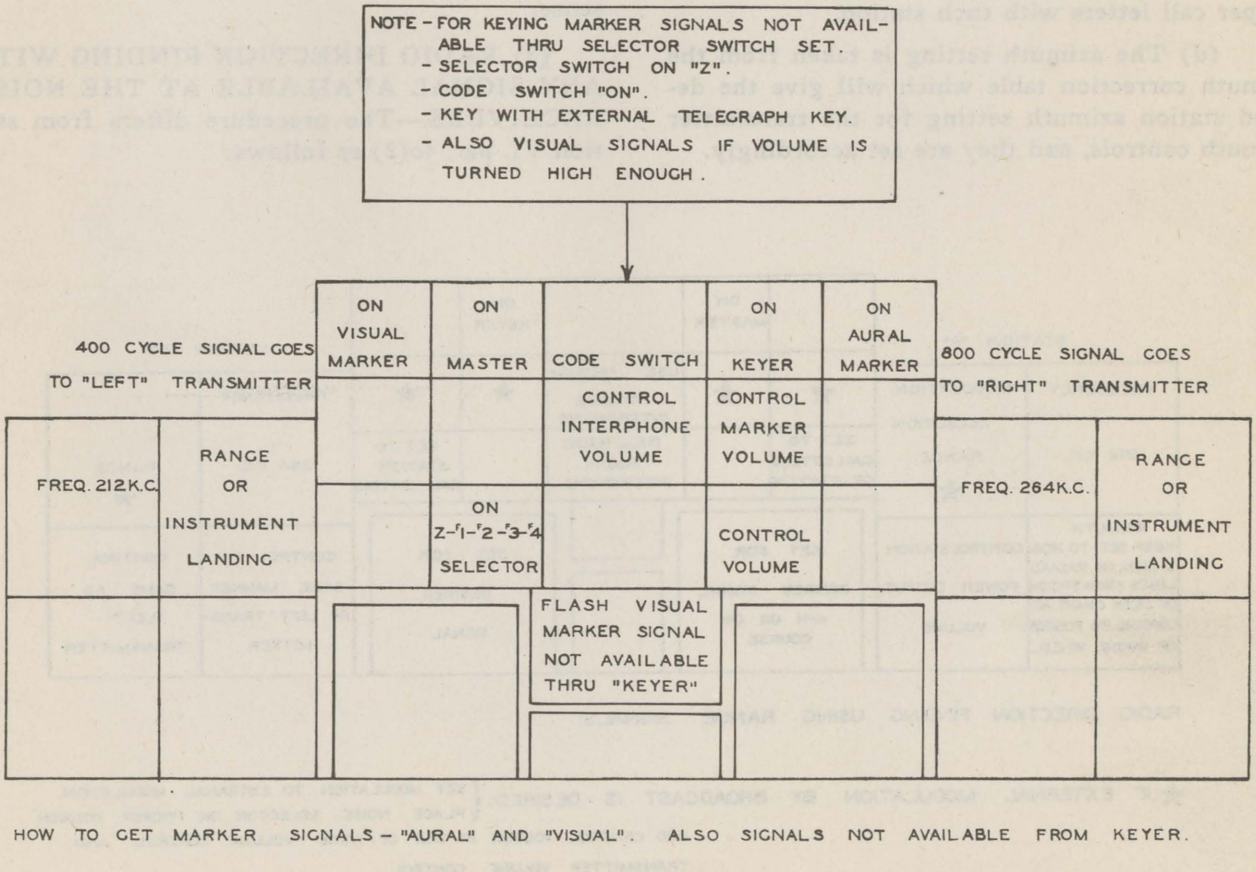


Figure 141—Marker Beacon Control Settings

NOTE

The above mentioned method of obtaining aural marker signals not available on the cams is also applied to visual marker signals if the marker beacon volume control is turned up far enough and the visual marker switch is on.

(*j*) For correct range operation, the receiver antenna switch should be in the "omni-directional antenna" position.

(2) RADIO DIRECTION FINDING ON RANGE SIGNALS.—Again calling the left transmitter (A) and the right transmitter (B), set the controls in the following manner:

(*a*) The desired frequency of the station or stations is chosen and set on the frequency controls of (A) and (B).

(*b*) The modulation selector switches of (A) and (B) are placed in the "range" position.

(*c*) The identification selector switches are placed in the position which will associate the proper call letters with each station.

(*d*) The azimuth setting is taken from the azimuth correction table which will give the desired station azimuth setting for the transmitter azimuth controls, and they are set accordingly.

(*e*) The desired transmitter volume is set on each transmitter volume control.

(*f*) The visual marker, code, and aural marker switches are turned off.

(*g*) The noise selector switches are turned off unless it is desired to add interference to the range signal. In this case the noise receivers are tuned to the desired type of interference and the noise selector switches are placed in the position that will associate the desired type of noise with each station. The signals to noise ratios are controlled by the noise volume controls.

(*h*) The interphone-radio switch is placed in the "radio" position.

(*i*) The A-N mixer controls are set to give the desired signal.

(*j*) The master and code-keyer switches are turned on.

(*k*) The radio operator uses either the "loop" position on his receiver antenna switch, or "comprehensive" position which will provide automatic sense.

(3) RADIO DIRECTION FINDING WITH ANY SIGNAL AVAILABLE AT THE NOISE RECEIVERS.—The procedure differs from section VI, par. 4c(2) as follows:

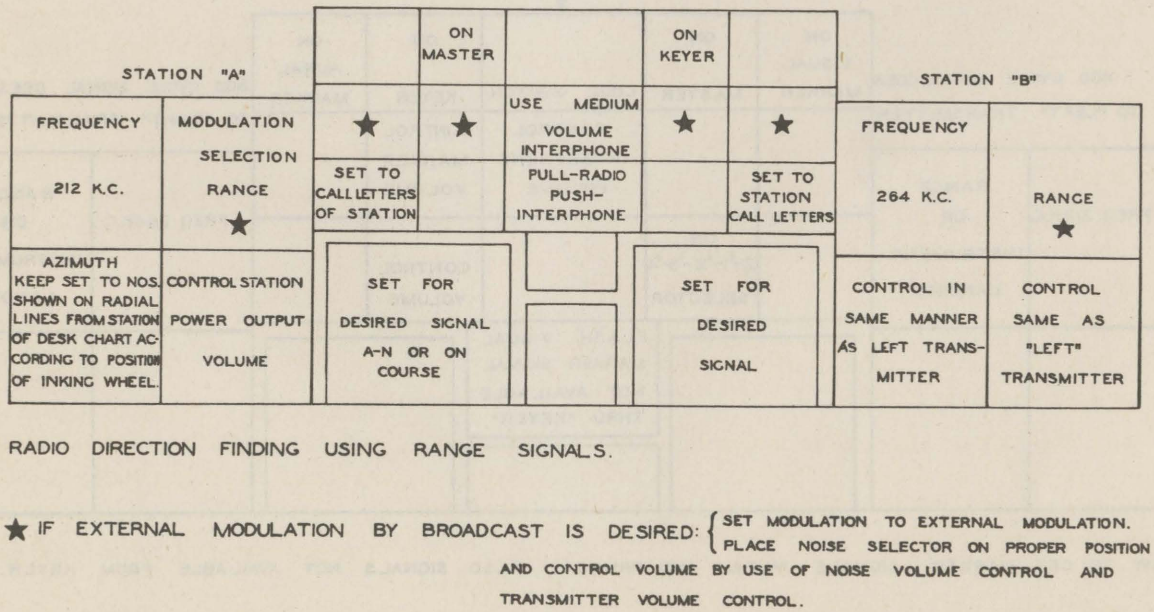


Figure 142—Radio Direction Finding Control Settings

(*a*) Place the modulation selector switches on external modulation [step (*b*)] and tune the noise receivers to the type of signal desired. The signal strength is now controlled by three factors: noise receiver gain, noise volume control, and transmitter volume control. Associate the desired signal with the two transmitters by use of the noise selector switches.

(*b*) Steps (*c*), (*g*), and (*i*) are eliminated but all other procedure is adhered to.

(4) TRANSMISSION AND RECEPTION OF CODE.—There are two audio frequencies upon which code may be practiced, 800 cycles and 3000 cycles.

(*a*) The 800-cycle code is available only on the right transmitter as follows:

1. The right transmitter modulation selector is placed in the instrument landing position.

2. The visual marker, aural marker and marker selector switches are placed in the "off" position.

3. The frequency of the right transmitter is placed as desired (left transmitter frequency at least 10 kc away).

4. The right noise selector switch is either placed in the "off" position or positioned to add interference.

5. The transmitter volume control is placed for signal strength as desired.

6. The master, code and code-keyer switches are placed in the "on" position.

7. The interphone-radio switch is placed in the "radio" position.

8. The receiver must be tuned to the proper frequency, and either the comprehensive antenna or loop positions may be used if the latter is not in a null position.

9. Controls not mentioned have no function and may be disregarded.

(*b*) The 3000-cycle code is available on both transmitters and is obtained as follows: The radio controls are set as in section VI, par. 4*c*(1) except that the aural marker switch is placed in the "on" position and the marker selector switch is placed in the "Z" position. The A-N mixer controls are placed in the "on-course" position and the marker beacon volume is turned up all the way. The signal strength is reduced to the desired level by use of the transmitter volume control.

(5) CONTROL TOWER COMMUNICATION (278 kc).

(*a*) The modulation selector of the transmitter to be used is placed on 278 kc (frequency control of the other transmitter at least 10 kc away).

(*b*) The interphone-radio switch is placed in the "radio" position.

(*c*) The visual marker, code, keyer, aural marker and master switches are turned off.

(*d*) The signal volume is controlled by the transmitter volume control. The volume of the other transmitter may be turned down.

(*e*) Interference may be fed in as described in section VI, par. 4*c*(1)(*h*).

(*f*) The remainder of the desk operator's radio controls may be ignored, but the radio receiver must be turned to 278 kcs and the interphone system set up for radio at those stations desiring control tower communications. (See section VI, par. 4*d*.)

d. INTERPHONE SYSTEM.

(1) INSTRUCTOR AND OPERATOR COMMUNICATION. — Communication between the instructor and desk operator is set up under the following conditions:

(*a*) The instructor's switch is placed in the "operator" position. This automatically lights the control desk signal lamp.

(*b*) The desk interphone-radio switch is placed in the "interphone" position.

(*c*) The control chassis interphone volume controls the volume of communication.

NOTE

The aural marker switch is placed in the "off" position.

(*d*) The radio operator's toggle switch is placed in the "interphone" position. The system volume control is now at the radio operator's control panel.

(*e*) The navigator also has interphone communication.

(2) VOICE-RANGE OPERATION. — For voice-range operation, set up the following condi-

tions. (For radio on range operation, see section VI, par. 4*c*.)

(*a*) The instructor's switch is placed in the "off" position.

(*b*) The desk interphone-radio switch is placed in the "radio" position.

(*c*) The pilot's toggle switch is placed in the "radio" position.

1. The "range-simultaneous-voice" switch is placed in the "simultaneous" position for voice superimposed on range.

2. The same switch is placed in the "voice" position for voice only.

3. The same switch is placed in the "range" position for range only.

4. The desk and the radio operator have communication on 1 and 2 above, and the pilot hears the conversation but cannot converse with them. The navigator and instructor are "out" under these conditions.

(3) INTERPHONE AND RADIO.—Any one of the crew except the navigator and instructor may cut out of the crew interphone and listen to the radio. Thus, the navigator and instructor may talk on interphone and, at the same time, the radio operator and pilot may listen to the radio signals.

(4) INTERPHONE SIGNALING.

(*a*) It is often required to gain the Trainer occupant's attention from the desk for the purpose of issuing instructions, obtaining position reports, etc. Although it is possible to use "voice" on radio, it is not always as convenient as using the interphone. Since there is no direct signaling system provided, the following method can and should be used:

1. To communicate with the desk, flash the visual marker on the pilot's panel with an "I" (. .) in code. To do this, turn the visual marker switch on and depress the marker push button with a series of "I's" (. . . . . .).

2. To communicate with the crew when the visual marker light flashes "I's" (. .), use the instructor's mike and earphones, after turning the selector switch to "operator."

(*b*) The members of the crew may signal for interphone communication by pressing their signal button which in turn will flash the light on the radio operator's panel. The instructor may signal the desk by simply turning his selector switch to the "operator" position.

e. POSITION OF THE RECORDER ON THE GRATICULE.—The position of the recorder should be, as previously described, so located at all times that the top edge is parallel with the parallels of latitude. A visual check should periodically be made to keep this position correct.

f. PREPARATION OF THE GRATICULE FOR RADIO NAVIGATION.

(1) STATION LOCATION AND IDENTIFICATION.—To begin a problem in radio navigation, two transmitter stations are located, according to their latitude and longitude coordinates, on the tracing paper covering the graticule to be used. The stations are identified as station (A) or station (B), etc., with arbitrary wave lengths, the settings for which are to be of at least 10 kcs frequency difference. Depending upon the particular flight in the problem involved, these stations are so located as to produce the desired results as a radio aid in navigation. As the problem progresses or extends over a long period of time, more radio stations are added along the route so that the Trainer will be within range of at least two stations at all times.

(2) RADIAL AZIMUTH LINES. (*See figure* 143.)

(*a*) LATITUDES BELOW 50° N.—A radio station compass rose is drawn about each station and inserted as an overlay or an underlay to the graticule. The compass rose lines extend out radially from the station so as to intersect the path of flight over as wide a range as possible. The compass rose indicates the bearing of the station **from** the Trainer.

(*b*) LATITUDES ABOVE 50° N. (*See figure* 144.)—Lines of equal bearing (loxodromic curves) may be drawn on the chart around the station. Thus, at any time the inking wheel is over one of these lines, the bearing of the station from the Trainer may be read and set on the transmitter azimuth control. Lines, drawn every ten degrees, will probably provide enough indication so that the control may be set to within two degrees by interpolation.

5. OPERATOR'S FORMS.

a. GENERAL.—In addition to preparing graticule overlays containing radio direction finding and meteorological information, the instructor will en-

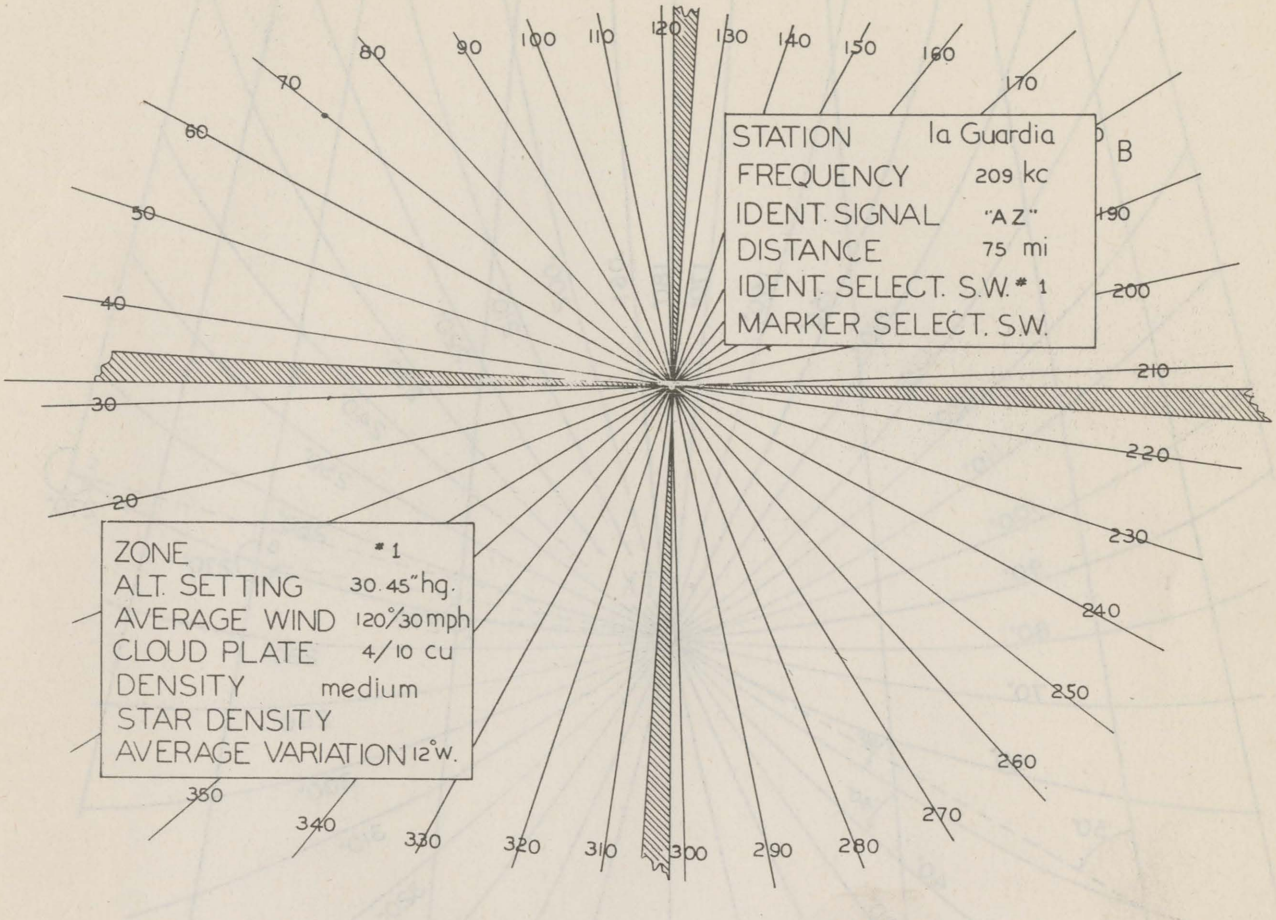


Figure 143—Radio Station Compass Rose

ter complete information concerning the problem on form sheets. As the desk operator is not concerned with anything other than the correct operation of the Trainer, the operator's forms contain only such information as is necessary to set the controls properly throughout the duration of the problem.

b. OPERATOR'S PRE-FLIGHT SHEET (*figure* 145).

(1) USE.—In order to minimize delay in setting up the Trainer preparatory to running a problem, the pre-flight sheet contains only those initial control settings necessary to start the exercise. The sheet provides entries for all types of navigational problems and, when the operator has satisfied all requirements, the crew is ready to enter the Trainer and begin the exercise.

(2) ENTRIES.

(*a*) In the upper right corner of the sheet is found the problem number, the type of navigational method to be used, and the name of the instructor responsible for constructing the exercise. Any questions regarding the conduct of the flight should be referred to this instructor.

(*b*) The first main entries on the sheet enable the operator to set the dome for the latitude, longitude and LHA Aries of the departure point. At the same time, the altimeters are set and synchronized along with the clocks. While in the fuselage, the operator will also set the indicated and true air-speed controls, the temperature control and rough air if indicated. Wind direction and speed, and variation are set in at the wind drift platform.

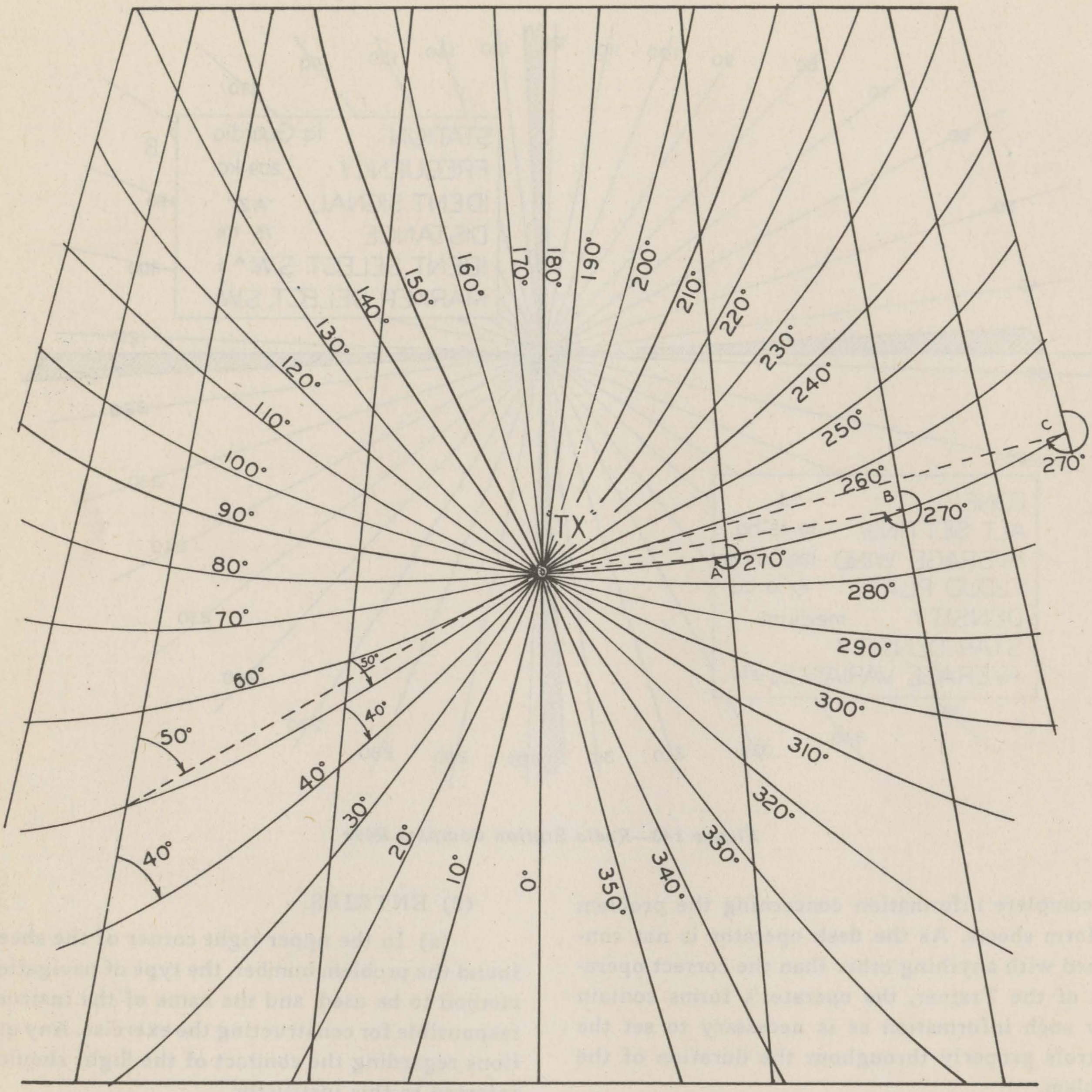


Figure 144—Lines of Equal Bearing for Radio Transmitter Azimuth Settings

(*c*) The section devoted to projection effects informs the operator of the terrain strip, the first plate area to be used and the plate azimuth. If the problem starts at a particular point within the plate area, the side and end scale values are listed. In addition, values for cloud, ground and star density are indicated.

(*d*) The radio data includes such information as is applicable to the first two radio stations which the navigator will use. Azimuth settings will be determined from the position of the recorder inking wheel with respect to the stations.

c. OPERATOR'S VARIABLE FLIGHT SETTINGS (*figure* 146).

(1) USE.—Once the navigation switch has been turned "on," and the flight is in progress, the operator must make further adjustments to the

OPERATOR'S PRE-FLIGHT SHEET

COPIES: Instructor
Operator
Radio Opr.

Problem No. 12
Problem Type All Methods
Prepared By H.E.Benham

D.R. AND CELESTIAL SETTINGS

Depart Mitchell Field Lat. 40° 44' N Time 0940 G.C.T.
Field Elevation 152 feet Long. 73° 35' W Date Mar. 3, 1943
Altimeter Setting 30.15" Hg LHAT 231° 43'

Surface Temp. +20°C IAS Control -1 Spot Variation 11° 30' W
Rough Air ______ TAS Control 0 Wind Direct & Speed 160°/20

PROJECTION EFFECTS

Strip 6 Area (s) 3 (Atl'nt'c C'ty) Plate Z 214°
Plate Side Scale ______ End Scale ______ Ground Density 0
Cloud Formation Clear Star Density 90
Cloud Density 0 Bomb Hit Timer 32 seconds

INITIAL RADIO TX STATIONS

Left TX Station
- Lat. 40°43.5' N
- Long. 73°55'W
- Frequency 209 kc
- Station Ident. "AZ" (La Guardia)
- Selector Switch No. 1
- Marker Selector No. ______

Right TX Station
- Lat. 39°52' N
- Long. 75°18.5' W
- Frequency 266 kc
- Station Ident. "SR" (Philadelphia)
- Selector Switch No. 4
- Marker Selector No. ______

Figure 145—Operator's Pre-Flight Sheet

OPERATOR'S VARIABLE FLIGHT SETTINGS

COPIES: Instructor
Operator
Radio Opr.

Problem No. 12
Problem Type All Methods
Prepared By H. E. Benham

D.R. CLIMB CHANGES

Duration of Climb to 10,000 feet at a V/S 500'/min. 20 minutes
Temp. Change from +20°C to 0°C at rate of 1°C per 1 min. climb
IAS Control from -1 to -24 at rate of 1+ units per 1 min. climb

D.R. LEVEL FLIGHT CHANGES

Temperature 0°C
Wind Direction and Speed 160°/20 mph
IAS Control -27
TAS Control 0
Change Decreasing / Change Increasing ________ units per hour

PROJECTION PLATE CHANGES

Operator to change plates to suit Recorder position.
Ground Density to change according to time of day.
Morning Twilight begins 1107 G.C.T. Sunrise 1135 G.C.T.
Sunset ________ G.C.T. Evening Twilight ends ________ G.C.T.

WEATHER CHANGES

Operator to make changes when Recorder enters Zone

WEATHER	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5	ZONE 6
Wind Direction	170	200	270	300	360	
Wind Speed	15	10	10	15	05	
Turbulence		Mild	Mild	Med.		
Alt. Setting	30.10	30.08	30.08	30.06	30.02	
Clouds	Clear	Thin Ci	.2a/cu	Clear	Overcast	

Remarks: ________

Figure 146—Operator's Variable Flight Settings

controls in order that correct values are indicated on the pilot's and navigator's instruments. Such changes are noted on this sheet.

(2) ENTRIES.

(*a*) During the climb, the temperature must be varied from ground temperature to that of flight altitude. The indicated air-speed control must also be varied from ground setting to that desired at flight altitude. Such variations must be accomplished smoothly and at a constant rate. As the pilot will climb to flight altitude at a constant vertical speed, changes in these control values are based on minutes of climb.

(*b*) After the calculated interval of climb has passed, the operator must presume the pilot has leveled off. The indicated and true air-speed controls are then set for level flight. Any changes are accomplished smoothly over the period of flight.

(*c*) Projection plate changes are made according to the technique previously described in this section of the Handbook. However, entries showing the beginning or end of twilight, and also the actual time of sunrise or sunset is indicated. Star and ground density should be varied accordingly over the period of twilight duration.

(*d*) While weather changes will be shown on the graticule overlay, a section is also provided on the sheet for this purpose. Any remarks or comments concerning meteorological conditions are entered after this section.

6. DO'S AND DON'TS FOR OPERATION

a. Don't set the dome drive variacs below "60."

b. Don't operate with the terrain projection plate drive wheels depressed.

c. Don't turn off the master switch until the altitude tank is at sea level pressure.

d. Don't turn off the ignition switch before locking the fuselage level.

e. Don't set the bomb time of fall below 5 seconds, or over 55 seconds.

f. Don't set the transmitter frequencies within 10 kcs of one another.

g. Don't open the Trainer door when the Trainer is not locked level and on an east heading.

h. Do operate the latitude crank smoothly.

i. Do turn the master switch "on" as soon as possible after entering the building.

j. Do turn up the cloud and ground density gradually.

k. Do hold the recorder above the desk when connecting the cable.

l. Do remove the terrain projection plates when they are not in use.

m. Do turn to an east heading slowly when in a locked level position.

n. Do keep metallic objects away from the bombardier's windows.

SECTION VII
MAINTENANCE

1. INTRODUCTION.

Inspection and maintenance should be made on the Trainer at regular specified intervals by well-trained personnel. Certain equipment such as the radio and the instruments require maintenance by specialized personnel (radio men and instrument repairmen). No attempt at maintenance should be made by untrained personnel, because incorrect maintenance will result in more damage than repair. Certain equipment such as the wind drift mechanism should receive repair at an authorized repair base or be returned to the main depot. Periodic lubrication (figure 155) and check sheets (figures 153 and 154) are included in this Handbook to aid in establishing a good maintenance routine. A list of important electrical items with their power supply, location and internal resistance is included (figure 156) in order to provide the electrician with a quick reference. In this respect, a special maintenance wiring diagram covering all the major Trainer circuits is included. Other circuits may be checked by reference to the engineering wiring diagrams (figures 162 through 210).

2. CELESTIAL MECHANISM MAINTENANCE.

a. MAIN STRUCTURE AND DOME RAIL.

(1) The main structure and dome rail should remain in adjustment and alignment indefinitely. The structure should be kept clean, with particular attention being given to the dome rail. The small holes drilled in the dome rail to accommodate the spiked wheel of the latitude teletorque drive, should be cleaned with a toothpick. Small errors in altitude of the stars at various hour angles may be the result of twist in the dome rail. This dome rail twist may be checked by placing a precision level at various points along the circumference of the rail. Place the vertical arm of the level against the side of the rail and note the bubble error. (See figure 122.) The error should not exceed one minute of arc. (One division on the precision level equals 20 seconds of arc.) If rail twist is excessive, a star on the meridian (sidereal hour angle adjustment) at 90 degrees latitude will not be on the meridian at some other latitude.

(2) Twist in the rail may be removed by adjustment of the upper and lower dome rail brackets. Usually it will be found that any twist present is caused by a stress loading on the rail, which in turn is caused by misalignment of the brackets. In this case, the brackets should be realigned as in the original installation, or realigned in the direction which will remove the rail twist as indicated by successive level readings along the rail. The lower bracket is adjustable along the chord of the rail for both angular and longitudinal position, and about a vertical axis by shimming the mounting plate on the north column. The upper bracket is adjustable perpendicularly to the plane of the rail by adjustment of the two support brackets.

NOTE

The dome rail should never be adjusted unless the building temperature has been held at 21° ± 3° C. (70° ± 4° F.) for the preceding twenty-four hour period.

b. DOME GEAR BOX.

(1) GENERAL.

(*a*) Before the adjustment for dome gear box level can be made, the dome gear box must be at the zenith of the rail. The zenith is checked with a zenith level (figure 122) and the pointer of the level compared to the mark on the dome gear box which indicates the center of the main shaft. The latitude stop can now be adjusted if necessary.

(*b*) The dome gear box should then be checked for level, north, south, east and west, by placing the level on the surfaces of the gear box. Adjustment is made by means of the eccentric roller mounts at the gear box. (See figures 4 and 5.) With the gear box at 90 degrees latitude, the pressure of the bottom rollers against the rail should be checked. Check the hub and the dome gear box rollers for pressure against the track by rotating the roller wheels with the fingers. It should be just possible to rotate the side rollers, but the top and bottom roller tension will vary with the dome position and original setting.

NOTE

The dome gear box should never be re-leveled, unless it has been determined by altitude observations on a collimated star while the dome is at the zenith, that the dome is not level. This check should be made whenever the setting of the dome rollers is varied.

(*c*) Before running the dome gear box up and down the rail, clean the rollers and dome rail surfaces thoroughly with a soft cloth dampened with light machine oil. The latitude teletorque drive holes should be cleaned with a toothpick.

(*d*) The dome gear box should then be run down the rail and at the same time inspected for any tendency to bind on any of the rollers. Adjust the roller cams if necessary. Return the dome gear box to the zenith and recheck levelness (if cams have been readjusted).

(2) DOME DRIVE CLUTCHES.

(*a*) The position in which the clutch stops is determined by the three-positioning cams on the clutch positioning cam shaft and the micro-switch position relative to these cams. Maladjustment here may cause the clutch to stop in a position intermediate to normal, neutral or reset. Before suspecting the clutch of internal mechanical slippage, check to see that the clutch cam-operated shaft stops in the full-out position for normal, the full-in position for reset, and the half-way position for neutral.

(*b*) If slippage is not caused by the above condition, it may be necessary to increase the tension on the clutch spring by turning the adjustment nut clockwise, thereby taking up on the clutch cone.

NOTE

Take up on the nut just enough so that the clutch ceases to slip.

(3) DOME RESET MECHANISM. (*See figure* 13.)—The dome reset motor belt should be inspected for wear and slippage. Replace when necessary.

(4) SHEAR PIN. (*See figure* 13.)

(*a*) If the dome reset clutch has been checked and found in adjustment, the dome reset motor functions, and the dome still will not turn (with the dome clutch control in "reset"), the reset drive shear pin probably has been sheared. Remove the reset mechanism by unscrewing the three mounting screws located on the east side of the dome gear box and install a new shear pin.

(*b*) The remainder of the dome gear box should remain in perfect adjustment. If it becomes necessary to make any further adjustments, such as the main shaft clutch, etc., a qualified service engineer should be called in, or the unit returned to the main depot.

c. LATITUDE SYSTEM.

(1) DRIVE MECHANISM.—The drive (drum and crank) assembly should be checked for smoothness and ease of operation. Care should be taken to see that excess force is not used when manually operating this drive. Occasionally remove the cover, clean, and regrease. Also at this time inspect for play in gears and the condition of the gear pins.

(2) SAFETY PAWLS AND CABLES.—The drive cable should be checked periodically in order to make sure it has not become frayed. A check should also be made of the proper functioning of the safety pawls. This may be done by pulling the gear box along the dome rail by hand, thereby relieving the tension on the cable, and observing the action of the pawl. An observer on the dome rail bridge should note whether the safety pawl engages the lugs on the rail immediately upon slackening of the cable tension. Replace the pawl springs if necessary.

(3) DOME COUNTERWEIGHT SYSTEM.

(*a*) The smoothness of the dome counterweight system can be checked by cranking the dome up and down the rail by hand. Visual inspection of the cables should be made periodically in order to be sure that they are not becoming frayed and thus weakened.

(*b*) Inspect the pulleys used in the system for binding caused by misalignment.

d. STAR LAMPS.

(1) A periodic check should be made to insure that all of the miscellaneous star lamps function. Burned out bulbs should be replaced as soon as discovered. Failure of a complete section of stars to light may be traced to a failure in the circuit to which it belongs. Check the connections and wiring by referring to the proper wiring diagrams.

(2) The size and color of the fixed stars should be noted, and a correction made if necessary. The blue lamicoid discs (filters) in the star lamps will become discolored in time, and the star will assume a yellowish appearance. In order to avoid this unnatural appearance, the lamicoids should be replaced as often as necessary. A check should also be made for light leaks around the lamp assemblies.

(3) To facilitate identification of star size when changing lamicoids, the star shell has been color coded with a spot of paint underneath the rubber insulator. Fixed stars No. 1, No. 2, No. 3, and No. 4 are respectively identified by black, green, yellow and red markings.

(4) Useful information concerning lamicoid discs and aperture sizes has been tabulated in figure 148.

e. LHA ARIES PROJECTOR.—A periodic check should be made in order to be sure that the LHA Aries projector does not get out of adjustment. Compare its position with respect to the wall target by reference to the desk indicator. If it is suspected that the LHA Aries projector has been disturbed from its original position, readjust as previously outlined. (See section IV, par. 3*q*.)

f. COLLIMATORS.

(1) Periodic maintenance of collimators consists of keeping the lenses clean, checking the position of the recognition star reflectors, and checking the circuits and bulbs. When cleaning the lenses, care must be taken not to disturb the alignment of the collimators or to scratch the surface of the glass. Use soft tissue for wiping off the lenses.

(2) Originally, all collimators are properly focused and checked at the factory. A mark in the form of a circle is inscribed on the lamp housing to indicate the proper position of the housing when it is in focus. The circular mark on the housing may be observed through a hole in the case into which the lamp housing is inserted. To be in proper focus, the housing should be positioned so that the circle coincides with the observation hole in the case.

(3) When replacing burned out bulbs in collimators, care must be exercised to return the housing to the proper position in the case by reference to the circular mark, as described in (2).

(4) The collimators are adjusted in the dome during the original installation for sidereal hour angle and declination. With careful handling while wiping off the lenses, this adjustment should remain indefinitely. Should star altitudes be suspected of errors greater than ± 5 minutes of arc, a check and adjustment should be made. It should be observed that altitude errors are not alone attributable to the sidereal hour angle and declination adjustment, but are closely tied in with the dome and dome gear box level. No attempt should be made to readjust the collimators for sidereal hour angle and declination without following the sequence described for final leveling of the dome. (See section IV, par. 3*n*.)

(5) Collimator star aperture discs come in three sizes in order that the navigational star magnitudes are represented more realistically with relation to one another. It is important in replacing collimator star discs that the proper size be used. The sizes are listed in figure 148.

(6) After the original adjustments are made, the collimators should remain in adjustment indefinitely with proper care. Should it become necessary to make readjustments, the following items should be inspected before the dome and collimators are checked or adjusted.

(*a*) Dome Counterweight.

(*b*) Latitude Drive.

(*c*) Operator's Desk.

(*d*) Dome Gear Box Teletorques.

(*e*) Dome Gear Box Wiring.

(*f*) Desk Control Connections.

(*g*) Star and Collimator Wiring to Hub.

(*h*) Dome Rail.

(*i*) Dome Gear Box.

3. FUSELAGE.

a. GENERAL.

(1) Before making any adjustments, make sure that:

(*a*) Electricity of the proper voltage and frequency is supplied.

(*b*) All setscrews are tight.

(*c*) All parts are securely mounted.

(*d*) No excess lost motion exists in any of the levers and rods.

(*e*) No rods, levers or shafts bind in their bearings.

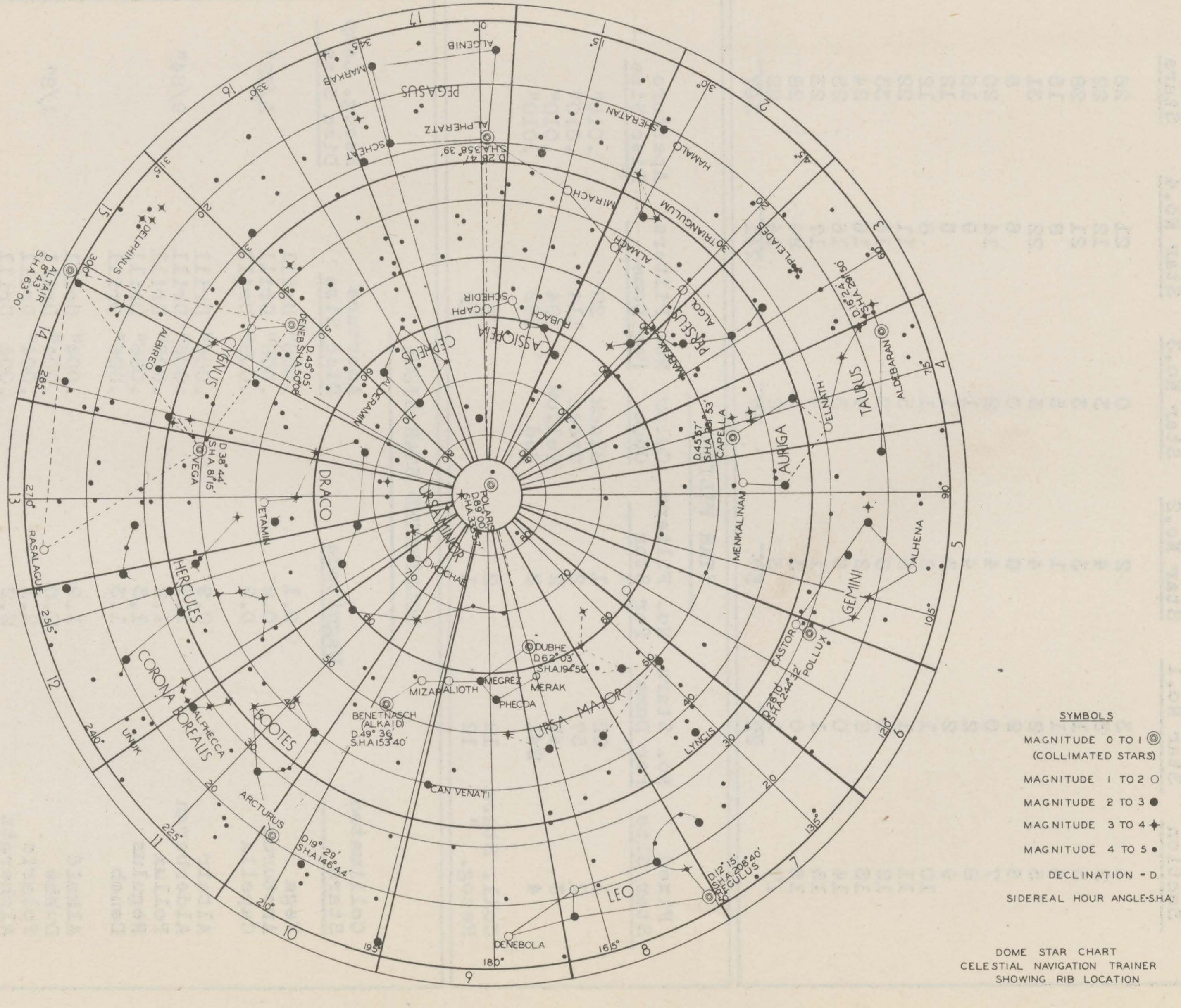


Figure 147—Trainer Star Chart

STAR POSITIONS

Dome Section	Fixed Star No.1	Fixed Star No.2	Fixed Star No.3	Fixed Star No.4	Total Stars
1	3	2	0	21	26
2	3	4	3	12	22
3	1	3	3	21	28
4	1	1	5	8	15
5	2	4	3	22	31
6	2	0	0	6	8
7	0	4	2	14	20
8	2	4	1	9	16
9	2	3	1	6	12
10	1	2	1	8	12
11	1	5	5	11	22
12	0	8	9	16	33
13	2	2	4	16	24
14	0	6	3	16	25
15	1	1	4	17	23
16	0	3	1	24	28
17	1	5	2	14	22
	22	57	47	241	367

STAR FILTERS

Fixed Star Size	No. Stars Per Dome	No. Filters Per Star	Color Code	No. Filters Per Dome	Aperture Disc Size
1	22	1	Black	22	.010"
2	57	2	Green	114	.010"
3	47	2	Yellow	94	.010"
4	241	2	Red	482	.010"
Coll. Stars	12	2		24	
Recog. "	12	1		12	

COLLIMATED STAR SIZES

Collimated Stars	Magnitude	Aperture Disc Size	Recog. Lamp Disc Size
Vega	0.1	.008" Drill	
Arcturus	0.2	.008" Drill	5/32"
Capella	0.2	.008" Drill	
Altair	0.9	.006" Drill	
Alderbaran	1.1	.006" Drill	9/64"
Pollux	1.2	.006" Drill	
Regulus	1.3	.006" Drill	
Deneb	1.3	.006" Drill	
Alkaid	1.9	.004" Drill	
Dubhe	2.0	.004" Drill	1/8"
Polaris	2.1	.004" Drill	
Alpheratz	2.2	.004 Drill	

Figure 148—Star Data

(*f*) All tubing is properly connected and airtight.

(*g*) Rubber tubing is free from slight cracks that might cause leaks.

NOTE

It is assumed that the air conditioning unit in the building is functioning properly. No adjustments to, or checks on, the Trainer fuselage should be made unless the temperature in the building has been maintained constantly between 18° C. and 24° C. (65° F. and 75° F.) for at least the preceding 24 hours.

b. CONTROLS AND MAIN VALVES.

(1) MAIN VALVES.

(*a*) The main valves, which are located under the pilot's seat, should be periodically lubricated with a fine powdered graphite. However, before doing this, it is recommended that the valve surfaces and ports receive a thorough cleaning with a clean, soft cloth in order to remove any tendency of the old graphite to pile up and possibly restrict the valve ports. Any such restriction might cause improper functioning of the Trainer. After cleaning, rub a thin layer of graphite into the valve surfaces, exercising care to wipe off any excess which might have any tendency to work into the valve ports. A drop of gun oil may be rubbed on the valve surfaces after approximately one hundred hours of operation purely as a rust preventative. As oil has a tendency to collect dust particles, any excess might tend to work into the valve ports (causing restriction) and into the vacuum lines and bellows (causing deterioration). Caution should be practiced in the use of oil, and all excess oil removed with a clean cloth.

(*b*) All linkages to the valves should be checked for wear, sloppiness, and friction. Correct for these conditions when necessary.

(2) ADJUSTING MAIN VALVES TO NEUTRAL. (*See figure* 34.)

(*a*) First check for static balance of the fuselage by releasing the tension on the leveling cables until they are loose. The fuselage should be approximately balanced with a tendency towards tail heaviness. With the Trainer running and maintaining a level flight position with the fuselage unlocked, the wheel and rudder pedals should be in a neutral position.

(*b*) Adjust all controls so that when the main valves are closed, the controls are in a neutral position. The adjustment is made by changing the length of the link rods. Make a flight check to test the functioning of all controls.

1. Pitching bellows (Trainer is brought up against the stops).

2. Banking bellows (Trainer is brought up against the stops).

3. Check the automatic features for operation and balance.

a. Automatic turn with bank.

b. Automatic bank with turn.

c. Automatic nose heaviness.

d. Automatic turn tightening.

(*c*) The features listed above are completely automatic, their operation being dependent on the various linkages. Unsatisfactory operation of any one of these three features is the result of loose linkage, leaky bellows, disconnected hose, or some such minor item which would be immediately discernible. Original adjustment of levers and linkages is not likely to be disturbed. However, if response to control movement is unsatisfactory and all connections are good, a study of the linkages and valves responsible for these items should enable a maintenance man to discover the remedy.

(3) SLIP-STREAM SIMULATORS. (*See figure* 32.)

(*a*) These units should be checked for any lost motion in the link rods to the controls, for the degree of stiffness, and for leakage.

(*b*) The stiffness is controlled by means of the "resistance adjustment" shown in figure 32. This figure also shows the packing nut. If this nut is too tight, it will cause excessive friction and a slight jerkiness at the start of the movements.

(*c*) It is seldom necessary to refill the unit. If fluid is required, it should be filled to the bottom of the filler hole. Use only No. 500 shock absorber oil obtainable from the main depot.

c. LEVELING DEVICE. (*See figure* 21.)

(1) The leveling device should be inspected for proper functioning. The cables, especially where they run over the pulleys, should be inspected to see that they are not frayed. The pulleys should also be checked for wear and general condition.

(2) The tension on all four cables should be equal when the fuselage is in the locked position. A turnbuckle at each of the four corners underneath the fuselage is provided for adjusting the tension of these cables. Care should be exercised, when making any adjustment to cable tension, to see that the fuselage remains level. This may be checked by using a small spirit level on the pitch and bank action limit stop plate.

(3) Ordinarily no lubrication should be required. The cables may be wiped with an oily cloth every month to prevent rust. The small pulleys operate on oilite (oil impregnated) bearings, which require no lubrication.

d. MAIN BELLOWS. (*See figure* 72.)

(1) The bellows should be inspected for leaks, with special attention to corners and creases and to the overlapped splice in the fabric. Because of atmospheric conditions, these seams may become unglued and leak. Such openings should be re-glued, and any other leaks patched immediately.

(2) An escape valve is provided in the top of each bellows. This consists of a row of holes through the top plate, covered by a strip of bellows fabric. This strip must lie flat (edges not curled) to avoid leakage. If the strip does not fit properly, it should be replaced by tacking on a new piece of fabric in the same place as the old one.

(3) All hoses leading to the main bellows or the turning motors should be inspected to make sure that they are not loose, kinked or chafed.

(4) The main bellows and the bellows cables are adjusted so that the bellows are one-half collapsed when the Trainer is locked level with the turbine "on." This is accomplished by measuring the bellows when fully collapsed and fully extended when adjusting the cable length. The two banking bellows are identical while the front and rear pitching bellows each differ from the others.

(5) It is recommended that only the patching cement supplied by the main depot be used for patching the bellows on the Trainer. Almost all other cements are apt to dry too hard, become brittle and crack, or loosen in a short time. In general, the patch should be of a material one grade lighter than the fabric being patched, to avoid undue stiffness. Both surfaces must be clean and dry. Each surface should be given a coating of cement and allowed to stand at least 20 minutes, preferably overnight. A second coat should then be applied to each surface and the patch pressed down smooth. The Trainer may then be turned on immediately and the vacuum will help hold the patch in place while it is drying.

e. INSTRUMENT INDICATIONS (VACUUM CONTROLLED).

(1) LOCKED LEVEL POSITION.

(*a*) Since all instrument indications are produced artificially, a basic reference is required during adjustment. This requirement is called "locked level" position and indicates that the Trainer is in cruising position and cruising condition, during which the fuselage is in a level flight attitude and the levers and linkages so positioned that the valves controlling changes of pressure to the instruments are closed or at cruising positions. Thus with the Trainer running, no loss or gain of altitude is indicated, and the vertical speed indicator should be at zero. The air-speed indicator, tachometer, and manifold pressure gages, with their respective controls at "cruising," might indicate almost any reading if they are not in proper adjustment. The very fact that the indicator hands are not at their cruising position when the Trainer is "locked level" is an indication that the system governing any particular part requires adjustment.

(*b*) The point which requires stressing is that no knowledge of the cruising position can be gained from noting the indications of the air speed, tachometer, and manifold pressure indicators before adjusting the Trainer to a "locked level" position.

(*c*) With the Trainer in a "locked level" position, the desired "cruising condition" is obtained by opening or closing the throttle so both climb and dive valve arms are against their stops (both valves closed).

NOTE

If it is found that trouble with any instrument is traced to faulty operation within the instrument itself, a competent instrument repair man should be called in to make the repair, or the instrument should be returned to the main depot and replaced with a new one.

(2) BLEED HOLES. (*See figure* 43.)

(*a*) GENERAL.

1. Proper functioning of the pressure indicating instruments (air speed, tachometer, and

manifold pressure indicators) is dependent on maintaining the correct size bleed holes which are placed in the lines leading to these instruments.

2. Since the function of the bleed holes is to provide a calibrated atmospheric leak which serves to balance the tension of the regulator spring against the vacuum being applied, it is important that they be kept open at all times. Before flight testing or adjusting the Trainer, these bleed holes should be cleaned with a broom straw or a toothpick.

CAUTION

Since the size of the hole has a definite bearing on the action of the air-speed tachometer and manifold pressure indicators, it is important that while the holes be fully open, they must not be enlarged.

(*b*) LOCATION OF BLEED HOLES.—The bleed holes mentioned in the above paragraph are located as follows:

1. Air-speed system: The bleed hole in the air-speed line may be found near the air-speed control box. The size of this bleed hole is .020 of an inch, located in capillary tube 1/4 inch by .025 of an inch.

2. Tachometer system: One bleed hole is located in the tachometer tubing behind the pilot's instrument panel, near the instrument itself, and the other one is in the tubing near the tachometer regulator bellows. The size of these holes is .025 of an inch.

3. Manifold pressure system: This bleed hole is located in the manifold pressure tubing behind the pilot's instrument panel near the manifold pressure gage and is .015 of an inch in size. There is also a bleed hole of the same size near the manifold pressure regulating bellows.

NOTE

If for any reason these bleed holes should become enlarged by the use of too coarse a material when cleaning, they should be plugged with solder and new holes drilled to the correct size.

(3) ALTITUDE SYSTEM. (*See figure* 43.)

(*a*) GENERAL.—The altitude vacuum system is connected to maintain a constant differential of 2 inches Hg to 2.5 inches Hg across the climb-dive valves. The exhaust air from the altitude pump is applied to the input or atmosphere ports of the differential pressure regulator. A relief valve in the line limits the air pressure to the desired differential. A constant pressure differential makes possible an original setting of "0" on the altimeter. [See section III, par. 2*h*(1).]

(*b*) DIFFERENTIAL PRESSURE REGULATOR. (*See figures* 44 *and* 45.)

1. If for any reason, either by accident, usage, or overhaul, the correct relationship between the bellows and slide valve becomes disturbed, it is important that it be reset by proper adjustment. It can be seen that the slide valve is permitted by its stops to travel .080 of an inch (5/64 of an inch) in either direction from its center. The unit is set up in such a manner that each bellows is compressed .080 of an inch in order to neutralize their spring action. Therefore, the slide valve should be exactly centered and both vacuum and atmosphere ports closed when the pressure in the bellows is the same and no external spring is attached. When the valve is against either stop, one bellows will be open and the other collapsed .160 of an inch, while one of the ports (vacuum or atmosphere) will be entirely open. If this relationship is properly set up, the pressure differential becomes entirely a function of spring tension. The procedure used in checking this differential pressure is as follows:

a. Connect a vacuum gage or mercury manometer across the climb-dive valves as shown (figure 149).

b. Back off the climb-dive limit valves until the maximum flow can be achieved through the valves.

c. With the climb valve in full open position, the vacuum gage or mercury manometer should read approximately 2 inches Hg. Adjust the nut if necessary.

d. With the dive valve in full open position, the vacuum gage or mercury manometer should read approximately 2 inches Hg. Adjust the nut if necessary.

e. Readjust the climb-dive limit valves.

2. Should the behavior of the regulator valve become erratic and jerky, it is probably caused by dirt or gummy oil on the slide, and the valve should be flushed with some solvent. The bellows themselves are "Hydron," extra flexible, and should require no attention other than routine inspection for damage and leaks.

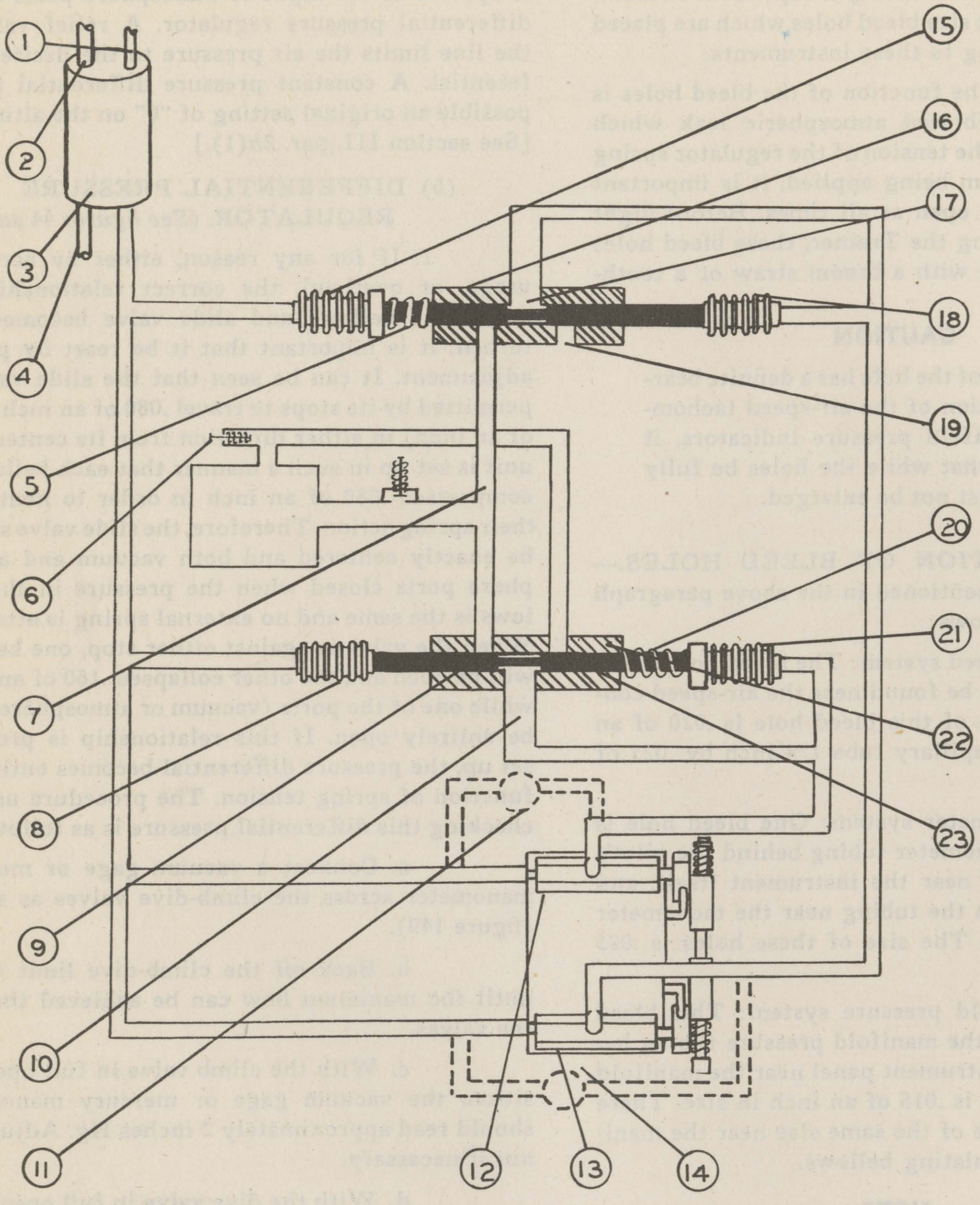


Figure 149—Method for Checking Differential Pressure Across Climb-Dive Valves

1. *To Vertical Speed*
2. *To Altimeter*
3. *Altitude Tank*
4. *To Altitude Compensator*
5. *Spring on Pump Bellows (Climb)*
6. *Relief Valve*
7. *Vacuum Port for Climb Valve*
8. *Altitude Tank Bellows (Dive)*
9. *Vacuum Port for Dive Valve*
10. *Outlet Port to System for Dive Valve*
11. *Vacuum Gage*
12. *Dive Valve*
13. *Climb Valve*
14. *Vacuum Gage*
15. *Altitude Tank Bellows (Climb)*
16. *Climb Regulator*
17. *Outlet Port to System for Climb Valve*
18. *Vacuum Pump Bellows (Climb)*
19. *Atmosphere Port for Climb Valve*
20. *Spring on Tank Bellows (Dive)*
21. *Vacuum Pump Bellows (Dive)*
22. *Dive Regulator*
23. *Atmosphere Port for Dive Valve*

(c) CLIMB-DIVE VALVE ASSEMBLY. (*See figure* 42.)

1. GENERAL.—These valves handle very small quantities of air and their proper functioning depends on their being in excellent condition and correctly adjusted. They are properly set at the factory, and the maintenance personnel, before making any kind of adjustment, should make absolutely certain that they thoroughly understand the mechanism.

2. FUNCTION.—These valves are extremely delicate and must be handled with care. The climb valve controls the vacuum applied to the altitude tank. The dive valve controls the flow of atmosphere back into the tank.

3. MAINTENANCE.—Actual maintenance of this unit consists chiefly of adjusting when necessary. Because of the delicate nature of the unit, if trouble is traced to the inside mechanism, it is advisable to return the unit to the main depot to be replaced with a new one.

4. ADJUSTMENTS. — Each of these valves has two adjustments: one is the clamp nut to take care of any looseness or wear in the threads, and the other consists of positioning the lever arm on the needle. When the arm is against the stop, the needle valve will just be closed. [See section III, par. 2*h*(1)(*c*).]

a. ADJUSTING FOR WEAR IN THREADS.—If side play can be felt in the valve needle, the clamp nut should be drawn up slightly. (Care must be taken to avoid over-tightening.) The clamp nut should be tightened one-sixth of a turn at a time and the valve tested after each one-sixth turn for tendency to bind. To make this test, swing the lever arm away from the stop and let go of it to see whether the compensator spring promptly returns the arm to the stop. Continue tightening the nut, testing for binding at each one-sixth turn. When tightened enough so that the spring does not promptly close the valve, loosen the nut just enough to stop the binding.

b. ADJUSTING NEEDLE VALVE.—There should seldom be any necessity for adjusting the needle valves, and before attempting to do so, the maintenance personnel should be sure it is necessary. There would be need of such adjustment only when it has been proven that the valve itself actually leaks, or when, due to unfavorable operating conditions, the valve has become partially or completely blocked by foreign matter in the atmosphere line and has to be removed for cleaning. This is extremely unusual because of the use of air inlet filters.

(1) The climb-dive assembly must be removed from the Trainer to adjust the needle valve and a manometer or vacuum gage capable of measuring up to 5 inches Hg is required.

(2) When a leak is suspected, time and labor can sometimes be saved by disconnecting the copper tubing from the valve and testing it with a manometer before removing the assembly from the Trainer.

(3) In adjusting the climb or dive valve needles, it is imperative that the needle never be screwed against the seat. To do so is to risk ruining the valve seat. The object of the adjustment is to have the needle, in the closed position of the lever arm, just barely reach the seat but not pressing against it.

(4) Since it is not practical to screw the needle against the seat in order to find the closed position, it will be necessary to find, by use of the vacuum gage, the point where the airflow is cut off. This should be done as follows:

(5) Remove the climb-dive valve assembly from the Trainer, and connect a vacuum gage or manometer to the end fitting.

WARNING

This connection between the valve and the vacuum gage must be absolutely airtight. Any leak in this line would give the appearance of a leak in the valve and in attempting to close the valve enough to prevent this leak, the needle would be forced against the seat and the valve ruined. If the leak is slight, proceed as follows:

(6) Loosen the clamp screw in the needle valve lever enough so that it will be holding only slightly.

(7) Place a 1/32-inch thick spacer, or feeler gage, between the lever arm and the stop.

(8) Connect one end of a 3/16-inch rubber tube to any convenient source of vacuum in the Trainer and the other end to the elbow fitting on the valve. Note the rate at which the vacuum gage moves to its maximum reading.

(9) Remove the tubing from the elbow, and open the valve to allow the vacuum gage

to return to zero, then allow the valve to close (arm against stop).

(10) Hold the vacuum line against the elbow so that the vacuum gage shows two or three inches Hg, yet there is a slight leak between the rubber tube and the elbow.

(11) Place the 1/32-inch gage between the arm and the stop, and hold the arm from moving. (Clamp, or otherwise secure it, if necessary.)

(12) With a small screw driver, turn the needle about 1/100 of a revolution in the direction of closing, being careful not to entirely cut off the flow to the vacuum gage.

NOTE

The dive valve needle has a LEFT-HAND THREAD.

(13) Vary the amount of leak between the rubber tubing and the elbow and note the rate of movement of the vacuum gage.

(14) Continue carefully screwing the needle in, a very little at a time, meanwhile varying the leak between the tube and elbow, until all the movements of the gage become sluggish.

(15) When this point is reached, the rubber tubing should be entirely removed from the elbow to allow the gage to return to zero. The tubing is firmly attached to the elbow at each test.

(16) When the needle is in far enough so that the full force of the vacuum only moves the gage slowly, tighten the lever arm clamp screw slightly, and remove the 1/32-inch gage, allowing the arm to move against the stop. (To return the gage to zero, remove suction tubing and open valve for a moment. Then replace tubing.)

(17) If the flow of air has been reduced sufficiently with the spacer in place, it will now be entirely cut off and the gage will remain at zero.

(18) If, however, there is still a small leak, replace the 1/32-inch spacer and, proceeding as before, reduce the amount of leak.

(19) Remove the spacer and test as before.

(20) The final adjustment must be one that shows a leak with the spacer in place and no leak with the arm against the stop. If the valves have been in use for several hundred hours, it is permissible to use a 3/64-inch spacer to obtain this condition.

(21) If the needle has been removed, the valve needle should be given a thin coat of light oil and started in the threads. Connect the vacuum gage as previously outlined and hold the vacuum tubing against the elbow. Vary the leak as before and screw the needle in with the fingers until the movement of the gage becomes sluggish. Replace the lever arm and compensator and proceed as in adjusting the needle valve.

c. ADJUSTING CLIMB-DIVE LIMIT VALVES.

(1) The climb-dive limit valves are located at the ends of both the climb and dive valves to restrict the flow of air in order to gain the desired rate of climb or descent.

(2) Set the altimeter to indicate zero feet of altitude and put the Trainer in a full climb (full throttle, and nose up). As the hand of the altimeter passes beyond 2000 feet altitude, the vertical speed should indicate 2000 feet per minute climb.

(3) Adjust the climb limit valve, if necessary, by using a screw driver.

(4) Nose the Trainer down with throttle fully retarded. As the hand of the altimeter passes any altitude above 2000 feet (start the flight well above 2000 feet, so that the Trainer can be flown down to this altitude), the vertical speed should indicate 2000 feet per minute descent.

(5) Adjust the dive limit valve if necessary by using a screw driver.

d. LEAK TEST.—Set the altimeter to zero and climb the Trainer up to 4000 feet of altitude, close the climb-dive valves, and turn the Trainer ignition switch off. The altimeter should not indicate a loss of more than 100 feet in 5 minutes. If a leak has developed, check all plumbing and connections.

(4) AIR-SPEED SYSTEM.

(*a*) GENERAL.

1. The Trainer should be locked level, with the master and navigation switches "on." For this adjustment the turbine need not be running, since the air-speed system receives its vacuum from the altitude pump. With the throttle in cruising position (climb-dive valves closed), the air-speed indication should be at the "3 o'clock" position. If the air-speed indication is high, loosen the tension on the regulator spring (figure 44); if the air-speed indication is low, increase the spring tension.

NOTE

The indicated air-speed control knob must be set on "0" before adjustments are made.

2. When making this adjustment, the ground speed output of the wind drift mechanism may be checked also. The ground speed wheel should be 1-1/2 inches from the center of the rubber ground speed plate at "cruising" air speed.

NOTE

Zero wind speed control. Adjustment for positioning the ground speed wheel has been previously described. [See section III, par. 3*b*(3).]

(*b*) REGULATOR SPRING TENSION. (*See figure* 35.)

1. With the Trainer still in "cruising condition," close the throttle and note the air speed. If the pointer of the air-speed indicator drops lower than 75 mph, it indicates the spring is too stiff. (This could not occur with the spring originally supplied on the Trainer, as it would not grow stronger.) If the instrument does not fall back low enough, it indicates a weak spring. The maintenance personnel should not be too ready to believe that the springs are bad, but should carefully recheck all other adjustments. If it is finally proven that the regulating spring has become too weak, a new spring must be fitted by careful stretching, to the individual Trainer. To accomplish this, proceed as follows:

2. Put the new spring in place, leaving the adjusting nut well out toward the end of the thread. Next, turn on the Trainer and check for "locked level" position. Open or close the throttle until the climb and dive valves are both closed (arms against the stops).

3. The regulating spring adjusting nuts should now be tightened until the indicator shows exactly the proper cruising speed. Next, close the throttle.

4. If the indicator falls back below the proper "idling" speed, the spring is too stiff and must be stretched slightly. To do this, remove the spring and hook one end of the spring onto a nail held in a vice or driven into any convenient board. Place a machinist's scale or rule under the spring and against the nail. Stretch the spring to a length of about 4 inches. Replace the spring in the Trainer and adjust the nut until the indicator is at the exact cruising position as before. Check the indications on the instrument at full throttle, and at closed throttle.

5. If, with closed throttle, the indicator still falls back too low, the spring must be removed and stretched again. This stretch should be to approximately 4-3/4 inches. Install the spring in the Trainer, then adjust and test as before. This process must be repeated until the desired indications are obtained.

WARNING

As soon as the indicator shows any effect from stretching the spring (doesn't fall back quite so low) any further stretching must be done very carefully so as not to overstretch and ruin the spring. At this point, the increase in stretch should be only a sixteenth of an inch at a time. However, if it has been overstretched, there is nothing that can be done but replace the spring and start the adjustments again.

6. Air-speed indicators, tachometers, and manifold pressure gages on the Trainer are so designed and calibrated as to require a certain amount of vacuum to move the pointers certain distances around the dial, regardless of the numeral appearing on the face of the instrument. The linkages and regulators are engineered so as to supply just that certain amount of vacuum at any given position of the throttle and/or attitude of the Trainer.

7. With the Trainer "locked level" in cruising position (climb-dive valves closed), in order to obtain best results, the air-speed indicator pointers should be horizontal at a position corresponding to the "3 o'clock" position on a clock face, regardless of the numeral appearing under the pointer. If it is desired to simulate a different cruising speed than appears under the pointer as mentioned above, it will be necessary to replace the indicator dial.

(*c*) AIR-SPEED TRANSMITTER.

1. The following items in the air-speed transmitter should be checked to maintain proper operating conditions:

a. The bellows should be clean and free from corrosion.

NOTE

The bellows are made from a very thin material (.005 copper) and must be handled carefully. A dent in the bellows will cause improper indication. If any electrical or vacuum connection in the air-speed transmitter requires soldering, be sure to use a clean solder-iron and rosin core solder. Acid or alkaline fumes may damage the bellows beyond repair.

b. The teletorque and telegon connections should be clean and the cables in good condition.

c. Mounting screws and setscrews should be tight.

d. The operating cord and return spring should be in good condition.

(5) TACHOMETER SYSTEM.

(*a*) ADJUSTING THE TACHOMETER.

1. Before making any adjustments to the tachometer, the linkages to the regulator bellows in the tachometer and manifold pressure systems should be checked for wear or friction, the bellows should be inspected visually for leaks and condition of the fabric, and the condition of the hoses noted for slight cracks and poor connections.

2. With the Trainer "locked level" in "cruising" position, if the tachometer reading is low, the tension of the spring at the regulating bellows should be increased; if the reading is high, the spring tension should be decreased. This is done by positioning the collar on the rod.

CAUTION

Do not squeeze the regulator bellows together by hand.

(*b*) REGULATOR BELLOWS. — These bellows, one for the tachometer and one for the manifold pressure system, require only reasonable attention. Periodically, the condition of the bellows fabric should be checked for leaks. Any leaks discovered should be patched according to instructions [section VII, par. 3*d*(5)]. It may be necessary after 1000 hours operation to remove the regulator bellows needle plate, which is screwed to the free side of the bellows, for the purpose of cleaning the needle valve which may have become gummed. If this becomes necessary, crocus cloth is recommended. The following tachometer indications are desired:

1. Propeller high pitch, cruising throttle 1900 rpm ± 50.

2. Propeller low pitch, cruising throttle 2500 rpm ± 50.

3. Propeller low pitch, closed throttle 300 rpm ± 200.

(*c*) LIMITING REGULATOR BELLOWS.—Adjust the limiting regulator bellows to the manifold and tachometer regulating bellows from 4 inches Hg to 4-1/4 inches Hg by means of the knurled nut on the bellows spring. Check by a suitable vacuum gage on the outlet line.

(6) MANIFOLD PRESSURE.

(*a*) Adjustment to the manifold pressure indicator is the same as for the tachometer.

(*b*) Slightly additional maintenance is required in the manifold pressure system because of the presence of the altitude compensator connected to the altitude tank. The altitude compensator provides for the automatic drop in the manifold pressure with increase in altitude. Rubber tubing to this altitude compensator should be inspected periodically for cracks and poor connections. The following manifold pressure indications are desired:

	Sea level	10,000 ft.
1. Take-off	38.5 in. ± 1 in. Hg	33.5 in. ± 1 in. Hg
2. Cruising	29.5 in. ± 1 in. Hg	24 in. ± 1 in. Hg

f. INSTRUMENT INDICATIONS (GYRO-CONTROLLED).

(1) BANK AND TURN INDICATOR.

(*a*) Most American turn indicators are calibrated to show either one-needle-width or two-needle-width deflection, during a standard rate turn of 3 degrees per second. These instruments usually have their scales divided into "Rate 1," "Rate 2," etc. indications. The intended rate of turn and the desired deflection must be known before an adjustment can be made.

(*b*) Knowing the desired rate of turn and deflection, turn on the Trainer leaving the fuselage "locked level." Allow the turbine to run for several minutes in order to permit the gyro to reach operating speed.

(*c*) Unlock the fuselage and apply rudder until the proper deflection of the turn indicator needle is obtained. With a stop watch, note the time required for a 180-degree or 360-degree turn. If the turn is completed too soon, the tension of the turn indicator regulator bellows spring must be increased. If the turn is completed too late, the spring tension must be decreased.

CAUTION

Do not attempt to change a one-needle-width indicator to two-needle-widths by merely increasing the vacuum. To do so will ruin the instrument. If this change is desired, the centering spring must be replaced and the instrument recalibrated. This should be done only by a competent instrument man, or the manufacturer.

(*d*) A periodic check for cleanliness of the air filter, which is attached to the case of the instrument, should be made. Remove the filter from the instrument, soak it in carbon tetrachloride, and blow out the dirt with compressed air. Send the instrument to an instrument repair shop for overhaul after 400 hours of operation.

(2) DIRECTIONAL GYRO.

(*a*) The filter of the directional gyro should be removed periodically, thoroughly cleaned, and replaced.

(*b*) A check on the rate of precession of the gyro should also be made by the instructor, who can thus be assured that students are taking into account this important factor. Inasmuch as this is a standard aircraft instrument, it will precess the same amount as one found in an aircraft.

(*c*) With the Trainer held on the four cardinal headings consecutively (after the gyro has been allowed to come up to operating speed), note the number of degrees that the indication changes over a 5-minute period. The gyro should not precess more than 3 degrees average in 15 minutes on all of the cardinal headings, nor more than 5 degrees on any one heading.

(*d*) After every 400 hours of operation, the directional gyro should be removed for an instrument repair shop overhaul.

(3) ARTIFICIAL HORIZON (PENDULUM CONTROLLED). (*See figure* 51.)—Once this instrument is leveled, it should require no further attention for approximately 1000 hours of operation. At this time, the quantity of oil in the dash pot should be checked, and freedom of movement of the linkage should be verified with the cover removed.

g. INSTRUMENT INDICATIONS (ELECTRICALLY CONTROLLED).

(1) OUTSIDE TEMPERATURE GAGE.—If trouble develops, such as the needle remaining stationary at zero or refusing to record properly, check the bridge resistance. It may be shorted or burned out.

(2) REMOTE REPEATER COMPASS.—This instrument should need no maintenance after the original installation. If trouble develops, it may be caused by improper setting of the compensating screws, or the splined shaft on the flexible cable may have become worn enough to allow some play in the gearing. (See section V, par. 3*w*.)

(3) CLOCKS. — These instruments should cause no trouble except through the teletorque transmitters or receivers. Check all wiring, and for proper adjustment. [See section III, par. 1*d*(11).]

h. VIBRATORS. (*See figure* 53.)

(1) There are 4 vibrator motors in the fuselage, one each located behind the navigator's and pilot's instrument panels, one on the altitude transmitter, and one on the differential pressure regulator.

(2) These vibrator motors provide the instruments with sufficient vibration to overcome the friction of the moving parts in the indicating instruments.

(3) Two vibrator weights are secured to the shaft by means of setscrews. Since both wheels are eccentric, it may be seen that the position of the vibrator weights with relation to one another has a direct effect on the amount of vibration produced, and consequently an effect on the instrument pointer action.

(4) The desired amount of vibration should be such that the instrument after being deflected will return to zero evenly and steadily.

(5) Since the instruments cannot be built entirely free of friction, a certain amount of vibration for smooth operation is required. If the pointer movement is jerky or unsteady with a lagging tendency, the output of the vibrator is insufficient. Unsteady movement with no lag indicates too much vibration.

(6) It is apparent that minimum vibration is obtained when the setscrews are 180 degrees apart,

while the maximum vibration is obtained when the setscrews are in line with each other. (See figure 53.)

(7) Excessive end play of the fly shaft should be avoided. The inner half of the fly wheel should be set on the shaft so that the end play of the shaft is approximately .007 of an inch.

WARNING

Too much vibration has been known to cause the pointer movement to be erratic.

i. INTERPHONE.—This system should need very little maintenance. Careful handling of the microphone and head phone jack plugs should be stressed to avoid breaking of wired and soldered connections.

j. EQUIPMENT — GENERAL. — Brackets for the drift sight, bomb sight, astrograph, and astro compass need no maintenance except to check for alignment. Specifically, the bomb sight, and astro compass brackets should be adjusted so as to come over the center of rotation. The astrograph adjustment depends on the definite height the instrument must be mounted above the navigator's table. The drift sight should be directly over and parallel to the longitudinal axis of the Trainer.

4. TOWER, COUNTERBALANCE FRAME, AND BASE.

a. TRAINER BASE.—In the original installation, the Trainer base, which supports the tower and fuselage, was so aligned that with the tower locking device engaged, the fuselage was headed due "east" (90 degrees from the center line of the dome rail). The fuselage should remain so aligned indefinitely. If it becomes necessary to realign the fuselage, the tower locking device lug, attached to the western leg, is adjustable.

b. MAIN BEARING.—The main bearing should not require attention during the entire life of the Trainer. To service this bearing the Trainer must be completely disassembled.

c. TURBO-COMPRESSOR (TURBINE). (*See figure* 77.)

(1) GENERAL.

(*a*) This machine has been carefully balanced and tested at the factory in order to insure proper operation. Service and maintenance of this machine must be strictly adhered to for maximum operating efficiency.

(*b*) Under normal operation, with a standard air bleed (5/16 of an inch) in the intake, the turbine will draw 30 cubic feet of air per minute, at 8 inches Hg to 9 inches Hg.

(*c*) When testing the turbine for maximum output, be sure that the proper voltage is being applied.

(2) DISMANTLING THE TURBINE.

(*a*) Considerable time is spent balancing and testing this machine in order to insure efficient operation. If it is necessary to dismantle the turbine, it should be remembered that the parts must be reassembled in exactly the **same relative position** to each other, to prevent unbalancing the turbine. Therefore, it is suggested that a mark be placed on each impeller, deflector head, etc., as it is dismantled so there will be no mistake in reassembling. Whenever the turbine has to be dismantled, it is necessary that the following procedure be followed:

(*b*) Begin at the intake and remove the end head, impeller, spacer, packing, deflector head, impeller, etc., respectively, until all impellers, head spacers, and deflector heads are removed. The division head should not be removed.

(3) REASSEMBLY OF TURBINE.

(*a*) After the motor is cleaned and overhauled, it may be reassembled and secured in position.

(*b*) Be sure that the packing is in place and tight around the shaft. If it has been disturbed in removing the motor or for any other reason, a new packing should be installed before the motor is reinstalled. First, start the motor and make sure that the shaft runs absolutely true.

WARNING

Do not let the motor run without a load on it. Loading can be accomplished by placing one impeller on the shaft and clamping it in place. One impeller will produce sufficient load to prevent the motor from racing and damaging itself. After testing, remove the impeller and start reassembling the turbine.

(*c*) Place the first impeller on the end of the shaft but do not tighten it. Next, place the deflector head in the casing and push the deflector head and the impeller together until the deflector head is

against the head spacer. Be sure that the deflector head, spacer, and impeller are in place. Remove the deflector head from the casing and with the aid of a scriber, scratch the shaft at the impeller hub. Push the impeller back against the division head and return it half way to the scratch mark on the shaft. Tighten the impeller hub bolts a little at a time, being careful not to change the position of the impeller on the shaft or to fracture the clamp. Replace the deflector head and follow this same procedure with the next impeller and deflector head. With the aid of a screw driver or a similar tool, calk the packing firmly into the groove. If available, a new packing should be used. When calking, be sure it is done evenly; otherwise, the deflector head will be off center and cause rubbing of the impellers.

(*d*) Continue this procedure until all the impellers are assembled in the casing. Install a new gasket between the casing and the end head. Tighten the bolts and draw the end head onto the casing evenly in order to prevent misalignment of the head spacer deflector head. When the turbine assembly is completed, it may be connected to the 220-volt supply and tested.

(*e*) Never attempt to operate the turbine with a damaged, repaired, or dirty impeller as its unbalanced condition will cause excessive vibration and may damage the turbine.

(4) TURBINE MOTOR AND CONTROLS.

(*a*) The turbine motor is a universal direct current, or 60-cycle 220-volts, 10,000 rpm series motor rated at 2 HP. Under full rated load it draws 10 amperes.

(*b*) Some sparking may normally be expected at the brushes of this motor. However, the commutator should be cleaned when it becomes dirty or greasy by holding a cloth dampened with carbon tetrachloride against the commutator while the motor is running. The brushes should last for 1000 to 1500 hours. However, they should be replaced before they become so short that the spring will not hold them in effective contact with the commutator. Replacement should be made with the same type brush. The brushes should be free to move in and out in the brush holders. If the commutator is found to be rough, upon making brush replacements, it may be dressed with fine sandpaper (never emery cloth). Under extreme conditions, the commutator should be turned down (as little as is necessary to achieve smoothness), and the segments undercut about 1/32 of an inch.

d. ALTITUDE PUMP. (*See figures* 78 *and* 79.)

(1) GENERAL.

(*a*) The altitude pump motor is a 115-volt, 60-cycle induction-repulsion motor with a 1/4 HP rating at 1725 rpm. Under full load it draws 4 amperes. With proper lubrication, this motor should run trouble free for the entire life of the Trainer.

(*b*) The direction of operation of the altitude vacuum pump is shown by the arrow on the pump. All joints should be airtight. If at any time it is necessary to disconnect a part of the unit, be sure to paint or shellac the joints when reassembling.

(*c*) Use medium motor oil for lubricating the cylinder. Keep the bearings filled with good machine oil, renewing the entire supply every month.

(*d*) The two relief valves operate automatically. The valve at the pump inlet is set for approximately 14 inches Hg of vacuum while the one at the outlet side is set for approximately 2 inches Hg. Use a vacuum gage for checking or resetting.

(*e*) If the pump sticks, pour kerosene into the cylinder and bearings, and work the pump by hand; or take off the side of the pump, remove the vanes and clean them with kerosene, then wipe them dry. Coat the vanes and the inside of the pump with oil before reassembly. Place the vanes in the correct numbered grooves. Examine the shaft for burrs or high spots, and if necessary, smooth them down by using a lathe, a fine hand file, or emery cloth. Do not touch the shaft with a hammer or a wrench. Use thinned shellac for sealing the cylinder head to the cylinder, being careful not to let any leak into the pump interior.

(*f*) Keep the belting tight in order to prevent slipping. Clean occasionally with a cloth moistened with carbon tetrachloride.

(2) INSTRUCTIONS FOR WASTE-TYPE SEPARATOR. (*See figure* 79.)

(*a*) This separator contains a filter made of ordinary cheese cloth.

(*b*) Remove the cover and inspect the filter at least once a week. If the cheese cloth has become saturated, replace with the same amount as in the original installation.

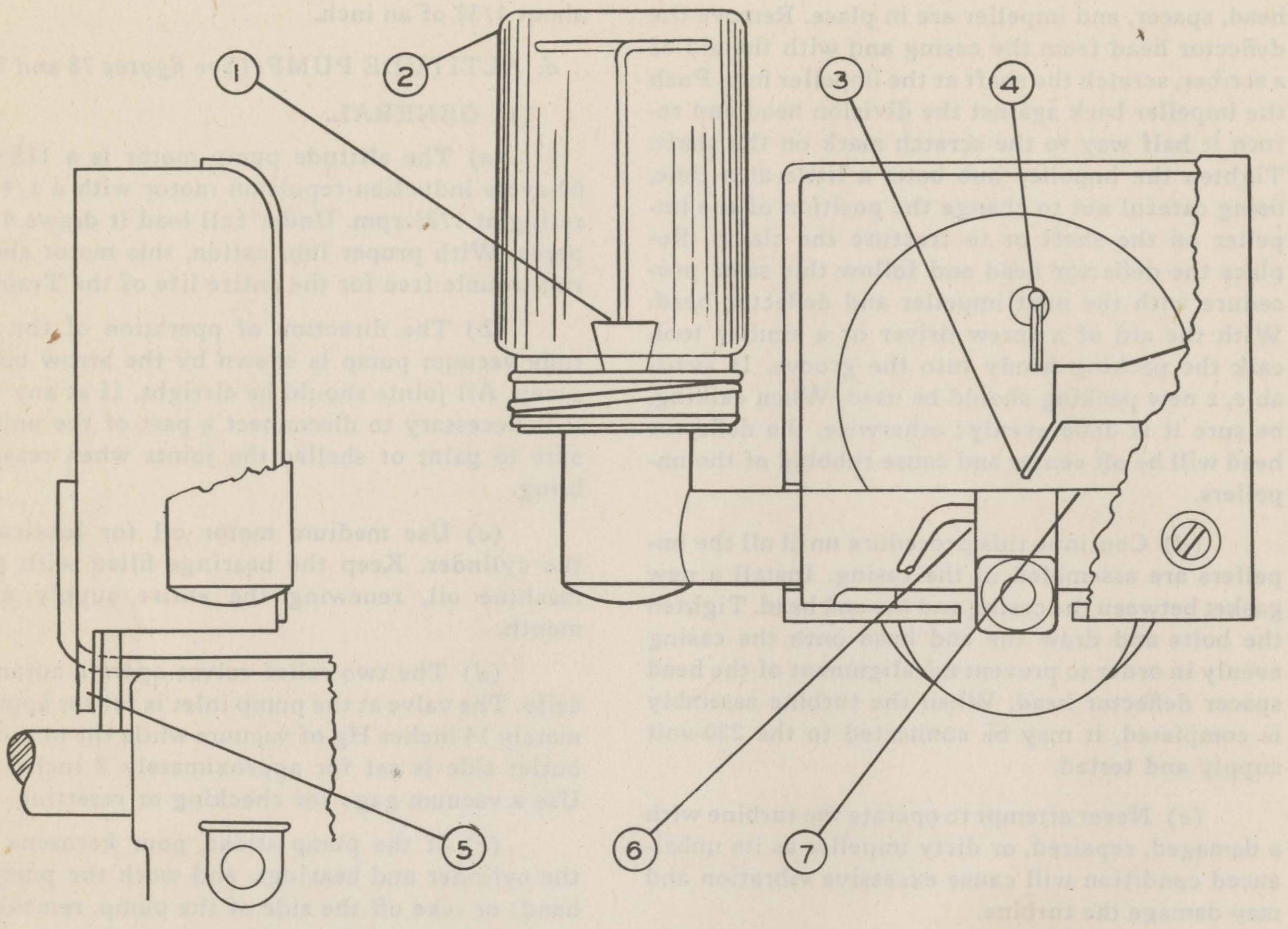


Figure 150—Instructions for C-182 Automatic Oiler

1. *This valve prevents oil running out of jar when handling.*
2. *Fill jar with medium vicosity oil (SAE 30) when empty. Feed will remain constant regardless of height of oil in jar.*
3. *Oil can be observed dropping from this point.*
4. *Eccentrically mounted dip pin can be adjusted away from wheel center to increase oil feed, and toward center to decrease feed.*
5. *Driving wheel rides lightly on pump shaft.*
6. *Oil is sucked into pump by tube from this point.*
7. *Constant level oil trough.*

(*c*) A change of cheese cloth will last perhaps a week or several months, depending on the service.

(*d*) If the pump appears to lose its blowing or suction power after running for a while, check all plumbing and the oil supply. If the filter is dirty or badly oil-soaked, it may be causing a back pressure, and should be changed.

(*e*) If the cheese cloth becomes saturated with oil too quickly, it is an indication that too much oil is being fed to the pump.

(*f*) The drain cock on the separator should be opened slightly to permit the oil to drain continuously.

e. TURNING MOTORS AND BELTS. (*See figures 73 and 74.*)

(1) The turning motors should be visually inspected for the following points:

(*a*) Both hoses connected.

(*b*) No holes in bellows.

(*c*) No loose or missing patches on bellows.

(*d*) No slide valve springs missing.

(*e*) No leather or composition nuts missing.

(*f*) Valves all in place and working properly.

(*g*) Valve seats well graphited (no bare wood showing).

(*h*) Connecting rods not binding.

(*i*) Crankshaft pinion gears on tight, and properly meshed with the drive gear.

(2) If wear occurs in the connecting rods, remove the screw and thin washer. Washers of the proper thickness can be made of standard brass shim stock.

CAUTION

Make sure there is absolutely no bind, as even a slight amount will cause the motor to run unevenly. It is better to have the rods too loose than too tight. If squeaking occurs in the bearing of these rods, a single drop of oil may be applied.

(3) Lubricate the valves by unscrewing the leather nut where the valve rod connects to the connecting rod, unhook the coil spring and remove the valve. Dip a damp rag into powdered graphite and rub the graphite well into the wood on the face of the valve. Fasten a rag to a stick and repeat this operation to lubricate the sliding valve seats. Do not use oil on these valves. Graphite at least every 50 hours of operation; more often if squeaking occurs, or if wood shows through the graphite. Do not lubricate other parts with too much oil or grease as there is danger of oil being thrown on the slide valves.

(4) Timing the opening of the slide valves is accomplished with two leather or composition nuts which position the slide valve yoke on the valve rod. The valve should start to open, and the bellows fabric should start to move just as the connecting rod passes dead center. This adjustment should not be disturbed while graphiting the valves.

(5) The gears should be greased lightly every 100 hours. Ball bearings are of the sealed type and do not require lubrication. Do not allow any oil to get on the bellows. (See Lubrication Chart, figure 155.)

(6) The belt tightener (figure 75) should be tightened enough so that the motors will turn the Trainer promptly. Cleaning the belts periodically with a clean cloth soaked in carbon tetrachloride will aid in minimizing belt slippage.

f. WIND DRIFT MECHANISM.

(1) GENERAL.

(*a*) The mechanical parts within the wind drift mechanism case, which compose the wind triangle, should not require servicing. Once the unit is installed, the mechanism should function satisfactorily until it wears out. All bearings are either oilite or provided with lubricant sufficient for the life of the unit. In the event of failure or fracture of any particular piece in the internal mechanism, the entire wind drift case should be returned to the main depot for replacement.

(*b*) The electrical units, such as the rotary switch for air-speed control or the teletorque circuits may, however, be serviced by any electrician who has had experience with these units. Should the teletorque units themselves fail to function, they may be replaced with new units and correctly synchronized.

(2) ORIGINAL ADJUSTMENTS.

(*a*) Adjustment checks on the input elements; that is, wind direction, wind speed, and true air speed, should be made periodically. Basic adjustment checks on the input elements to the wind drift mechanism precede checks on the output elements. For the information of the maintenance personnel, the following original adjustments and tolerances are given:

CAUTION

Do not make these adjustments unless absolutely necessary and after careful thought.

1. Inspect and check wiring.

2. Synchronize the wind speed input by centering the wind pivot, disconnect the flexible drive from the wind speed indicator, set the indicator to zero and reconnect. The center is checked by revolving the wind heading through 360 degrees and noting the movement of the air-speed pinion (tolerance ± 1 gear tooth). The center is adjusted by moving the stop collar on the low end of the wind speed input bar.

3. Synchronize the wind direction input by aligning the wind bar with the air-speed bar and so that it lies beneath the wind bar when the Trainer is locked on an east heading. Disconnect the wind direction flexible drive, rotate the indicator to 270 degrees, and reconnect.

4. Check the air-speed slide at "cruising" with the true air-speed control at zero. The slide should be 15/16 of an inch from the stop at a speed of 160 units per hour. Adjust by rotating the teletorque receiver in the mounting collar. The follow-

up switch must be checked for operation. The contact pressure may be changed by varying the spring tension. The contact surface may be rotated slightly to increase the overlap which changes the "hunting" of the follow-up motor. If the contact binds on the notch, use a fine emery paper to smooth the contact.

5. As a check against the rate of recorder travel, run the recorder for 10 minutes at cruising air speed (slide 15/16 of an inch from the stop, air speed frozen by insulating the points of the air-speed relay). Check the wind speed, true air speed, and indicated air-speed controls for zero. The distance of recorder travel should measure 3.38 inches.

6. If the distance traveled is not correct, adjustment may be made by adjusting the length of the ground speed link rod (figure 62), moving the ground speed wheel towards the rim of the ground speed plate in order to increase the rate of travel, or moving it in towards the center of the plate in order to decrease the rate of travel.

WARNING

The air-speed output check should not be made until the wind drift mechanism has been checked for wind speed and true air-speed inputs.

(3) GROUND SPEED GEARING.

(*a*) Wind drift ground speed plate—6 rpm.

(*b*) Wind drift ground speed take-off wheel —1.575 inches (statute mph).

(*c*) Terrain projection plate drive wheels—1.425 inches to 1.428 inches, geared 60 to 1.

(*d*) Recorder drive wheels—11/16 of an inch, geared 80 to 1.

g. BOMB HIT MECHANISM. (*See figure* 82.)

(1) HIT PROJECTOR.

(*a*) The hit projector should be checked for proper focus. Adjustment is made by sliding the focusing tube in or out as necessary, in order to obtain a sharp target on the screen.

(*b*) The position of the target should be checked as follows: With the Trainer locked on an east heading, introduce 20, 40, and 60 miles per hour winds from the north and south respectively. Note, after setting the bomb sight up correctly, at what points the objects aimed at cross the longitudinal axis on the screen. These points may not be the same for all winds, but all of them should be close enough so that the hit projector may be adjusted to the average of these points and still insure "hits" for any amount of wind. After determining the average point on the screen, adjust screw (A) so that the flash occurs on the longitudinal axis, and adjust screw (B) so that the flash occurs on the point desired. This adjustment should serve for all types of bombs and for any wind. The adjustment should be checked weekly.

(2) HIT TIMER.—This mechanism should not require any maintenance. However, to prevent damage to the contacts, never set the timer for less than 5 seconds nor more than 55 seconds time of fall. Keep the contacts clean.

(3) SOLENOID.—If trouble develops in the solenoid, check the coil for proper resistance. (See Electrical Resistance Tables, figure 156.) If the coil is burned out, replace it. Check the spring for adequate plunger travel.

(4) AIR-SPEED FREEZING RELAY.—The same trouble may be found to exist in this unit as in the solenoid (burned out coil). Check and replace it if necessary. Keep the relay contacts clean.

h. INSTRUMENT TAKE-OFF. — This unit does not require any maintenance or adjustment after the original installation. If proven to be faulty, replace it with a new unit from the depot.

i. INSTRUMENT DRIVE.—This assembly is lubricated and adjusted at the factory and should not require any attention during the life of the Trainer. In case repairs are necessary, the unit should be returned to the main depot.

j. COMPASS VARIATION SETTING CONTROL.—There are not any moving parts in this assembly so maintenance should not be necessary.

k. TOWER LOCKING DEVICE. (*See figure* 76.)—The plunger, located at the base of the tower and engaging the lug on the base, should be checked periodically for proper operation. The cable should be checked for condition and tension. The spring tension at the plunger should also be checked to insure that it is giving the plunger full action.

l. CLOUD PROJECTOR.—The maintenance of the cloud projector corresponds to that of the terrain projector, cleanliness being the important factor. The adjustment for focus and maximum illumination is the same as that for the terrain projector. (See section V, par. 3s.) The plate should also be checked to see that it runs freely on its guides.

m. PROJECTOR SCREEN. (*See figure* 70.)

(1) The projector screen requires no further adjustment after the original installation. Small holes may be patched in a similar manner as that used in patching any doped fabric surfaces. The screen should be cleaned by using a soft brush or broom as often as necessary.

(2) The screen will, of course, get dirty in time. Washing with **neutral soap** and **water** is perfectly satisfactory and should not damage the fabric in any way. In order to clean the screen, it may be necessary to remove it from the tower.

5. TERRAIN MECHANISM.
(*See figure* 87.)

a. AZIMUTH RAIL.

(1) In the original installation, the azimuth rail was secured to the floor so that its center was on the axis of rotation of the Trainer tower; or in other words, directly below the zenith of the rail. The line through the center point and the zero graduation is parallel to and directly underneath the dome rail. The azimuth rail itself is level.

(2) To check the alignment and level of the rail, proceed as follows:

(*a*) The 360°–180°, and the 90°–270° graduations should line up with the north-south and east-west lines, respectively, on the Trainer floor.

(*b*) Place a spirit level on the rail, and, if necessary, adjust the leveling screws.

(3) The above steps are merely checks, and adjustment should not be necessary as this is a semi-permanent installation.

b. TERRAIN BASE FRAME.

(1) The projector frame rides the azimuth rail on rollers which are provided with an eccentric adjustment. Although it is unlikely that the terrain mechanism will change position after the original adjustment, a periodic check should be made as follows:

(*a*) Check the plate rollers for freedom of movement and alignment of plate travel, being sure that the plate bears evenly on all of the rollers. Adjust eccentric rollers if necessary.

(*b*) Ascertain plate levelness by placing a level on the terrain projection plate and rotating the frame through 360 degrees on the azimuth rail. Note that the plate clearance from the collector ring assembly should not exceed 1/4 of an inch. Adjust the leg rollers for frame levelness, making final adjustment for plate levelness by means of the eccentric rollers on the plate carriage.

(*c*) Be sure that the azimuth pointer is in the center position of the frame.

(*d*) Check the tension and position of the pawl which engages the teeth of the azimuth rail.

(2) The azimuth rail rollers and the entire mechanism should be checked for cleanliness daily, and given a thorough cleaning periodically.

c. TERRAIN PROJECTOR. (*See figure* 90.)—The terrain projector should require no further adjustment after the original installation. The focus lens (located in the main bearing housing) should be kept spotless at all times. A soft material such as kleenex is ideal for the purpose. The optical system, including the focus lens, should be cleaned only when it becomes dusty. The lens will become excessively scratched by too frequent cleaning.

6. CONTROL DESK.

a. RECORDER. (*See figure* 106.)

(1) ALIGNMENT.

(*a*) GENERAL.

1. The recorder should be tested and adjusted periodically (or whenever a need is indicated) for alignment and proper tracking.

2. To check the alignment of the drive wheels, place a straightedge against them. (See figure 151.) Both wheels should be flat against the straightedge. If not, loosen the setscrew in one of the three large gears which are mounted on vertical shafts, turn the shaft so both wheels are flat against the straightedge and tighten the setscrew. To align the inking wheel, place the straightedge against one of the drive wheels and the inking wheel (figure 152). Again, the two wheels should be flat against the straightedge. While this latter alignment is not mathematically exact because of the difference in thickness of the drive wheel and inking wheel, it is sufficiently accurate for practical purposes.

3. The pointer must be exactly in line with the inking wheel. Place the straightedge tightly against the two drive wheels. Set the pointer so that it is exactly on 90 degrees (or 270 degrees) and pointed in the direction of the inking wheel travel.

4. The driving teletorques obtain current through slip rings located above the motors. These

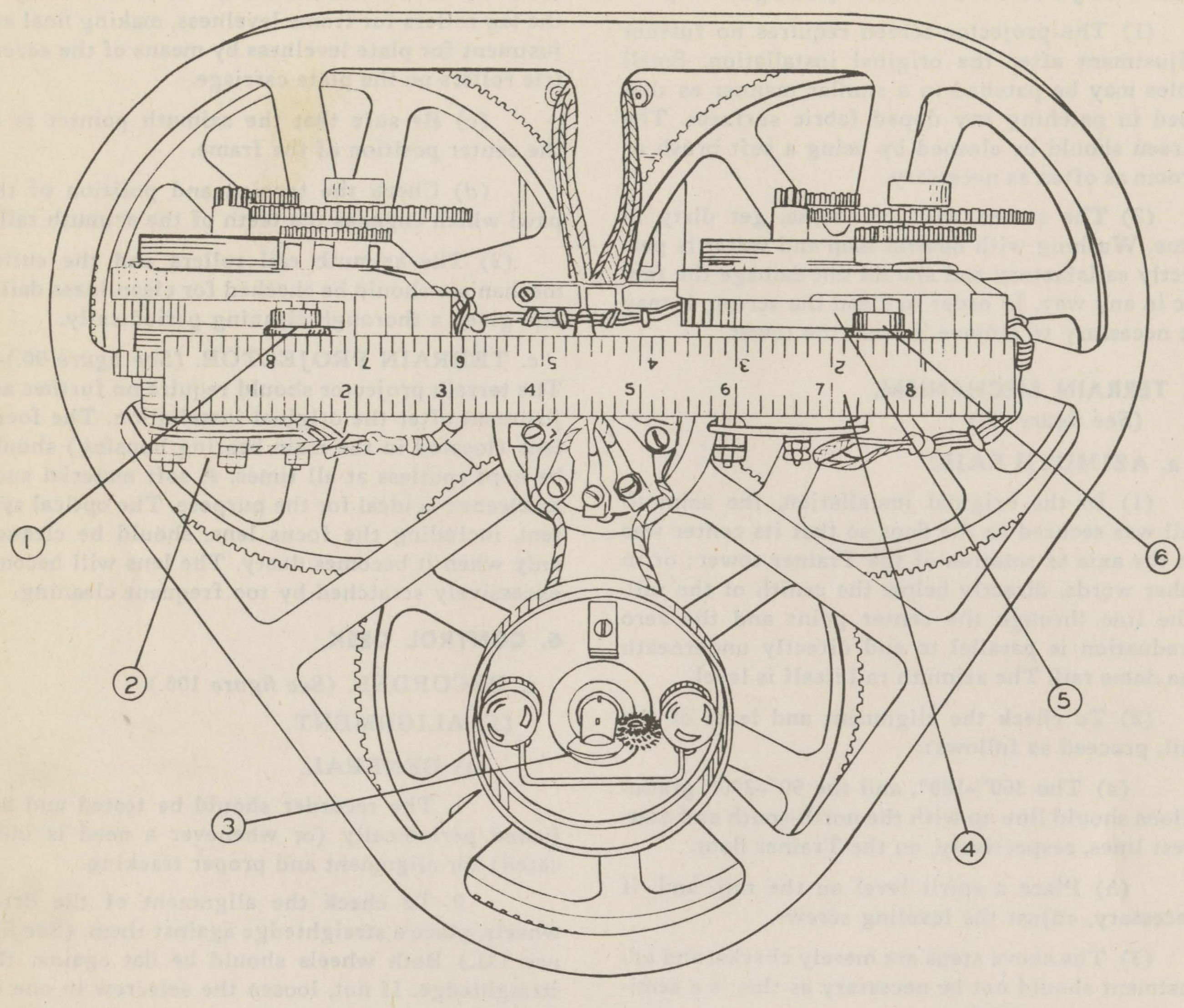


Figure 151—Aligning Both Drive Wheels

1. *Teletorque Drive Wheel*
2. *Teletorque*
3. *Inking Wheel*
4. *Straightedge*
5. *Teletorque*
6. *Teletorque Drive Wheel*

rings and brushes must be kept clean and the brushes firmly pressed against the rings.

5. If the recorder is pressed hard against the desk, bumped against the desk, or otherwise roughly handled, the drive wheels will be sprung out of line. If this occurs, the recorder will draw non-parallel lines in reciprocal headings, and circles of unequal diameter in opposite directions. This is caused by displacing the drive wheels from their proper positions; i.e. their point of contact on the map exactly under the center of the vertical spindle.

(*b*) TEST TRACK.

1. To check for wheel alignment, with the Trainer locked on its east heading, turn on the navigation and time switches and let the recorder run for 5 or 6 minutes. (The turbine need not be running.) Then unlock the Trainer by raising the locking plunger and walk the Trainer tower around exactly 180 degrees, using the base as a reference. Allow it to run for another 5 minutes, then turn **back** to the previous heading, walking the tower around as before. All three tracks should be paral-

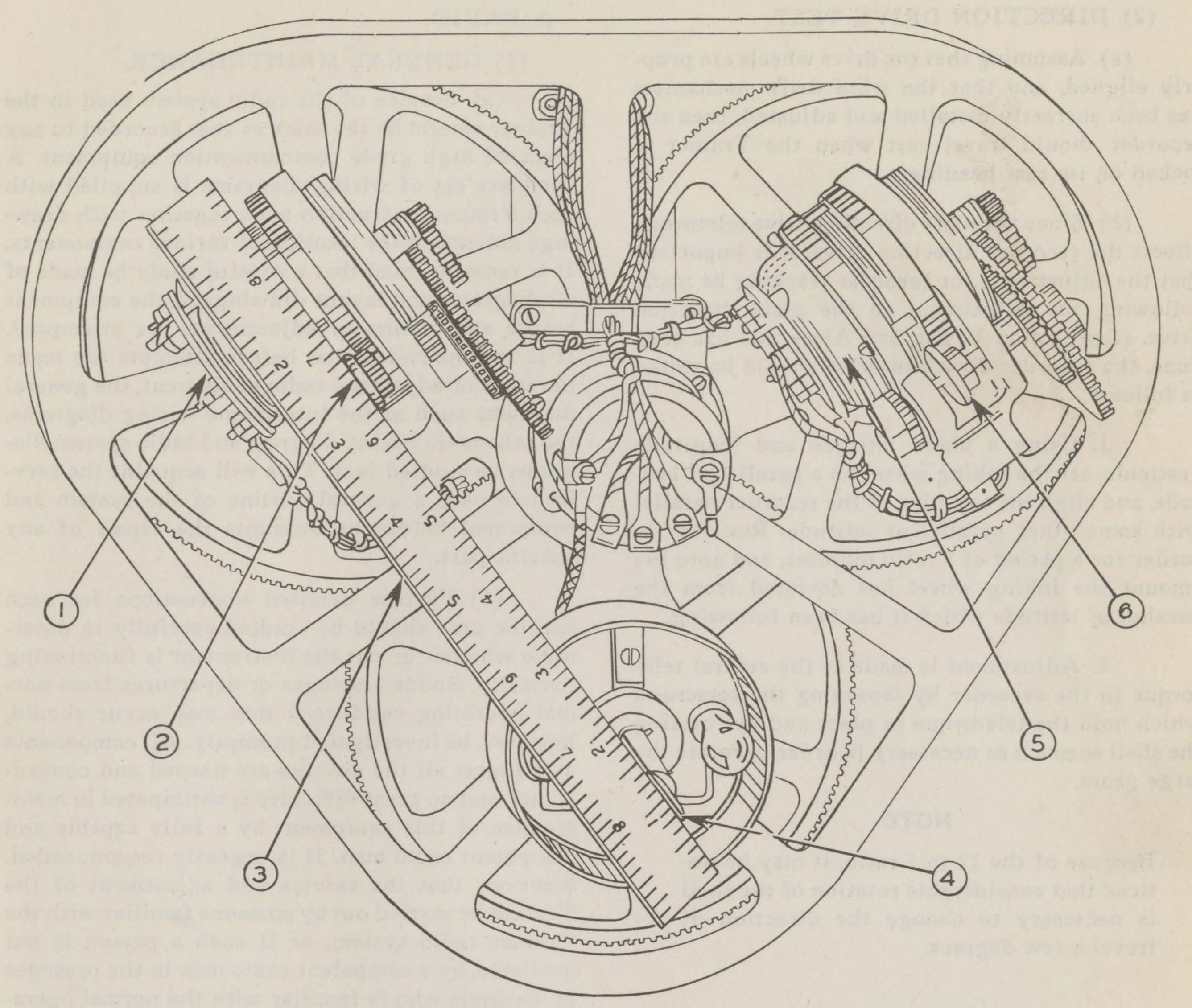


Figure 152—Aligning One Drive Wheel and Inking Wheel

1. *Teletorque*
2. *Teletorque Drive Wheel*
3. *Straightedge*
4. *Inking Wheel*
5. *Teletorque*
6. *Teletorque Drive Wheel*

lel within 1/32 of an inch in 6 inches, and the same distance apart within 1/32 of an inch. In making this test, do not attempt to fly the Trainer around the turns, or to do it by the turn indicator. Errors in the indicator and inaccuracy of execution would make the results undependable.

2. The rate at which these turns are made is not especially important. It is important that the rate be the same in both directions. This can be done quite accurately by stepping the tower around, timing the steps with a stop watch at, for example, one step per second.

3. If the test track is not within limits, one or two other tracks should be run in order to make sure that the fault is in the recorder and not in the operator's technique.

4. If the two outside lines are parallel and the middle one is not, one of the drive wheels is not centered. If the lines are parallel but not equally spaced, both wheels are off center.

5. If the wheels are not centered beneath their axis of rotation, the recorder should be returned to the main depot for repair.

(2) DIRECTION DRIVE TEST.

(*a*) Assuming that the drive wheels are properly aligned, and that the wind drift mechanism has been correctly installed and adjusted, then the recorder should travel east when the Trainer is locked on its east heading.

(*b*) Since the plate direction drive teletorque affects the recorder direction drive, it is important that the adjustment for recorder tracking be made following the adjustment to the plate direction drive. (See section V, par. 3*s*.) After this has been done, the recorder direction drive should be tested as follows:

1. Using a blank latitude and longitude graticule, set the inking wheel on a parallel of latitude, and align the top edge of the recorder parallel with some other parallel of latitude. Run the recorder for a period of 5 to 10 minutes, and note the amount the inking wheel has deviated from the parallel of latitude which it has been following.

2. Adjustment is made at the central teletorque in the recorder by loosening the setscrews which hold the teletorque in place and by rotating the shell as much as necessary in order to rotate the large gears.

NOTE

Because of the 12 to 1 ratio, it may be noticed that considerable rotation of the shell is necessary to change the direction of travel a few degrees.

CAUTION

Be sure that the wind bar in the wind drift mechanism is at zero as described. (See section V, par. 3*r*.)

(3) RECORDER SPEED TEST.—The plate speed as well as the recorder speed is determined by the ground speed output of the wind drift mechanism. With the wind speed control at zero and the throttle set to cruising, the ground speed drive wheel should be riding 1-1/2 inches from the center of the rubber-faced ground speed plate. Assuming that basic adjustment to the air-speed slide in the wind drift mechanism has been made, the position of the ground speed drive wheel with respect to the center of the plate may be altered by lengthening or shortening the ground speed link rod.

b. RADIO.

(1) GENERAL MAINTENANCE.

(*a*) Service of the radio system used in the Trainer should be the same as that accorded to any piece of high grade communication equipment. A complete set of wiring diagrams is supplied with each Trainer instruction book together with drawings indicating the location of various components. It is recommended that a careful study be made of all diagrams and layout drawings of the equipment before any repairs or adjustments are attempted. It is recommended that before attempts are made to repair or adjust the radio equipment, the general diagrams such as the interphone wiring diagrams, the schematic wiring diagram and radio system diagrams be studied first. This will acquaint the serviceman with a general outline of the system and equipment before he attempts the repair of any specific part.

(*b*) Further detailed instructions for each specific unit should be studied carefully to determine whether or not the instrument is functioning normally. Sudden changes or departures from normal operating conditions that may occur should, however, be investigated promptly. All components and almost all the circuits are normal and conventional, and no great difficulty is anticipated in maintenance of this equipment by a fully capable and competent radio man. It is urgently recommended, however, that the service and adjustment of the Trainer be carried out by someone familiar with the Trainer radio system, or if such a person is not available, by a competent radio man in the presence of someone who is familiar with the normal operation of the Trainer radio system. Haphazard repairs or adjustments without the use of a complete set of diagrams, or proper tools, or by untrained personnel are to be discouraged.

(*c*) In general, service should be sub-divided as follows:

1. Visual inspection.
2. Electrical and mechanical check.
3. Repair.
4. Recheck and final test.

(*d*) For visual inspection, units should be removed and inspected both on the top side and the under side for damaged or burned components, loose wires, connections, or mechanically deformed parts. If a visual inspection reveals no information, the serviceman should continue with electrical tests.

This is usually performed with a voltmeter, ohmmeter, or similar apparatus, having at hand at all times a wiring diagram and whatever additional information may be helpful for reference. Preceding this, however, the tubes should first be removed, wiped clean, and then checked. It is essential that service work on equipment using electronic tubes be done in this manner, because a defective tube may cause a condition which would make it appear that there were several things very seriously wrong throughout the entire piece of equipment; whereas, it may be actually but one tube. If a tube checker is not available it is recommended that a complete set of tubes known to be in good operating condition replace the set of tubes in the instrument, and then a check be made to see if this cures the difficulty. Failing this, the serviceman should make an actual test with the voltmeter and ohmmeter. This step will usually reveal the nature of the fault, and then steps should be taken to determine whether or not the unit under test itself is at fault, or whether or not its condition may be caused by some unit to which it is interconnected. Having definitely established the location of the fault, the next step is repair. Almost all parts used in the radio are commercially available. Reference should be made to the wiring diagrams for the size and capacity of the component before replacement is made.

(*e*) All repairs and replacements should be made with due care. Parts of the radio are necessarily crowded and compact. In replacing parts under these conditions, extreme care must be exercised not to damage an adjacent part while repairing another part. Particular care should be exercised in crowded quarters not to burn the insulation on the wires with a soldering iron while soldering a connection. All repairs should be made neatly and securely to obviate the necessity of re-servicing a part because of the fact that the original job was not carefully done. Check with a voltmeter or ohmmeter before returning the unit. The unit should then be reinstalled in its proper place and the performance of the system checked by someone who is familiar with the correct performance. Any difficulty encountered in the service of the Trainer radio system which is not readily corrected should be referred to the service department at the factory for further information.

(2) CONTROL CHASSIS.

(*a*) In the event of the failure of any part or parts of the system, it is recommended that the tubes first be removed and checked. Any tube that checks within plus or minus 10% of normal may be used. Relays are to be afforded the same type of maintenance as is accorded any relay. It has been found that the relays used in the control chassis, if stored unoperated for long periods of time, will suffer from contact oxidization. Before any attempt is made at repair of a relay, however, the relay should be carefully inspected for mechanical distortion, making sure that the contact springs actually close. If they appear too close mechanically, but not electrically, the contacts may be cleaned.

(*b*) Because of the small surface area of contacts and the small amount of contact material contained in them, the cleaning of contacts should be done carefully. It is essential that no grade of abrasive coarser than crocus cloth be used in cleaning relay contacts. Using a coarser grade than crocus cloth is apt to damage the relay to such an extent that it may not be repaired.

(3) ADJUSTMENT OF BEAM SHIFT AND BEAM SHIFT CENTERING CONTROLS. (*See figures* 97 *and* 100.)—The beam shift centering controls are to be adjusted in the following manner:

(*a*) With the Trainer radio master switch "on," tune the receiver to the transmitter to be tested. Place the modulation selector switch on "range" and the beam shift control on "0." This setting should produce a steady "on-course" signal. By shifting to the "A" or "N" side of the beam shift, the "A" or "N" should begin to rise out of the "on-course" tone between graduations "one" and "three" on the dial. The "on-course" signal should be heard through an equal distance on either side of "0."

(*b*) The beam shift controls have an "A-N" centering adjustment on the control chassis for each transmitter. This adjustment is a 50,000-ohm center tap variable resistor to control the "A," "N," and "on-course" signal proportion. The "A" signal should come in clearly (without any solid background of tone) at about "10" when the beam shift is turned to the left, and the "N" when the pointer on the beam shift is turned past "0" to the right to an equal setting. If the "on-course" signal is not centered at the "0" setting, a slight change in the centering adjustment should be made. Loosen the lock nut slightly and shift the centering adjustment until the "on-course" signal is centered at "0" and then tighten the nut.

(4) SERVICE AND ADJUSTMENTS TO THE RADIO RANGE KEYER.
(*See figures* 99, 100, *and* 101.)

(*a*) GENERAL.—This unit requires very little attention beyond keeping it clean, and periodic lubrication.

(*b*) CLEANING AND LUBRICATION.

1. A good grade of gun oil or light machine oil should be used. A small drop should be applied to each moving part, except cams and cam followers, and any excess should be wiped off. Each gear should receive a drop of oil which will distribute itself as the gear rotates. Occasionally, the motor bearings should be removed, wiped clean and a little oil applied and worked in. Care should be taken to avoid excess oil.

2. The only cleaning required by the contact points is to occasionally slide a strip of ordinary hard surface writing paper between them.

CAUTION

The knurled knob on the extreme right-hand end of the keyer is part of the cam shaft assembly bearing pin and has a LEFT-HAND THREAD. To remove, it must be turned to the RIGHT. The cam shaft or gears should never be turned backwards by hand because of danger of damaging cam followers.

(*c*) ADJUSTMENT OF CONTACTS.

1. One of the A-N points should make contact just as the other is breaking. There should be no overlap, yet there must be no interval between the opening of one contact and the closing of the other.

2. Both fixed contacts should just barely be touching the movable contact when the cam follower is half way between the high and low parts of the cam. Another check on the adjustment is to make sure that when the follower is at the low part of the cam, the fixed point which is making contact is pushed away from the adjusting screw head the same distance as the other movable contact is from its screw head, when the follower is on the high part of the cam.

3. The final test is to listen to the signal with the "beam shift control" in the "on-course" position and the "beam" volume set at about "60." No clicks should be heard. If the "on-course" signal is not an even tone, back off one of the A-N contact adjusting screws until there is a definite break in the signal; then screw it in again until the key click just disappears.

4. All other contacts should be adjusted so there is an air gap of 1/32 of an inch between the points when the cam follower is on the highest part of the cam.

(*d*) TIMING OF CAMS ON CAM SHAFT ASSEMBLY.

1. If the cams are removed and replaced, it is necessary that the spacing between the cams be established as before. Each cam has a spot drilled in one side to assist in timing. Ordinarily the cam is placed on the shaft with this spot away from the gear. There are two keyways in each cam so it is necessary to know which one to use. Each cam must use the keyway which, when the spot on one cam lines up with the follower of that cam, permits all **other** spots to line up with **their** respective cam followers. Since the cam followers are staggered, the spots will also be staggered.

2. In some cases, one cam will produce a different pair of call letters if it is reversed. To do this, simply turn the cam over so the spot is toward the gear, but with the spot still lined up with its own cam follower.

(*e*) ADJUSTMENT OF MOTOR POSITION AND DRIVE GEARS.

1. If the motor should be removed for any reason, or its clamp screws should become loosened, it will be necessary to adjust its position to obtain proper mesh between the gear on the cam shaft and the heavy pinion which drives it.

2. The motor mounting screws are in slots which permit the motor and gear train to be raised or lowered as a unit. This unit should be raised or lowered as necessary to make the cam shaft gear and its drive pinion mesh without undue slack, and yet without binding. The pivot of the small reduction gear also moves up or down with the motor assembly, in a slot in the keyer frame. Care should be exercised to avoid damage to this pivot, while making adjustments.

CAUTION

Do not make unnecessary adjustments. The design and material of this unit are such that adjustments will seldom be necessary if it is not disturbed other than by cleaning, lubricating and normal handling in changing cam assemblies.

(5) SERVICE AND ADJUSTMENT OF TRANSMITTERS. (*See figures* 96 *and* 97.)

(*a*) Any failure of transmitter operation should first be checked by removing the tube and checking it or replacing it with a tube known to be in operating condition. Should the fault appear that a carrier is heard but no modulation in any position of the modulation selector switch, the difficulty may also lie in the control chassis. Modulation voltages may be measured directly at the control grid cap of the "6K8" oscillator tube. This voltage should be between 15 volts and 21 volts when the transmitter volume control is on the full volume position. Following the replacement of a tube in one of the transmitters, it may be noticed that the transmitter frequency dial is no longer true in calibration. Should this be found, proceed as follows:

(*b*) Turn the radio system on, tune the receiver to 400 kc, set the transmitter dial to 400 kc and by means of a screw driver, adjust the trimmer condensers (C-4) located on the left side of the transmitters. Should it be found that the replacement of a tube has varied the spot tuning frequency of 278 kc proceed as follows to rectify this condition: Turn the system on, tune the radio receiver to 278 kc. A spot marked on the dial indicates this precise frequency. Set the modulation selector switch at the control tower position and with a screw driver adjust condensers (C-6) until maximum volume is heard in the headphones. These adjustments may be made by one man without assistance as the output of the radio receiver is heard at all times by the instructor at the desk.

(6) ADJUSTMENTS TO THE POWER SUPPLY. (*See figures* 102 *and* 103, *and wiring diagram, figure* 200.)—If the plate voltage of the radio is questioned it may be measured between terminal (3, +) and terminal (1, −) of the Jones plug on the radio power supply. The voltage should be 250 under full load (64 ma). If this voltage is not obtained, adjust resistor No. 10378 until 250 volts appear at terminals (1) and (5) under full load conditions. A dummy load resistor of 3900 ohms and 20 watt rating may be used between terminals (1) and (3) if it is not convenient to use the load of the radio system while making the adjustment.

NOTE

Check the rectifier tube and transformer voltages before making any adjustment.

(7) ADJUSTMENT OF TRANSMITTER GONIOMETER UNITS.

(*a*) Place the azimuth control of the transmitter unit on zero and check the mechanical stop position. The control should be rotatable from zero around and slightly through zero. If this is not true, loosen the Bristo setscrew fastening the azimuth control to the shaft and rotate it until the above is true. Reset the Bristo setscrew.

(*b*) With the azimuth control on zero, loosen the goniometer rotor drive pulley from the rotor shaft, and rotate the goniometer rotor until it lines up with the longitudinal stator coils of the unit. Refasten the pulley to the goniometer shaft. Care should be taken not to stress the wired connections to the rotor.

NOTE

The same effect may be obtained by loosening the setscrew holding the goniometer rotor loop to the rotor shaft, rotating the rotor, and refastening the setscrew.

(*c*) Place one station on 200 kc and the other on 400 kc. Set the radio up for range. (An "on-course" signal is preferable although an "A" on one transmitter and an "N" on the other may be desired for differentiation between stations.)

(*d*) Drive the loop motor until a null is obtained on one station. Switch the receiving frequency to the other station and adjust, by loosening the setscrew, fastening the transmitter goniometer rotor to the rotor drive shaft and turning the rotor slightly on the shaft, until the previous loop azimuth control setting also yields a null for this station.

NOTE

Navy DZ-2 installations require the loop azimuth to be driven manually.

(*e*) The transmitter goniometer units are now synchronized.

(8) SYNCHRONIZING THE PICK-UP GONIOMETER UNIT WITH TRAINER.—To synchronize the pick-up goniometer with the SCR-269-A receiver see installation instructions. (See section V, par. 3*x*.)

(9) SENSING ADJUSTMENT.

(*a*) Lock the Trainer on the east heading and set the transmitter azimuth control at zero.

NOTE

The azimuth setting on the transmitter control is the bearing of the station **from** the plane. Obtain a null at 270 degrees on the loop azimuth control and switch to "sense" on the receiver. Note the signal strength. Increase the loop azimuth reading by 90 degrees (now reading zero degrees) and note the change in signal strength. If there has been an increase, "sense" is properly set up. If there was a decrease in signal strength, turn the Trainer master switch "off" and rotate the pick-up goniometer unit as nearly as possible through 180 degrees. Turn the master switch on and check. A "build" should now be obtained upon switching to "sense" and increasing loop azimuth reading by 90 degrees.

(*b*) With the station azimuth on zero and "sense" correctly adjusted, note that with the receiver antenna switch on "sense" there are either two minima near a loop azimuth setting of zero, or one minimum on zero. In the latter case the omni-directional antenna signal strength is all right; however, in the former case, the coupling between the omni-directional antenna and the plate lead of the transmitter oscillator is too loose. In this case move the omni-directional antenna closer to the plate lead and check again for a double null as above. Proper adjustment is achieved when a fairly sharp single minimum exists as explained above. Too close coupling vill lead to unrecognizable builds and fades when using the "sensing" procedure.

(10) TRANSMITTER GONIOMETER CORRECTION TABLE.

(*a*) It will be found that bearings taken with the loop azimuth control will differ a few degrees from the correct relative bearing on station azimuth and heading combinations other than that heading and station azimuth used in synchronizing the loop azimuth control and transmitter goniometer units, i. e., 90 degrees and zero degrees. In order to eliminate this error, a correction table may be determined giving the azimuth setting for the desired azimuth. The table may be constructed as shown (using figures taken from an actual installation) or a card may be placed under the azimuth control knob and marked to eliminate this error.

LEFT TRANSMITTER		RIGHT TRANSMITTER	
Desired Azimuth	*Azimuth Setting*	*Desired Azimuth*	*Azimuth Setting*
0°	02°	0°	0°
20	22	20	20
40	43	40	40
340	342	340	340

(*b*) In order to determine the transmitter goniometer azimuth error, the Trainer heading must be known. This is accomplished in the following procedure by locking the Trainer on the east heading. When the Trainer is locked on the east heading it is apparent that the transmitter azimuth is 90 degrees more than the relative bearing as taken from the loop azimuth reading when a null has been obtained in the loop. Therefore, if a null is obtained by shifting the transmitter azimuth control and leaving the loop azimuth control on a fixed known bearing, the desired station azimuth may be determined by adding 90 degrees to the loop azimuth reading (remembering that the Trainer has a 90-degree heading). Thus the necessary transmitter azimuth setting may be determined to yield the desired "azimuth setting" in order to obtain a null with the loop azimuth control fixed. Therefore, the data for a table as described previously may be taken as follows:

1. Lock the Trainer on the east heading.
2. Set the transmitter that is to be used on "range" position, using a steady "on-course" signal.
3. Tune the receiver and place the antenna on loop.
4. Drive the loop to 270 degrees and find a null with the transmitter azimuth control near or on zero degrees.
5. Record the transmitter azimuth control setting which yielded the null, as transmitter azimuth setting.
6. To the loop azimuth dial reading add 90 degrees and record this as desired azimuth setting.
7. Proceed for loop azimuth settings every 10 or 20 degrees, and through 360 degrees. As the loop azimuth control is advanced, the transmitter azimuth control must of course be advanced a corresponding amount to obtain a null.
8. When the table has been completed for one transmitter, proceed in the same manner for the other transmitter.

CELESTIAL NAVIGATION TRAINER

DAILY INSPECTION SHEET

TRAINER NO. ______ STATION ______ DATE ______

(A) DOME AND CONTROLS

Clean and Oil Dome Rail.

Check Operation of Dome Reset.

" " " Time Drive.

" " " Long. Drive.

" " " Lat. Drive.

Synchronize Lat. Indicator.

" LHA Aries Indicator.

(B) D.R. TRAINER

Clean Plate Guides.

Clean Azimuth Rail.

Clean Projection Lenses and Mirror. (Soft Cleaning Tissue)

Check Altitude Pump. (Oil Reservoir and Filter)

Wind-Drift Mechanism. (Check A/S Slide for 15/16" -at 160 Units Indicated A/S)

(C) FUSELAGE AND INSTRUMENTS

Clean Bleed Holes (5).

"Zero" V/S Indicator.

"Zero" Altimeter.

Conduct Leak Test (100'-5 Min)

Check V/S at Full Throttle, (At 0' Alt.; V/S 550 ± 50').

MANIFOLD PRESSURE
1. Cruising; 0' Alt.;29" ± 1"
2. Full Throttle;" ;38.5± 1"
3. Cruising;10,000' ;24" ± 1"
4. Full Throttle " ;33.5± 1"

TACHOMETER
1. Cruising;Hi.P.;1900±50 RPM
2. " ;Low P;2500±50 RPM
3. Closed Throttle; Low P; 500±50 RPM

AIRSPEED
1. IAS Control "0"; IAS "0"
2. Cruising - - - - IAS 160±3
3. Throttle Open- - IAS 180±3

FLIGHT CHECK
1. Turn Rate.
2. Max. Climb; Max. Dive.
3. Compass Deflector- (Operation and Amt.)
4. Turn Motor Smoothness.
5. Instrument Smoothness.
6. Full and Proper Control Actions.
7. Automatic Features.
8. Radio; Phones; Lights.

REMARKS: ______

INSPECTED BY ______

Figure 153—Daily Inspection Form

CELESTIAL NAVIGATION TRAINER

WEEKLY INSPECTION SHEET

TRAINER NO.__________ STATION__________ DATE__________

CELESTIAL MECHANISM	
(A) Daily Check	
1. Clean and oil dome rail.	
2. Operation of dome reset.	
3. Operation of time drive.	
4. Operation of longitude drive.	
5. Operation of latitude drive.	
6. Synchronize dome position and latitude indicator.	
7. Synchronize dome position and LHA Aries indicator.	
(B) Gear Box- Check all rollers for cleanliness and bind.	
(C) Collimators - Check for functioning and cleanliness of lens.	
(D) Dome Counterweight System - Check operation and condition of cables.	
(E) Limit Switches and Stops. - Check operation and adjustment.	
(F) Slip Rings and Wiring - Clean and inspect.	
(G) Recognition Lights - Check functioning and position.	
FUSELAGE AND INSTRUMENTS	
(A) Daily Check.	
1. Clean bleed holes. (5)	
2. "Zero" V/S. (Ignition "off" and Vibrators, "on").	
3. "Zero" Altimeter.	
4. Leak Test. (Not more than -100' in 5 min. from 2000' with C/D valves closed. Ignition "off," Vibrators "on")	
5. Vertical Speed. (550±50 rpm passing 1000' alt. at full throttle)	
6. Manifold Pressure.	
Full throttle at sea level.............38.5" Hg±1"	
Cruising throttle at sea level.........29.0" Hg±1"	
Full throttle at 10,000' altitude......33.5" Hg±1"	
Cruising throttle at 10,000' altitude..24.0" Hg±1"	
7. Tachometer	
Prop high pitch and cruising throttle..1900 RPM±50	
Prop low pitch and cruising throttle...2500 RPM±50	
Prop low pitch and closed throttle..... 300 RPM±200	

Figure 154—Weekly Inspection Form (Page 1 of 3 pages)

DATE ____________

FUSELAGE AND INSTRUMENTS (Cont'd)

8. Airspeed (Indicated A/S density control on zero)
Cruising throttle..............................160 MPH ± 3
Full throttle.................................180 MPH ± 3

(B) Jones Plug Connections - Check security and condition of wiring.

(C) Linkages - Check for slop or bind.

(D) Leveling Device- Check for level and condition of cables.

(E) Main Bellows and Hoses - Inspect for condition.

(F) Gyro Instrument Filters - Inspect and change as necessary.

(G) Vacuum clean interior of fuselage.

BASE UNITS AND OPERATOR'S DESK

(A) Turning Motors - Inspect, clean and service motors and belts.

(B) Turbine - Inspect and clean commutator and brushes.

(C) Altitude Pump - Inspect and service.

(D) Tower Locking Device - Check operation of lock and safety switch.

(E) Base Slip Rings - Clean. (Main power supply "off").

(F) Terrain Mechanism
1. Clean plate rollers, guides, rail and projector lens and mirrors.
2. Check alignment of drive wheels.
3. Focus projector.

(G) Recorder
1. Clean slip rings.
2. Check alignment of drive wheels and inking wheel.
3. Clean inking wheel and re-ink felt roller.

(H) Wind Drift Mechanism
1. Check wind direction and velocity input.
2. Check operation of follow up motor and position of slide at 160 MPH true A/S. (15/16")
3. Synchronize terrain and recorder drives with W/D and trainer.
4. Run recorder and plate rate of travel check.

Figure 154—Weekly Inspection Form (Page 2 of 3 pages)

DATE ____________

BASE UNITS AND OPERATOR'S DESK (Cont'd)

(I) Magnetic Compass
1. Check compass deviation on cardinal points.
2. Check functioning of the variation control.
3. Check operation of compass deflector.

(J) Radio
1. Check proper functioning of controls.
2. Check loop azimuth control synchronization.
3. Check beam shift control centering.
4. Check frequency control if a tube has been replaced.
5. Inspect microphone and headphones for condition.

(K) Cloud Projector - Clean lens and mirror, check operation.

FLIGHT CHECK

1. Check rate of turn. (Adjust turn indicator 180°/ min.)
2. Maximum climb and dive.
3. Turning motor smoothness.
4. Instrument smoothness.
5. Control action and smoothness.
6. Automatic features.

Remarks: ____________

____

____

____

Checked By ____________

Figure 154—Weekly Inspection Form (Page 3 of 3 pages)

Section	Part Name	No. Places	Location	Lubricant	Hours	Remarks
Celestial Mechanism	Dome Rail Machined Surfaces	8	From North Tower to Truss	SAE 30	Daily	Wipe with oil dampened cloth
	Motor Reduction Gears	4	Time, Longitude, Reset and Clutch Motors on Gear Box	* Link 295	1000	Check: Add grease if necessary
	LHA Take-off Split Gear	1	West Side of Gear Box	Microfine Graphite	100	Use dry graphite
Fuselage	All Ball Joints-Rudder, Aileron, Pitch Action & Throttle Linkages		Control Section under Pilot's Seat and Control Panel	SAE 30	100	Wipe off all excess oil
	Main Valves	4	Left Side of Fuselage	Microfine Graphite	100	Never use oil except for rust prevention
	Fuselage Leveling Mechanism	2	Pilot's Control Panel	* Link 295	100	
	Vibrator Motors	4	Navigator's Panel, Pilot's Panel, Altitude Transmitter, Control Panel	SAE 30	1000	Bearings have felt oil retainer
	Rough Air Motor	1	Below Fuselage Left Side	SAE 30	1000	Bearings have felt oil retainer
	Bellows Universals	4	Below Fuselage	SAE 30	100	Oil seal ball on each universal
	Pressure Differential Regulator	4	On Lower Frame Member Rear of Fuselage	Watch Oil	100	Use oil sparingly on slides

Figure 155—Lubrication Chart (Page 1 of 3 pages)

Section	Part Name	No. Places	Location	Lubricant	Hours	Remarks
Tower Base	Turbine	2	On Tower Base	** Link 6975	100	Do not over-lubricate
	Altitude Pump-Reservoir	1	On Side of Altitude Pump	SAE 30	Daily	Oil must always be in reservoir
	Altitude Pump-Motor	2	On Tower Base	SAE 30	1000	Standard motor maintenance
	Cloud Fan Motor	2	Mounted on Cloud Projector	SAE 30	1000	Standard motor maintenance
	Wind Drift Differentials	4	On Platform Below Tower	* Link 295	1000	Lubricate only if necessary. Do not over-lubricate.
	Wind Drift Slides	4	On Platform Below Tower	SAE 30	100	Lubricate only when necessary.
	Turning Motor Valve Slides	20	Motors Under Tower Base	Graphite Paste	100	Mix micro-fine graphite and water
	Turning Motor Connecting Rods	20	Motors Under Tower Base	Microfine Graphite	100	Use graphite dry
Terrain Mechanism	Azimuth Rail		On Floor	SAE 30	Daily	Wipe with oil dampened cloth
	Azimuth Rail Rollers	4	Support for Terrain Base Frame	SAE 30	100	Wipe with oil dampened cloth
	Projector Fan Motor	2	On Projection Bulb Housing	SAE 30	1000	Oil ways capped with screws

***Figure 155—Lubrication Chart** (Page 2 of 3 pages)*

Section	Part Name	No. Places	Location	Lubricant	Hours	Remarks
Desk	Relay Armature Pivots	4	Rear Section Radio Control Panel	Gun Oil	1000	Be sure oil does not spread to relay points or coil
	Keyer Shaft	2	Radio Control Chassis	Gun Oil	1000	Avoid excess oil
	Keyer Motor	2	Radio Control Chassis	SAE 30	1000	Bearings have felt oil retainer
	Intermittent Cam Motor	2	Bottom Side Dome Control Panel	SAE 30	1000	Bearings have felt oil retainer
	Intermittent Cam Shaft	2	Bottom Side Dome Control Panel	Gun Oil	1000	Avoid excess oil
Protection of Exposed Parts Against Corrosion	*** Bellows Cables	4	Below Fuselage	SAE 30	Weekly	
	Fuselage Leveling Cables	4	Below Fuselage	" "	Weekly	
	Tower Locking Cable	1	From Fuselage to Tower Base	" "	Weekly	
	Dome Counterweight Cable	1	From Gear Box to Counterweight	" "	Weekly	
	Latitude Drive Cable	1	From Gear Box to Latitude Drive	" "	Weekly	Dampen a cloth with oil and apply to all parts to be protected
	Sector Snubber Cable	1	From S.W. Tower Col. tc Counterweight	" "	Weekly	
	Leveling Cable Lead Screw	1	On Pilot's Control Panel	" "	Weekly	
	Belt Tightener Lead Screws	1	Near Turn Motors Below Tower Base	" "	Weekly	
	Latitude Drive Cable Drum	1	On North Column	" "	Weekly	
	Depressor Roller Terrain Projector	4	Terrain Mechanism	" "	Weekly	
	Dome Gear Box Support Rollers	16	Above Gear Box	" "	Weekly	

* Link 295—Penola Cam Lubricant # 0-1/2—Colonial Beacon Oil Co.

** Link 6975—M-6 Lubriko-12 oz.—Spencer Turbine Co.

*** If any of these parts become coated or gummed, clean with a mild penetrant (such as kerosene) and then coat with a thin film of oil.

Figure 155—Lubrication Chart (Page 3 of 3 pages)

		Unit	Location	Power Supply: Volts	Power Supply: Location	Description or D-C Resistance	
LIGHTS	BASE & TOWER	Bomb Hit Proj.	Bearing Hub	6	Tower Junction Box	Prefocused 32-CP Bay. Base	
		Cloud Projector	Tower Carriage	110	Term. 3-8 Tower J.B.	Projector-type Bulb 500-w	
		Moon Beam Lamps	Tower Base Leg	12	Base Junction Box	6 CP Double Con. Bay. Base	
		Terrain Projector	Terrain Carriage	110		Projector-type Bulb 500-w	
	BOOTH	Recorder (2)	Recorder	32	Parallel with Track Tel.	25 v Bay. Base Mazda 1484	
		Neon (3)	Dome Cont. Panel	110	Desk Junction Box	1/4-w Med. Screw Base	
		Operators	Op'r's Desk	110	Service Entrance	Mazda Standard Base	
	FUSELAGE	Fuselage, Dome	Above Pil. Pos.	6	Fuselage Power Supply	15 CP 6-8 v Bay. Base	
		Fluorescent	" " "	110	Fuselage J.B. No. 1	Electronic-type X 205	
		Fluorescent	" Nav. "	110	" " " " "	" " " "	
		Moon Beam (Red)	" Pil. "	6	Fuselage Power Supply	6-8 v Bayonet Base	
		Navigation Desk	" Nav. Desk	110	Fuselage J.B. No. 1	5 w Standard Base	
	MISC.	Dome Neut. Ind.	On Stairway Landing	110	Desk Junction Box	5 w Standard Base	
		Fuselage Ind.	Fuselage	12	Power Supply	Bayonet Base 13-v GE 33A	
						F. Windings	*A. Windings*
MOTORS		Altitude Pump	Tower Carriage	110	Base Junction Box	1.2 Ohms	
		Anti-Backlash	Wind Drift	110	Nav. Switch	7 "	
		Bomb Time-of-Fall	Bomb Hit Timer	110	Tower J.B. 3-4	160 "	
		Bomb Time-of-Flash	" " "	110	" " " "	Across Relay and Motor 65 Ohms	
		Cloud Fan Motor	Tower Carriage	110	" " " "		
		Clutch Set	Dome Gear Box	110	Desk Junction Box	33 "	24 Ohms

Figure 156—Electrical Resistance Table (Page 1 of 4 pages)

		Unit	Location	Power Supply		D-C Resistance	
				Volts	Location	F. Windings	A. Windings
MOTORS		Dome Reset	Dome Gear Box	110	Desk Junction Box	19 Ohms	19 Ohms
		Follow Up	Wind Drift	110	Nav. Switch	70 "	
		Ground Speed	" "	110	" "	15 "	
		Inverter	Counter. Frame	24	Rectifier		
		Latitude	North Tower	110	Desk J.B. 54-55	19 "	19 "
		Longitude	Dome Gear Box	110	" " " "	19 "	19 "
		Time	" " "	110	" " " "	15 "	
		Turbine	Counter. Frame	220	1-2 Tower Junction Box	1.3 "	
		Vibrators	Desk Inst. Panel	110	1-2 Fuselage Junction Box	19 "	
		Vibrators	Nav., Pil., Radio, Inst. Panel	110	1-2 Fuselage Junction Box	19 "	
RELAYS	BOMB HIT	A/S Freezing	Wind Drift	110	Tower Junction Box	600 Ohms	
		Anti-Turn	Tower Carriage	110	Bomb Hit Timer	50 "	
		Bomb Release	Tower Junction Box	24		215 "	
		Time of Fall	Time Mechanism	110	Tower Junction Box	160 Ohms Across Relay and Motor	
		Time of Flash	" "	110	" " "	" " " "	
	DOME	Clutch	Desk Junction Box	110	Dome Control Panel	600 Ohms	
		Colli. Recog.	" " "	110	Switch in Nav. Panel	600 "	
		Latitude	" " "	110	Dome Control Panel	600 "	
		Longitude	" " "	110	" " "	600 "	

Figure 156—Electrical Resistance Table (Page 2 of 4 pages)

		Unit	Location	Power Supply		D-C Resistance		
				Volts	Location			
RELAYS	RADIO	Range	Cent. Desk Draw.	20	Desk Power Supply	750 Ohms		
		Switching	" " "	20	" " "	1000 "		
		Visual Marker	" " "	*	" " "	650 "		
		Voice	" " "	20	" " "	750 "		
	MISC.	Turbine Thermal Cutout	Tower J. B.	110	Tower Junction Box	60 Ohms		
		Safety Door Latch	Fuselage	110	Switch on Lock. Device	50 "		
TELEGON	A/S ALTIMETER					*Primary*	*1st Phase*	*2nd Phase*
		Receiver	Pilot Panel	75 v, 700 ± 35 Cycles	Cover—Base J.B.	275	1050	1050
		"	Nav. "		" " " "	"	"	"
		Transmitter	A/S Cont. Box		" " " "	"	"	"
		Receiver	Pilot Panel		" " " "	"	"	"
		"	Nav. "		" " " "	"	"	"
		Transmitter	A/S Cont. Box		" " " "	"	"	"
MAGNESYNS	COMPASS	Receiver	Comp. Pil. Panel	26 Volts 400 Cycles	Tower J.B. & Inverter	235	1050	1350
		"	Comp. Nav. Panel		" " " " "	"	"	"
		Transmitter	Artificial Comp.		" " " " "	"	"	"
TELETORQUES	A/S						*Terminals*	
						1-2	2-3	A-G
		Receiver	Wind Drift	32	Tower Junction Box	15 Ohms	15 Ohms	24 Ohms
		Transmitter	A/S Trans. Box	32	" " "	15 "	15 "	24 "

* Visual Marker Relay Amplifier Plate Output (Varies with Marker Beacon Volume Setting)

Figure 156—Electrical Resistance Table (Page 3 of 4 pages)

TELETORQUES

	Unit	Location	Power Supply		D-C Resistance		
			Volts	Location	1-2	2-3	A-G
LAT.	Receiver	Desk Inst. Panel	32	Desk Inst. Panel	32 Ohms	32 Ohms	62 Ohms
	Transmitter	Dome Gear Box	32	" " "	32 "	32 "	62 "
LONG.	Receiver	Desk Inst. Panel	32	" " "	32 "	32 "	62 "
	Transmitter	Dome Gear Box	32	" " "	32 "	32 "	62 "
LHA	Receiver	Desk Inst. Panel	32	" " "	32 "	32 "	62 "
	Transmitter	Dome Gear Box	32	" " "	32 "	32 "	62 "
GONIO	Receiver	Radio Rec. Chas.	32	" " "	15 "	15 "	24 "
	Transmitter	Heading Gear Box	32	Tower Junction Box	15 "	15 "	24 "
G/S	Receiver (2)	Recorder	32	Desk Inst. Panel	36 "	36 "	44 "
	" (2)	Terrain	32	Base Junction Box	32 "	32 "	62 "
	Transmitter	Wind Drift	32	Tower Junction Box	15 "	15 "	24 "
TIME	Receiver	Desk Inst. Panel	32	Desk Inst. Panel	32 "	32 "	62 "
	"	Navigators Panel	32	Tower Junction Box	32 "	32 "	62 "
	"	Pilots "	32	" " "	32 "	32 "	62 "
	Transmitter	Dome Gear Box	32	Desk Inst. Panel	15 "	15 "	24 "
TRACK	Receiver (1)	Recorder	32	" " "	15 "	15 "	24 "
	" (2)	Terrain	32	Base Junction Box	15 "	15 "	24 "
	Transmitter (2)	Wind Drift	32	Tower " "	15 "	15 "	24 "

Figure 156—Electrical Resistance Table (Page 4 of 4 pages)

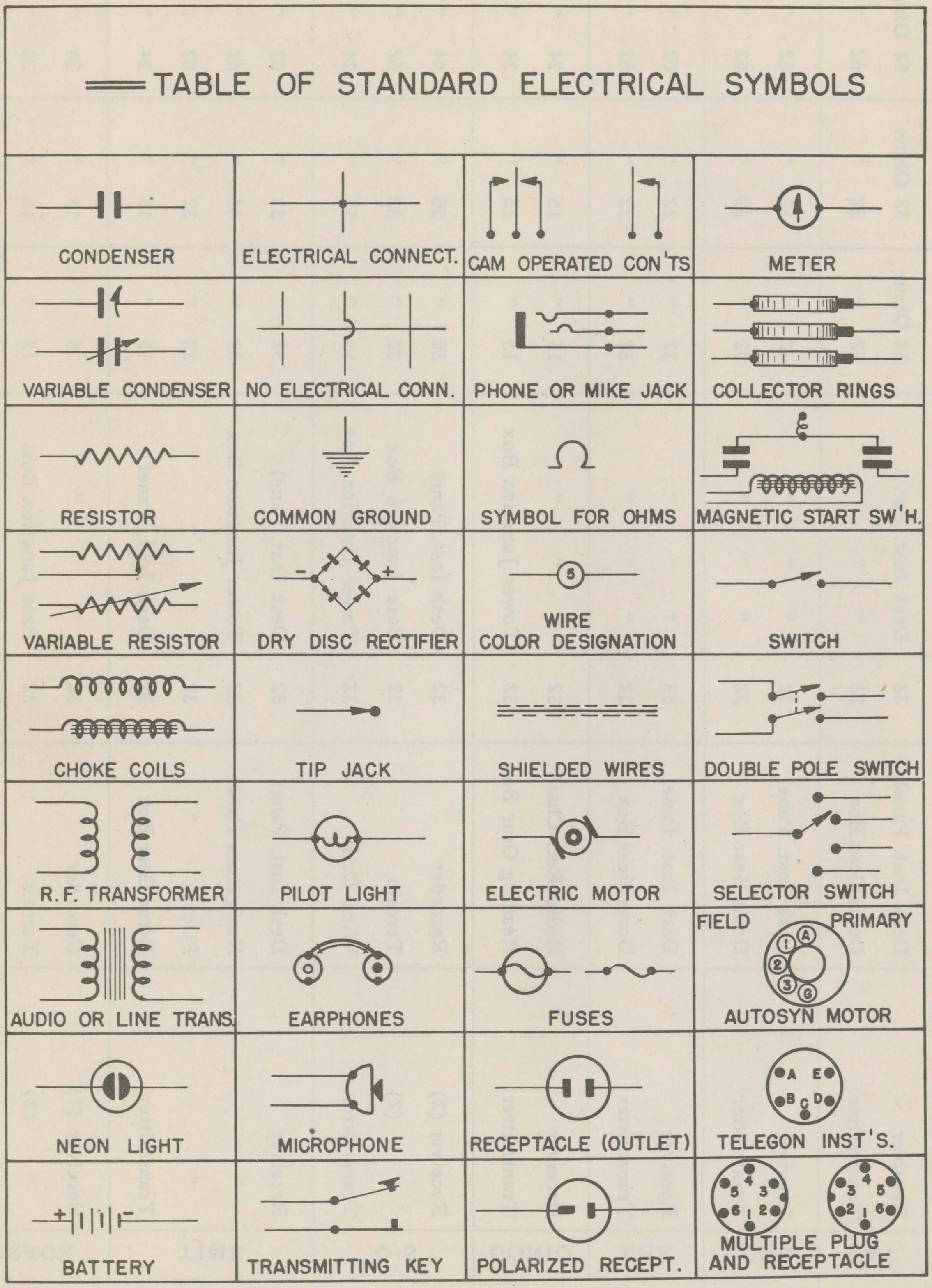
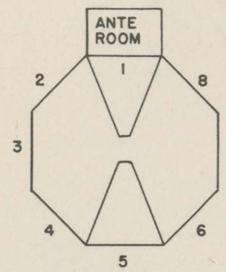
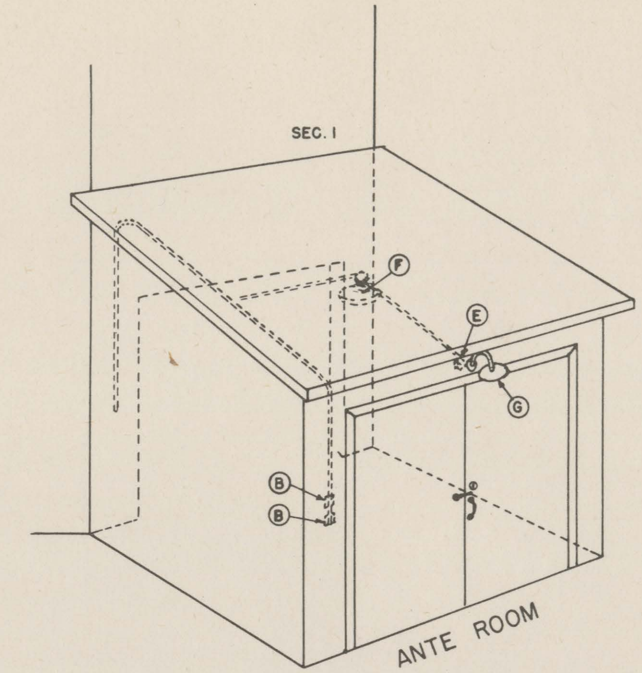
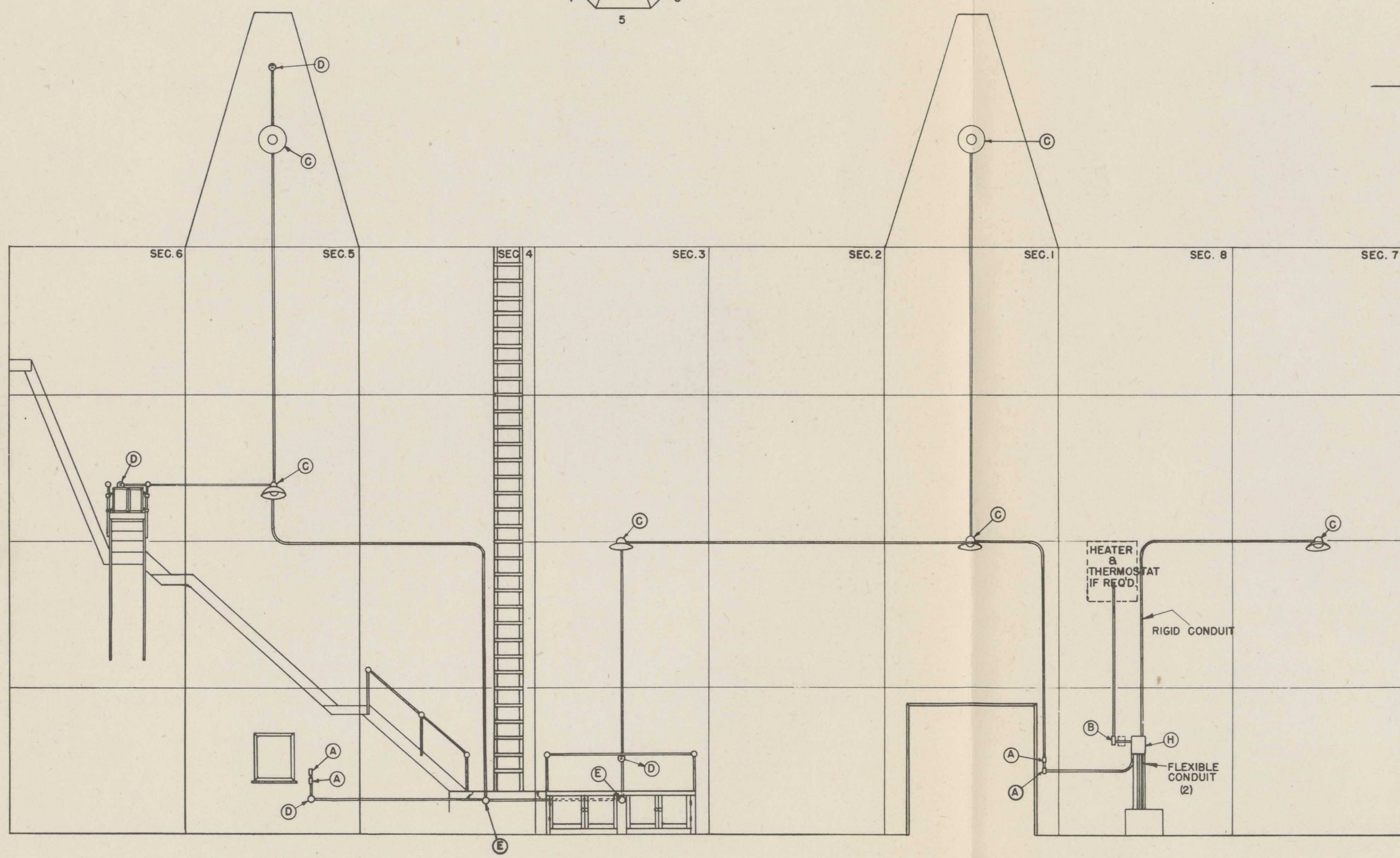


Figure 157—Code of Electrical Symbols used in Wiring Diagrams







CODE LETTER	NO. REQ'D.	NAME	MFG. SERIAL NO.
(A)	4	3-WAY SWITCH	GE-2593
		SWITCH BOX	SP-6975
(B)	3	SINGLE POLE SWITCH	GE-2842
		SWITCH BOX	SP-6975
(C)	6	4" OCTAGONAL BOX	SP-24151
		BOX COVER AND SWIVEL SOCKET	GE-3287
		SHADE HOLDER	GE-2378
		20" PORCELAIN R. L. M. SHADE	
		200 WATT BULB (FROSTED)	
(D)	4	RECEPTACLE BOX	SP-5800
		RECEPTACLE BOX COVER	
		DUPLEX RECEPTACLE	GE-2685
(E)	3	4" OCTAGONAL BOX	SP-24151
		4" BLANK COVER	
(F)	1	4" OCTAGONAL BOX	SP-24151
		PORCELAIN LAMP HOLDER	
		13" PORCELAIN R. L. M. SHADE	
		100 WATT BULB	
(G)	1	GOOSENECK LIGHT	
(H)	1	PULLOUT SWITCH (TRUMBLE)	2926-4

Figure 158—Wiring Layout, Building

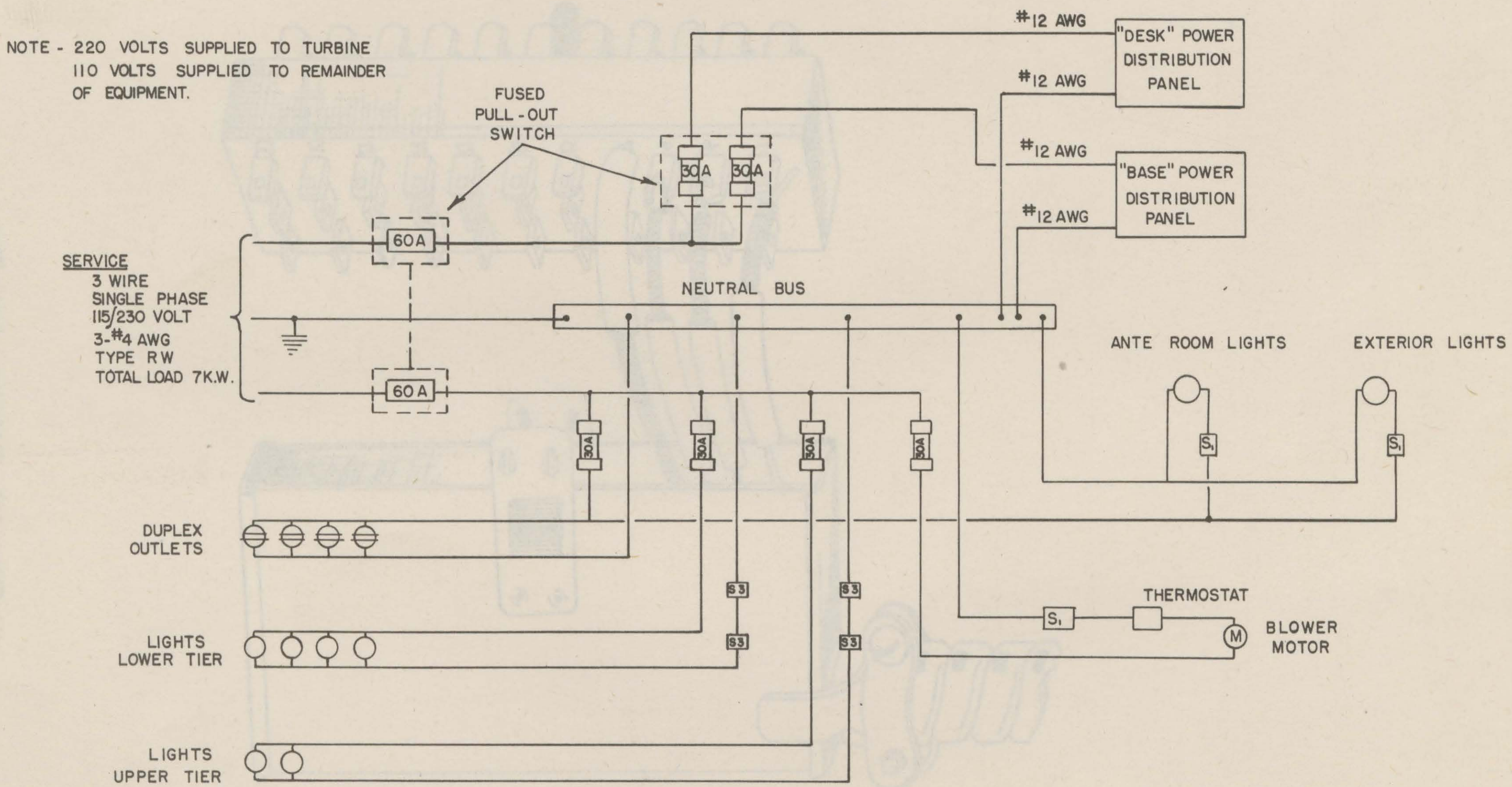


Figure 159—Wiring Diagram, Building

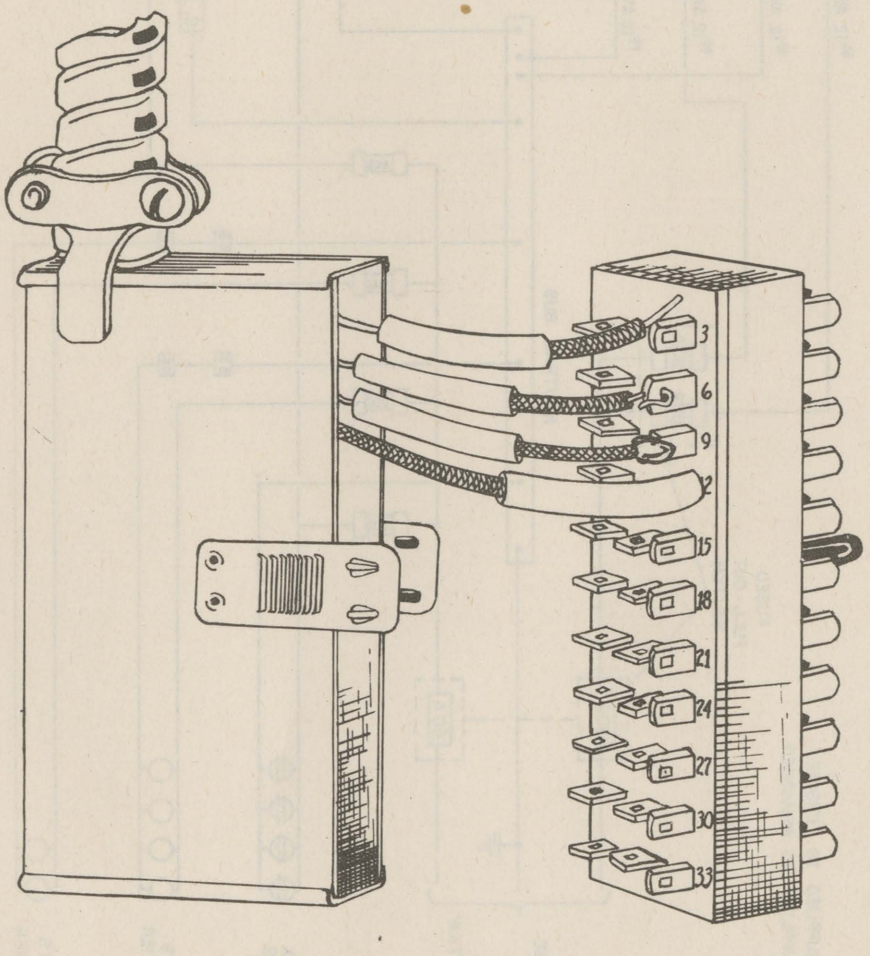
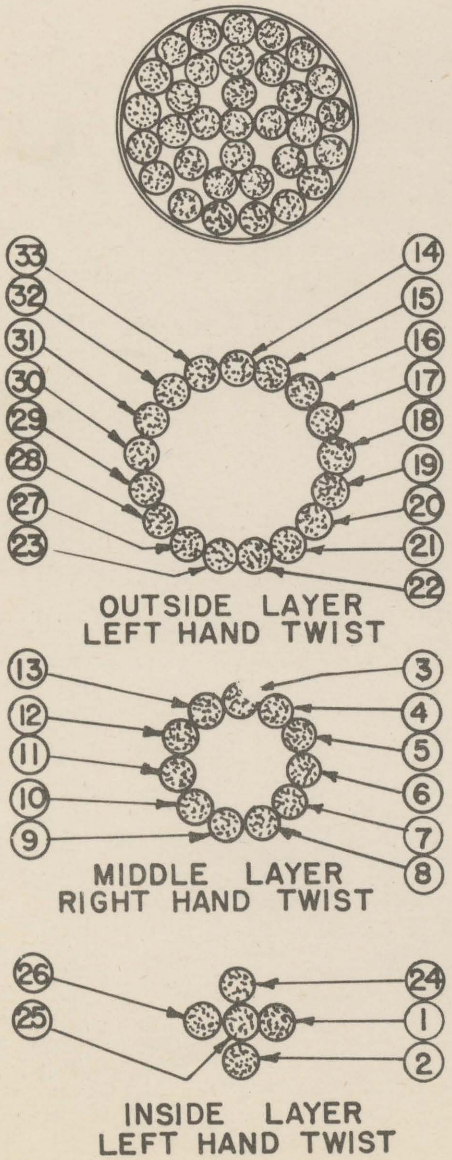


Figure 160—Soldering a Jones Plug



WIRE NO.	COLOR BRAID	NO. OF TRACERS	COLOR TRACER
1	GREEN	DOUBLE	WHITE
2	BLUE	- - - -	- - - -
3	RED	SINGLE	BLACK
4	RED	DOUBLE	BLACK
5	ORANGE	- - - - -	- - - -
6	ORANGE	SINGLE	WHITE
7	ORANGE	DOUBLE	WHITE
8	ORANGE	SINGLE	BLACK
9	ORANGE	DOUBLE	BLACK
10	YELLOW	- - - -	- - - -
11	YELLOW	SINGLE	BLACK
12	YELLOW	DOUBLE	BLACK
13	GREEN	- - - -	- - - -
14	WHITE	- - - -	- - - -
15	WHITE	SINGLE	BLACK
16	WHITE	DOUBLE	BLACK
17	MED. BROWN	- - - -	- - - -
18	MED. BROWN	SINGLE	WHITE
19	MED. BROWN	DOUBLE	WHITE
20	BLACK	- - - -	- - - -
21	BLACK	SINGLE	WHITE
22	BLACK	DOUBLE	WHITE
23	MAROON	- - - -	- - - -
24	GREEN	SINGLE	WHITE
25	BLUE	SINGLE	WHITE
26	BLUE	DOUBLE	WHITE
27	MAROON	SINGLE	WHITE
28	MAROON	DOUBLE	WHITE
29	MAROON	SINGLE	BLACK
30	MAROON	DOUBLE	BLACK
31	RED	- - - -	- - - -
32	RED	SINGLE	WHITE
33	RED	DOUBLE	WHITE

33 WIRE FLEXIBLE CABLE

WIRE NO.	COLOR
1	BLACK
2	BLUE
3	BROWN
4	GRAY
5	WHITE
6	GREEN
7	MAROON
8	ORANGE
9	YELLOW
10	RED
11	BLACK+YELLOW
12	BLACK+RED

12 WIRE FLEXIBLE CABLE

Figure 161—Color Code, Jones Plugs and Cables

SECRET

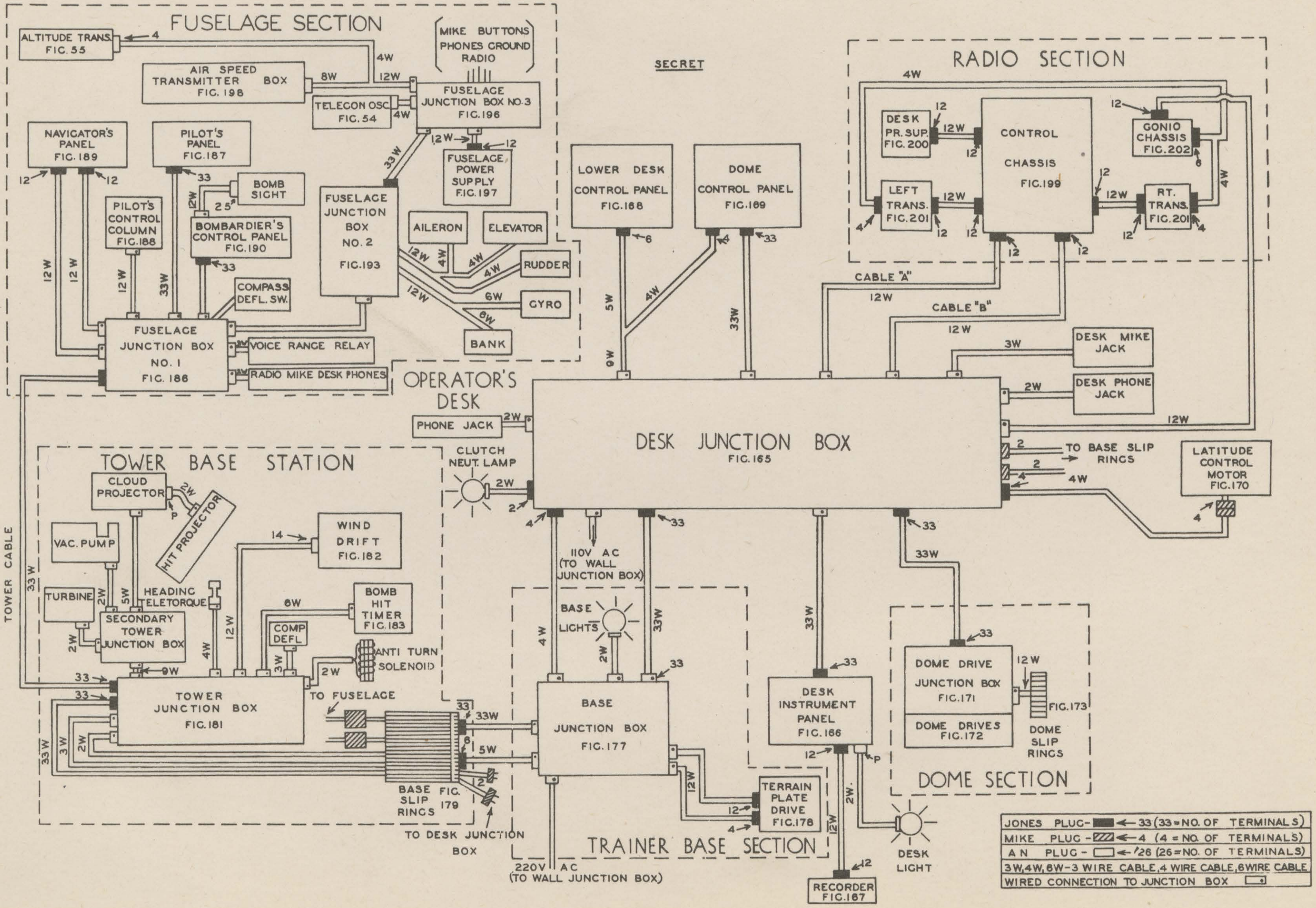


Figure 162—Wiring Layout, General Schematic

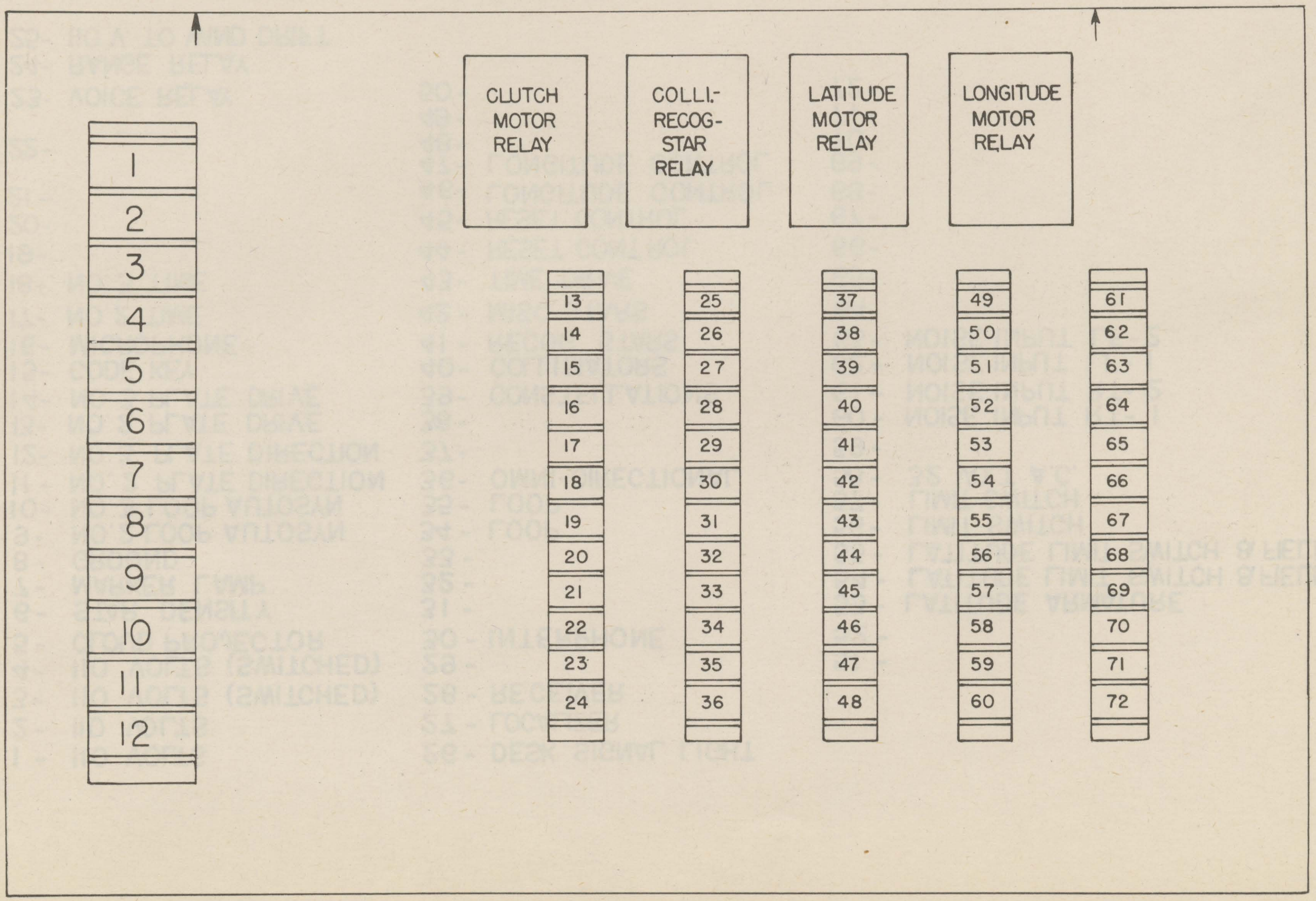


Figure 163—Terminal Layout, Desk Junction Box

1 - 110 VOLTS
2 - 110 VOLTS
3 - 110 VOLTS (SWITCHED)
4 - 110 VOLTS (SWITCHED)
5 - CLOUD PROJECTOR
6 - STAR DENSITY
7 - MARKER LAMP
8 - GROUND
9 - NO. 2 LOOP AUTOSYN
10 - NO. 3 LOOP AUTOSYN
11 - NO. 2 PLATE DIRECTION
12 - NO. 3 PLATE DIRECTION
13 - NO. 2 PLATE DRIVE
14 - NO. 3 PLATE DRIVE
15 - CODE KEY
16 - MICROPHONE
17 - NO. 2 TIME
18 - NO. 3 TIME
19 -
20 -
21 -
22 -
23 - VOICE RELAY
24 - RANGE RELAY
25 - 110 V. TO WIND DRIFT
26 - DESK SIGNAL LIGHT
27 - LOCALIZER
28 - RECEIVER
29 -
30 - INTERPHONE
31 -
32 -
33 -
34 - LOOP
35 - LOOP
36 - OMNI-DIRECTIONAL
37 -
38 -
39 - CONSTELLATIONS
40 - COLLIMATORS
41 - RECOG. STARS
42 - MISC. STARS
43 - TIME DRIVE
44 - RESET CONTROL
45 - RESET CONTROL
46 - LONGITUDE CONTROL
47 - LONGITUDE CONTROL
48 -
49 -
50 -
51 -
52 -
53 - LATITUDE ARMATURE
54 - LATITUDE LIMIT SWITCH & FIELD
55 - LATITUDE LIMIT SWITCH & FIELD
56 - LIMIT SWITCH
57 - LIMIT SWITCH
58 - 32 VOLT A.C.
59 -
60 - NOISE INPUT RT-1
61 - NOISE INPUT RT-2
62 - NOISE INPUT LF-1
63 - NOISE INPUT LF-2
64 -
65 -
66 -
67 -
68 -
69 -
70 -
71 -
72 -

Figure 164—Terminal Wiring, Desk Junction Box

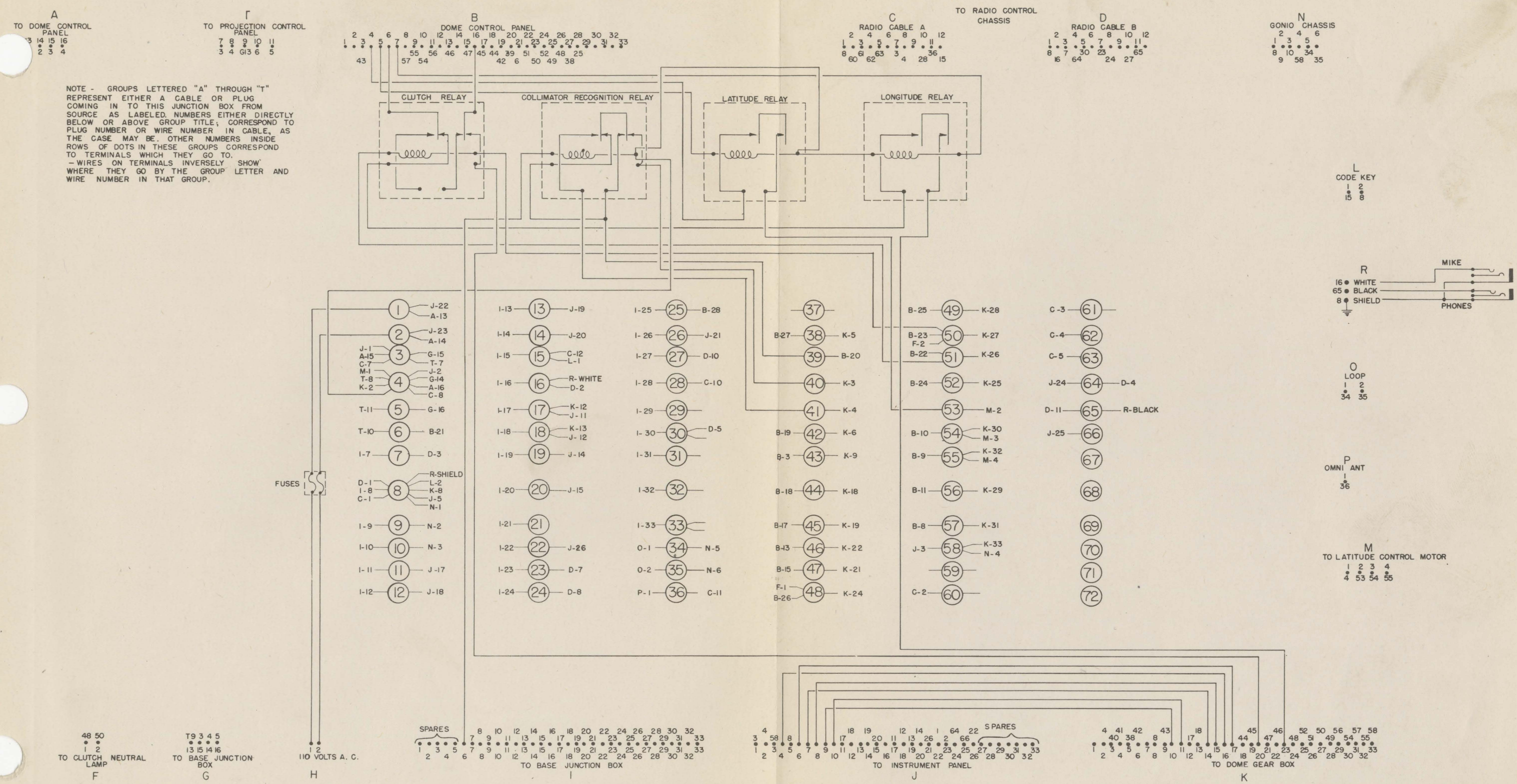


Figure 165—Wiring Diagram, Desk Junction Box

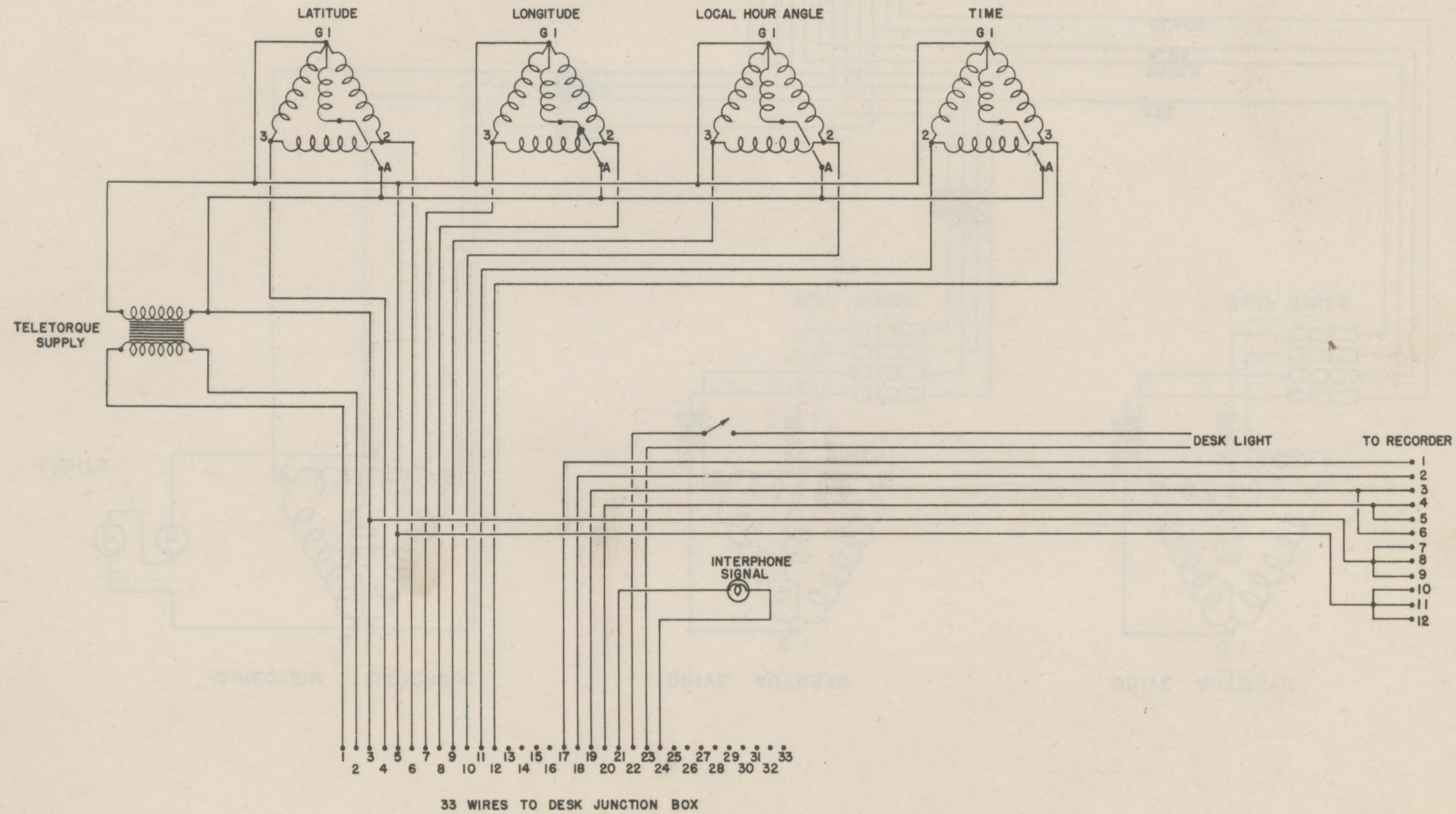


Figure 166—Wiring Diagram, Desk Instrument Panel

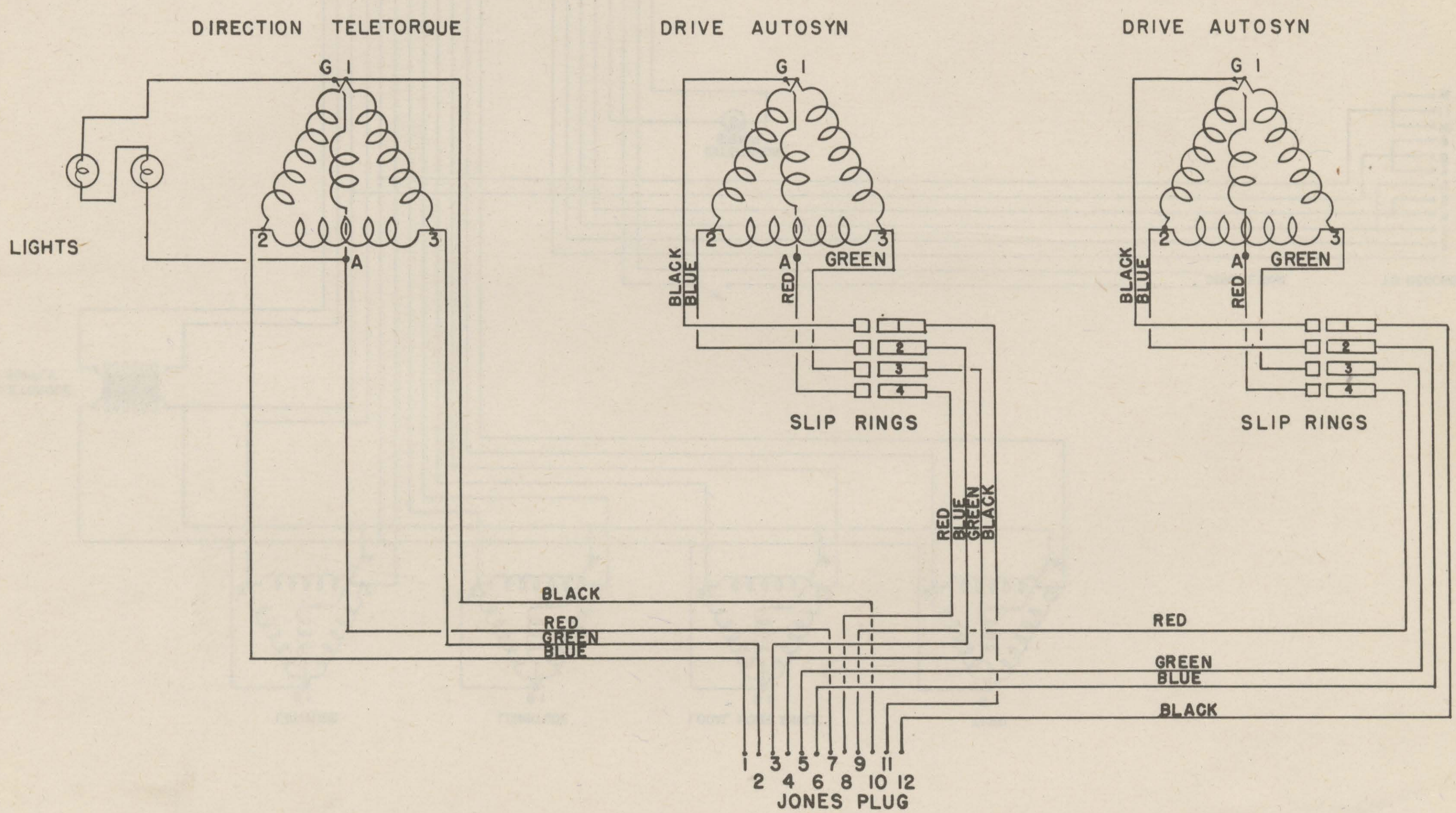


Figure 167—Wiring Diagram, Recorder

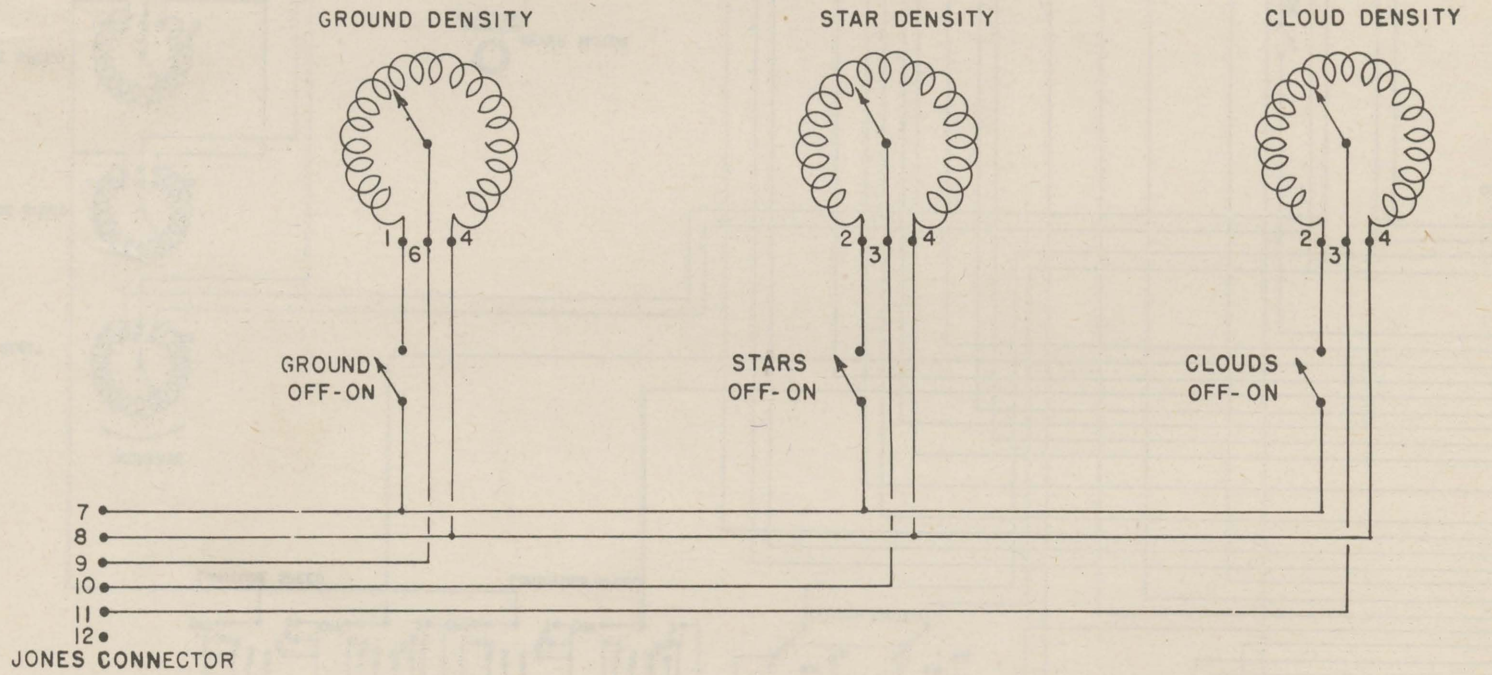


Figure 168—Wiring Diagram, Lower Desk Control Panel

NOTE:
NUMBERS ON CAMS INDICATE POSITION OF CAM COUNTING FROM MOTOR OUTWARD.—IDENTICAL NOS. INDICATE COMMON CAM WITH TWO CONTACT ASSEMBLIES.

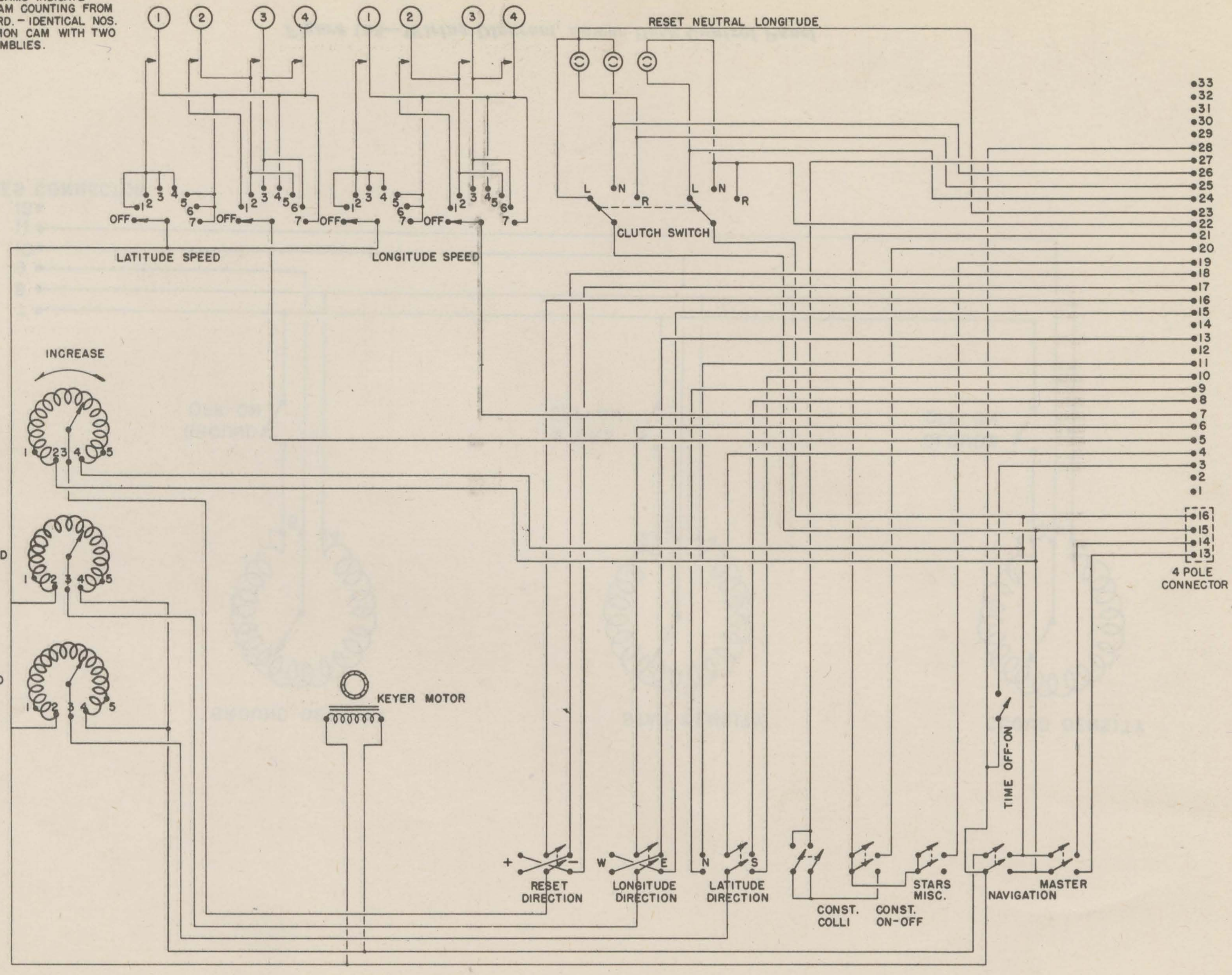


Figure 169—Wiring Diagram, Desk Dome Control Panel

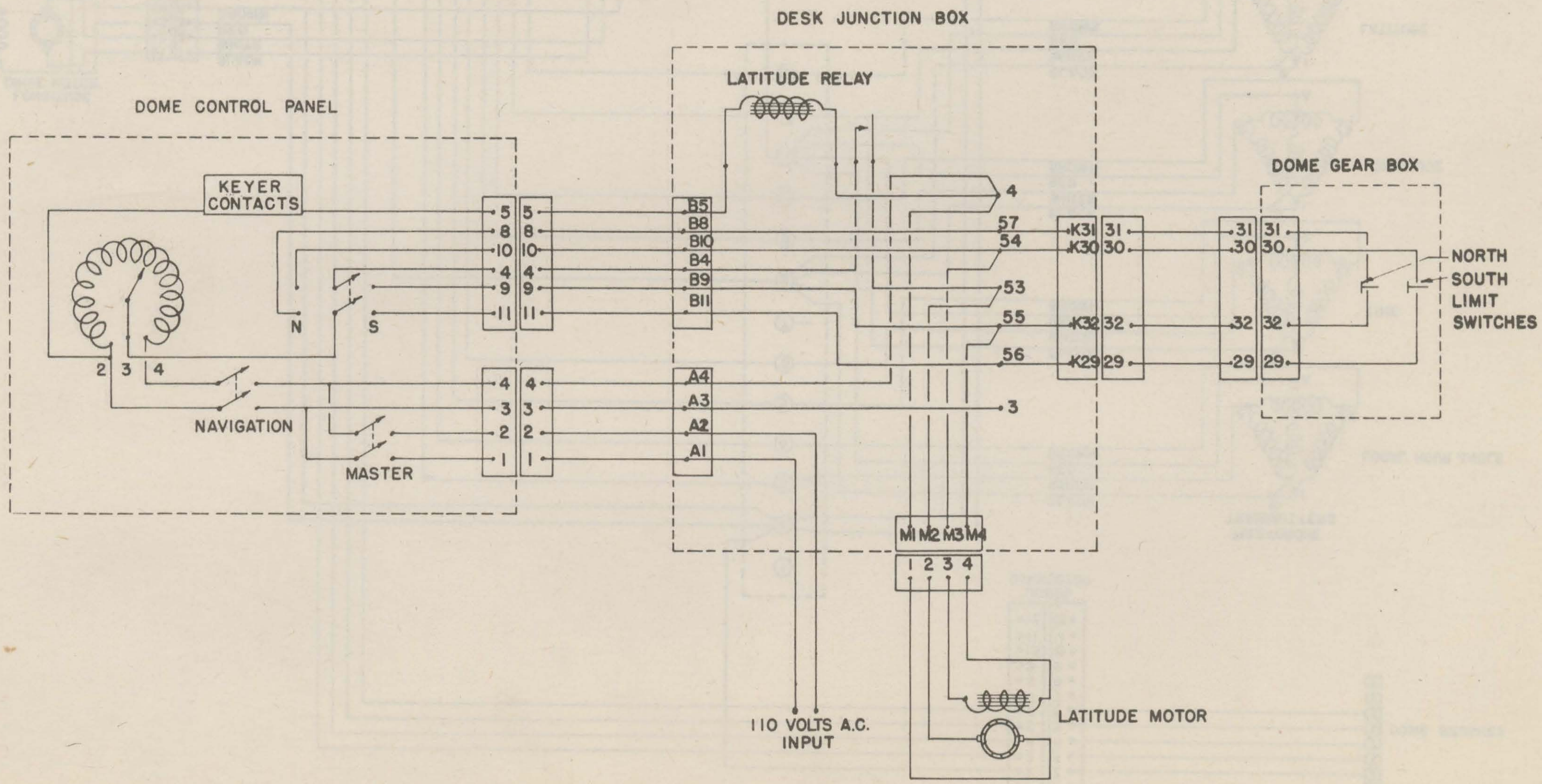


Figure 170—Wiring Diagram, Latitude Drive Circuit

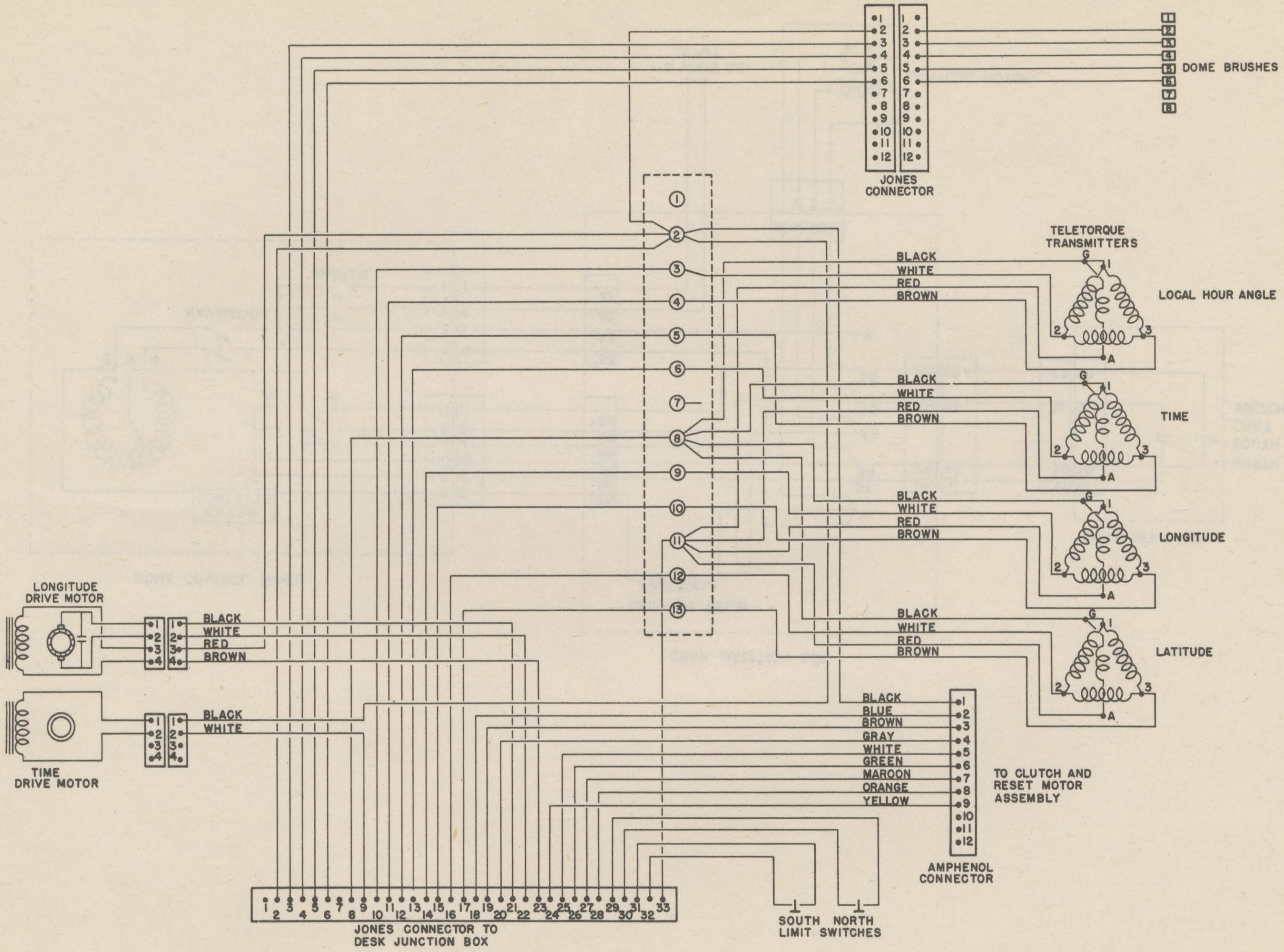


Figure 171—Wiring Diagram, Dome Gear Box

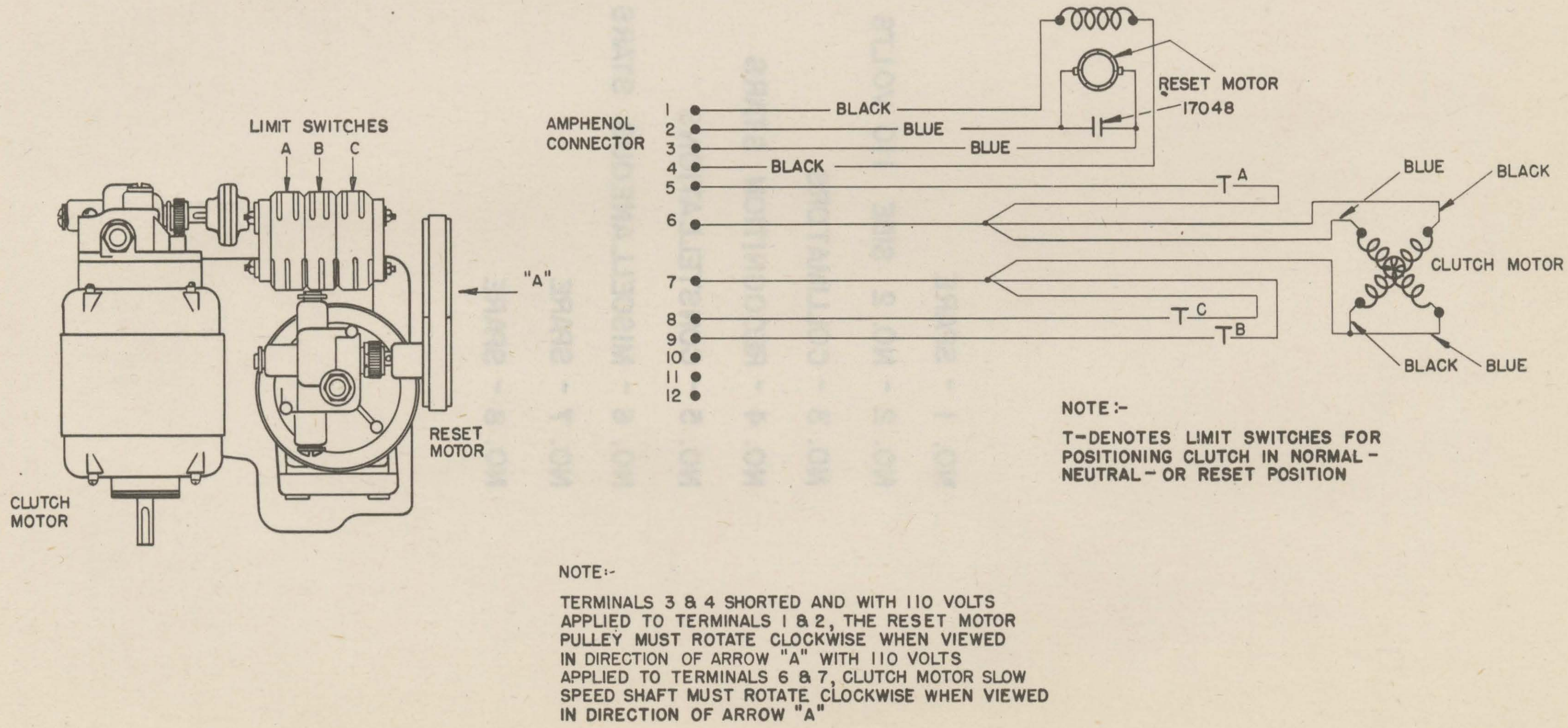


Figure 172—Wiring Diagram, Dome Clutch and Reset Motors

NO. 1 - SPARE

NO. 2 - NO. 2 SIDE 110 VOLTS

NO. 3 - COLLIMATORS

NO. 4 - RECOGNITION STARS

NO. 5 - CONSTELLATIONS

NO. 6 - MISCELLANEOUS STARS

NO. 7 - SPARE

NO. 8 - SPARE

Figure 173—Terminal Wiring, Dome Slip Rings

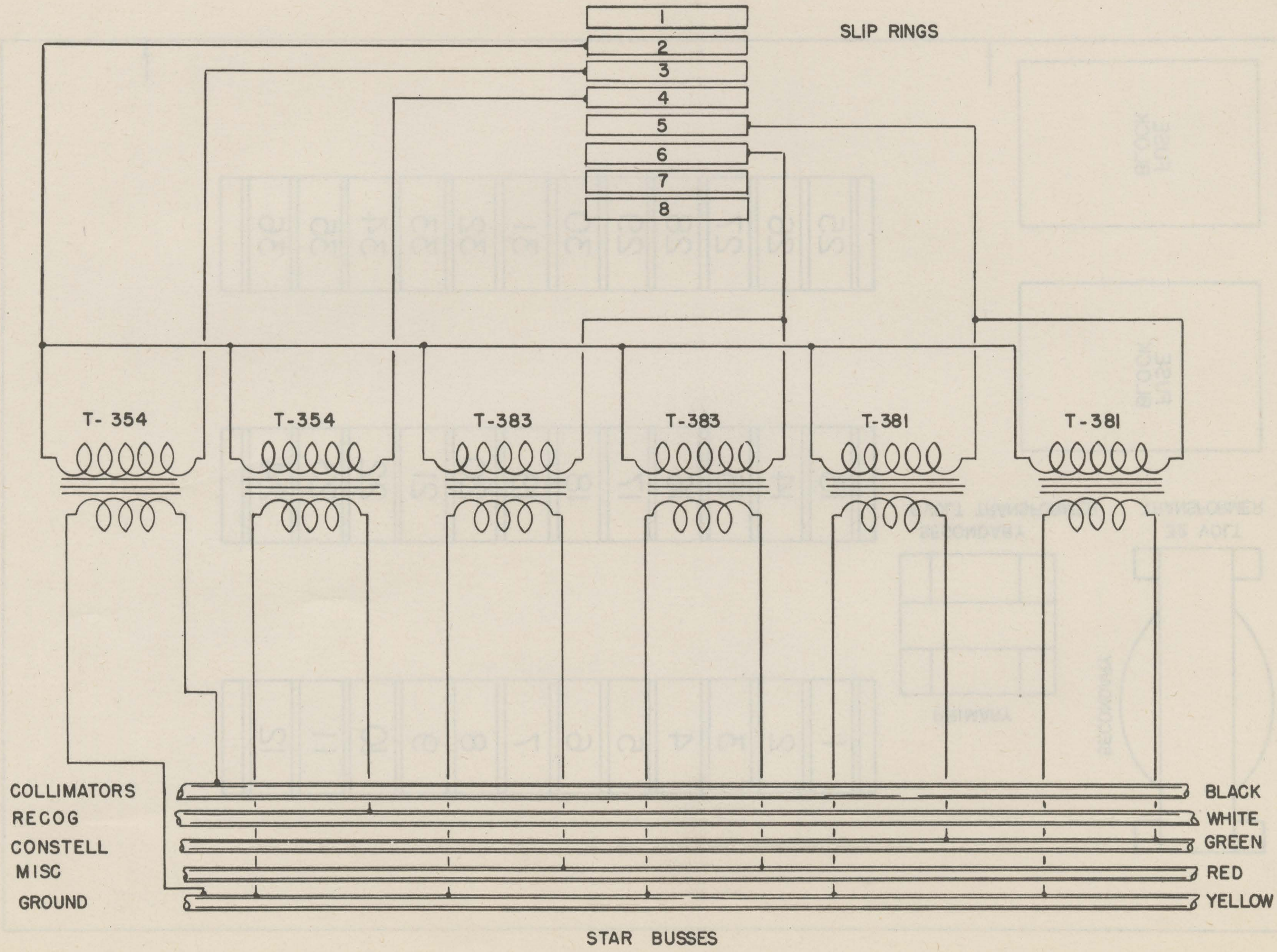


Figure 174—Wiring Diagram, Dome

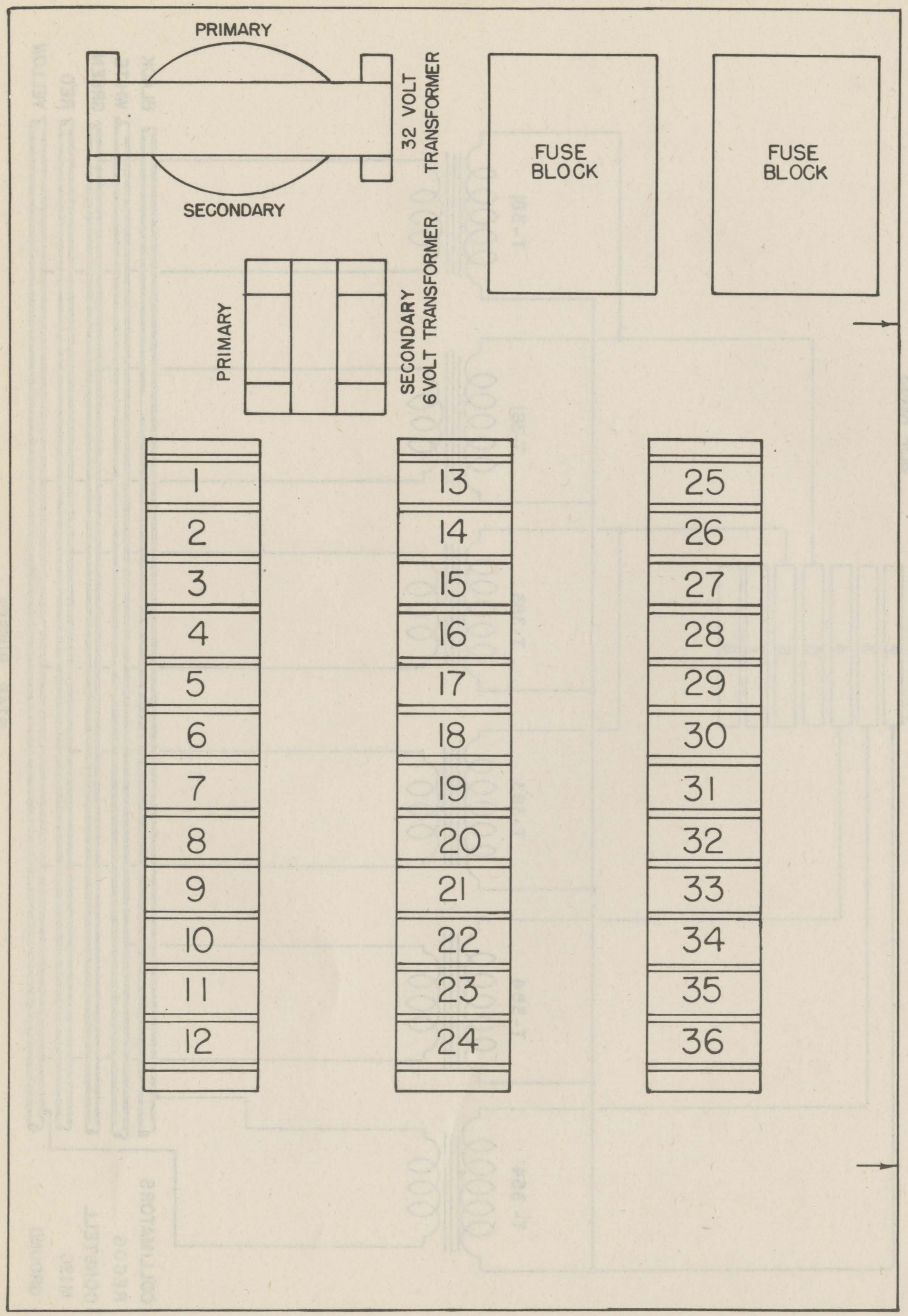


Figure 175—Terminal Layout, Base Junction Box

1	TURBINE SUPPLY
2	TURBINE SUPPLY
3	110 VOLTS A.C.
4	110 VOLTS A.C.
5	CLOUD PROJECTOR
6	RECOG. STAR SWITCH
7	MARKER LAMP
8	GROUND
9	NO. 2 LOOP AUTOSYN
10	NO. 3 LOOP AUTOSYN
11	NO. 2 PLATE DIRECT
12	NO. 3 PLATE DIRECT
13	NO 2 PLATE DRIVE
14	NO 3 PLATE DRIVE
15	CODE KEY
16	MICROPHONE
17	NO 2 TIME
18	NO 3 TIME
19	
20	
21	C ALTIMETER
22	B ALTIMETER
23	VOICE RELAY
24	RANGE RELAY
25	110 VOLTS TO WIND DRIFT
26	DESK SIGNAL LIGHT
27	LOCALIZER
28	RECEIVER
29	
30	INTERPHONE
31	
32	
33	
34	TERRAIN PROJECTOR LAMP
35	PLATE CARRIAGE AUTOSYN SUPPLY (32 V.)
36	

Figure 176—Terminal Wiring, Base Junction Box

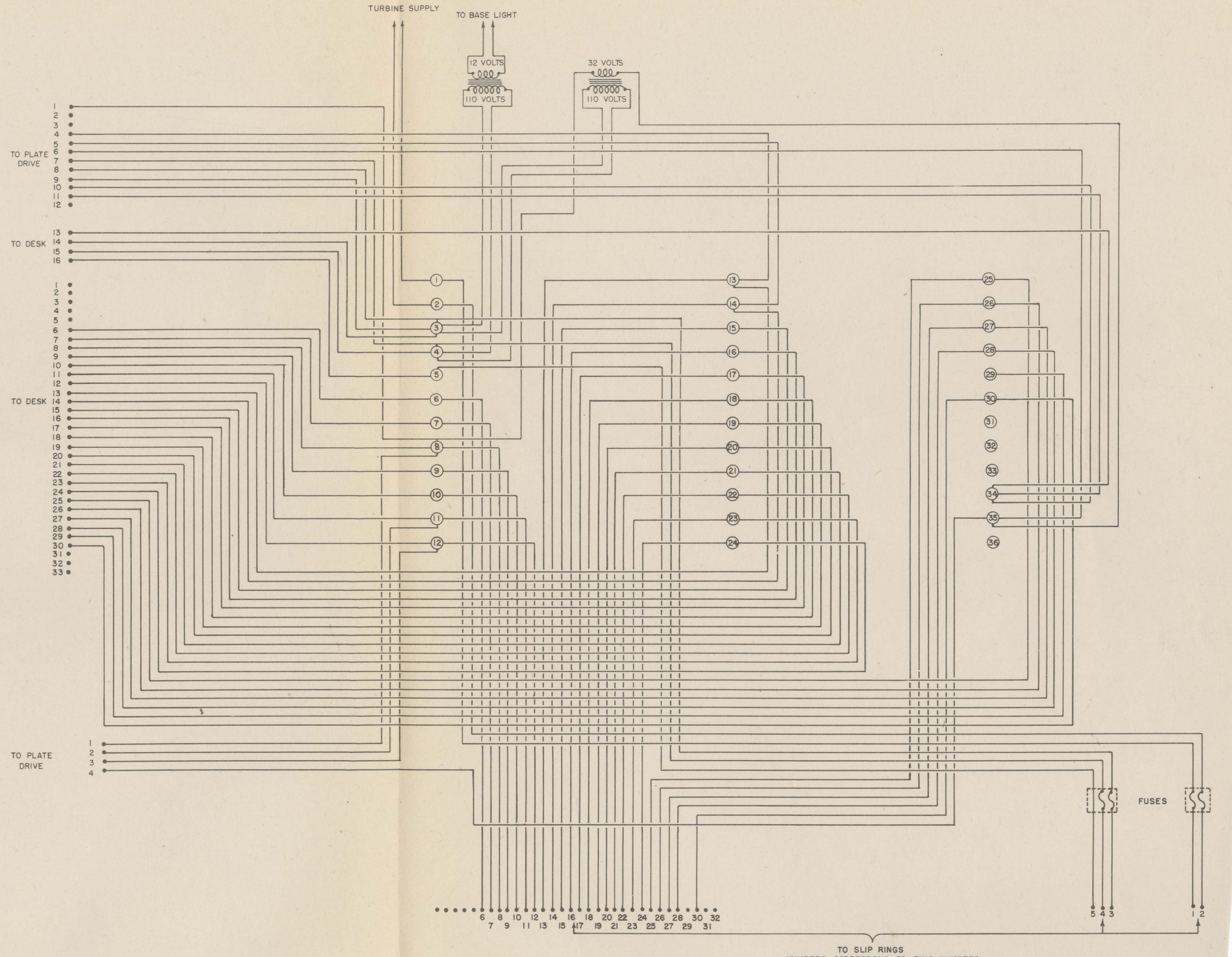


Figure 177—Wiring Diagram, Base Junction Box

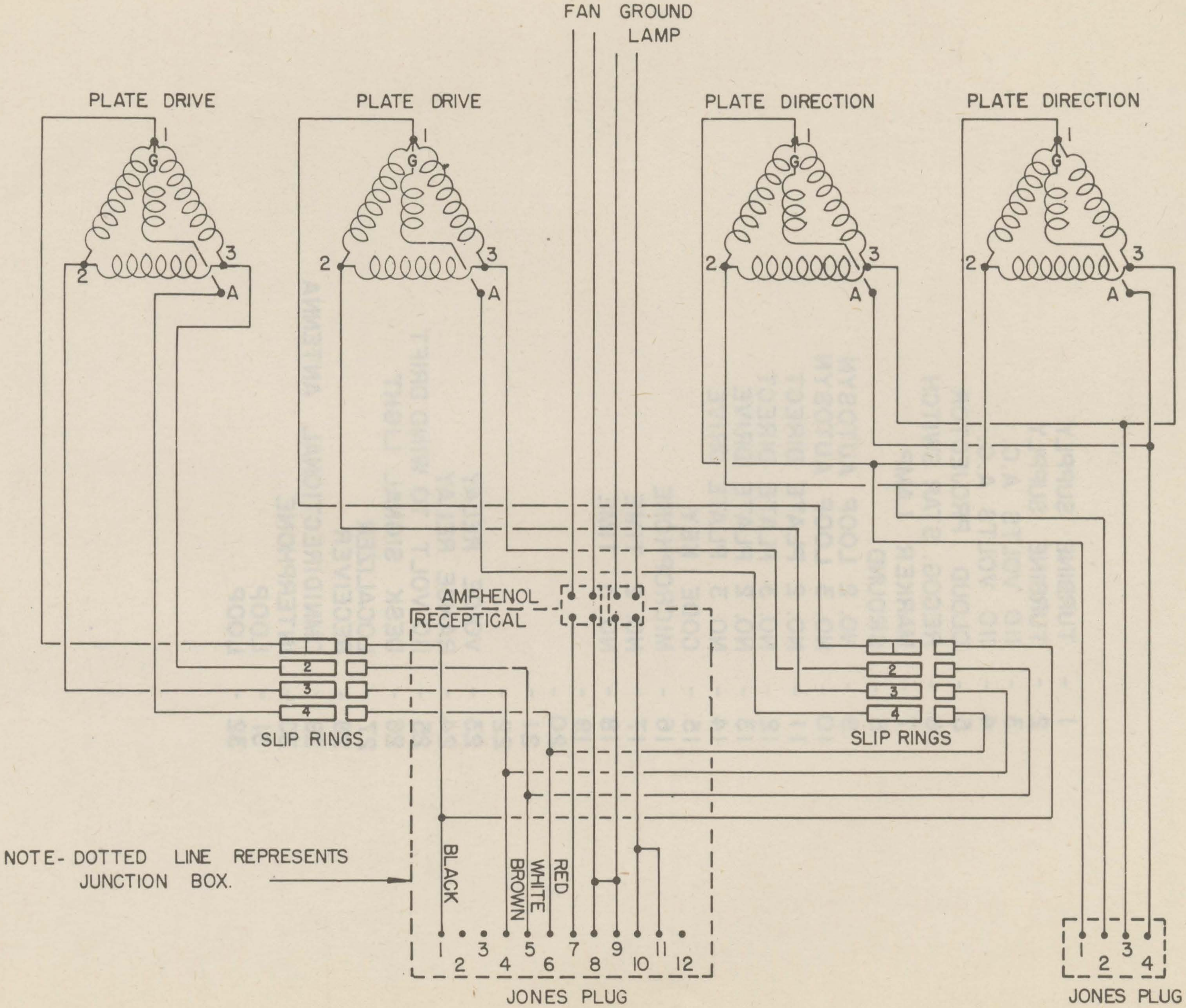


Figure 178—Wiring Diagram, Terrain Plate Drive

1 - TURBINE SUPPLY
2 - TURBINE SUPPLY
3 - 110 VOLTS A.C.
4 - 110 VOLTS A.C.
5 - CLOUD PROJECTOR
6 - RECOG. STAR SWITCH
7 - MARKER LAMP
8 - GROUND
9 - NO. 2 LOOP AUTOSYN
10 - NO. 3 LOOP AUTOSYN
11 - NO. 2 PLATE DIRECT
12 - NO. 3 PLATE DIRECT
13 - NO. 2 PLATE DRIVE
14 - NO. 3 PLATE DRIVE
15 - CODE KEY
16 - MICROPHONE
17 - NO. 2 TIME
18 - NO. 3 TIME
19 -
20 -
21 -
22 -
23 - VOICE RELAY
24 - RANGE RELAY
25 - 110 VOLT TO WIND DRIFT
26 - DESK SIGNAL LIGHT
27 - LOCALIZER
28 - RECEIVER
29 - OMNIDIRECTIONAL ANTENNA
30 - INTERPHONE
31 - LOOP
32 - LOOP

Figure 179—Terminal Wiring, Base Collector Rings

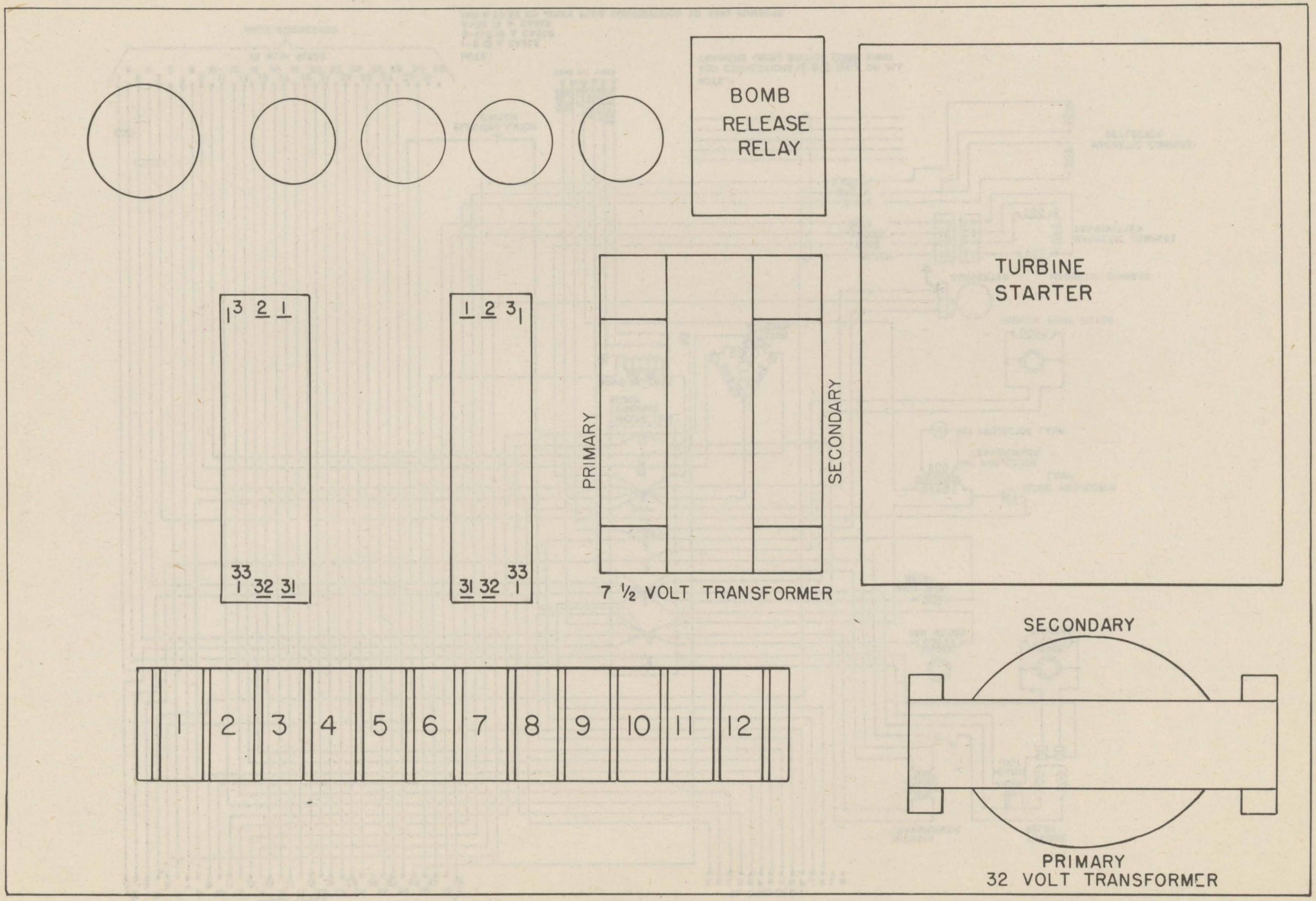


Figure 180—Terminal Layout, Tower Junction Box

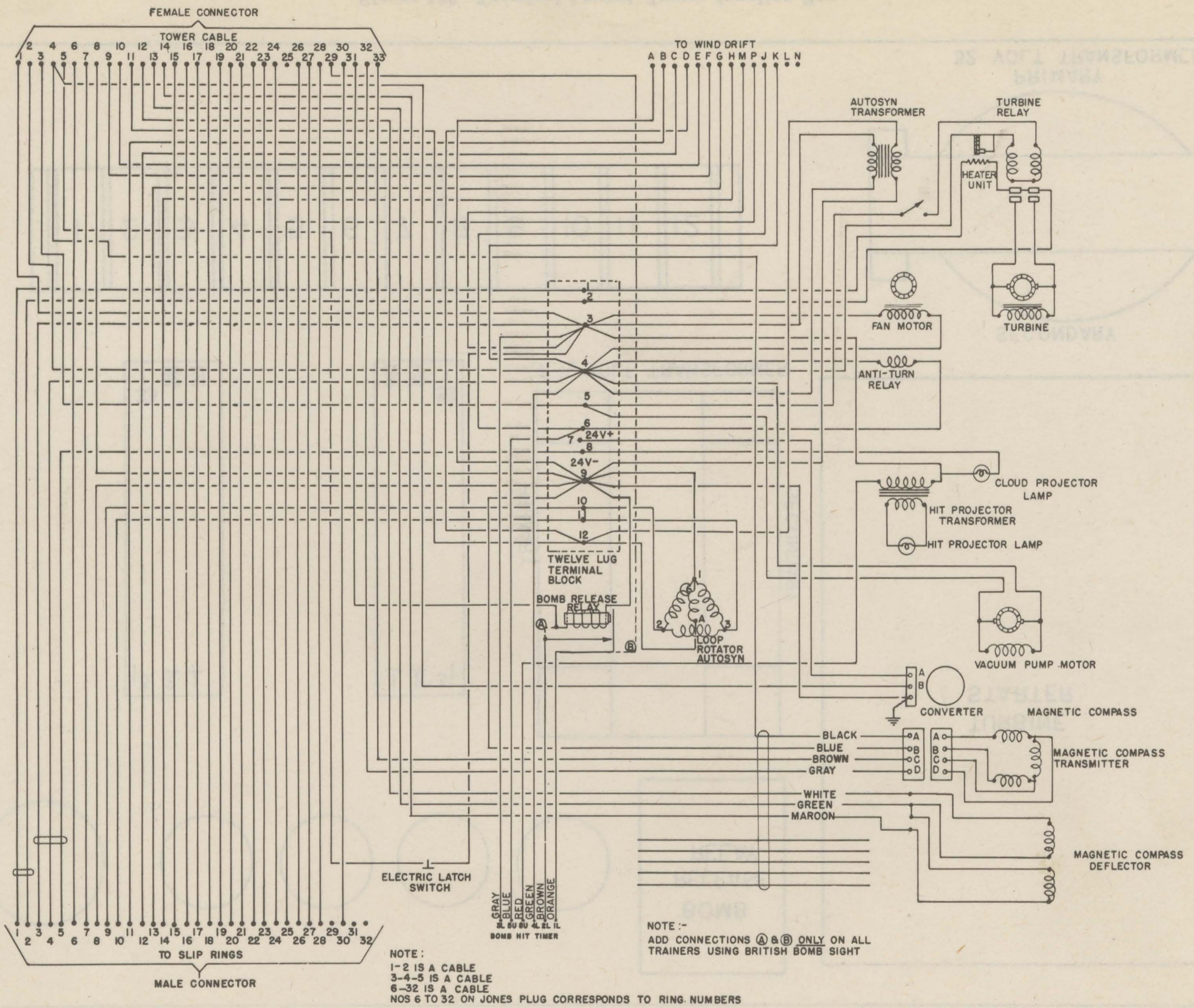


Figure 181—Wiring Diagram, Tower Junction Box and Associated Apparatus

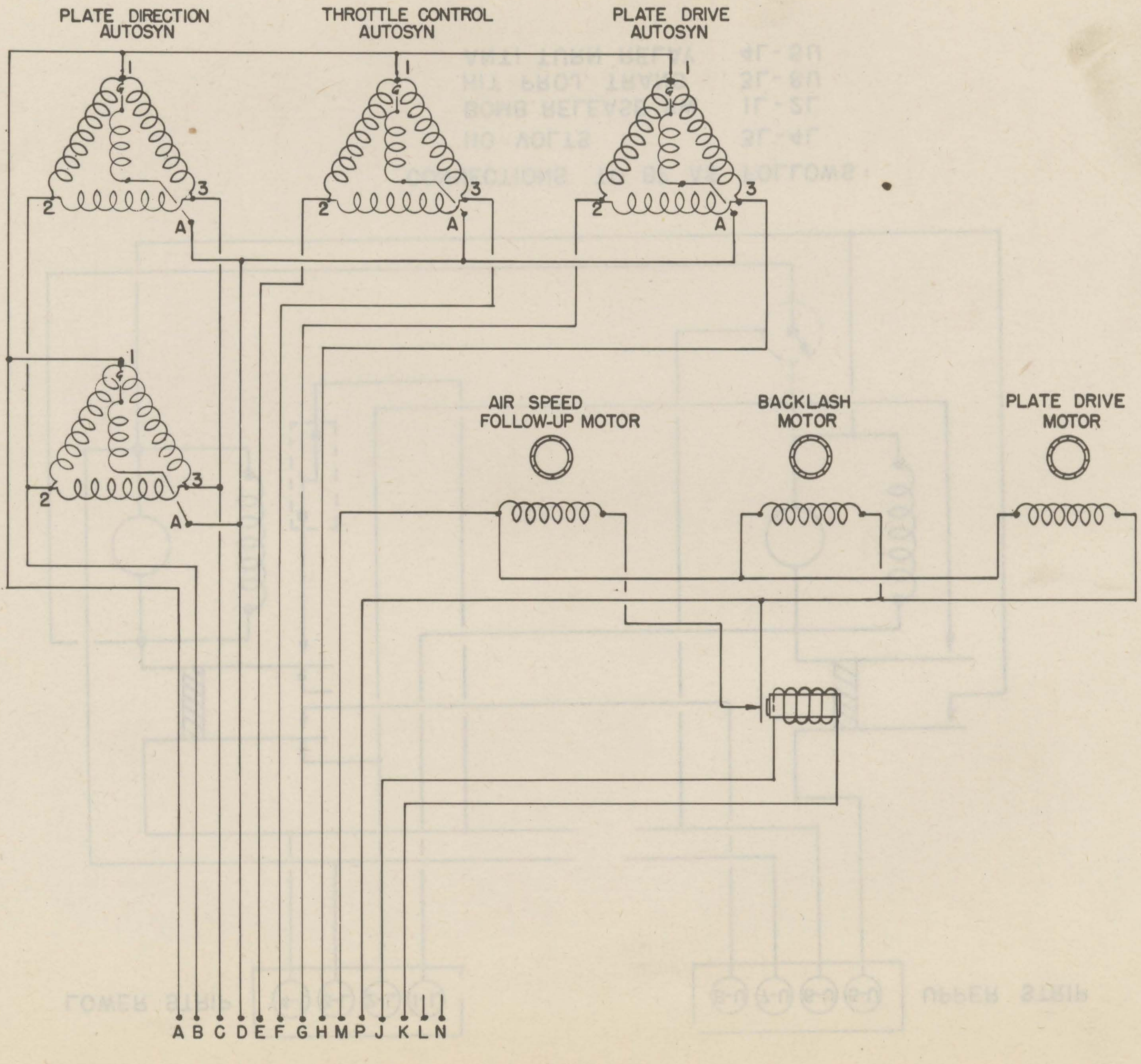
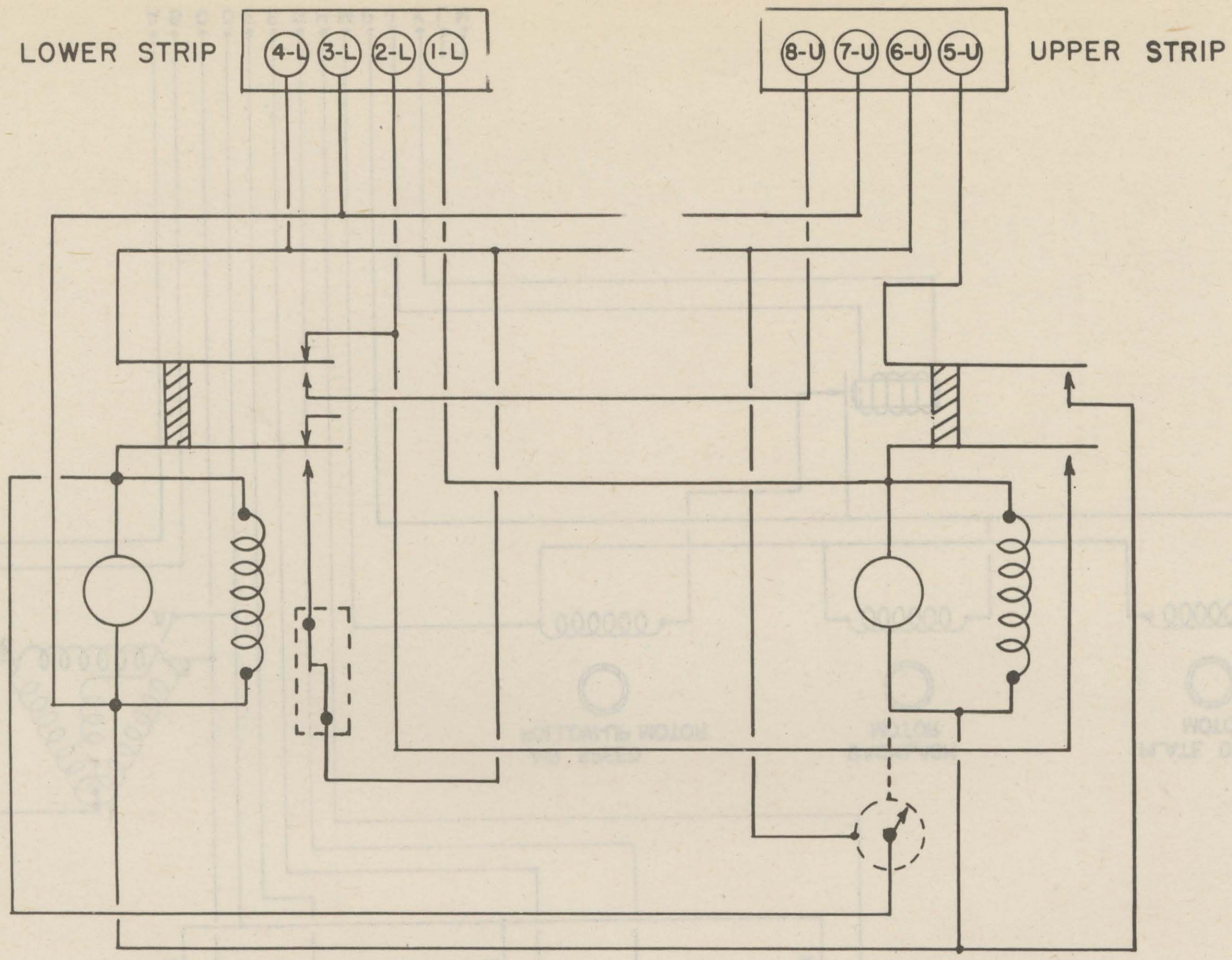


Figure 182—Wiring Diagram, Wind Drift Unit



CONNECTIONS TO BE AS FOLLOWS:

110 VOLTS	3L-4L
BOMB RELEASE SW.	1L-2L
HIT PROJ. TRANS	3L-8U
ANTI TURN RELAY	4L-5U

Figure 183—Wiring Diagram, Hit Projector Timer

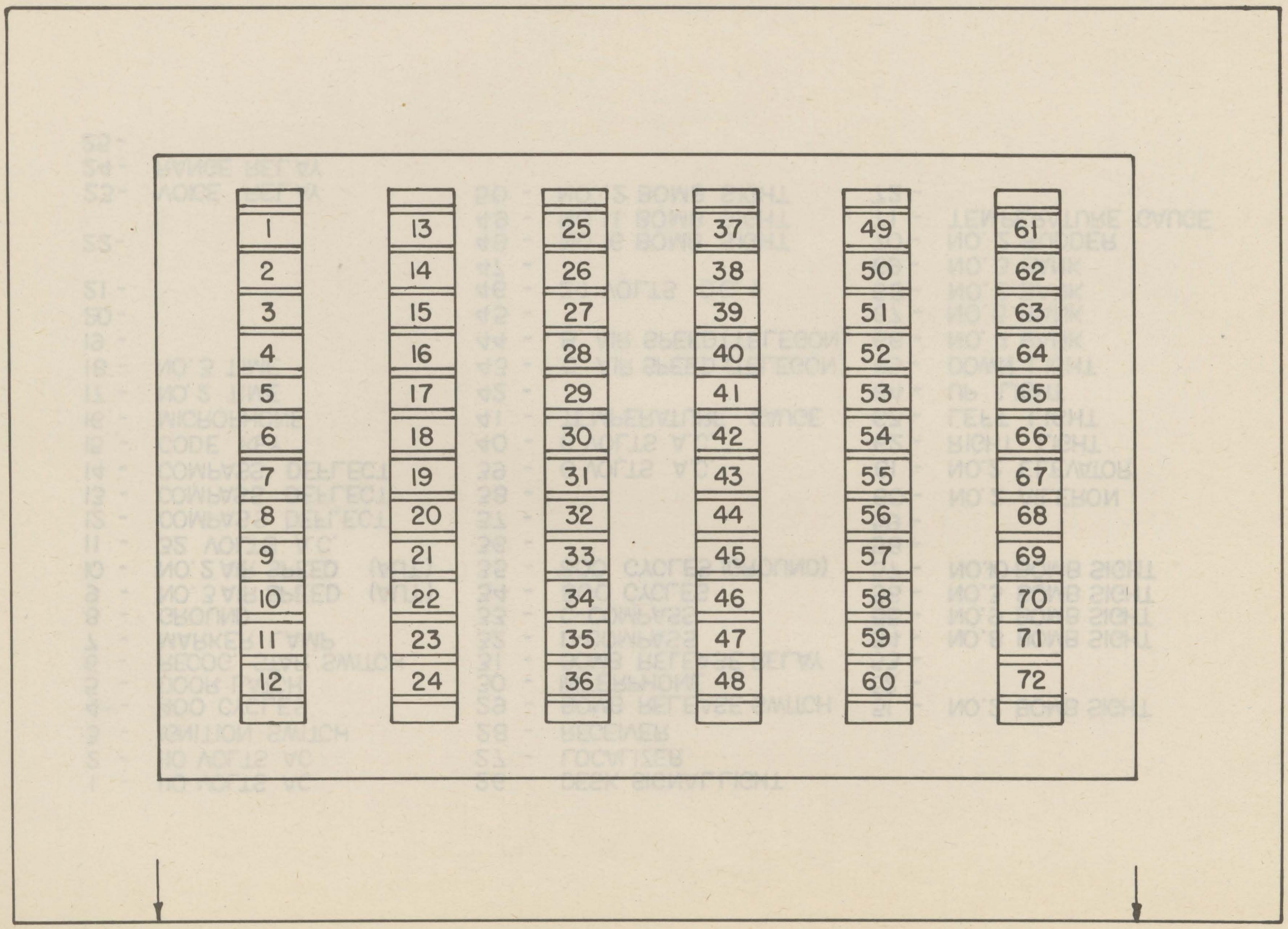


Figure 184—Terminal Layout, Fuselage Junction Box #1

1 - 110 VOLTS AC
2 - 110 VOLTS AC
3 - IGNITION SWITCH
4 - 400 CYCLES
5 - DOOR LATCH
6 - RECOG. STAR SWITCH
7 - MARKER LAMP
8 - GROUND
9 - NO. 3 AIR SPEED (AUT)
10 - NO. 2 AIR SPEED (AUT)
11 - 32 VOLTS A.C.
12 - COMPASS DEFLECT
13 - COMPASS DEFLECT
14 - COMPASS DEFLECT
15 - CODE KEY
16 - MICROPHONE
17 - NO. 2 TIME
18 - NO. 3 TIME
19 -
20 -
21 -
22 -
23 - VOICE RELAY
24 - RANGE RELAY
25 -
26 - DESK SIGNAL LIGHT
27 - LOCALIZER
28 - RECEIVER
29 - BOMB RELEASE SWITCH
30 - INTERPHONE
31 - BOMB RELEASE RELAY
32 - D-COMPASS
33 - C-COMPASS
34 - 800 CYCLES
35 - 800 CYCLES (GROUND)
36 -
37 -
38 -
39 - 6 VOLTS A.C.
40 - 6 VOLTS A.C.
41 - TEMPERATURE GAUGE
42 -
43 - C AIR SPEED (TELEGON)
44 - B AIR SPEED (TELEGON)
45 -
46 - 24 VOLTS D.C. +
47 -
48 - NO. 16 BOMB SIGHT
49 - NO. 11 BOMB SIGHT
50 - NO. 12 BOMB SIGHT
51 - NO. 2 BOMB SIGHT
52 -
53 -
54 - NO. 8 BOMB SIGHT
55 - NO. 9 BOMB SIGHT
56 - NO. 3 BOMB SIGHT
57 - NO. 10 BOMB SIGHT
58 -
59 -
60 - NO. 2 AILERON
61 - NO. 2 ELEVATOR
62 - RIGHT LIGHT
63 - LEFT LIGHT
64 - UP LIGHT
65 - DOWN LIGHT
66 - NO. 4 BANK
67 - NO. 5 BANK
68 - NO. 2 BANK
69 - NO. 3 BANK
70 - NO. 2 RUDDER
71 - TEMPERATURE GAUGE
72 -

Figure 185—Terminal Wiring, Fuselage Junction Box #1

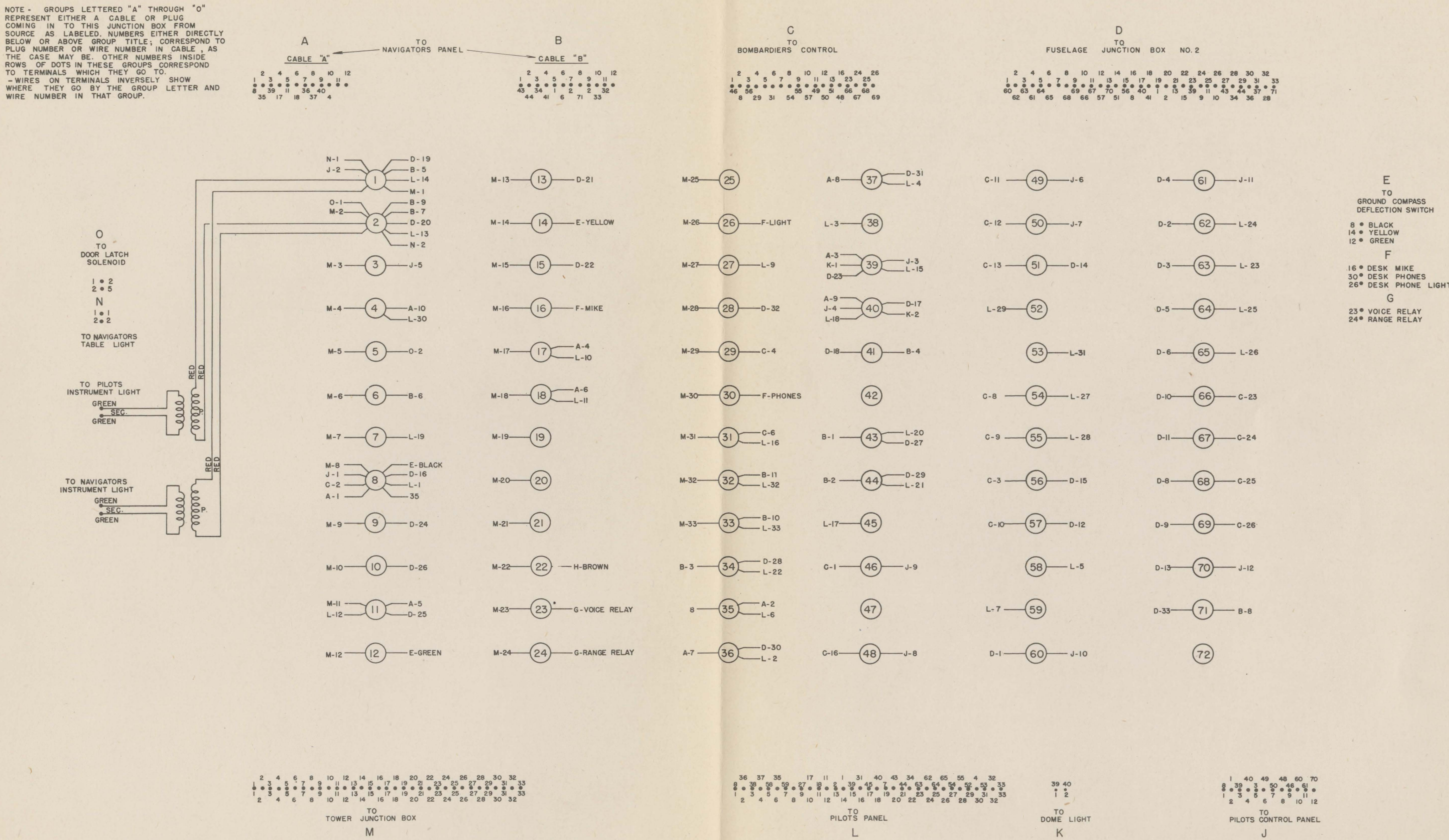


Figure 186—Wiring Diagram, Fuselage Junction Box #1

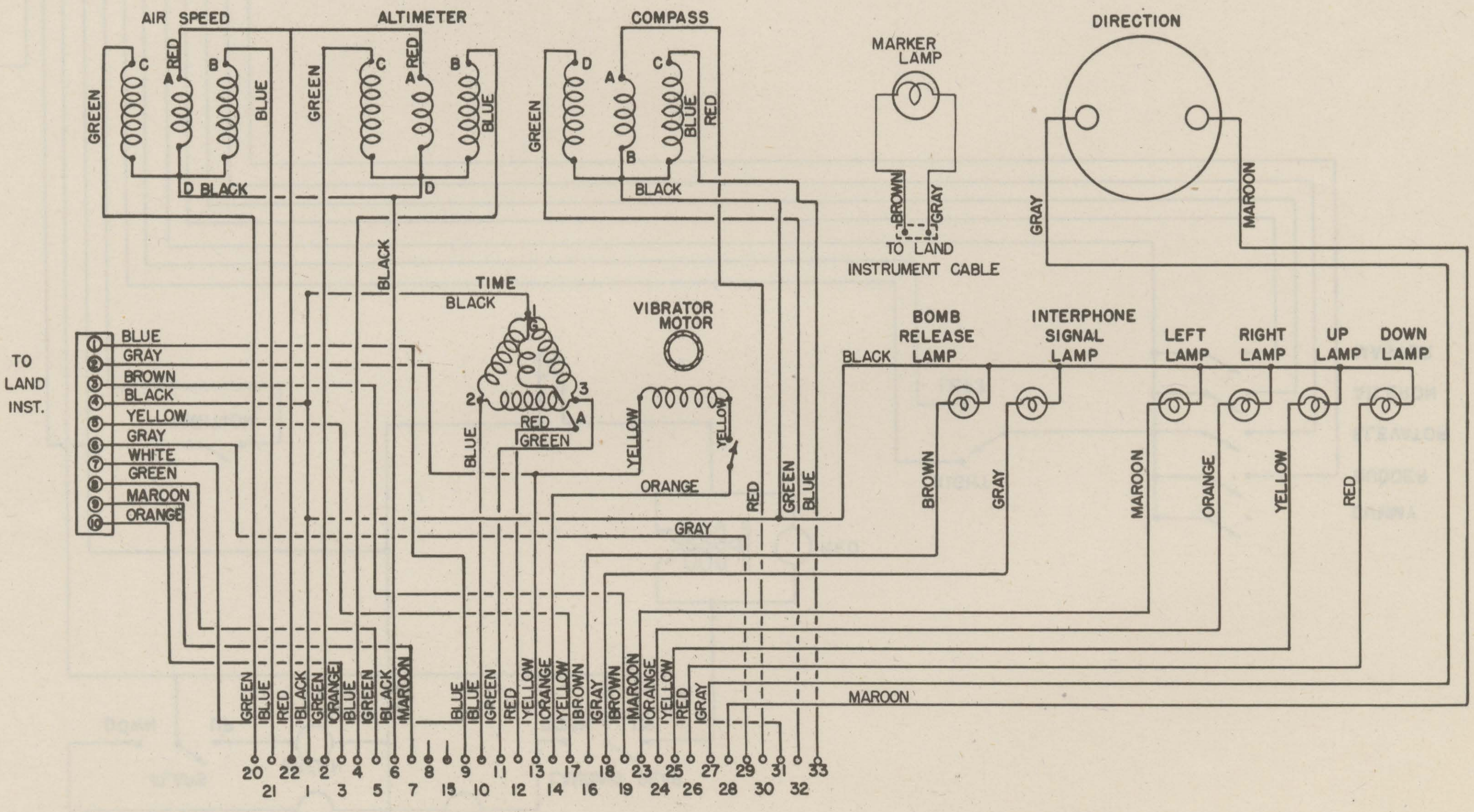


Figure 187—Wiring Diagram, Pilot's Instrument Panel

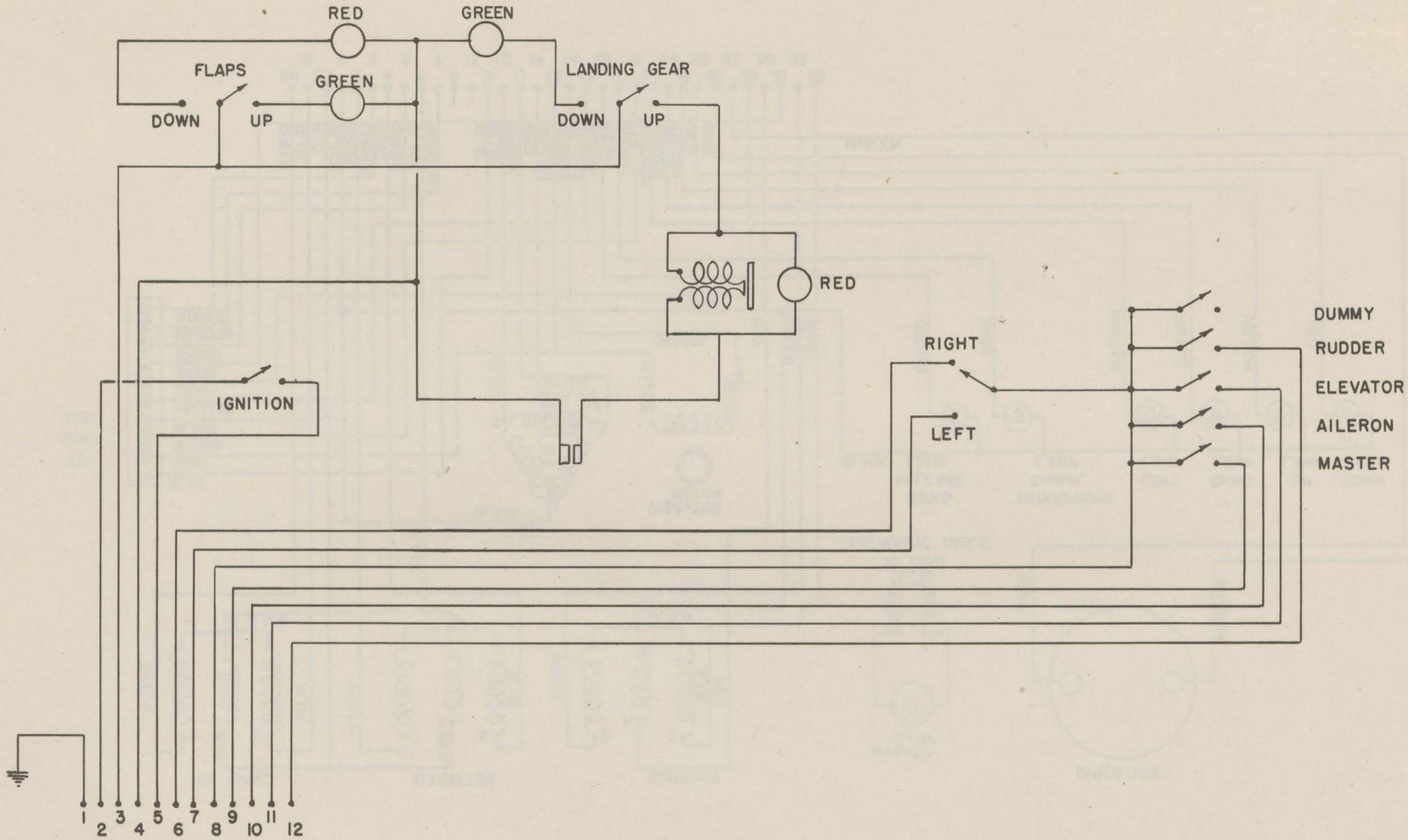


Figure 188—Wiring Diagram, Pilot's Control Panel

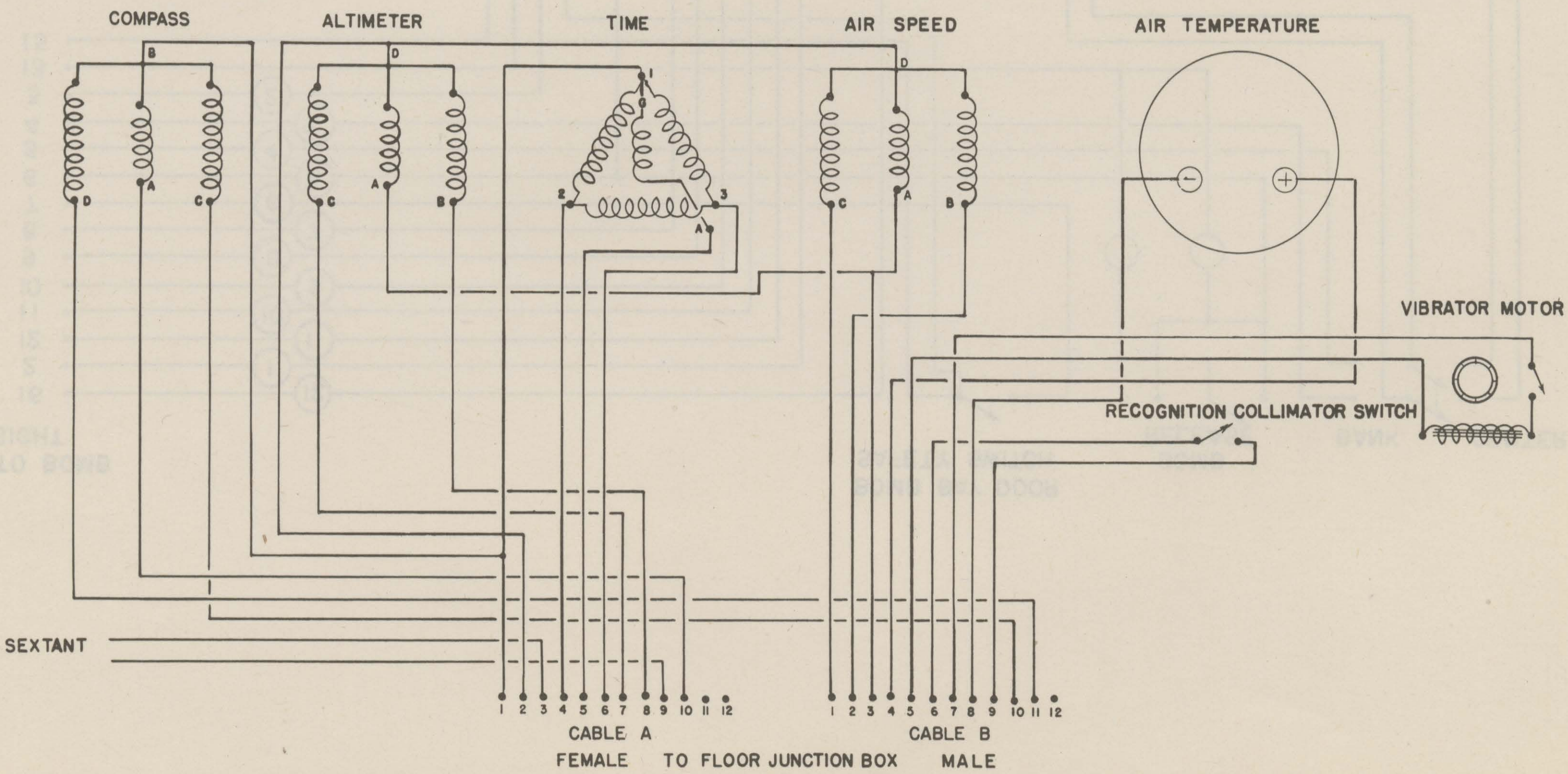


Figure 189—Wiring Diagram, Navigator's Instrument Panel

RESTRICTED

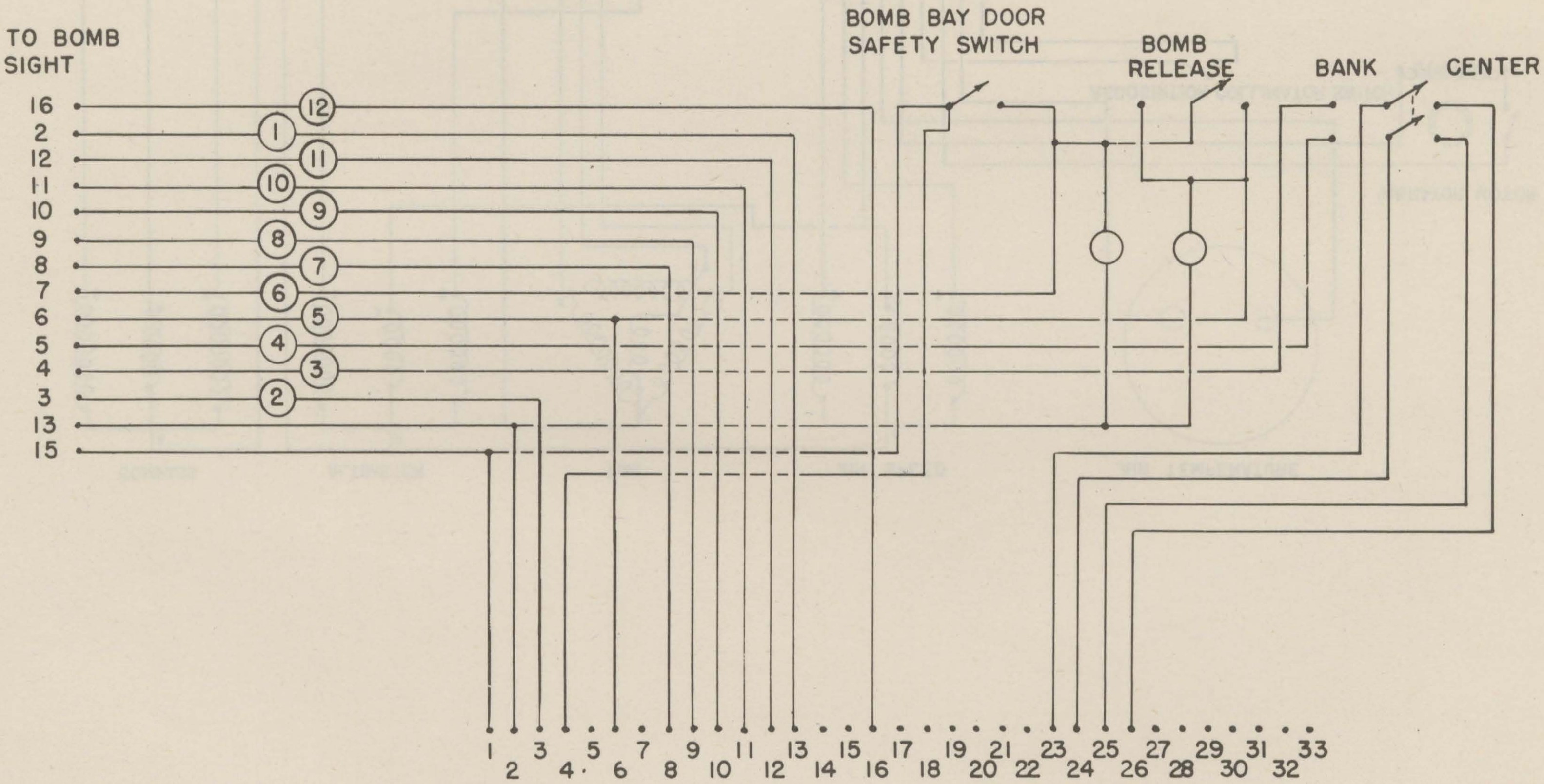


Figure 190—Wiring Diagram, Bombardier's Control Box

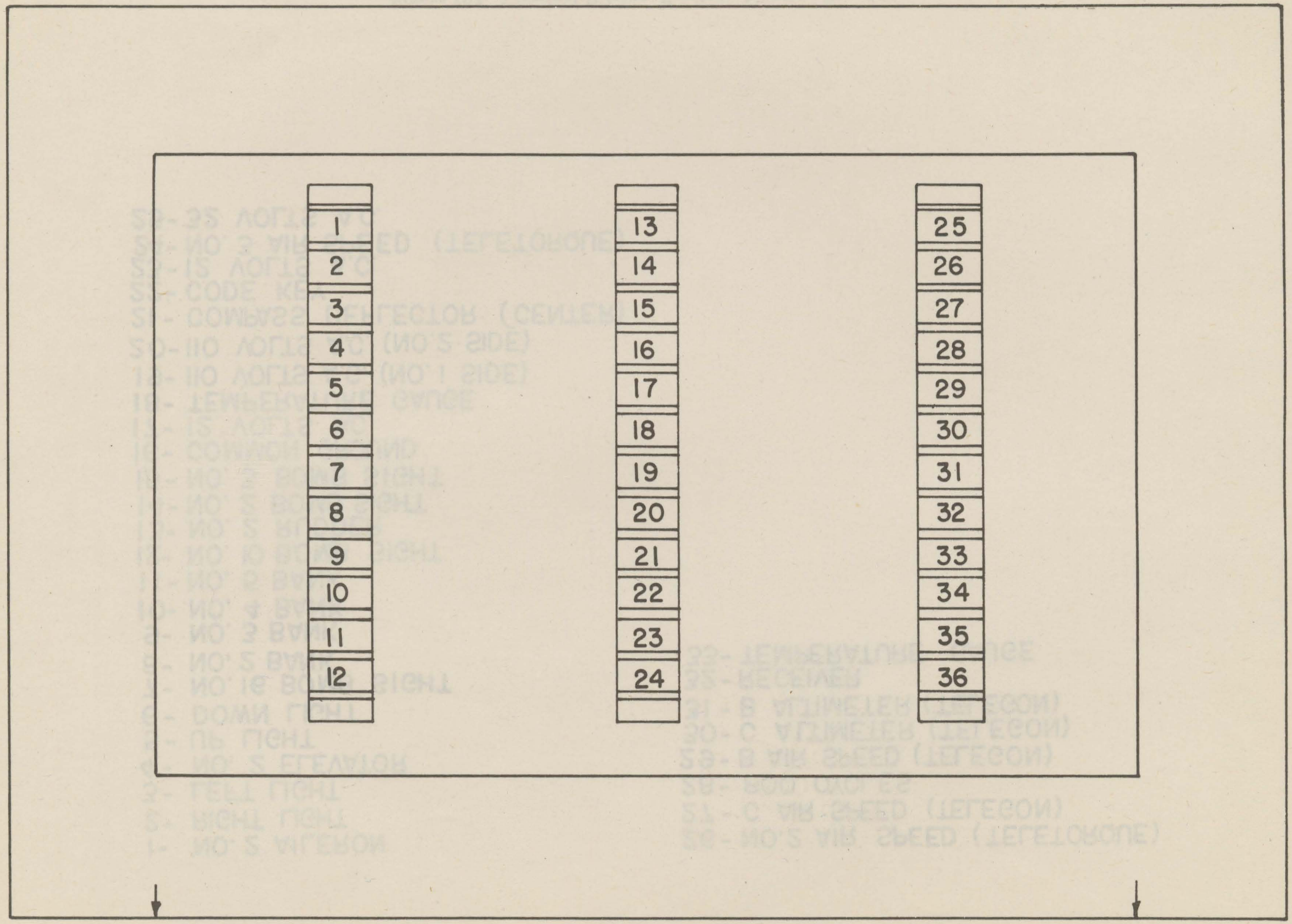


Figure 191—Terminal Layout, Fuselage Junction Box #2

1- NO. 2 AILERON
2- RIGHT LIGHT
3- LEFT LIGHT
4- NO. 2 ELEVATOR
5- UP LIGHT
6- DOWN LIGHT
7- NO. 16 BOMB SIGHT
8- NO. 2 BANK
9- NO. 3 BANK
10- NO. 4 BANK
11- NO. 5 BANK
12- NO. 10 BOMB SIGHT
13- NO. 2 RUDDER
14- NO. 2 BOMB SIGHT
15- NO. 3 BOMB SIGHT
16- COMMON GROUND
17- 12 VOLTS A.C.
18- TEMPERATURE GAUGE
19- 110 VOLTS A.C. (NO. 1 SIDE)
20- 110 VOLTS A.C. (NO. 2 SIDE)
21- COMPASS DEFLECTOR (CENTER)
22- CODE KEY
23- 12 VOLTS A.C.
24- NO. 3 AIR SPEED (TELETORQUE)
25- 32 VOLTS A.C.
26- NO. 2 AIR SPEED (TELETORQUE)
27- C AIR SPEED (TELEGON)
28- 800 CYCLES
29- B AIR SPEED (TELEGON)
30- C ALTIMETER (TELEGON)
31- B ALTIMETER (TELEGON)
32- RECEIVER
33- TEMPERATURE GAUGE

Figure 192—Terminal Wiring, Fuselage Junction Box #2

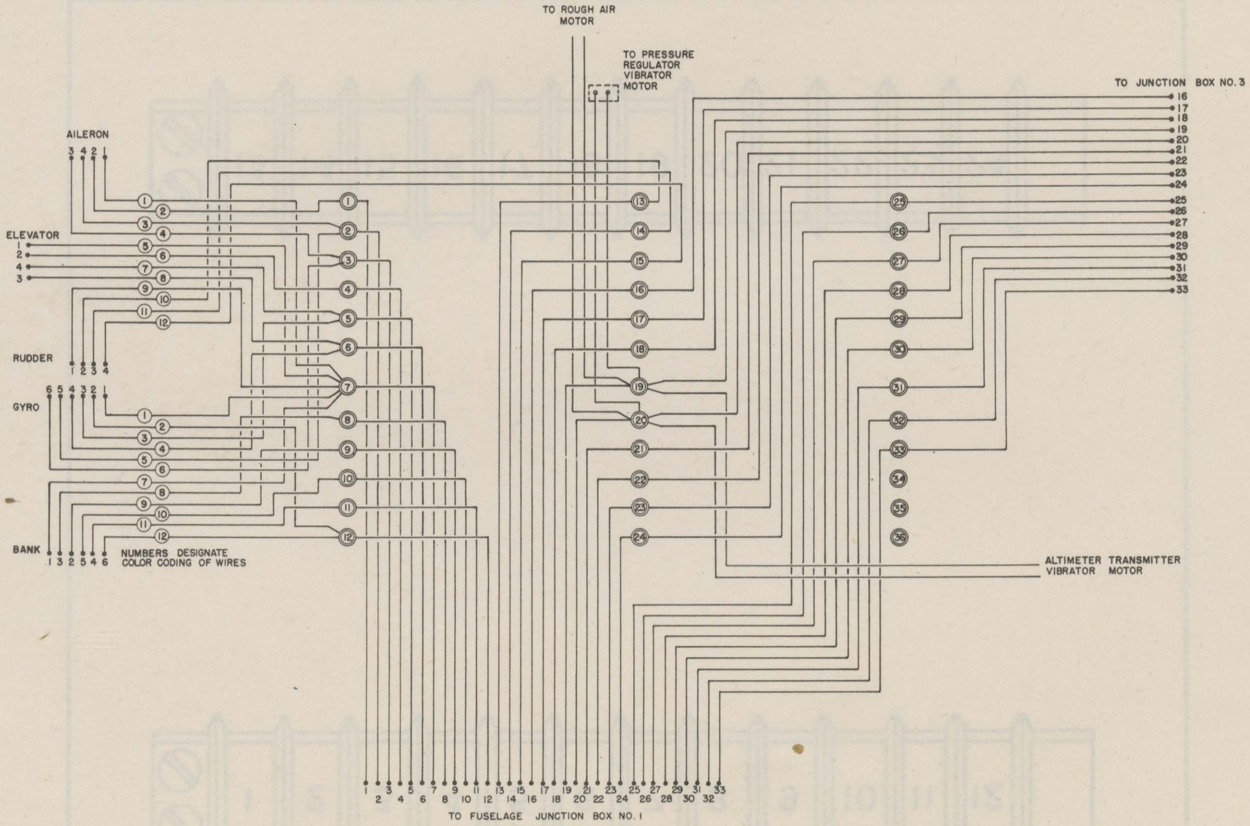


Figure 193—Wiring Diagram, Fuselage Junction Box #2

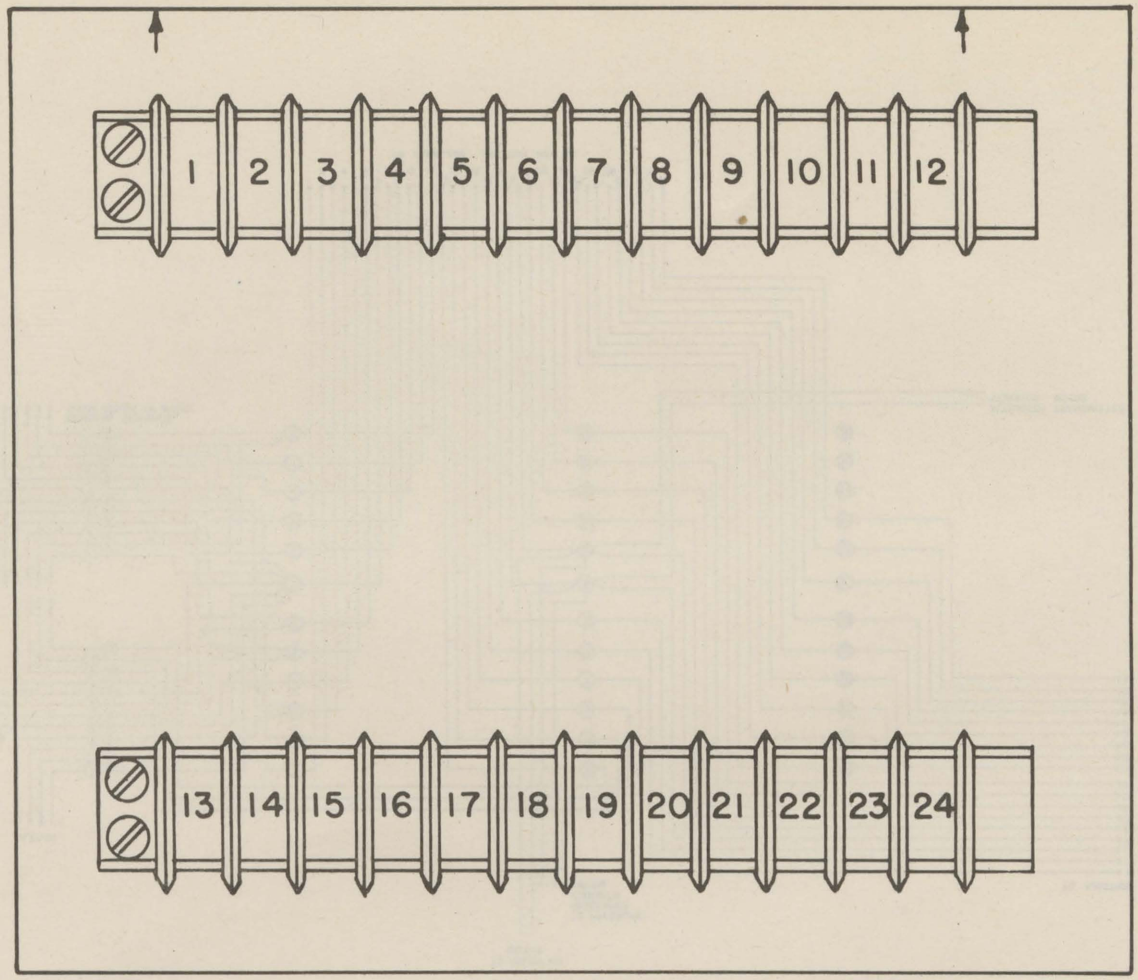


Figure 194—Terminal Layout, Fuselage Junction Box #3

1	COMMON GROUND	21
2	12 VOLT A. C.	22
3	TEMPERATURE GAUGE	23
4	110 VOLT A. C. (#1 SIDE)	24
5	110 VOLT A. C. (#2 SIDE)	25
6	COMPASS DEFLECTOR	26
7	CODE KEY	27
8	12 VOLT A. C.	28
9	#3 AIR SPEED (TELETORQUE)	29
10	32 VOLT A. C.	30
11	#2 AIR SPEED (TELETORQUE)	31
12	C AIR SPEED (TELEGON)	32
13	800 CYCLES	33
14	B AIR SPEED (TELEGON)	
15	C ALTIMETER (TELEGON)	
16	B ALTIMETER (TELEGON)	
17	MICROPHONE	
18	PHONES	
19	RECEIVER	
20	TEMPERATURE GAUGE	

Figure 195—Terminal Wiring, Fuselage Junction Box #3

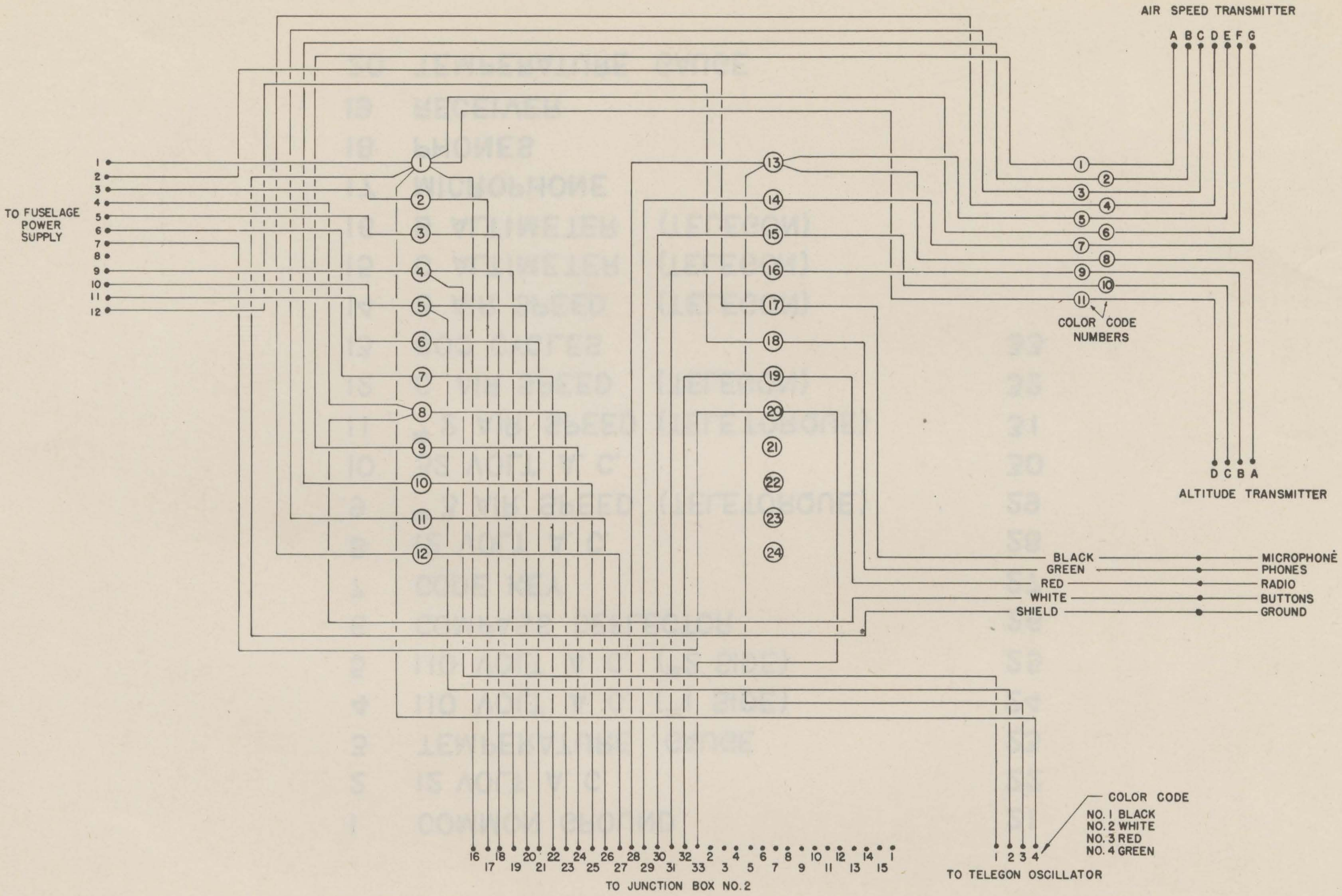


Figure 196—Wiring Diagram, Fuselage Junction Box #3

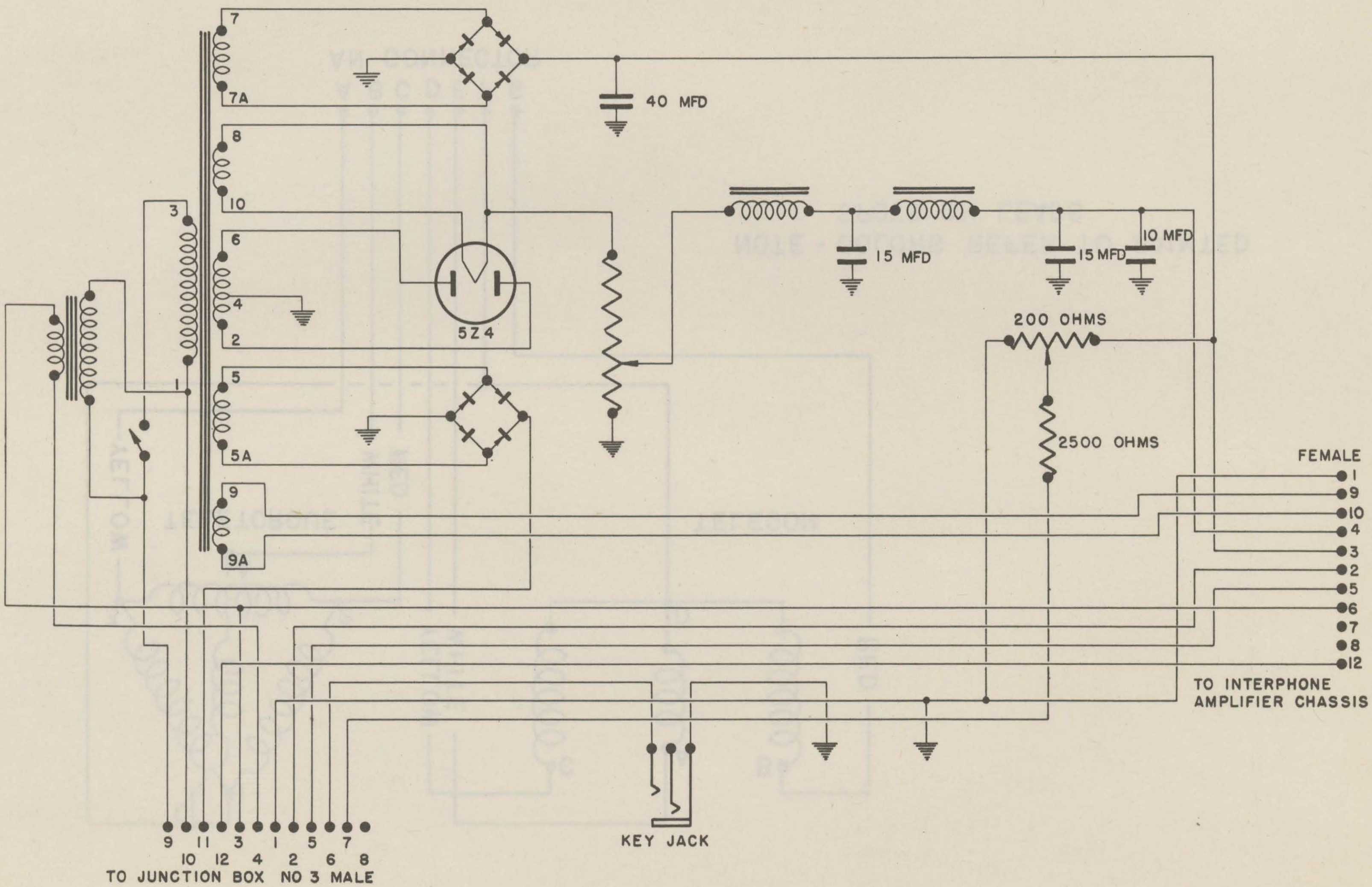
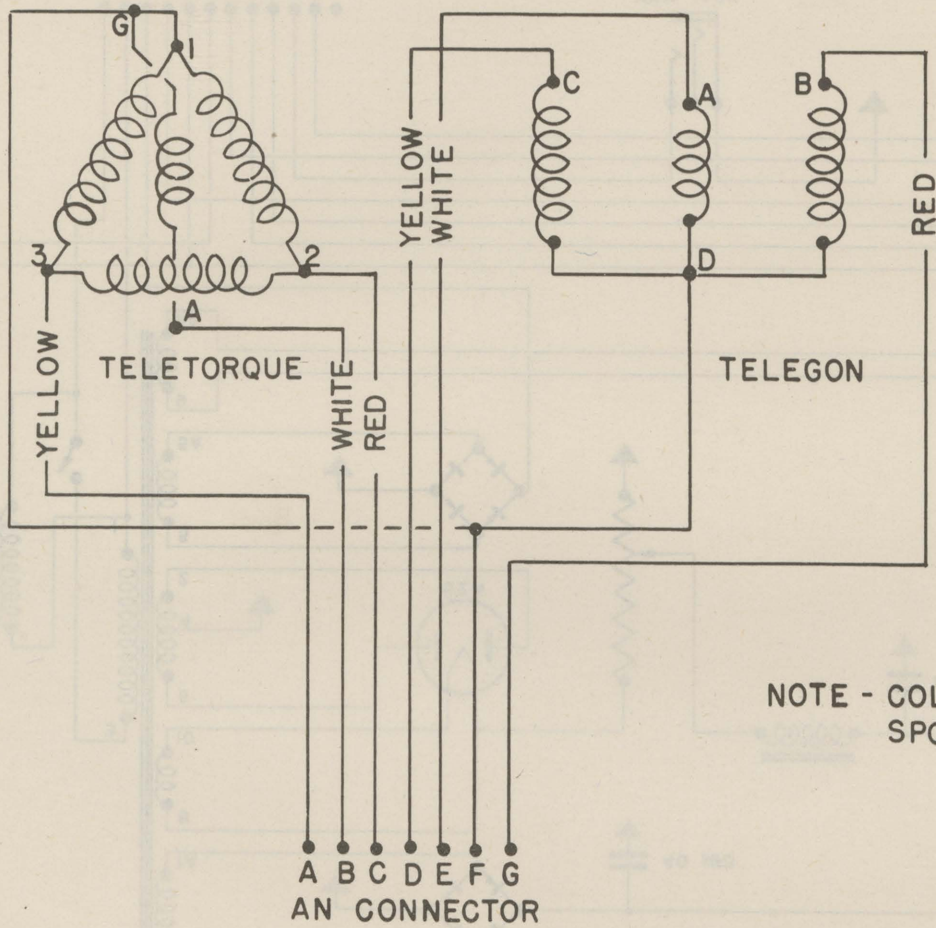
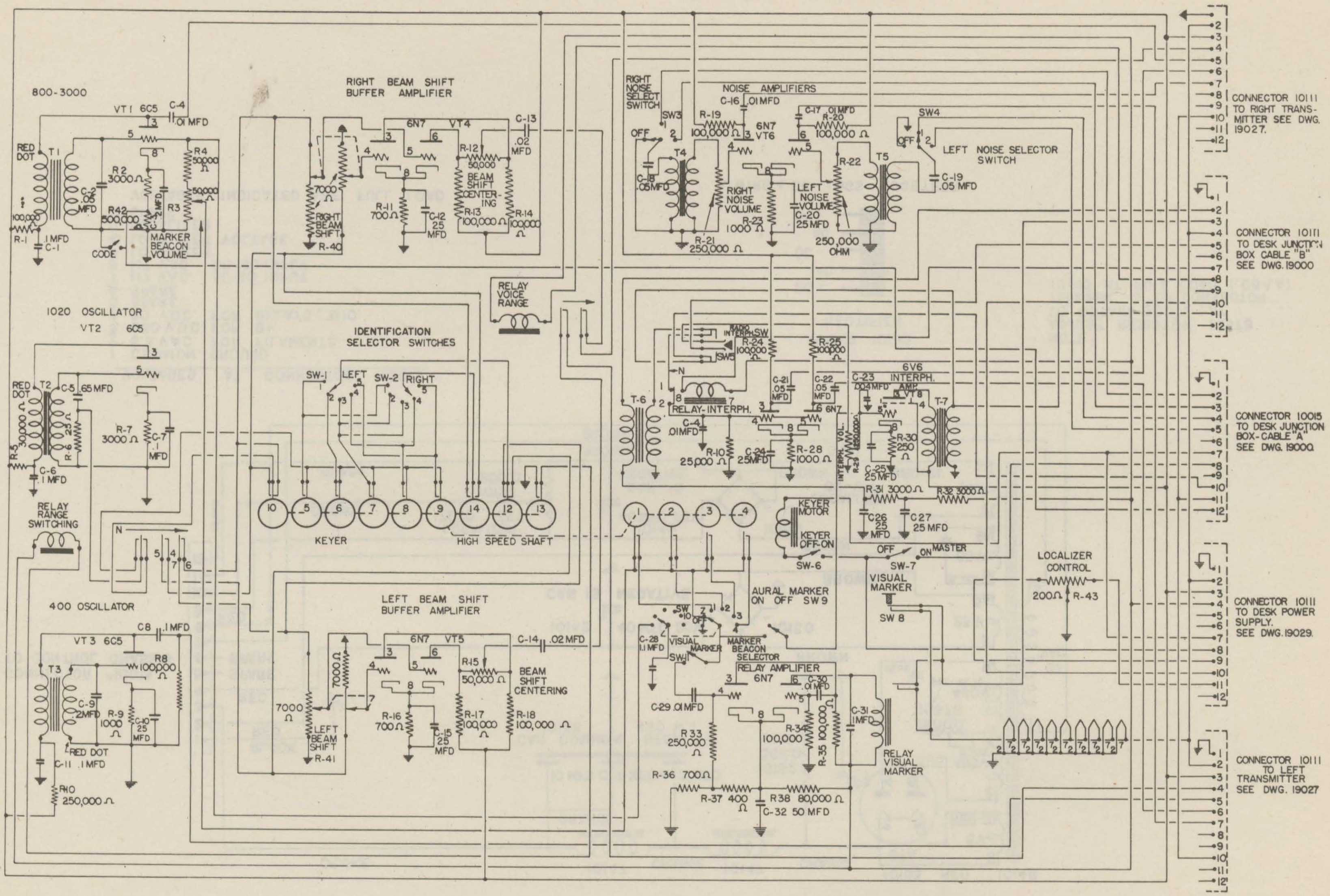


Figure 197—Wiring Diagram, Fuselage Power Supply



NOTE - COLORS REFER TO PAINTED SPOTS ON LEADS

Figure 198—Wiring Diagram, Air-Speed Transmitter



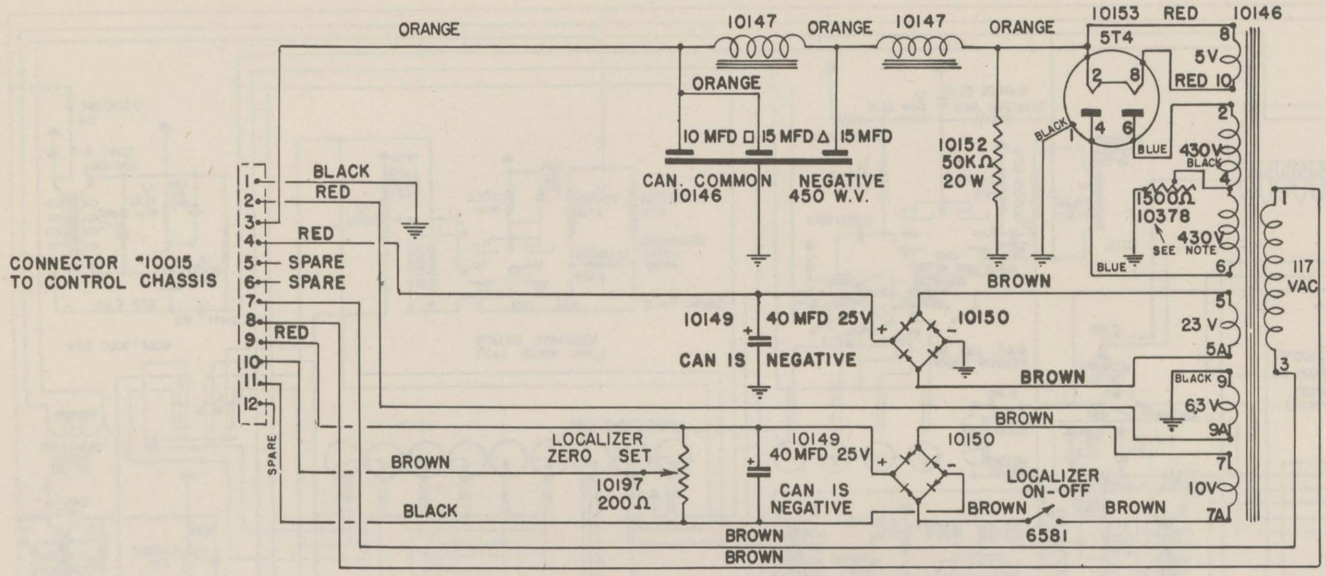
NOTES

ALL NUMBERS ARE FOR REFERENCE ONLY.

NUMBERS ADJACENT TO TUBE ELEMENTS AND RELAY CONTACTS ARE SOCKETPIN NUMBERS.

KEYER CAMS ARE NUMBERED FROM THE MOTOR END OF KEYER. NO. 1 CAM IS NEXT TO MOTOR NO. 2 CAM IS THE NEXT REMOVED, ETC.

Figure 199—Wiring Diagram, Radio Control Chassis

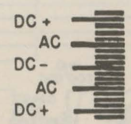


VOLTAGES AT CONNECTOR 10015

1 COMMON GROUND
2 6.3 V.A.C. FOR FILAMENTS
3 250 V.D.C. FOR B+
4 20 V.D.C. FOR RELAYS, MIC.
5 SPARE
6 SPARE
7 117 V.A.C. 50-60 INPUT
8 117 V.A.C. 50-60 INPUT
9 LOCALIZER
10 LOCALIZER VOLTAGE
11 LOCALIZER
12 SPARE

VOLTAGES INDICATED ARE FULL LOAD

WIRING 10150
RECTIFIER



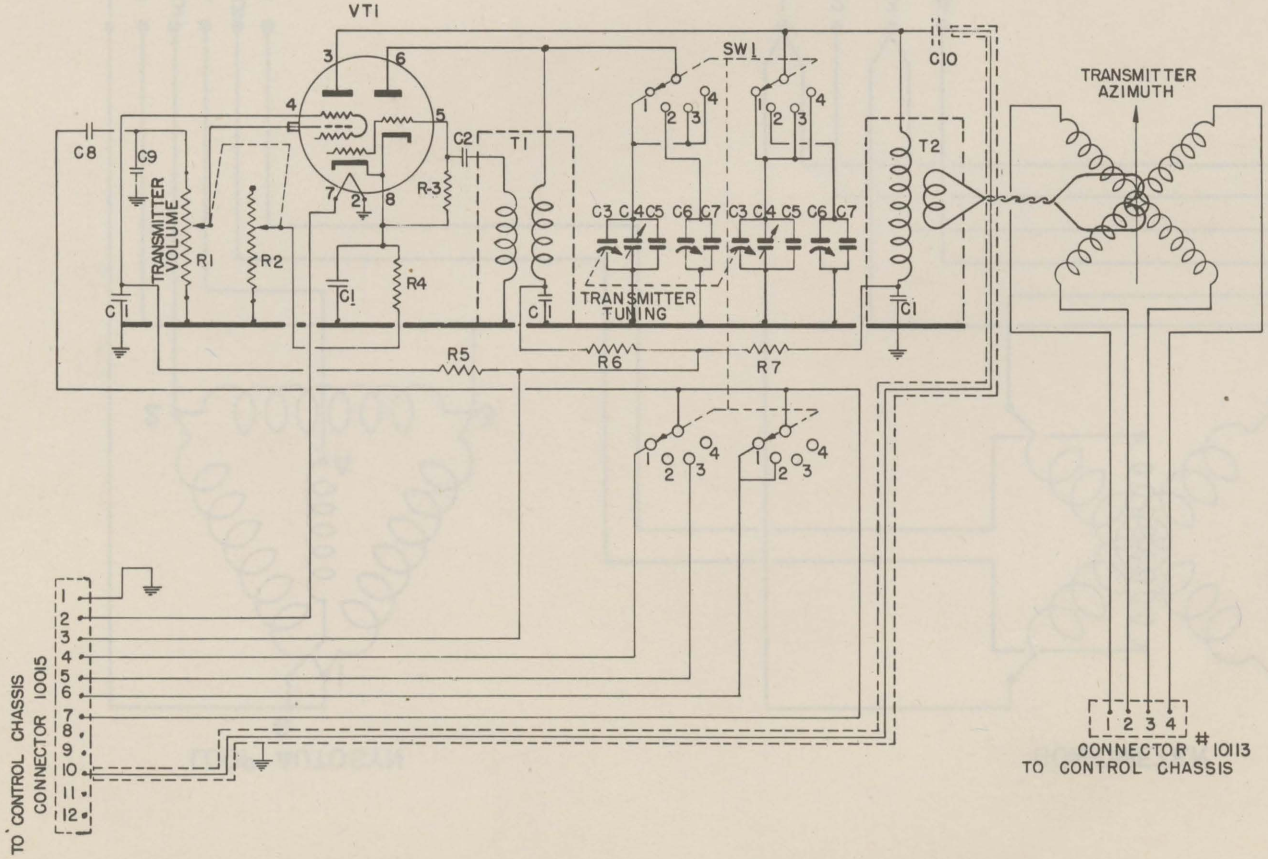
WIRE + DC LUGS TOGETHER

NOTE -
ADJUST RESISTOR 10378
TO OBTAIN 250 V AT
TERMINAL 3 OF CONNECTOR
10015 AT FULL LOAD (.064 A)

Figure 200—Wiring Diagram, Desk Power Supply

MODULATION SELECTOR SWITCH SW I

POSITION	R.F. CARRIER	MODULATION
1- RANGE	TUNABLE 200-400 KC	RANGE & VOICE
2- 278	FIXED TUNE - 278 KC	VOICE ONLY
3- INST. LAND	TUNABLE 200-400 KC	TONE ONLY
4- EXT. MOD.	TUNABLE 200-400 KC	EXT. MOD. ONLY



	VALUE	FUNCTION
R 1	200,000 Ω	TRANSMITTER VOL.
R 2	1500 Ω	TRANSMITTER VOL.
R 3	50 K Ω .5W	OSC. GRID LEAK
R 4	250 Ω 1W	BIAS RESISTOR
R 5	25 K Ω .5W	SCREEN RESISTOR
R 6	40 K Ω .5W	OSC. PLATE RES.
R 7	2500 Ω .5W	AMP. PLATE RES.
C 1	.1MFD 400V	BY-PASS COND.
C2	300MMF MICA	GRID COUPLING
C3	220MMF VAR.	TRANSMITTER TUNE
C4	15 MMF ADJ.	TRIMMERS ON T.C.
C5	15 MMF MICA	TUNING COND. SHUNT
C6	50MMF VAR.	278 KC TUNING
C7	70MMF MICA	278 KC TUNING
T 1		OSC. COIL
T 2		AMP. COIL
VT1	6K8	OSC. AMP. TUBE
SW1	4POLE 4POS.	MODULATION SEL.
C8	.004MFD MICA	COUPLING COND.
C9	.01MFD MICA	FILTER COND.
C10	APPROX. 1.2 MMF	

Figure 201—Wiring Diagram, Radio Transmitter

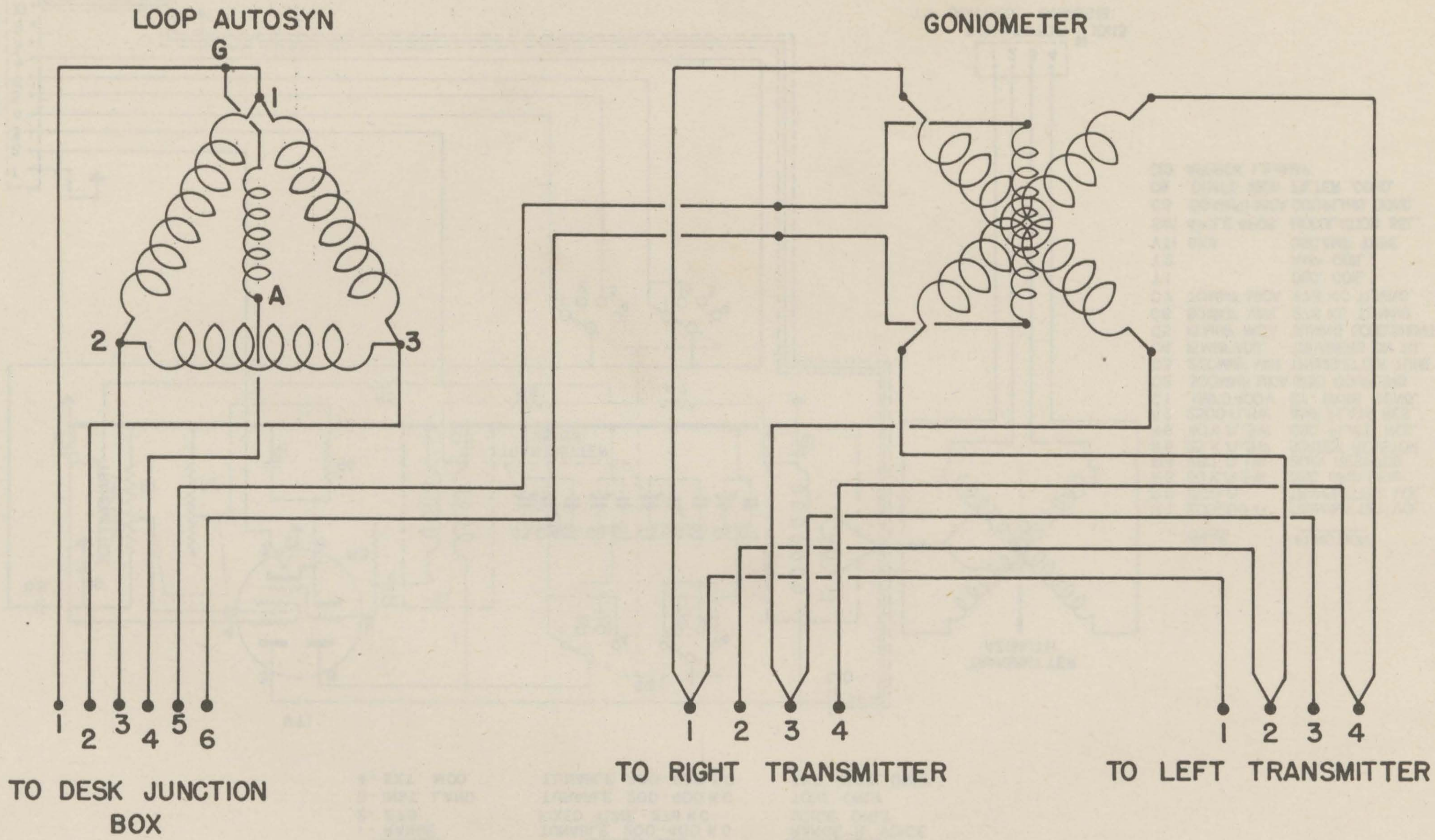


Figure 202—Wiring Diagram, Remote Receiver Loop

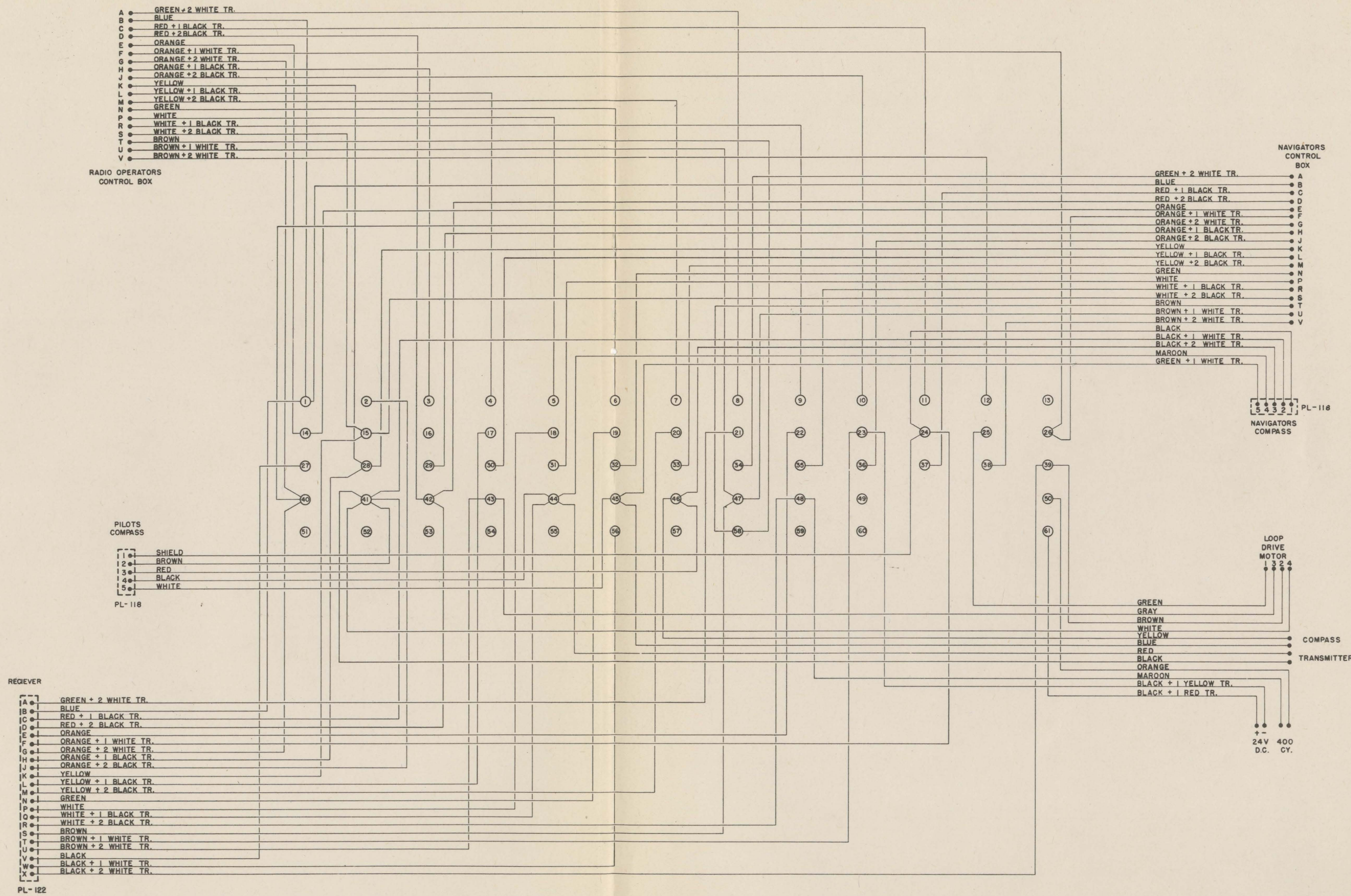


Figure 203—Wiring Diagram, Automatic Radio Compass Relay Box

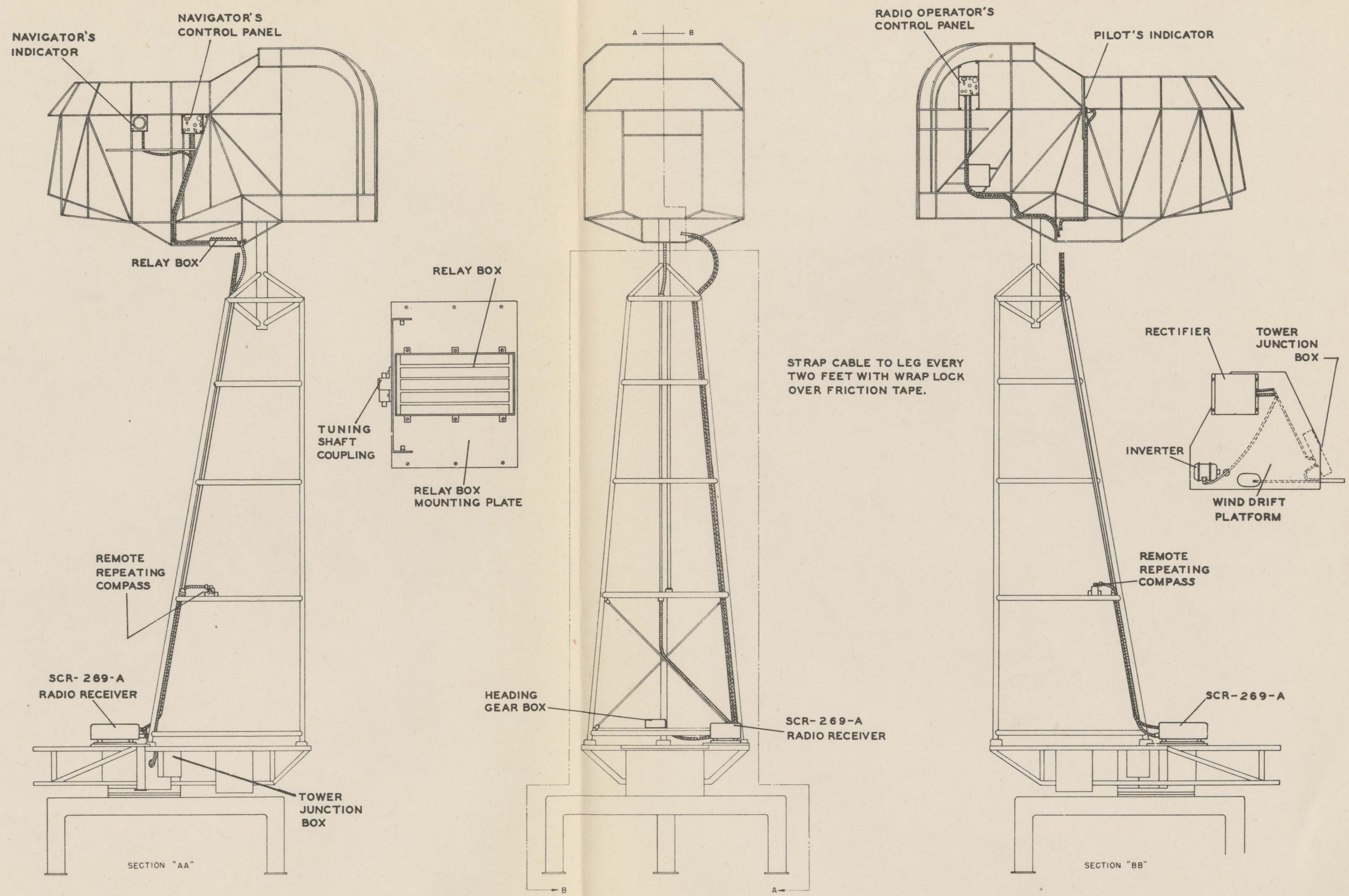


Figure 204—Wiring Layout, SCR-269-A Radio Installation

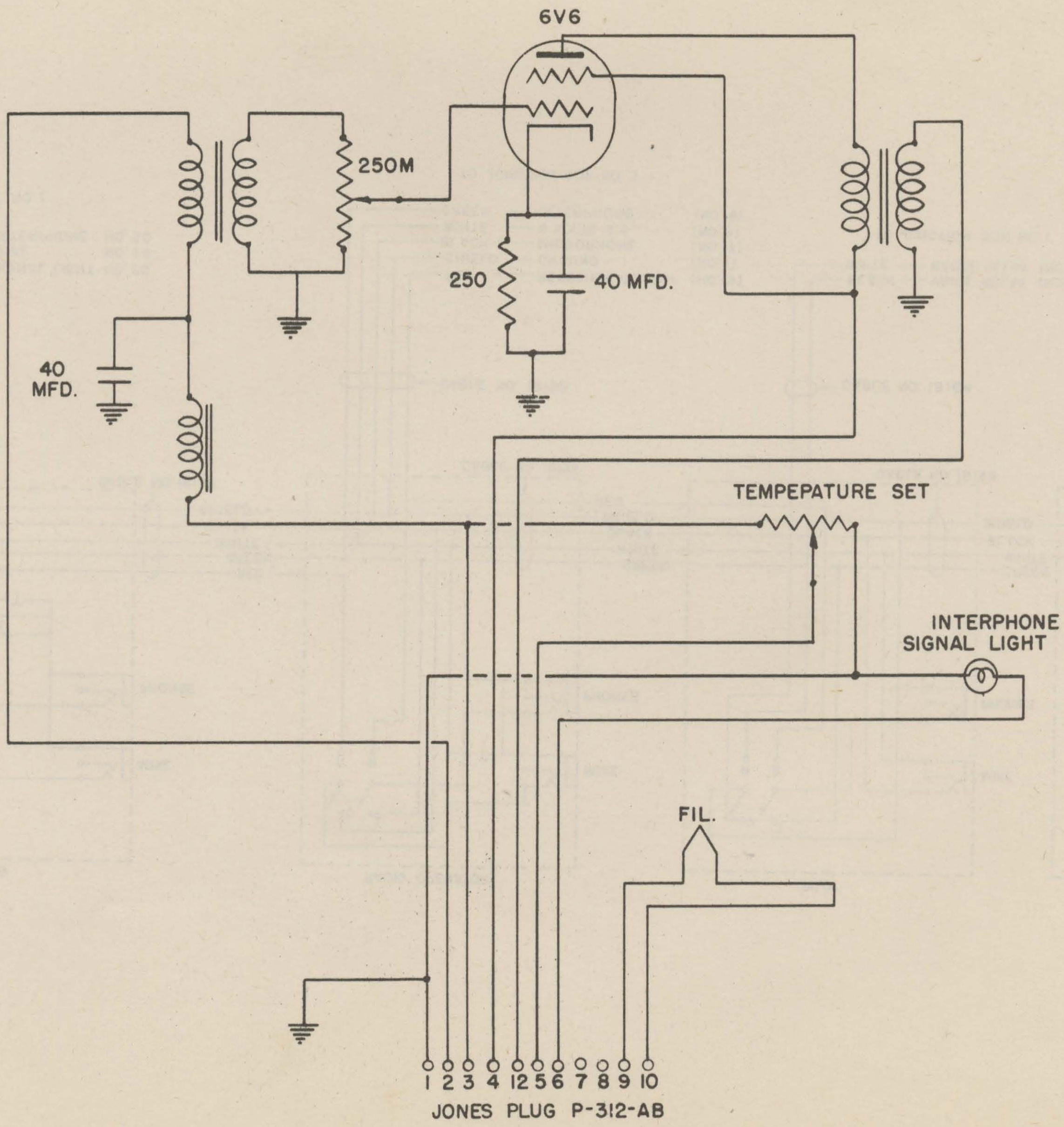


Figure 205—Wiring Diagram, Fuselage Interphone Amplifier

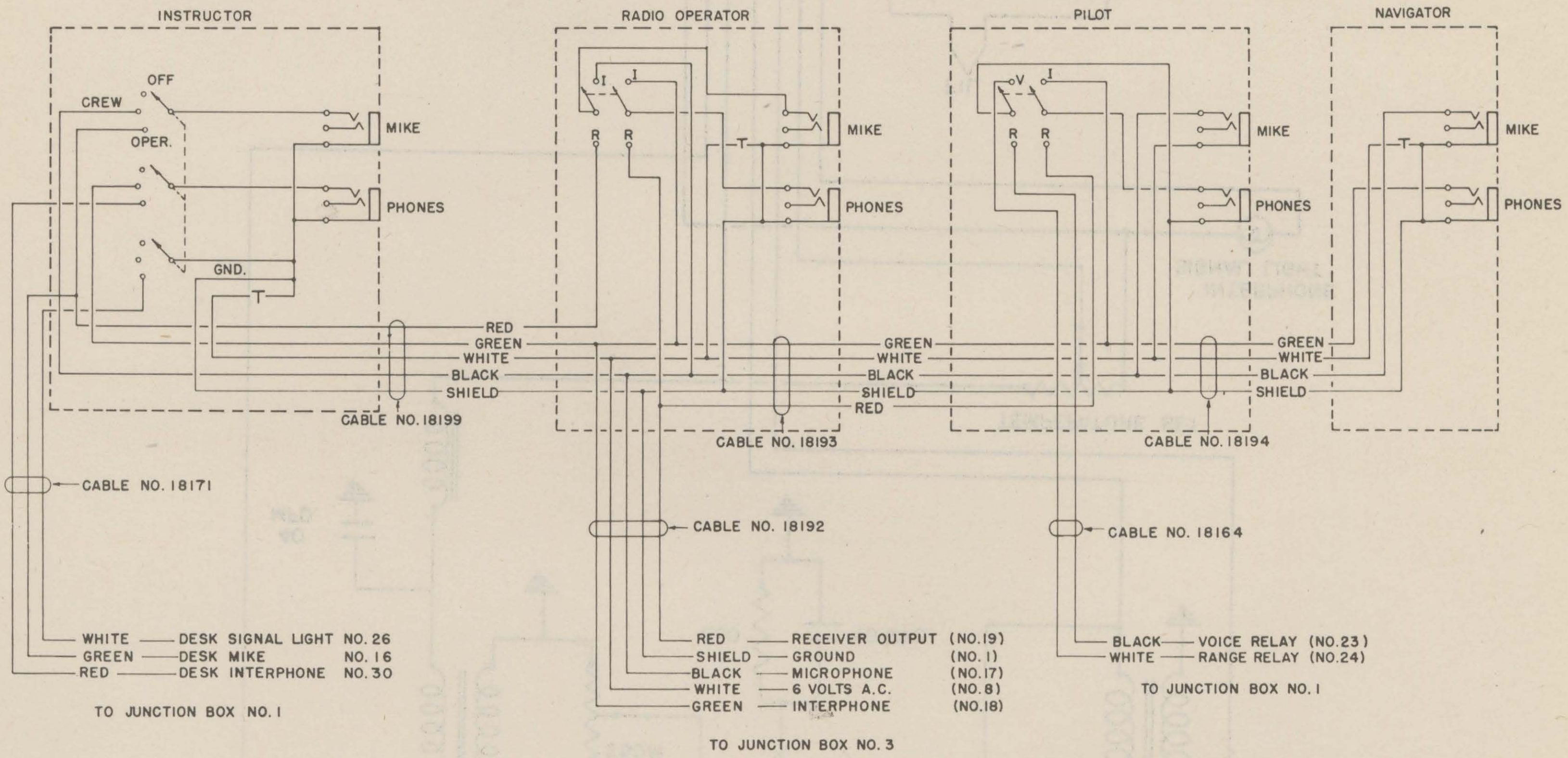


Figure 206—Wiring Diagram, Interphone System

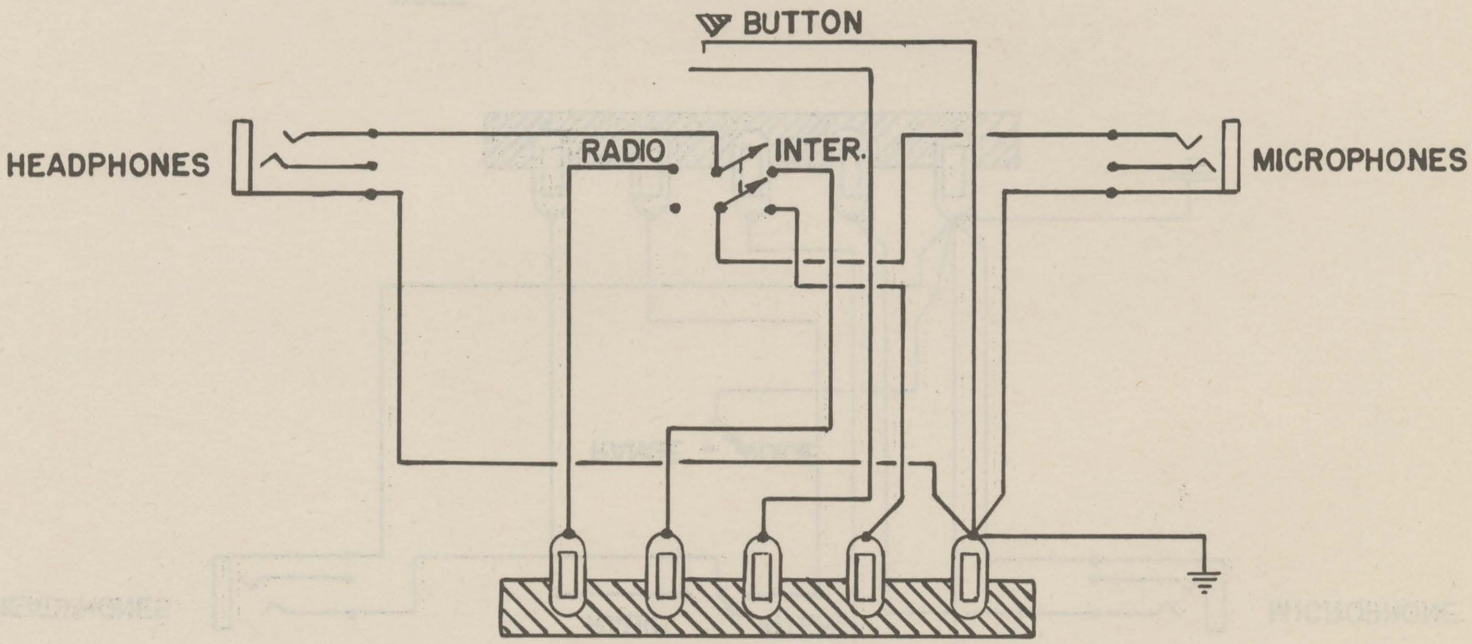
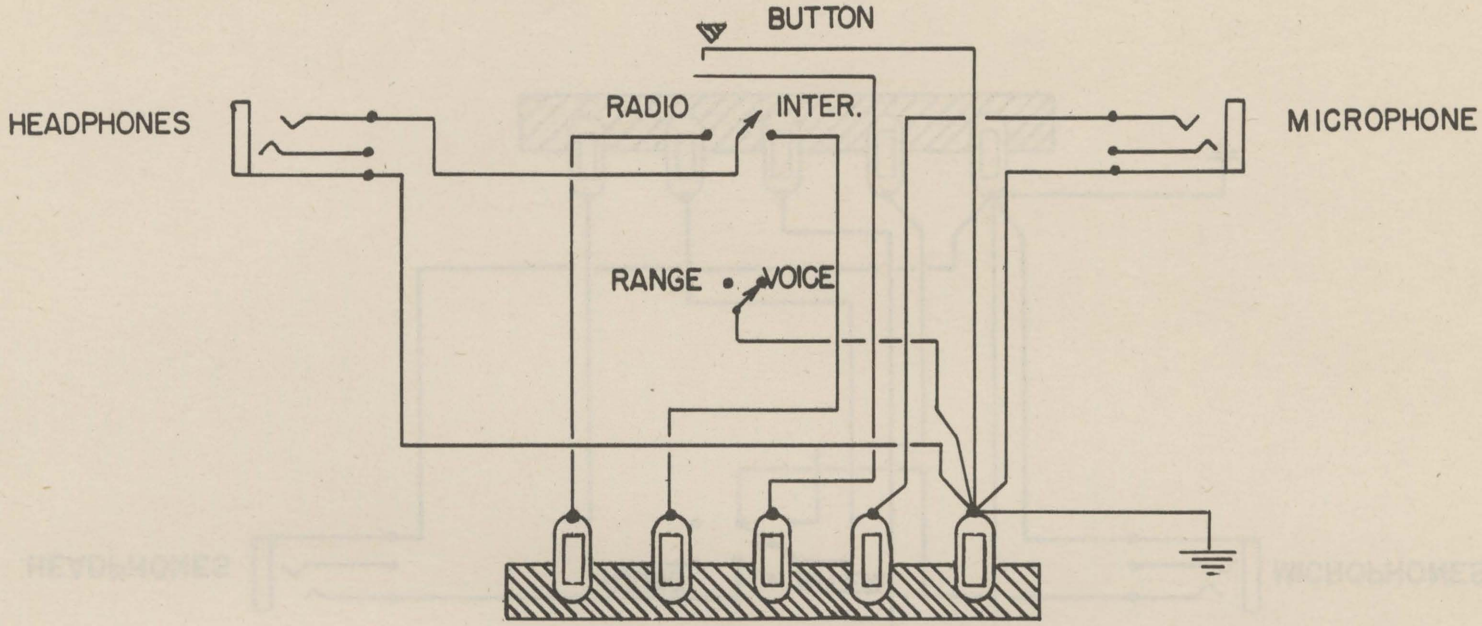


Figure 207—Wiring Diagram, Radio Operator's Interphone Box



NOTE-
RANGE AND VOICE LEADS ARE NOT SHOWN BECAUSE THEY ARE NOT PART OF THIS ASSEMBLY.

Figure 208—Wiring Diagram, Pilot's Interphone Box

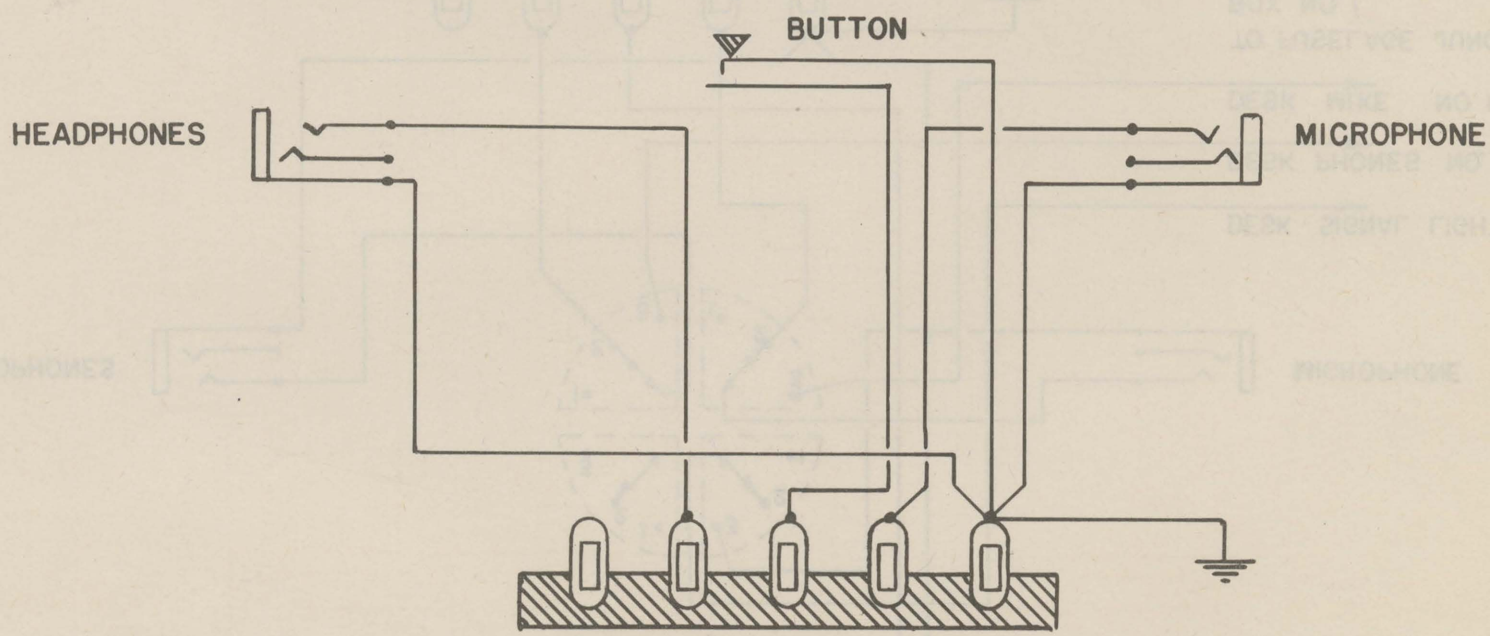
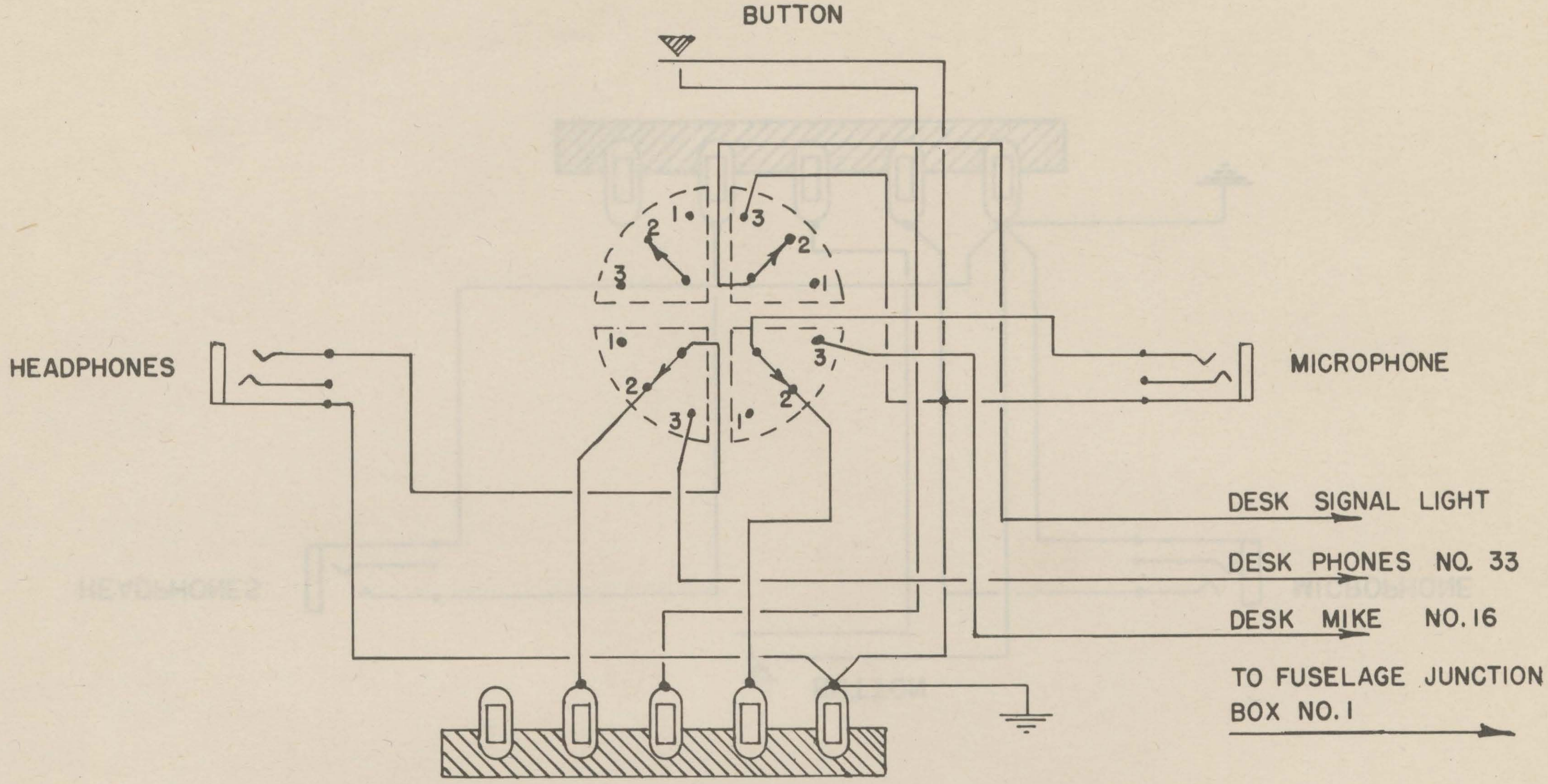


Figure 209—Wiring Diagram, Navigator's Interphone Box



POSITION NO. 1 - OFF
" NO. 2 - CREW
" NO. 3 - OPERATOR

Figure 210—Wiring Diagram, Instructor's Interphone Box

APPENDIX I

UNITED STATES-BRITISH GLOSSARY OF AERONAUTICAL AND RELATED NOMENCLATURE

(Terms shown in **bold face type** are to be used in preference to other terms.)

United States	British Equivalent	Definition
Accessory mounting face (Brit.) See **Pad.**		
Accumulator	**Accumulator** or pressure reservoir	A reservoir of air pressure in a hydraulic system which may be used to produce pressure when the hydraulic pump is not in operation.
Accumulator (Brit.) See also **Battery storage.**		
Admiralty mile (Brit.) See **Mile, sea.**		
Aerial (Brit.) See **Antenna.**		
Aerial Navigation See **Navigation, air.**		
Aerodrome (Brit.) See **Airport**		
Aerodrome beacon (Brit.) See **Beacon, auxiliary airport.**		
Aerodrome-proximity beacon (Brit.) See **Beacon, airport.**		
Aero-engine (Brit.) See **Engine.**		
Aeronautical mile See **Mile, sea.**		
Aeroplane (Brit.) See **Airplane.**		
Air cleaner (Brit.) See **Filter, air.**		
Aircraft	**Aircraft**	Any weight-carrying device designed to be supported by the air, either by buoyancy or by dynamic action. In Britain used only as a collective plural, and in the United States as either a singular or a collective plural.

United States	British Equivalent	Definition
Air controls See **Controls, air.**		
Airdrome See **Airport.**		
Air duct See **Duct, air.**		
Airfield See **Airport.**		
Air filter See **Filter, air.**		
Air navigation See **Navigation, air.**		
Air photography (Brit.) See **Photography, aerial.**		
Airplane	**Aeroplane**	A mechanically driven aircraft, heavier than air, fitted with fixed wings, and supported by the dynamic action of the air. Note: "Curtiss Aeroplane Division" is correct in the United States.
Airport, airfield or airdrome	**Aerodrome**	A definite and limited area of ground or water intended to be used in connection with the arrival, departure, and servicing of aircraft.
Airport beacon See **Beacon, airport.**		
Air-speed head See **Head, air-speed.**		
Air-speed indicator reading (Brit.) See **Speed, indicated air.**		
Alemite lubricator fitting See **Fitting, grease.**		
(to) Alight (Brit.) See (to) **Land.**		
Alighting gear See **Gear, alighting.**		
Alighting-gear doors See **Doors, alighting gear.**		
All right, satisfactory, or O.K. (slang)	**All right** or satisfactory	Correct; meeting the requirements in every detail.
All-up weight (Brit.) See **Weight, gross.**		
Anchor pin (Brit.) See **Pin, knuckle.**		
Aneroid, capsule, stack, or pack	**Aneroid** or capsule	A bellows used to operate a valve and actuated by changes in atmospheric pressure.

United States	British Equivalent	Definition
Antenna	**Aerial**	A conductor consisting of a wire or wires supported in the air for directly transmitting or receiving electric waves.
Antifriction bearing See **Bearing, ball.**		
Approach beam (Brit.) See **Beam, landing.**		
Area, effective landing	**Landing area**	That portion of an airdrome with approaches clear within allowable safe climbing and gliding angle available for take-off and landing of aircraft.
Artificial Horizon See **Horizon, artificial.**		
Attachment plug See **Plug.**		
Automatic boost control unit (Brit.) See **Regulator, manifold-pressure.**		
Automatic direction finder See **Direction finder, radio.**		
Auxiliary airport beacon See **Beacon, auxiliary airport.**		
Avigation (Brit.) See **Navigation, air.**		
Axis, lateral, wing axis, or Y axis	**Lateral axis** or pitching axis	The axis of an airplane passing from wing tip to wing tip.
Axis, longitudinal, fuselage axis, or X axis	**Longitudinal axis** or rolling axis	The fore-and-aft axis of an airplane through the fuselage.
Axis, vertical, or Z axis	**Vertical axis,** normal axis or yawing axis	An axis at right angles to the horizontal plane of the longitudinal and lateral axes, and passing through their intersection.
Ball bearing See **Bearing, ball.**		
Battery, storage	**Storage battery** or accumulator	A battery of leakproof design which will not discharge its liquid contents during violent maneuvers.
Beacon, airport	**Aerodrome-proximity beacon**	A beacon light of high candlepower near an airport for the purpose of indicating its general location.
Beacon, auxiliary airport	**Aerodrome beacon**	A beacon light of moderate candlepower at or near an airport for the purpose of indicating its specific location.
Beacon, radio range	**Radio track beacon**	A radio transmitter supplying directive radio waves that provide a means of keeping aircraft on the proper course.

United States	British Equivalent	Definition
Beam, landing	**Approach beam**	A beam projected from a landing field to indicate to the pilot his height above the ground and the position of the airplane on its proper path for a glide landing.
Bearing, ball, roller bearing, or antifriction bearing	**Ball bearing** or **roller bearing**	A bearing designed to eliminate sliding friction by balls or rollers, which have only rolling contact with the cones and races.
Bearing plate (Brit.) See **Pelorus.**		
Binding post See **Post, binding.**		
Blind flying See **Flying, instrument.**		
Bomb-bay doors See **Doors, bomb.**		
Bomb doors See **Doors, bomb.**		
Boomer See **Bombardier.**		
Boost (Brit.) See **Pressure, manifold.**		
Boost control unit (Brit.) See **Regulator, manifold-pressure.**		
Boost pressure (Brit.) See **Pressure, manifold.**		
Bourdon tube See **Sylphon.**		
Box-end wrench See **Wrench, spanner.**		
Box spanner (Brit.) See **Wrench, socket.**		
Bumper	**Fender**	Any device for absorbing shock or preventing damage in a collision, as on a vehicle. (Cf. **Fender.**)
Cable controls See **Controls, air.**		
Calibrated air speed See **Speed, calibrated air.**		
Capacity, fuel, or gasoline capacity	**Fuel volume** or **petrol volume**	The amount of fuel which an aircraft can carry.
Cap screw See **Screw, cap.**		
Capsule See **Aneroid.**		

United States	British Equivalent	Definition
Ceiling	**Cloud height**	The height of the cloud base above the ground.
Centre line (Brit.) See **Line, mean.**		
Chassis or structure	**Chassis**	The framework supporting the body of an airplane.
Chassis See also **Gear, alighting.**		
Check valve See **Valve, check.**		
Cheese-headed screw (Brit.) See **Screw, fillister.**		
Classified documents See **Documents, classified.**		
Clevis	**Clevis,** fork joint, or knuckle joint end	A device usually consisting of a forked piece of metal with the ends perforated to receive a pin, used to fasten the end of a rod to another part of a structure.
Clinometer (Brit.) See **Inclinometer.**		
Clip See **Clip, tubing.**		
Clip, tubing, clip, or adel clip (trade name)	**Tubing clip** or tubing clamp	A spring-wire clip used to fasten tubing in place.
Closed spanner wrench See **Wrench, spanner.**		
Cloud height (Brit.) See **Ceiling.**		
Coal oil See **Kerosene.**		
Cock (Brit.) See **Valve.**		
Cockpit enclosure See **Enclosure, cockpit.**		
Commutator	**Commutator** or invertor	A device for reversing the direction of an electric current, as through the primary circuit of an induction coil.
Compound, anti-seize or thread lubricant	**Anti-seize compound** or thread lubricant	Any substance applied to two relatively moving parts to prevent seizure.
Conduit or electrical tubing	**Conduit**	A tube for receiving and protecting electric wires or cables.
Cone, union	**Nipple**	A joint that is brazed onto the end of a pipe.
Control cock (Brit.) See **Valve, four-way.**		

United States	British Equivalent	Definition
Controllable-pitch propeller (Brit. propeller) See **Propeller, controllable-pitch.**		
Controllable propeller See **Propeller, controllable-pitch.**		
Controls, air, cable controls, or flight controls	**Flying controls**	The means employed to operate the control surfaces of an aircraft.
Control valve See **Valve, four-way.**		
Converter	**Converter** or motor generator (A.C. to D.C.)	A motor coupled to a generator for transforming electric currents. (Cf. **Inverter.**)
Copilot	**Second pilot**	The assistant to the pilot of an aircraft.
Cord	**String**	The British "string" is equivalent to a "thin cord" in American. (Cf. **String** and **Twine.**)
Cord (Brit.) See **Twine.**		
Cotter pin See **Pin, cotter.**		
Countersunk-head screw (Brit.) See **Screw, flathead.**		
Course	**Track angle**	The direction over the surface of the earth, with respect to true north, that an aircraft is flown.
Course See also **Track.**		
Course (Brit.) See **Heading.**		
Course made good or true course	**True track-angle**	The true direction the aircraft bears from the point of departure.
Critical speed See **Speed, stalling.**		
C-spanner (Brit.) See **Spanner.**		
Cup-headed screw (Brit.) See **Screw, round-head.**		
Cylinder, flask, or bottle	**Cylinder**	A metal vessel for holding compressed gases.
Directional gyro See **Gyro, directional.**		
Directional radio See **Radio, directional.**		
Directional wireless (Brit.) See **Radio, directional.**		

United States	British Equivalent	Definition
Direction finder (Brit.) See **Radio, directional.**		
Direction finder, radio, or automatic direction finder	**Radio direction finder,** (R.D.F.), radio compass, or steering director	A radio instrument which if once tuned to a station, points continuously and automatically to that station.
Direction indicator See **Gyro, directional.**		
Documents, classified	**Protected papers**	All documents which are classified for protection to a greater or lesser degree from the general public.
Domestic	**Inland**	Situated within the country in question. (Cf. **overseas.**)
Doors, bomb, or bomb-bay doors	**Bomb doors** or bomb-bay doors	The doors in the belly of a bombardment airplane through which bombs are dropped.
Doped patch See **Patch, doped.**		
Double-ended union body (Brit.) See **Nipple.**		
Drag, drag force, or drag component	**Drag,** longitudinal force, or head resistance	A force or component in the drag direction.
Drag component See **Drag.**		
Drag force See **Drag.**		
Drift	**Drift-angle**	The angle between the heading and the track.
Drift angle (Brit.) See **Drift.**		
Drift bomb See **Float, drift.**		
Drift float See **Float, drift.**		
Drift indicator See **Meter, drift.**		
Drift meter See **Meter, drift.**		
Drift sight (Brit.) See **Meter, drift.**		
(to) Dump See (to) **Jettison.**		
Earth (Brit.) See **Ground.**		
Egress (Brit.) See **Exit.**		

United States	British Equivalent	Definition
Elastic stop nut See **Nut, self-locking.**		
Electrical tubing See **Conduit.**		
Elevator or flipper	**Elevator**	A movable auxiliary airfoil, the function of which is to impress a pitching movement on the aircraft.
Empennage, airplane tail assembly, tail surfaces, tail group, or tail.	**Empennage** or tail unit	The tail surface group (rudder, elevators and stabilizers).
Empty weight See **Weight, empty.**		
Enclosure, cockpit or cowling (cockpit)	**Cockpit enclosure**	A removable covering around and over a cockpit.
Engine or power plant	**Aero-engine**	An engine used to provide the motive power for an aircraft. (Cf. **Section, engine.**)
Engine section See **Section, engine.**		
Engine speed indicator (Brit.) See **Tachometer.**		
Exit	**Exit** or egress	A passage out of a place.
Fender (Brit.) See **Bumper.**		
Field, landing	**Landing ground**	A field of such a size and nature as to permit of aircraft landing and taking off in safety.
Fillister screw See **Screw, fillister.**		
Filter, screen, or strainer (oil)	**Filter**	A porous material or a unit through which engine oil is passed to cleanse and strain it.
Filter, air	**Air cleaner**	A porous, usually oil-soaked material through which air is passed to remove dust and sand.
Fin (Brit.) See **Stabilizer, vertical.**		
Fitting, grease, Alemite lubricator fitting, or pressure-grip lubricator fitting	**Greaser**	A fitting for lubricating a part with grease under pressure.
Fixed tail surface See **Stabilizer.**		
Flare, signal	**Signal projectile** or signal star	A pyrotechnic signaling device of distinctive color and characteristics.
Flashing light See **Light, flashing.**		
Flathead screw See **Screw, flathead.**		

United States	British Equivalent	Definition
(to) **Flatten out** (Brit.) See (to) **Level off.**		
Flight controls See **Controls, air.**		
Flipper See **Elevator.**		
Float, drift, drift bomb, flame float, or smoke float	**Sea marker,** navigation flame-float, or navigation smoke-float	A substance or article dropped from an aircraft over water, forming a point of reference for observing the drift angle.
Flying controls (Brit.) See **Controls, air.**		
Flying, instrument, or blind flying	**Instrument flying**	The act of flying an aircraft solely by instruments.
Force, side, or side component	**Lateral force**	A force or component perpendicular to the plane of symmetry.
Force, vertical	**Vertical force** or normal force	The component along the vertical axis of the resultant force. This includes the resolved component of gravity.
Fore-and-aft level (Brit.) See **Inclinometer.**		
Foreign See **Overseas.**		
Fork joint (Brit.) See **Clevis.**		
Four-way cock (Brit.) See **Valve, four-way.**		
Four-way valve See **Valve, four-way.**		
Frequency meter See **Meter, frequency.**		
(to) **Fret** or gall.	(to) **Fret**	To damage or wear by an oscillating motion, as in the case of splines.
Fuel, gasoline, or gas (slang)	**Fuel,** petrol or motor spirit	A volatile, inflammable, liquid, hydrocarbon mixture used as a fuel.
Fuel capacity See **Capacity, fuel.**		
Fuel-contents gauge (Brit.) See **Gage, fuel.**		
Fuel gage See **Gage, fuel.**		
Fuel-level gage See **Gage, fuel.**		
Fuel level indicator (Brit.) See **Gage, fuel.**		

United States	British Equivalent	Definition
Fuel volume (Brit.) See **Capacity, fuel.**		
Full load See **Weight, gross.**		
Fuselage axis See Axis, **longitudinal.**		
Gage, fuel, or fuel-level gage.	**Fuel-contents gauge** or fuel level indicator	A gage for indicating the quantity of fuel in a fuel tank.
(to) Gall See (to) **Fret.**		
Gas See **Fuel.**		
Gasket	Gasket, joint or washer	A sheet or ring of packing used for engine heads, pipe joints, and similar purposes.
Gasoline See **Fuel.**		
Gasoline capacity See **Capacity, fuel.**		
Gear, alighting, landing gear, undercarriage, or chassis	**Alighting gear,** undercarriage, or chassis	The understructure which supports the weight of an aircraft when in contact with the surface of the land or water and reduces the shock on landing.
Gear, retractable alighting, retractable landing gear, or retractable undercarriage	**Retractable alighting gear,** retractable undercarriage, or retractile undercarriage.	An alighting gear which can be withdrawn into the body or wings of an airplane to secure better streamline efficiency while in flight.
Gearbox or transmission	**Gearbox**	The unit comprising the change gears in a power-transmission system.
Generator	**Generator** or dynamo (obsolescent)	A machine by which mechanical energy is changed into electrical energy.
Geographical mile See **Mile, sea.**		
Graticule See **Reticule.**		
Grease fitting See **Fitting, grease.**		
Greaser (Brit.) See **Fitting grease.**		
Ground	Ground or earth	The connection made in grounding an electrical circuit.
Grub screw (Brit.) See **Setscrew.**		
Gyro-directional, or direction indicator	**Directional gyro,** direction indicator, or gyroscopic turn indicator	An instrument employing a gyroscope for indicating any change in the direction of the aircraft in azimuth from a straight course.

United States	British Equivalent	Definition
Gyro horizon See **Horizon, artificial.**		
Gyroscopic turn indicator (Brit.) See **Gyro, directional.**		
Hardware	**Ironmongery**	Ware made of metal, as fittings, cutlery, tools, appliances, parts of machines, or utensils.
Head, air-speed	**Pressure head**	An instrument which in combination with a gage is used to measure the speed of an aircraft relative to the air. It usually consists of a pitot static tube or a pitot venturi tube.
Heading	**Course**	The angular direction of the longitudinal axis of an aircraft with respect to true north.
Headless setscrew See **Setscrew.**		
Head resistance (Brit.) See **Drag.**		
Horizon, artificial, or gyro horizon	**Artificial horizon**	A self-contained, artificial reference, to be used as a horizon when the natural horizon is obscured, or when an airplane is at too great an altitude to determine the natural horizon with accuracy.
Horizontal stabilizer See **Stabilizer.**		
Inclinometer	**Clinometer** or fore-and-aft level	An instrument that measures the attitude of an aircraft with respect to the horizontal.
Indicated air speed See **Speed, indicated air.**		
Indicated air-speed (Brit.) See **Speed, calibrated air.**		
Inland (Brit.) See **Domestic.**		
Inspection port (Brit.) See **Window, inspection.**		
Instrument flying See **Flying, instrument.**		
Intercom (Brit.) See **Interphone.**		
Intercommunication (Brit.) See **Interphone.**		
Interphone	**Intercommunication** or intercom (slang)	A system of communication between different stations on the same aircraft.
Inverter	**Motor generator (D.C. to A.C.)**	A motor coupled to a generator for transforming electric currents. (Cf. **Converter.**)
Invertor (Brit.) See **Commutator.**		

United States	British Equivalent	Definition
Ironmongery (Brit.) See **Hardware.**		
(to) **Jettison** or dump	(to) **Jettison,** dump, or slip	To release material from an aircraft in danger of being lost or wrecked.
Joint (Brit.) See **Gasket.**		
Kerosene or coal oil	**Paraffin** or kerosene	An illuminating oil distilled from petroleum.
Knuckle joint end (Brit.) See **Clevis.**		
Label (Brit.) See **Tag.**		
(to) **Land**	(to) **Land** or alight	To come to the ground or the surface of the water.
Landing area (Brit.) See **Area, effective landing.**		
Landing beam See **Beam, landing.**		
Landing field See **Field, landing.**		
Landing gear See **Gear, alighting.**		
Landing-gear doors See **Doors, alighting-gear.**		
Landing ground (Brit.) See **Field, landing.**		
Landing strip See **Runway.**		
Lateral axis See **Axis, lateral**		
Lateral force (Brit.) See **Force, side.**		
Left	**Port**	Situated to the left, looking in the direction of motion of an aircraft.
(to) **Level off**	(to) **Flatten out**	To make the flight path of an airplane nearly horizontal before making contact with the earth.
Line, mean	**Centre line**	In an airfoil section, a line each point on which is equi-distant from the upper and lower boundaries of the section.
Locknut (Brit.) See **Palnut.**		
Lock washer See **Washer, lock.**		
Lock wire See **Wire, safety.**		

United States	British Equivalent	Definition
Longitudinal axis See **Axis, longitudinal.**		
Longitudinal force (Brit.) See **Drag.**		
Loop aerial (Brit.) See **Loop, radio.**		
Loop antenna See **Loop, radio.**		
Loop, radio or loop antenna	**Loop aerial**	A specified number of turns of wire located in the wings or wound around the fuselage of an airplane. Small portable loops on a rectangular frame are also used.
Manifold pressure See **Pressure, manifold.**		
Manifold-pressure regulator See **Regulator, manifold-pressure.**		
Manometer pressure See **Superpressure.**		
Mean line See **Line, mean.**		
Message, meteorological, or weather signal	**Meteorological report**	Any signal giving information about the weather, usually including temperature, visibility, ceiling, rain, snow, and wind direction and velocity.
Meteorological message See **Message, meteorological.**		
Meteorological office See **Bureau, weather.**		
Meteorological report (Brit.) See **Message, meteorological.**		
Meter, drift, or drift indicator	**Drift sight**	An instrument for measuring the drift angle.
Meter, frequency	**Wavemeter**	An instrument for measuring the frequency of a radio wave.
Mile, sea aeronautical mile, nautical mile, or geographical mile	**Sea mile** or Admiralty mile	A measure of distance equal in the United States to 6080.20 feet and in Britain to 6080 feet. One knot is one sea mile per hour.
Monkey wrench See **Wrench, monkey.**		
Motor generator, A.C. to D.C. (Brit.) See **Converter.**		
Motor generator, D.C. to A.C. (Brit.) See **Inverter.**		

United States	British Equivalent	Definition
Motor spirit (Brit.) See **Fuel.**		
Nacelle doors See **Doors, alighting-gear.**		
Nautical mile See **Mile, sea.**		
Navigation, air, or aerial navigation	**Avigation**	The guidance of craft through the air in accordance with previous calculations. "Avigation" has been used, but is considered unnecessary, in the United States.
Navigation flame-float (Brit.) See **Float, drift.**		
Navigation smoke-float (Brit.) See **Float, drift.**		
Nipple	**Double-ended union body**	A coupling for pipes and fittings, facilitating connection or disconnection.
Nipple (Brit.) See **Cone, nipple.**		
Normal axis (Brit.) See **Axis, vertical.**		
Normal force (Brit.) See **Force, vertical.**		
Normal velocity (Brit.) See **Velocity, vertical.**		
Nose-heavy	**Nose-heavy**	The condition of an airplane in which the nose tends to sink when the longitudinal control is released. (Cf. **Tail-heavy.**)
Nose-heavy (Brit.) See also **Bow-heavy.**		
Nut, self-locking, or elastic stop nut (trade name)	**Self-locking nut** or Simmonds nut (trade name)	A nut so constructed that it locks in place when tightened.
Nut, spanner	**Ring nut**	A ring-shaped nut with notches in the outer circumference.
O.K. See **All right.**		
Operator, radar	**Radio-direction-finder** (R.D.F.) **operator**	The operator of a radio direction finder.
Operator, radio	**Wireless operator**	The operator of a radio sending and receiving set.
Overseas or foreign	**Overseas**	Situated outside the country in question. (Cf. **Domestic.**)
Pack See **Aneroid.**		

United States	British Equivalent	Definition
Pad	**Accessory mounting face**	A raised machined surface on an engine, upon which accessories may be mounted. (May include end of drive shaft.)
Palnut	**Locknut** (type of)	A very thin steel nut with a shallow-cup-shaped bottom face. It is used on engines, and is self-locking because, as it is drawn up, the cup-shaped lower face causes it to be distorted or reformed just enough to cause a binding on the bolt.
Paraffin	**Paraffin** or paraffin wax	A waxy, inflammable substance produced in distilling wood, lignite or coal.
Paraffin (Brit.) See **Kerosene.**		
Paraffin wax (Brit.) See **Paraffin.**		
Patch, doped, or doped cover	**Doped patch,** doped cover, or tear-off patch	A fabric patch treated with airplane dope to increase its strength, tautness, and air-tightness.
Pelorus	**Bearing plate**	A circular plate graduated in degrees, mounted so that it lies horizontally and provided with sighting means, which when oriented may be used to determine directions of objects.
Petrol (Brit.) See **Fuel.**		
Petrol volume (Brit.) See **Capacity, fuel.**		
Photography, aerial	**Air photography**	The act of photographing the earth's surface from an aircraft.
Pilot	**Pilot**	The operator of an aircraft.
Pin, cotter	**Split pin**	A split cotter, the ends of which are bent after insertion through the cotterway.
Pitching axis (Brit.) See **Axis, lateral.**		
Plughole See **Socket.**		
Plug or attachment plug	**Plug**	A removable male fitting for making electrical connections by insertion in a receptacle or body.
Port (Brit.) See **Left.**		
Post, binding	**Terminal**	A metallic post attached to electrical apparatus for convenience in making connections.
Power plant See **Engine.**		

United States	British Equivalent	Definition
Power plant (Brit.) See **Section, engine.**		
Pressure diaphragm See **Sylphon.**		
Pressure-grip lubricator fitting See **Fitting, grease.**		
Pressure head (Brit.) See **Head,** air-speed.		
Pressure, manifold	**Boost pressure** or boost	The pressure in the induction system at a point standardized for each type of engine. "Manifold pressure," on American installations, is usually measured in inches mercury absolute; on British installations, however, it is known as "boost pressure" and is measured in pounds per square inch above or below standard sea-level atmospheric pressure.
Pressure reservoir (Brit.) See **Accumulator.**		
Propeller, controllable-pitch, controllable propeller, or hydromatic propeller (trade name)	**Controllable-pitch propeller,** controllable pitch propeller, variable-pitch propeller, or variable pitch propellor	A propeller whose blades are so mounted that the pitch may be changed while the propeller is rotating. (Cf. **Propeller, adjustable.**)
Protected papers (Brit.) See **Documents, classified.**		
Radar operator See **Operator, radar.**		
Radio	**Wireless**	A device for the transmission or reception of signals by means of electric waves.
Radio compass (Brit.) See **Direction finder, radio.**		
Radio, directional	**Direction finder** or directional wireless	Equipment for finding the azimuth of a distant transmitter.
Radio direction finder See **Direction finder, radio.**		
Radio-direction-finder operator (Brit.) See **Operator, radar.**		
Radio loop See **Loop, radio.**		
Radio operator See **Operator, radio.**		
Radio range beacon See **Beacon, radio range.**		
Radio track beacon (Brit.)		
R.D.F. (Brit.) See **Direction finder, radio.**		

United States	British Equivalent	Definition
R.D.F. operator (Brit.) See **Operator, radar.**		
Regulator, manifold-pressure	**Boost control unit** or automatic boost control unit	An automatic device which so regulates the throttle that a predetermined boost pressure is not exceeded.
Reticle, reticule, or graticule	**Reticle**, reticule, or graticule	A system of lines or wires in the focus of the eyepiece of an optical instrument.
Reticule See **Reticle.**		
Retractable alighting gear See **Gear, retractable alighting.**		
Retractable landing gear See **Gear, retractable alighting.**		
Retractable undercarriage See **Gear, retractable alighting.**		
Retractile undercarriage (Brit.) See **Gear, retractable alighting.**		
Rev. counter (Brit.) See **Tachometer.**		
Revolution indicator (Brit.) See **Tachometer.**		
Right	**Starboard**	Situated to the right, looking in the direction of motion of an aircraft.
Ring nut (Brit.) See **Nut, spanner.**		
Ring spanner (Brit.) See **Wrench, spanner.**		
Roller bearing See **Bearing, ball.**		
Rolling axis (Brit.) See **Axis, longitudinal.**		
Roundhead (Brit. **round-head**) **screw** See **Screw, round-head.**		
Runway or landing strip	**Runway**	An orientated path within the effective landing area along which aircraft arrive and depart.
Safety wire See **Wire, safety.**		
Screen (ignition) See **Shield.**		

United States	British Equivalent	Definition
Screen (oil) See **Filter.**		
Screw, cap	**Set screw**	A threaded bolt used generally without a nut to secure a cap or cover.
Screw, fillister	**Cheese-headed screw**	A screw whose head is cylindrical and slotted, with a convex or flat top.
Screw, flathead	**Countersunk-head screw**	A screw with a flat head, which is beveled on the lower side so as to fit into a countersink.
Screw, roundhead	**Round-head screw** or cup-headed screw	A screw with a hemispherical head.
Screw-spanner (Brit.) See **Wrench, monkey.**		
Sea mile See **Mile, sea.**		
Second pilot (Brit.) See **Copilot.**		
Section, engine (complete)	**Power plant** or power egg	A complete unit grouping the engine, fuel, oil, and coolant system, accessories, and controls, built into one detachable structure designed for rapid installation or removal from an airplane. (Cf. **Engine.**)
Self-locking nut See **Nut, self-locking.**		
Set screw (Brit.) See **Screw, cap.**		
Setscrew or headless setscrew	**Grub screw**	A headless machine screw, screwed through one part tightly upon another part to prevent relative movement.
Shield or screen (ignition)	**Ignition harness** or screening	A device which protects other electrical apparatus from being affected by magnetic fields set up by the ignition system.
Side component See **Force, side.**		
Side force See **Force, side.**		
Signal flare See **Flare, signal.**		
Signal star (Brit.) See **Flare, signal.**		
Simmonds nut (Brit.) See **Nut, self-locking.**		
Slip stream (Brit. **slipstream**) See **Stream, slip.**		
Smoke float See **Float, drift.**		

United States	British Equivalent	Definition
Socket, plughole, or jack	**Socket**	A fixed female fitting for making electrical connections by the insertion of a plug.
Socket wrench See **Wrench, socket.**		
Spacer	**Distance piece**	A thick washer used to hold two members at a given distance from each other.
Spanner	**C-spanner**	A wrench used for turning slotted spanner nuts.
Spanner (Brit.) See **Wrench.**		
Spanner nut See **Nut, spanner.**		
Spanner wrench See **Wrench, spanner.**		
Speed, calibrated air	**Indicated air-speed** (A.S.I.)	The reading of the air-speed indicator, corrected for instrumental and installation errors.
Speed, indicated air (IAS)	**Air-speed-indicator reading**	The reading of the air-speed indicator.
Speed, stalling or critical speed	**Stalling speed**	The lowest speed of an aircraft at which control can be maintained.
Split pin (Brit.) See **Pin, cotter.**		
Spring washer (Brit.) See **Washer, lock.**		
Stabilizer, horizontal stabilizer or fixed tail surface	**Tail plane**	A fixed surface forming part of the empennage to increase longitudinal stability.
Stabilizer, vertical, tail fin, or vertical tail surface	**Fin**	A fixed surface approximately parallel to the plane of symmetry, affecting the lateral stability of the motion of an aircraft.
Stack See also **Aneroid.**		
Stalling speed See **Speed, stalling.**		
Starboard (Brit.) See **Right.**		
Steering director (Brit.) See **Direction finder, radio.**		
Storage battery See **Battery, storage.**		
Strainer See **Filter.**		
Stream, slip, or propeller race	**Slipstream**	The stream of air driven aft by the propeller.
String	**Twine**	The British "twine" means the lightest sort of string in American. (Cf. **Cord** and **Twine.**)

United States	British Equivalent	Definition
String (Brit.) See **Cord.**		
Structure See **Chassis.**		
Superpressure or manometer pressure	**Super-pressure**	The excess pressure inside the envelope of an aerostat over the atmospheric pressure at a standard reference point.
Sylphon, pressure diaphragm, or Bourdon tube	**Sylphon,** or Bourdon tube	A brass, copper, or bronze element of internal-pressure recording instruments, which translates the internal pressure into mechanical movement to actuate indicator needles or valves.
Tachometer	**Tachometer,** engine speed indicator, revolution indicator, or rev. counter	An instrument which measures revolutions per minute of an engine.
Tag	**Tag** or label	A slip of paper, cloth, or metal affixed to anything and indicating the contents, ownership, destination, rating, or designation.
Taildrift sight (Brit.) See **Meter, drift.**		
Tail-heavy	**Tail-heavy**	The condition of an airplane in which the tail tends to sink when the longitudinal control is released. (Cf. **Nose-heavy.**)
Tail-heavy (Brit.) See also **Stern-heavy.**		
Tail plane (Brit.) See **Stabilizer.**		
Tail surfaces See **Empennage.**		
Tail unit (Brit.) See **Empennage.**		
Terminal (Brit.) See **Post, binding.**		
Thread lubricant See **Compound, anti-seize.**		
Track or course	**Track**	The projection of the path of the center of gravity of an aircraft onto the earth's surface.
Track angle (Brit.) See **Course.**		
Transmission See **Gearbox.**		
True course See **Course made good.**		
True track-angle (Brit.) See **Course made good.**		

United States	British Equivalent	Definition
Tube	**Valve**	A radio electron tube. (Cf. **Valve**.)
Twine	**Cord**	The British "cord" means something strong, about equivalent to the American "twine." (Cf. **String** and **Cord**.)
Twine (Brit.) See **String.**		
Undercarriage See **Gear, alighting.**		
Undercarriage doors See **Doors, alighting-gear.**		
Union (Brit.) See **Nipple, union.**		
Valve	**Valve** or cock	Any device by which the flow of liquid or gas may be started, stopped, or regulated. (Cf. **Tube**.)
Valve (Brit.) See also **Tube.**		
Valve, check	**Check valve** or non-return valve	A valve which permits flow in one direction but prevents a return flow.
Valve, four-way or control valve	**Four-way valve,** four-way cock, or control cock	A valve connected with four pipes, and having two or more passages in the plug, by which the adjacent pipes may be made to communicate.
Variable-pitch propeller or propellor (Brit.) See **Propeller, controllable-pitch.**		
Velocity, vertical	**Vertical velocity,** or normal velocity.	The component velocity along the vertical axis relative to the air.
Vertical axis See **Axis, vertical.**		
Vertical force See **Force, vertical.**		
Vertical stabilizer See **Stabilizer.**		
Vertical tail surface See **Stabilizer, vertical.**		
Vertical velocity See **Velocity, vertical.**		
Vice or vise	**Vice**	A device having two jaws closed by a screw to hold work.
Vise See **Vice.**		
Washer (Brit.) See **Gasket.**		

United States	British Equivalent	Definition
Washer, lock	**Spring washer**	An open, spiral, spring-tempered steel washer for preventing the loosening of nuts.
Wavemeter (Brit.) See **Meter, frequency.**		
Weather bureau See **Bureau, weather.**		
Weather signal See **Message, meteorological.**		
Window, inspection	**Inspection port**	A small transparent window fitted in the envelope of a balloon or airship, or on an airplane, to allow inspection of the interior.
Wing	**Main plane**	The main supporting surface of an airplane.
Wing axis See **Axis, lateral.**		
Wireless (Brit.) See **Radio.**		
Wireless operator (Brit.) See **Operator, radio.**		
Wire, safety, or **lock wire**	**Safety wire** or **lock wire**	A wire used to secure a small part so that it cannot loosen.
Wrench	**Wrench** or **spanner**	An instrument for exerting a twisting load, as in turning bolts or nuts.
Wrench, monkey	**Screw-spanner**	A straight-handle wrench having one fixed jaw set at right angles to the handle and one adjustable jaw.
Wrench, socket	**Box spanner**	A section of hexagonal tubing which fits over a nut and which is turned by means of a bar passed through its upper end.
Wrench, spanner, closed spanner wrench, or box-end wrench	**Spanner wrench** or **ring spanner**	A wrench with a ring-shaped end into which the nut fits.
X axis See **Axis, longitudinal.**		
Y axis See **Axis, lateral.**		
Yawing axis (Brit.) See **Axis, vertical.**		
Z axis See **Axis, vertical.**		