

WADC TECHNICAL REPORT 54-536
VOLUME II

A STUDY OF THE OPERATION AND TEST PROCEDURES
FOR THE PARACHUTE WHIRL TOWER

Volume II. Operation and Lubrication Procedure for the Whirl Tower

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FOREWORD

This report constitutes Item IIB of the subject contract. It is the final report of the work accomplished and results obtained by Radioplane Company in a study of the operation and test procedures for the Parachute Whirl Tower, El Centro, California. The work was carried out by the Aero-Mechanical Research Laboratory under Research and Development Order No. RDO 672-167-SR-1₂.

In the interest of convenience and clarity, the report is presented in two volumes as follows:

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|-----------|--|
| Volume I | Results of the study and test evaluation of the Parachute Whirl Tower (with subject appendices). |
| Volume II | Section I Maintenance and lubrication of the Parachute Whirl Tower. |
| | Section II Operation of the Parachute Whirl Tower. |

The appended notes (Volume I) consists of a group of theoretical studies on various aspects of Whirl Tower operation and parachute testing which were useful in determining operating limitations and the types of tests that could be effectively accomplished with this facility. They include, in addition, detailed information supplementary to the recommendations made for improvement of Whirl Tower components and test equipment.

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ABSTRACT

A study of the operation and test procedures for the Whirl Tower and the results obtained with the facility in the performance of representative parachute tests, is reported. Continuous work was required both to keep the facility operable and to overcome minor shortcomings of the original design. Its use is presently restricted to release speeds of 300 miles per hour or less, to loads of 300 pounds, or less, and to parachutes of 32 feet diameter, or less. Further changes in design, equipment and instrumentation are recommended. These would permit attainment of the full capability of the Whirl Tower for parachute testing and increase release speeds to the 500 miles per hour for which it was designed. It is concluded that within these limits the tower at present compares favorably with other facilities in economy of operation and accuracy of evaluation of parachute performance data.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

For Robert H. Dawley Maj USAF
WARREN P. SHEPARDSON
Chief, Parachute Branch
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SECTION I PROCEDURE FOR TOWER OPERATION

General Procedures

1. Minimum Power Circuit

To bring the facility from a complete power shut down to power-on state, where the 110 volt circuits are available for lights and general power:

a) Close the AC fuse to the battery charger carefully so that the fuse is not damaged and check the voltage meter in the battery charger for 120 to 150 volts. (Located in the battery room)

H.V. panels 1,2,3 and 4 in the main machinery room have their GREEN lights on when the current is flowing.

b) Close the power circuit breaker switches on H.V. panels 1 and 4; RED lights will now come on.

2. Charging Batteries

To charge the battery bank, with power on, close the selector switch on the "metallic rectifier".

Circuit Check

To check any tower circuit, except the circuit which energizes the main drive motor "P" through oil blast circuit breaker No. 3.

a) Lower oil breaker No. 3 to the halfway position, according to the procedure outline under Section 3.

b) By-pass the breaker by inserting the "Jumper" assembly between the two contact poles left open when the breaker is lowered.

NOTE: The identification of machinery and equipment conforms with G.E.I. 30048, Instructions for Drive Equipment for Parachute Test Tower. A copy of this manual is kept in the control room.

c) When the circuit check is complete, return the breaker to the circuit according to the procedure outlined in Section 3.

3. Servicing Oil Blast Circuit Breakers

Both electrical and manual removals of the oil blast circuit breakers are possible.

a) For electrical operation the procedure outlined under Section 1 provides current to the elevating motor in any of the four cabinets.

b) Before opening the cabinet door, turn the breaker switch handle to "Trip", or the inside switches will not be in the circuit, and the "Manual Trip Device" button on the unit inside will not energize the elevator control switches.

c) Inside the cabinet, on the right, is a small switch box, Figure 1. This is the elevator control system. The selector switch must be turned from "Manual" to "Operate" to run the breaker up or down by the motor. (With the selector on "Manual", the unit can only be raised or lowered by the hand crank, usually reserved for emergencies)

To raise or lower the breaker, push the appropriate button.

d) A service cart is provided to carry the breaker when removed from the cabinet, running inside the cabinet on three tracks which insure alignment.

e) A service rack, located along the south wall of the tower building, is available for work on the breaker.

4. Manual Operation for Removal of Oil Circuit Breaker

a) Before opening the cabinet doors, turn the breaker switch handle to "Trip".

b) Inside the cabinet, on the right, is a small "T" handle. This is the motor clutch release. Pull it out approximately 1/2 inch, to disengage the clutch, which allows the breaker to be cranked

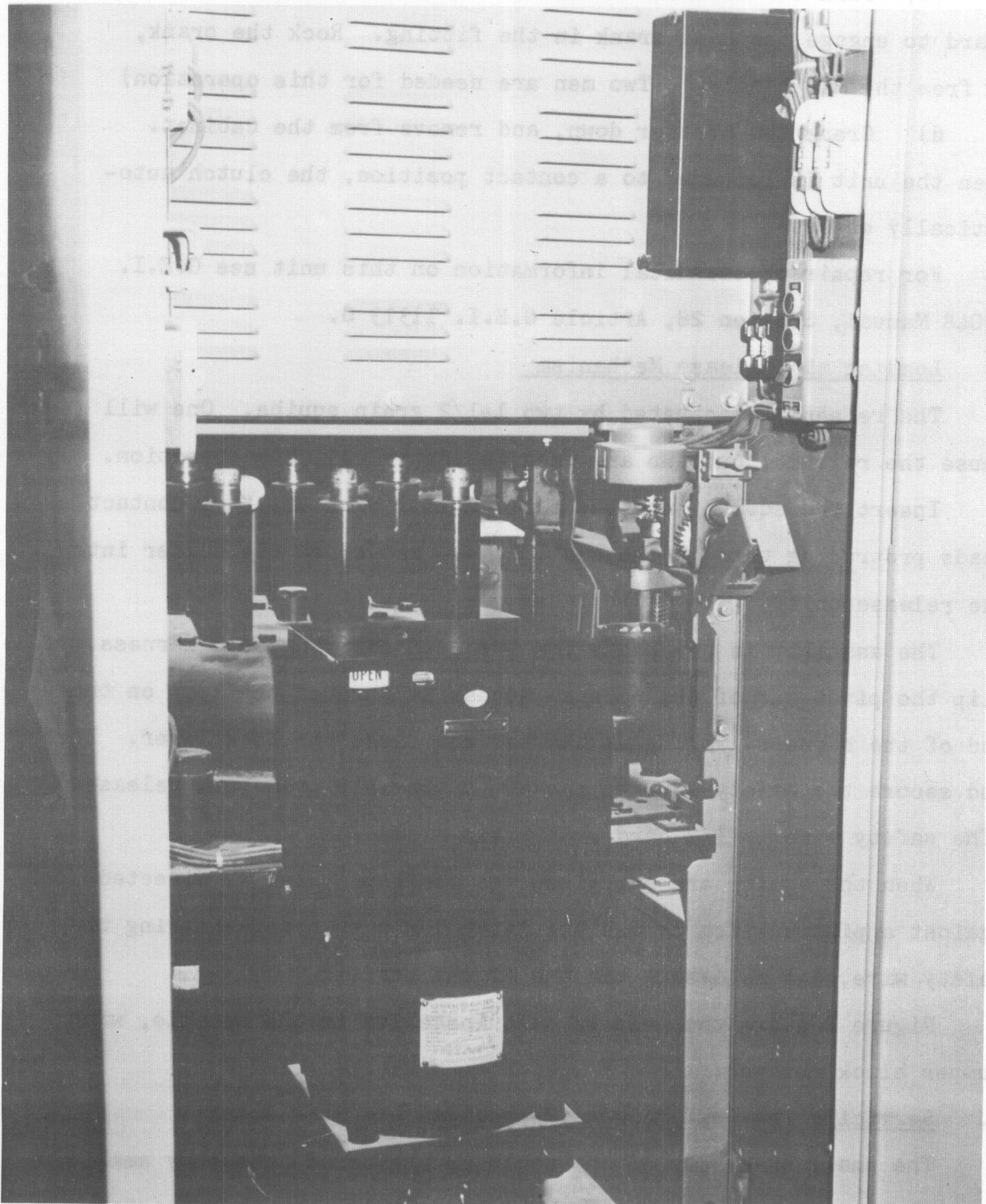


FIGURE 1
OIL BLAST CIRCUIT BREAKER CONTROLS

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down. This step must be done concurrently with step (c).

(c) Turn the selector switch to "Manual". Lift the hinged guard to engage the hand crank in the fitting. Rock the crank, to free the "T" handle. (Two men are needed for this operation)

d) Crank the breaker down, and remove from the cabinet.

When the unit is returned to a contact position, the clutch automatically engages.

For repair or technical information on this unit see G.E.I. 30048 Manual, Section 28, Article G.E.I. 11313 G.

5. Loading the Release Mechanism

The release is actuated by two 1-1/2 grain squibs. One will cause the release; but two are used to insure reliable operation.

Insert the squibs into the squib holder with the four contact leads protruding through the small holes, and screw the holder into the release unit.

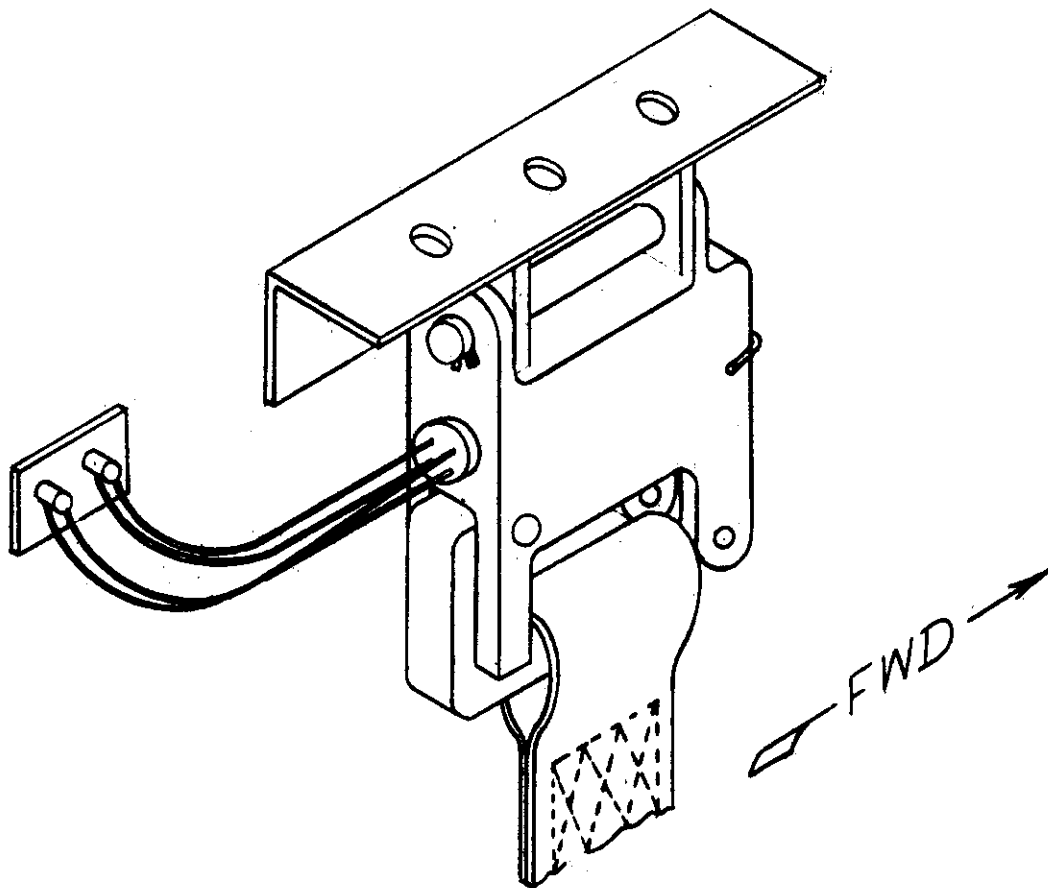
The assembly is now ready for the load carrying belt harness. Slip the pivot bar of the release mechanism through the loop on the end of the harness. Bring up the bar and close the lock lever. Insert and secure the safety wire to prevent a possible premature release. (The safety wire is 1/2 hard .051 brass wire)

When the squibs are energized the confined blast is directed against a piston which causes the latch lever to move, shearing the safety wire, and releasing the end of the harness.

Figure 2 shows the release unit installed in the nacelle, with bumper block removed.

6. Servicing the Load Release Mechanism

The small brass cap of the squib is shattered into many small particles on explosion. These particles usually can be extracted by removing the squib holder and tapping the release unit on the bench.



LOAD RELEASE MECHANISM

Fig. 2

Occasionally, the latch actuating piston will jam. Loosen by forcing the piston back with a screw driver or similar instrument. If necessary, remove the bolt on which the latch lever pivots, to permit access to the piston.

At intervals of about ten drops, remove the piston and clean out the firing chamber with Powder Solvent. If this is done systematically the mechanism will always function properly. Free action of the piston is important to satisfactory operation.

The small nylon block on the latch lever is important because it acts as a shock absorber. It must be replaced when cracked (approximately every twenty drops).

7. Installation of Release Mechanism

The assembled mechanism is joined to the port side load fitting. (Figure 2). The snap ring is removed from one end of the load pin, the pin inserted through the release unit, the load fitting and the snap ring installed.

The squib leads are attached to the terminal strip. It is important that wires of the same color be connected to the same terminal.

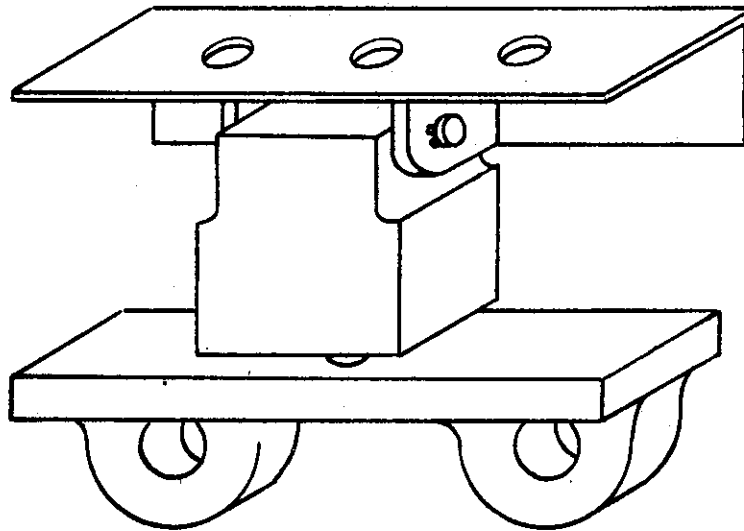
Removal of this mechanism needs no description.

8. Installation of Adjustment Link

This unit is secured to the load bracket on the starboard side of the nacelle, (Figure 3). The link consists of: (a) a load pin, (b) load block, (c) adjustment screw, and (d) load beam.

The load pin is inserted through the load bracket and load block and the snap ring put in place. The adjustment screw is placed through the load beam and engaged in the load block threads. The screw is backed off as far as possible without its becoming disengaged from the load block.

When the load carrying harness is a little longer than adjustment



LOAD ADJUSTMENT BRACKET

Fig. 3

permits, the bolt bottoms in the load block before the belt is tight. This can be corrected by placing washers between the adjustment bolt and the load beam. It is mandatory that the belt harness be cinched as tight as possible on installation of the dummy vehicle.

9. Installation of Dummy Leg Braces

There are two attitudes for installing the torso dummy, neck leading and legs leading. In either case, the leg stump brace must be installed, by removing the two bottom bolts in the shoulder sway pad on each side of the nacelle. The brace is put in place and the bolts again engaged in the threads. The same brace fits either end of the nacelle.

10. Rigging the Torso Dummy

Two methods of securing the parachutes to the dummies have been used.

The first employs the standard personnel harness in which the load is transmitted through two risers on the harness into the dummy. In this case, the tensiometer is installed in a riser section between the harness and the parachute.

The second is a simplified harness assembly that merely holds the parachute pack on the dummy. In this arrangement, the parachute load is not transferred through the harness but goes through a single riser to the tensiometer, which is bolted in the dummy neck recess.

The two parachute harness rigs are visible in Figure 4.

11. Installation of Tensiometer Inside Dummy Neck

Before the tensiometer is placed in the dummy neck, the opposite end must be attached to the parachute riser. This is especially true of short tensiometers.

The tensiometer must have a long lanyard since it is actuated by a 3 foot static line which is secured to the nacelle. This starts

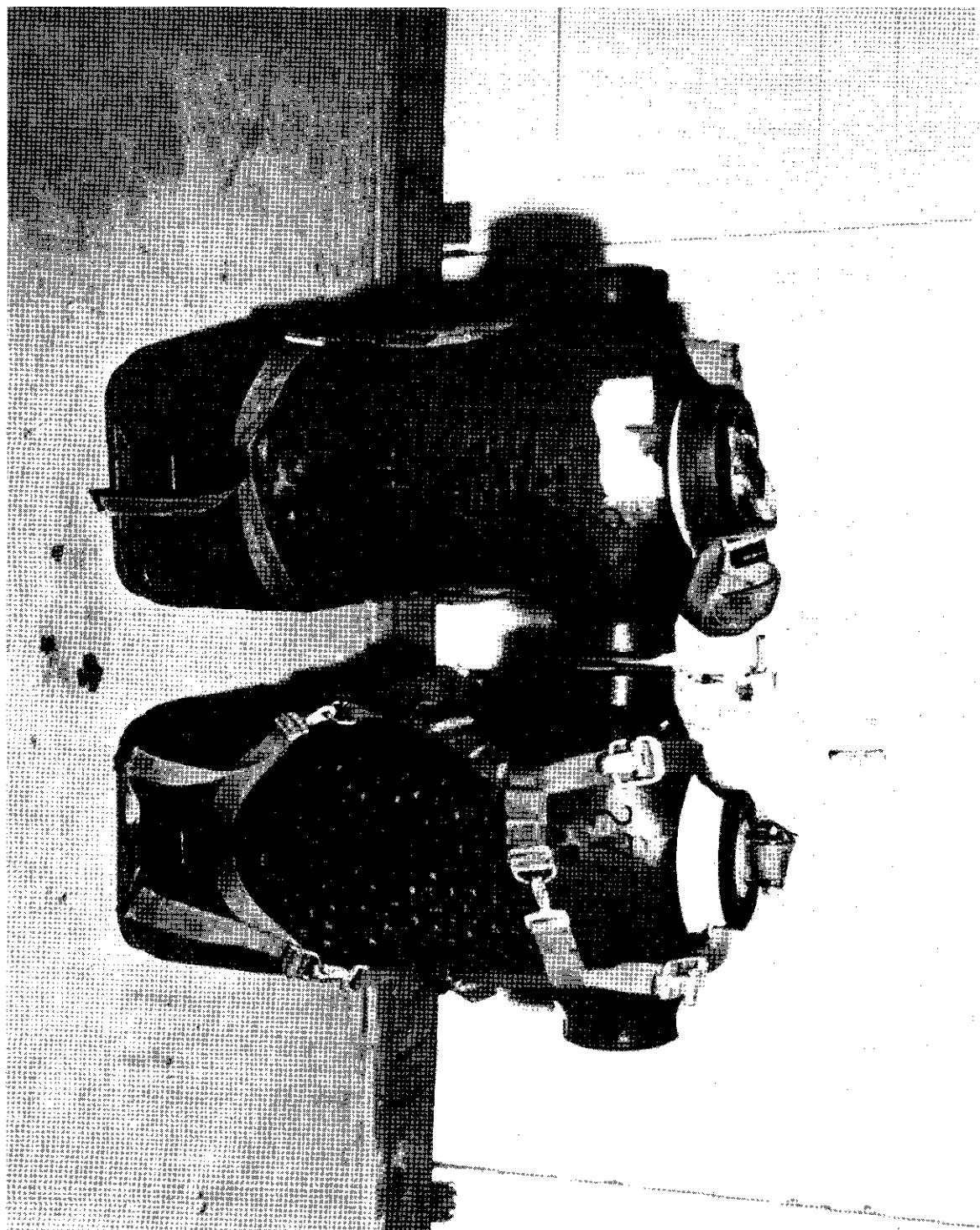


FIGURE 4
SIMPLIFIED AND REGULAR PARACHUTE HARNESES

the tensiometer at the same moment the parachute pack is opened.

To load the tensiometer and load block in the neck cavity, remove the bolt through the dummy shoulder tubes.

Figure 5 shows the assembled slide pin load block and tensiometer ready for fitting into the neck.

The unit is lowered into the recess until the bolt holes in the dummy align with the slide pin. This pin is forced out as the bolt is replaced. The shoulder plugs are replaced. Figure 6 shows a cross-section of the tensiometer secured in the dummy and ready for test.

12. Installation of Tensiometer on Neck

This installation is the same as that used in aircraft drops, except that the tensiometer is activated by a 3 ft. static line secured to the nacelle.

13. Rigging the Shell Projectile

To rig the shell projectile:

Attach one end of the tensiometer to the load block and the other to the parachute riser. Rig the tensiometer lanyard so that it can be tied to the jettisonable end cover.

This assembly is placed inside the shell and the load block is secured to the stud bolt extending aft of the nose piece. Use the access-hole on the front of the shell. The access-hole cover is not replaced until the parachute pack has been stowed in the shell and the tensiometer lanyard secured.

The pack, with pilot chute attached, is retained by a jettisonable cover on the aft end of the shell. (If the pilot chute is to be tied to the cover with a suitable break cord, follow the rigging instructions for the particular test being performed. Tie the tensiometer lanyard to the cover. Finally, attach the cover to the aft

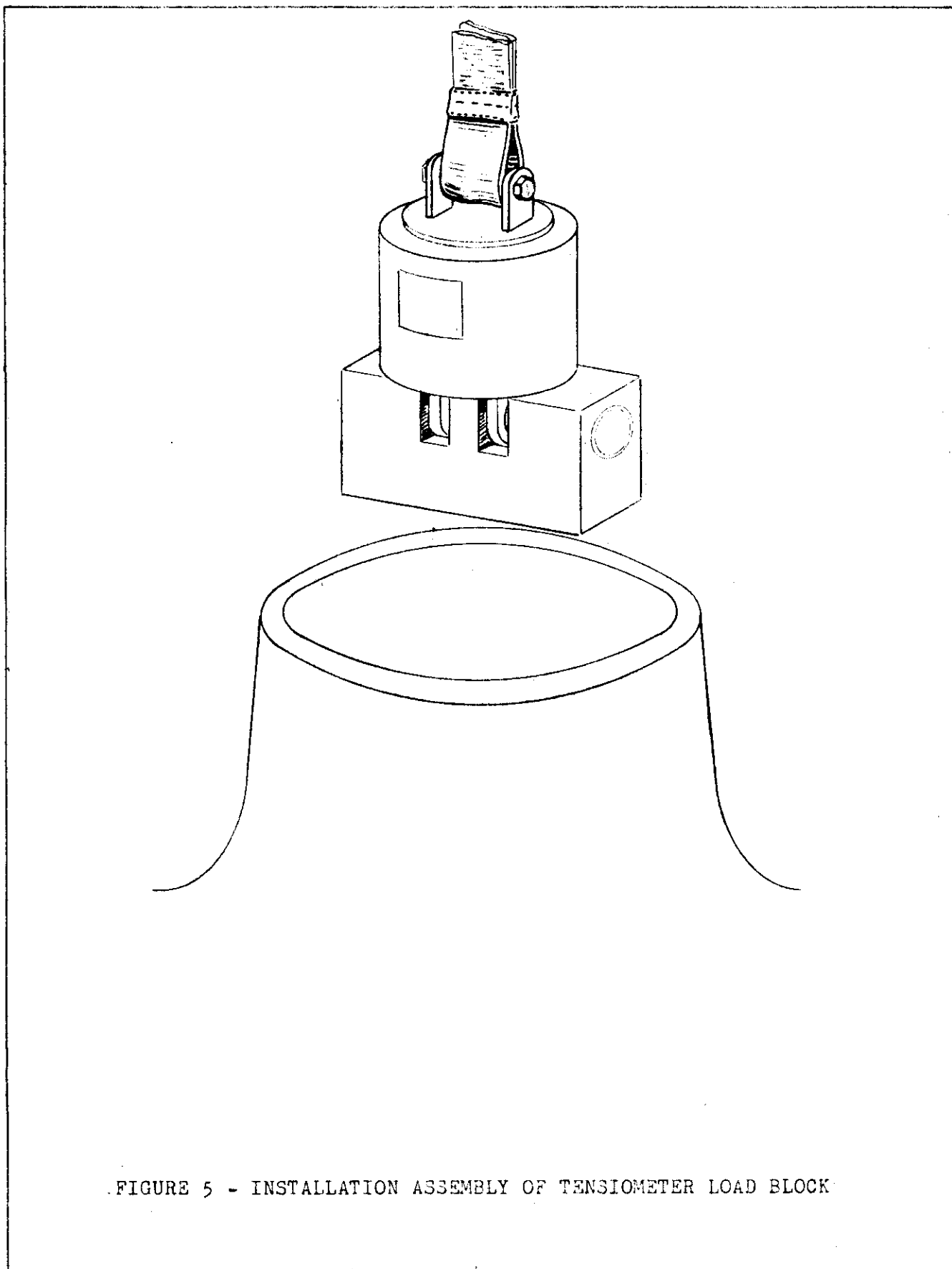


FIGURE 5 - INSTALLATION ASSEMBLY OF TENSIOMETER LOAD BLOCK

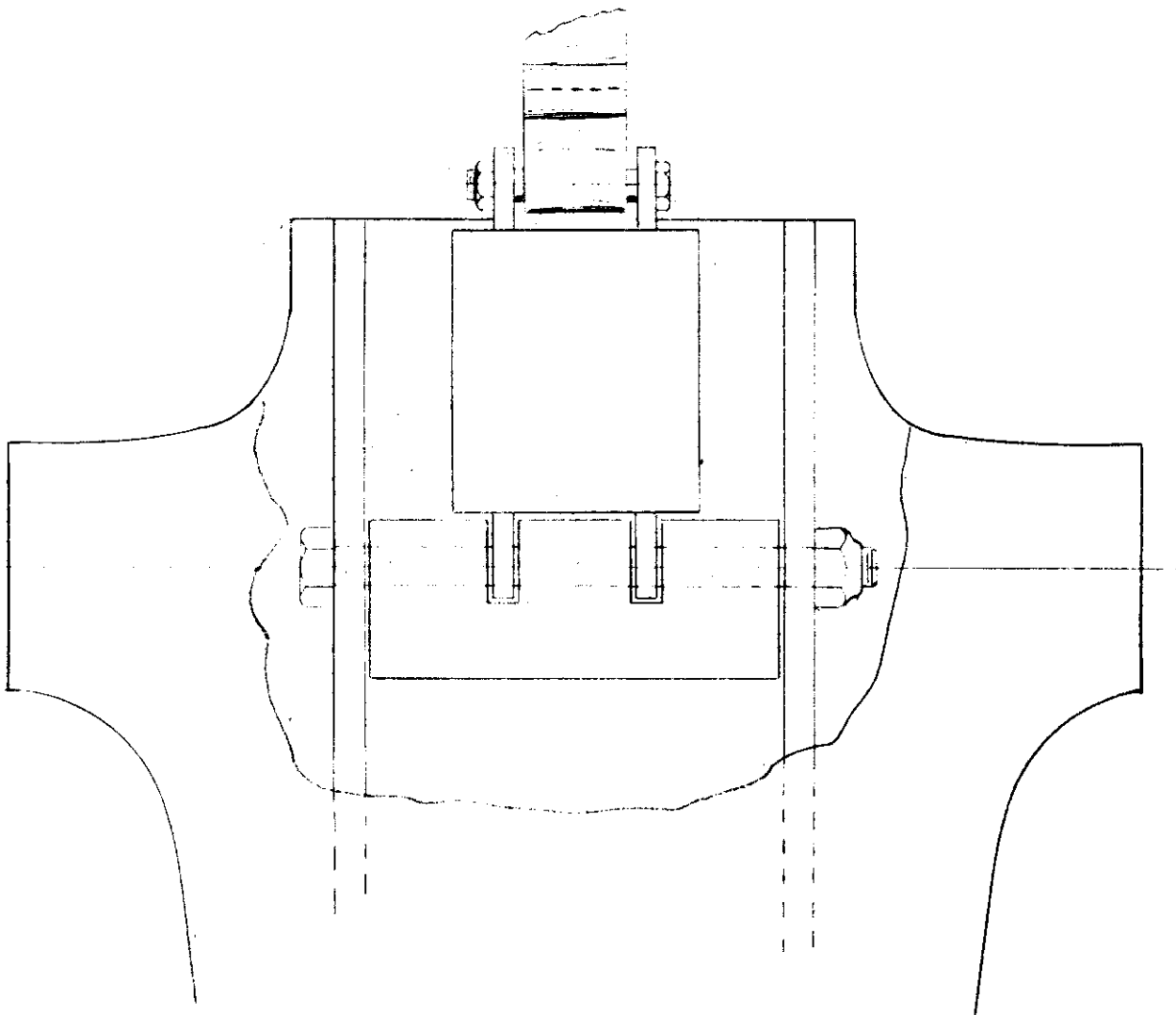
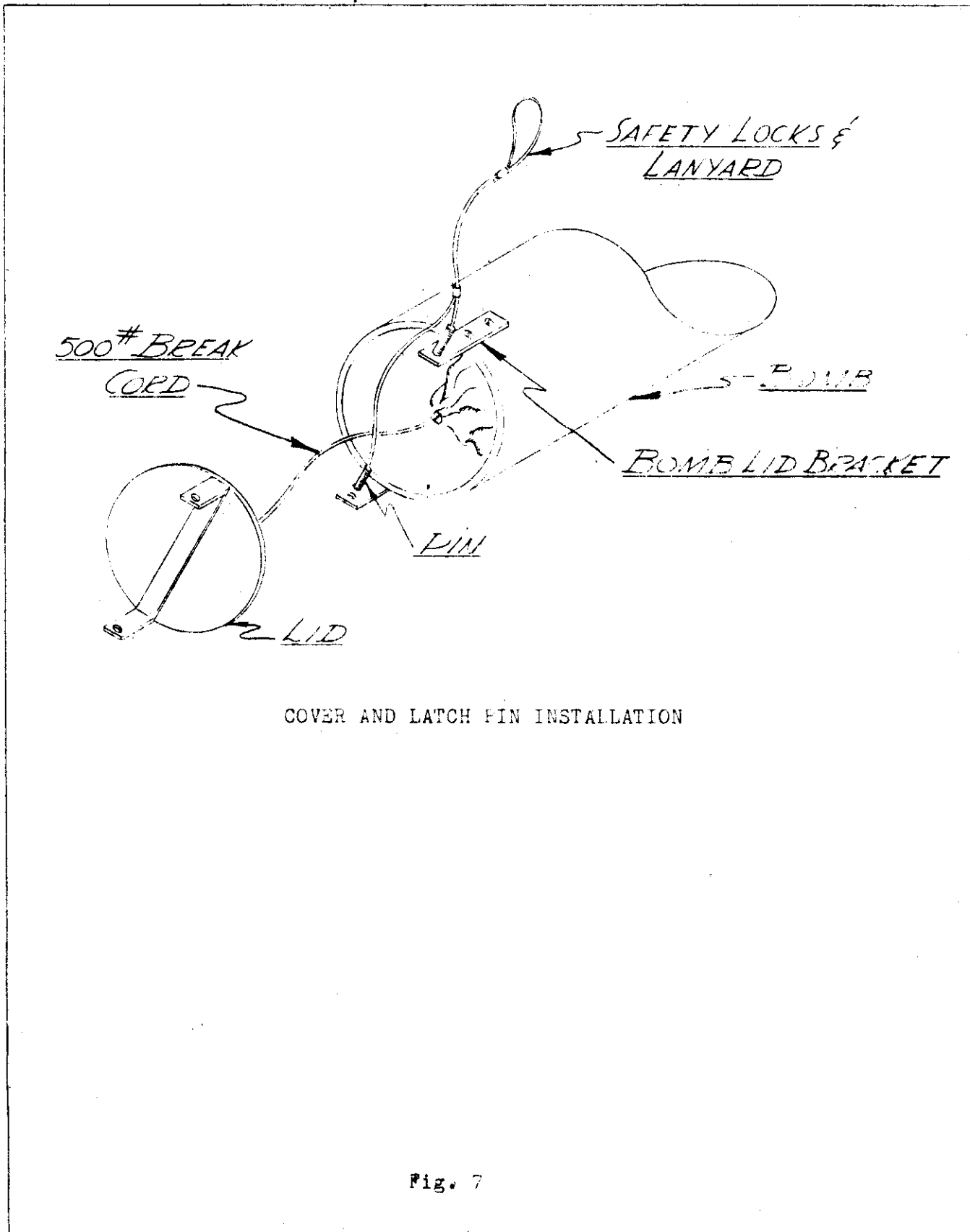
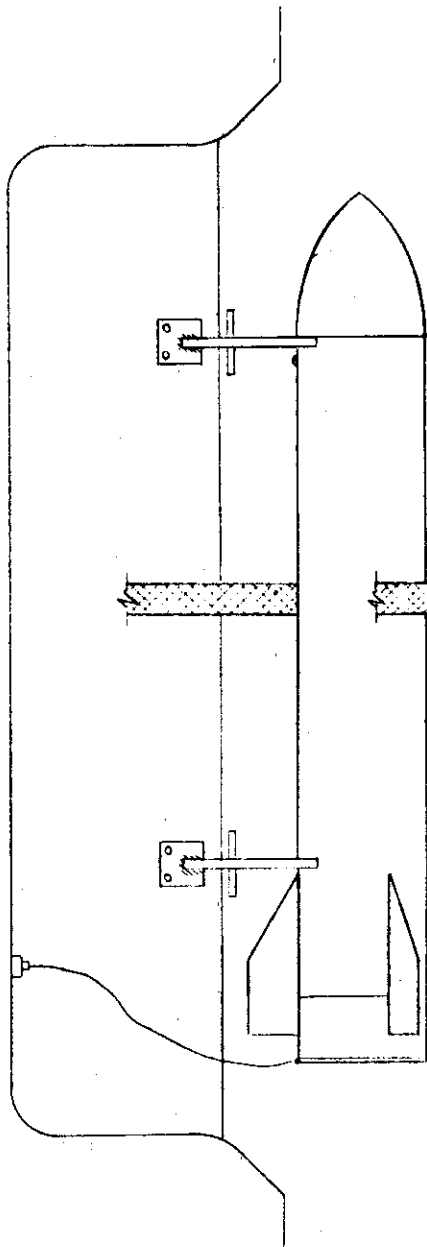


FIGURE 6 - ASSEMBLY OF TENSIOMETER LOAD BLOCK IN TORSO



COVER AND LATCH PIN INSTALLATION

Fig. 7



Installation of Bomb

Fig. 8

end of the shell by the means provided so that it will be released as the shell flies clear of the nacelle. Figure 7 shows a cover installation in which the latch pins are tied to a short static line on the nacelle.

14. Installation of Bomb Sway Braces

The shell is always dropped nose first. It is stabilized by two sway braces, one longer than the other. To aid installation, one brace is marked "Front" and must be placed between the forward shoulder sway pads. The braces are secured by the two bottom bolts in the sway pads. These must be placed with the semi-circular saddle down to hold the bomb properly.

15. Bomb Handling

The rigged bomb is loaded on the dolly in the same manner as the torso dummy, jacked up into the nacelle cavity and made secure in the sway braces as shown in Figure 8. It will be observed that the front brace is just forward of one of the three nose-piece screws.

16. Securing the Shell

After the shell is properly positioned, the belt harness is made secure. The belt required for the shell is longer than that used for the torso dummy. The remainder of the procedure is the same as that for the torso dummy installation. It is important that the belt harness be tight before the dolly is let down. The static line is secured to the nacelle and the bomb is ready for the test run.

17. Boom Camera Circuit

A permanent mounting for a gun sight aiming point (GSAP) 16mm camera was made on the boom. This was used early in the program for a study of the behavior and stability of the suspension cable fairing and nacelle flight.

The camera is easily accessible from the Tower's top platform,

and no personnel hazard is involved. The tower operator controls boom camera operation through a special circuit which is a part of the load release circuit. Since the boom camera serves only for study of the nacelle or fairings, it is wired into a part of the release circuit. Thus, load release while the boom camera is operating is not presently practicable. A single pole, single throw, switch was added to the circuit which connects to a lead on the vertical shaft inner slip ring drawing on the 110 volt AC supply in the tower control room. The center ring is a constant ground for the slip ring contacts. When the camera is mounted, the release circuit leads, going out to the boom, are broken. The 110V-24V transformer is wired into the shaft-end leads and the camera connections are made through the transformer. The unit is then ready for operation.

The camera will continue to run as long as the switch in the control tower is closed. (Figure 9)

18. Field Camera Circuit

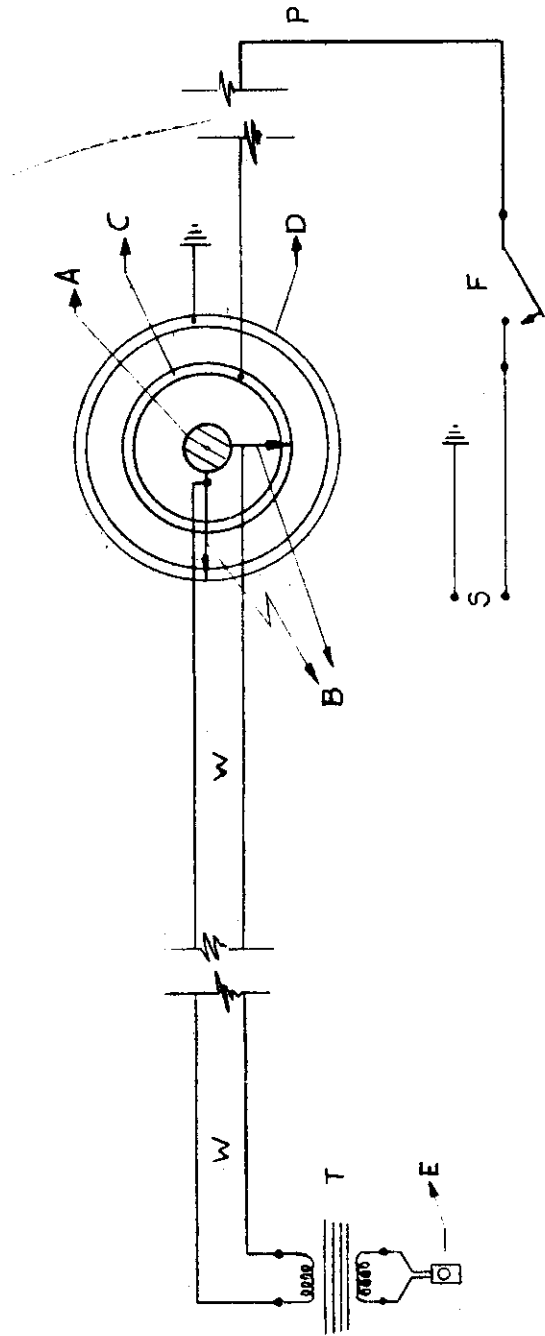
To establish camera data for the photogrammetry study, (Appendix "I"), it was necessary to operate two field cameras on a common circuit. A third camera for tracking studies of the parachute action was also necessary. These are identified as cameras C1, C2 and C3.

The circuitry devised for this purpose is shown in Figure 10.

Two circuits, operated by separate switches S_2 and S_3 , were run out to the C1 camera from a 110V AC source in the tower control room.

The S_2 switch controlled the operation of the L_2 circuit which is normally open, when closed it energized the motors driving the C1, C2 and C3 cameras.

Since it was necessary to correlate the films from the three cameras, a periodic impuse system was used in which .01 sec. time

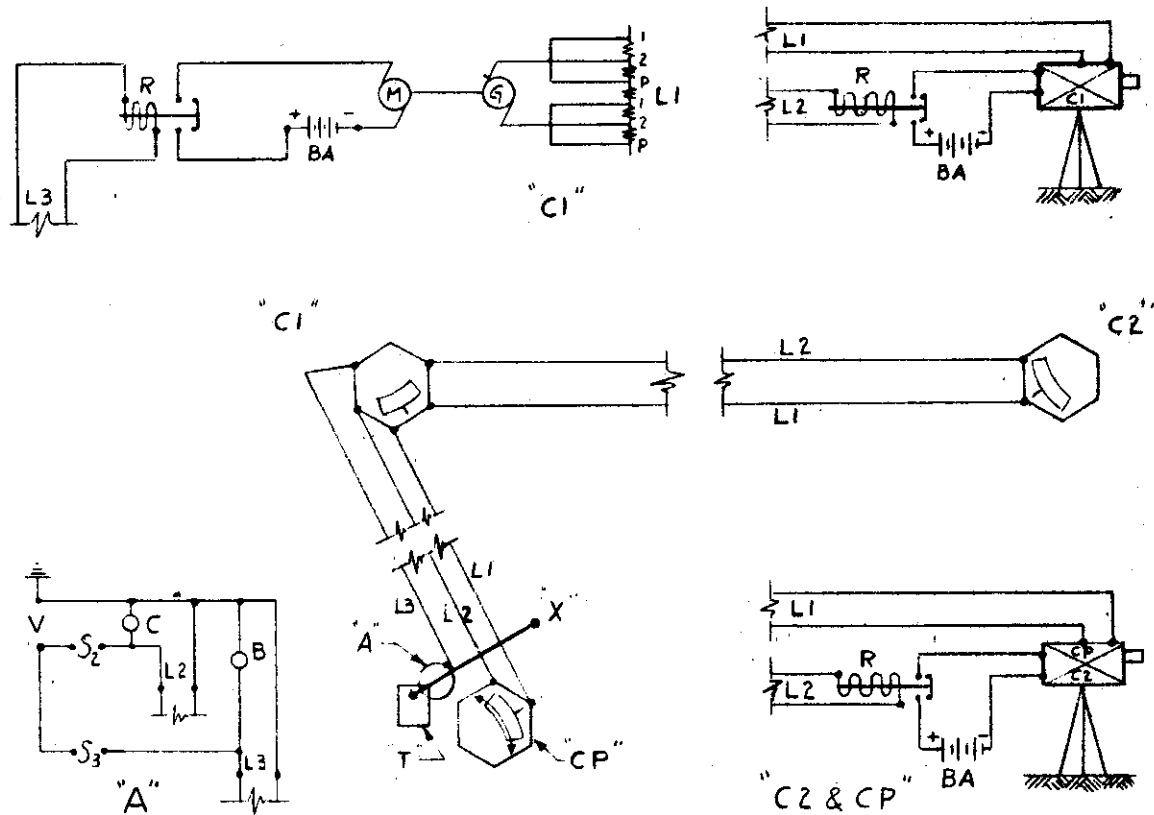


SCHMATIC DIAGRAM BOOM CAMERA CIRCUITRY

- A. Tower Shaft Brushes
- B. Tower Shaft Mounting
- C. Inner Ring Mounting
- D. Center Ring Mounting
- E. 28 Volt 16mm GSAP Camera
- F. Control Room Off-On Switch
- P. Control Room Panel to Ring
- S. Any 110 Volt A.C. Source
- T. 110 V - 24 V Transformer
- W. Boom-Shaft-Brush Wiring System

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Fig. 9



SCHEMATIC CIRCUITRY FIELD CAMERA OPERATION

- X - Ground Projection of Release Point
- T - Tower Building
- A - Control Tower Camera Operation Circuitry
- C1 - Position 1 Fixed Camera Circuitry
- C2 - Position 2 Fixed Camera Circuitry
- CP - Moveable Camera Position
- L1 - Blip Generator
- L2 - 110 Volt Camera Relay Circuit
- L3 - 110 Volt Blip Motor Relay Circuit
- R - 110 Volt A.C. Relay
- S₂ -- Switch, Camera Relay, "Off-On" Control
- S₃ - Switch, Blip Motor Relay, "Off-On" Control
- B - Blip Motor Lamp Indicator
- BA - 28 Volt Batteries
- C - Camera Motor Lamp Indicator
- G - 100 Cycle Per Sec Blip Generator
- M - 28 Volt D.C. Motor
- V - 110 Volt A.C. Source

Fig. 10

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"blips" were recorded on the film. This necessitated the use of the L₃ circuit.

The S₃ switch controlled the operation of the L₃ circuit which energized the normally open 110V AC relay at the C1 camera. When the relay was closed the time impulse motor-generator was energized through its 28V battery, creating the L₁ circuit.

The L₁ circuit was the time impulse circuit and ran from the C1 camera to the C3 and C2 cameras. The motor generator was located at the central C1 camera.

Because of general mechanical difficulties and film handling requirements, the time impulse system was abandoned for the photo flash film synchronizing method and the S₃ switch and circuits L₁ and L₃ were removed from the camera control circuit.

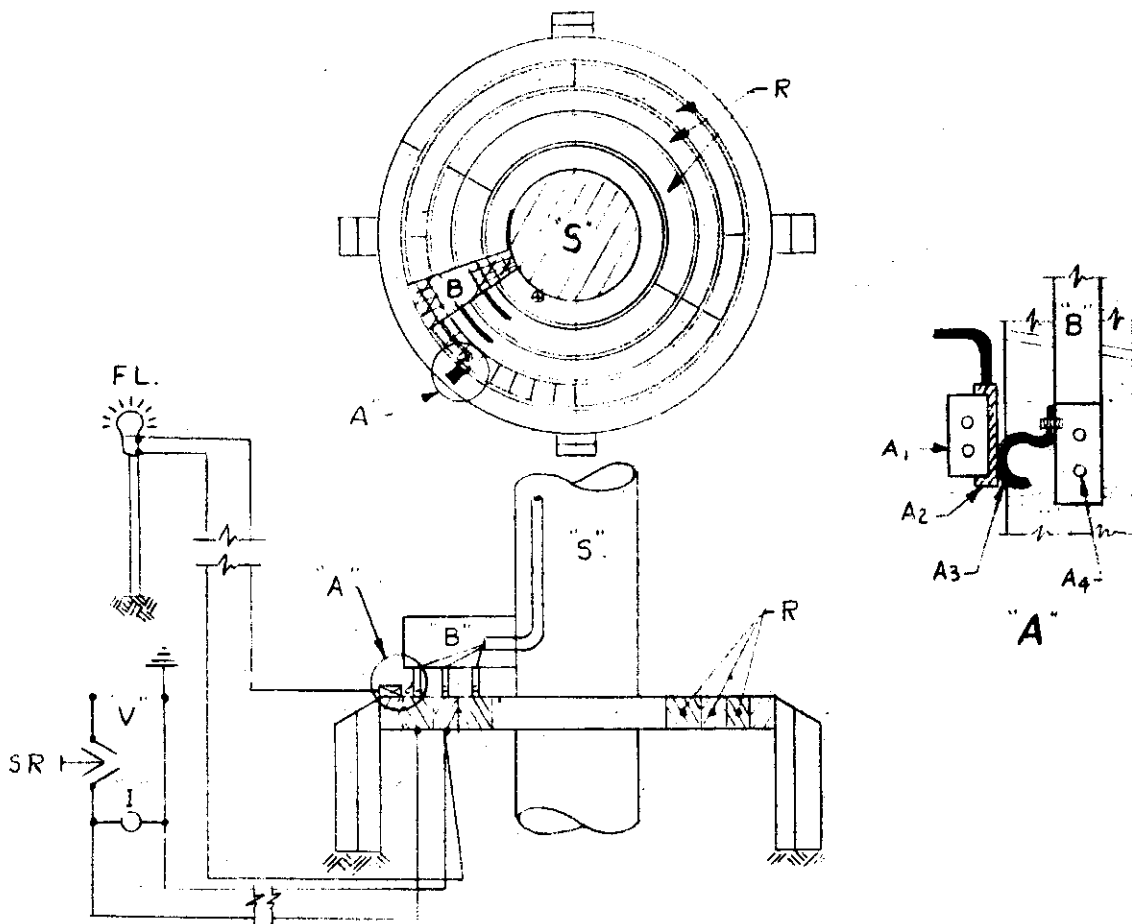
19. Horizon Flash Indicator

Since mountains obscure the horizon, a fictitious horizon for the camera program was established. This was done by placing a photo-flash bulb at a point in the field where its light could be recorded by the C1 and C2 cameras.

The circuit used to actuate this bulb is shown in Figure 11. To effect this a change was made in the regular load release circuit, which is actuated by the button on the control panel. A small Micarta block was fitted to the vertical shaft slip ring support. A contact on this block was arranged to pick up an electric impulse from the release contact shoe as it passed over the selected release point. A conductor lead was run out to the flash bulb from this contact.

Operating Procedure

To bring the facility from a complete power shut down to a "load release" state, for releasing the dummy vehicle from the nacelle, and for returning the unit to a safe power-on shut down, the following



SCHEMATIC DIAGRAM

GROUND FLASH INDICATOR CIRCUITRY

- A - Ground Flash Bulb Circuit
- A₁ - Contact with Release Block Brush
- A₂ - Insulated Block
- A₃ - Brass Plate Contact
- A₄ - Brush Spring Wire
- A₄ - Release Ring Brush
- B - Shaft Brush Block and Ring Contact Brushes
- F.L. - Ground Flash Bulb Indicator
- R - Fixed Rings
- S - Rotating Shaft
- SR - Control Panel Release Button Normally Open
- I - Release Indicator Light
- V - 110 Volt A.C. Source

Fig. 11

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steps are to be followed:

20. Preliminary

a) Close the AC fuse to the battery charger carefully so that the fuse is not damaged and check the voltage meter on the battery charger for 120 to 150 volts.

H.V. panels 1, 2, 3, and 4 in the main machinery room have their GREEN lights on when the current is flowing.

b) Close the power circuit breaker switches on H.V. panels 1 and 4; RED lights will now come on.

c) Close circuit breaker switch handles on the "Cabinetrol" near the east wall of the main machinery room.

d) Open the doors on L.V. panel 2 and close circuit breakers, 29BA, 29TR and 29Ta.

CAUTION Circuit breaker 29 must not be closed as this is the control of the machine heaters which are not used at this time.

Next, turn emergency lockout switch 86 EM to "Reset". The emergency stop RED indicator light should come on.

e) Close the knife switch, 29D, inside L.V. panel 3. The electronic tube on no. 14 sub-panel should glow, indicating an active circuit. Two minutes should elapse, to allow the time relays to warm up to proper operational temperature before proceeding.

21. Auxiliary Operations

a) Observe and record measurement of the oil level in the gauge mounted on the exterior of the tank above the floor on the reduction gear box. The minimum and maximum levels should be 7 and 10 inches, respectively, when the oil circulating pump is idle. Immediately after the pump is energized, the oil level will drop. This is a normal indication; part of the oil is now being circulated through the mechanism by a spray-splash system.

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- b) Start the oil circulating pump on L.V. panel 2. The RED indicates current flow.
- c) In the oil sump room:
1. Check and record oil pressure (55 - 60 lbs.)
 2. Open filter valves
 3. Check and record oil temperature
 4. Check and record oil pump casing temperature
 5. Check the oil flow indicator glasses in the oil sump room and on top of the reduction gear.
 6. Operate the oil pump 20 minutes (or until the oil temperature is constant within 2 degrees variation for 5 minutes) before starting the facility from the control tower.
- d) Start Blower Motors BP, BM, and BD on L.V. panel 2. RED lights should come on.
- e) Start the auxiliary Motor Generator set on L.V. panel 2. A RED light glows. The voltmeter on the upper part of this panel should indicate 250 - 255 volts (constant potential excitor voltage.)
- f) Start the tachometer Motor Generator set on L.V. panel 2. There will be a RED light. Inspect motor operation behind L.V. panel 3.
- g) Check power circuit breaker switches on H.V. panels 2 and 3. Turn the switch handle on panel 2 to "Normal" and leave the one on panel 3 on "Trip". This is a safety measure until the "All Clear" signal is given for control tower operation.
- h) Start Motor T.S. on L.V. panel 2.
- At this point great care must be exercised because the following checks are to be made almost simultaneously:
1. RED light on L.V. panel 2 is on.

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2. AMBER light H.V. panel 2 is on and remains on until the operating speed is obtained. The field is automatically energized at this speed and the RED light on H.V. panel 2 comes on. The pointer in the DC ammeter on the upper section of this panel should read approximately $1/3$ of the scale.

i. There will now be RED lights on L.V. panel 2 and H.V. panels 1, 2 and 4. The AMBER light (machine heater) on L.V. panel 2 will be off.

j) Check oil rings and oil level indicators on Motor T.S. and Generator G.

After these preliminary and auxiliary preparations and checks, the whirl tower is ready for operation from the control tower.

22. Control Tower Operations

a) Turn the switch handle on H.V. panel 3 to "Normal".

CAUTION This should be done when the tower is ready to operate and the following items have been checked:

1. The nacelle is free
2. All personnel are accounted for
3. The nacelle flight path is clear around the tower

b) Release the brake by pumping the foot brake pedal in the control tower, until the brake pressure light on the control cabinet stays on.

c) Engage the safety bar and check the brake drum shoes for clearance. If necessary, adjust the turn-buckle on the brake shoe restraining cable to provide clearance.

d) The RED light marked "Ready for Start" located on the tower control panel should be on.

e) Check with personnel at the nacelle to see that the loaded

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projectile is ready for release.

f) Check the tower danger area to see that safety precautions are being observed.

g) Activate the warning system.

h) Turn the speed control rheostat to zero. The tower speed indicator should read approximately 30 rpm.

i) Throw the tower control lever switch to "Complete Start". This causes the AMBER starting light to come on. The BLUE indicator light of motor "D" comes on as the tower speed approaches "zero". The oil rings and oil lever on the frequency set, motor "D", and generator converter "M" should be checked for proper lubrication.

j) After the tower speed indicator reaches "zero", the oil circuit breaker of H.V. panel 3 closes, and the blue light of the tower control panel under converter "M" and motor "P" come on.

NOTE The closing of the oil circuit breaker is dependent upon electronic relay No. 14 and may delay up to 40 seconds. If the tower indicator is on "zero" and the breaker has not closed, it can be operated manually. Manual closing of the oil circuit breaker is usually required on the first start of each day.

k) The rotation of the tower shaft is initiated by immediately setting the pre-set speed adjustment (speed control rheostat) at 10 or more. This will be indicated as approximately 5 rpm on the Tower tachometer as the main shaft comes up to speed. The velocity stipulated for a test may be obtained by determining the necessary control setting from the conversion chart of Appendix "H".

23. Load Release Operation

a) Turn the "Parachute Release Position" knob to the specified sector.

b) Sound the warning system.

c) Ascertain that all personnel are at their stations and prepared to observe and record data on the release.

d) As the nacelle passes the N.E. corner of the building, press the "Parachute Release" button and hold it down until the release is accomplished. When the release is made, the RED indicator light "Release Circuit Open" is energized.

e) In case of "non-release", sound the warning system and turn the speed control rheostat to zero.

24. Nacelle Shut Down Operation: Normal

a) Turn the speed control to "zero"

WARNING Do not push "Emergency Stop". Leave all further control to the tower drive mechanism, as it will bring the unit to a slow creep. A man should be with the nacelle at this time to help prevent swaying.

b) As the nacelle is over its mooring location, the control switch is turned to "normal stop". All power to the vertical drive mechanism is off and the following lights on the control panel remain on.

1. "Ready to Start" - Green
2. "Release Button" - Green
3. "Oil Pressure" - Blue

25. Electric Shut Down Operation: Tower

a) Release the parking brake safety bar, and push the "Parking Brake" button.

b) To de-energize the test facility, kill all circuit breakers on LV panel 2 and all the oil circuit breakers on H.V. panels 3 and 4. As the last operation, pull the main fuse in the battery room.

26. Nacelle Shut Down Operation: Emergency

The use of the emergency stop button on the control panel,

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located in the tower room, should be restricted.

When this button is pushed current to all electrical machinery except the oil pump is cut off. Thus, the nacelle is allowed to decelerate in a "free wheeling" attitude. Under this condition, there is no control of the nacelle. Its diving tendency is magnified which requires closer handling to prevent damage.

For additional information on operating the facility, refer to G.E.I. 30048 "Instructions for Drive Equipment for Parachute Test Tower".

SECTION II

PROCEDURE FOR MAINTENANCE AND LUBRICATION

1. General

a) The ensuing procedure for lubrication and maintenance of mechanical and electrical components of the whirl tower drive system is a supplement to the General Electric Company manual G.E.I. - 30048. Questions or problems arising which are beyond the scope of this outline of procedure may be referred to that manual.

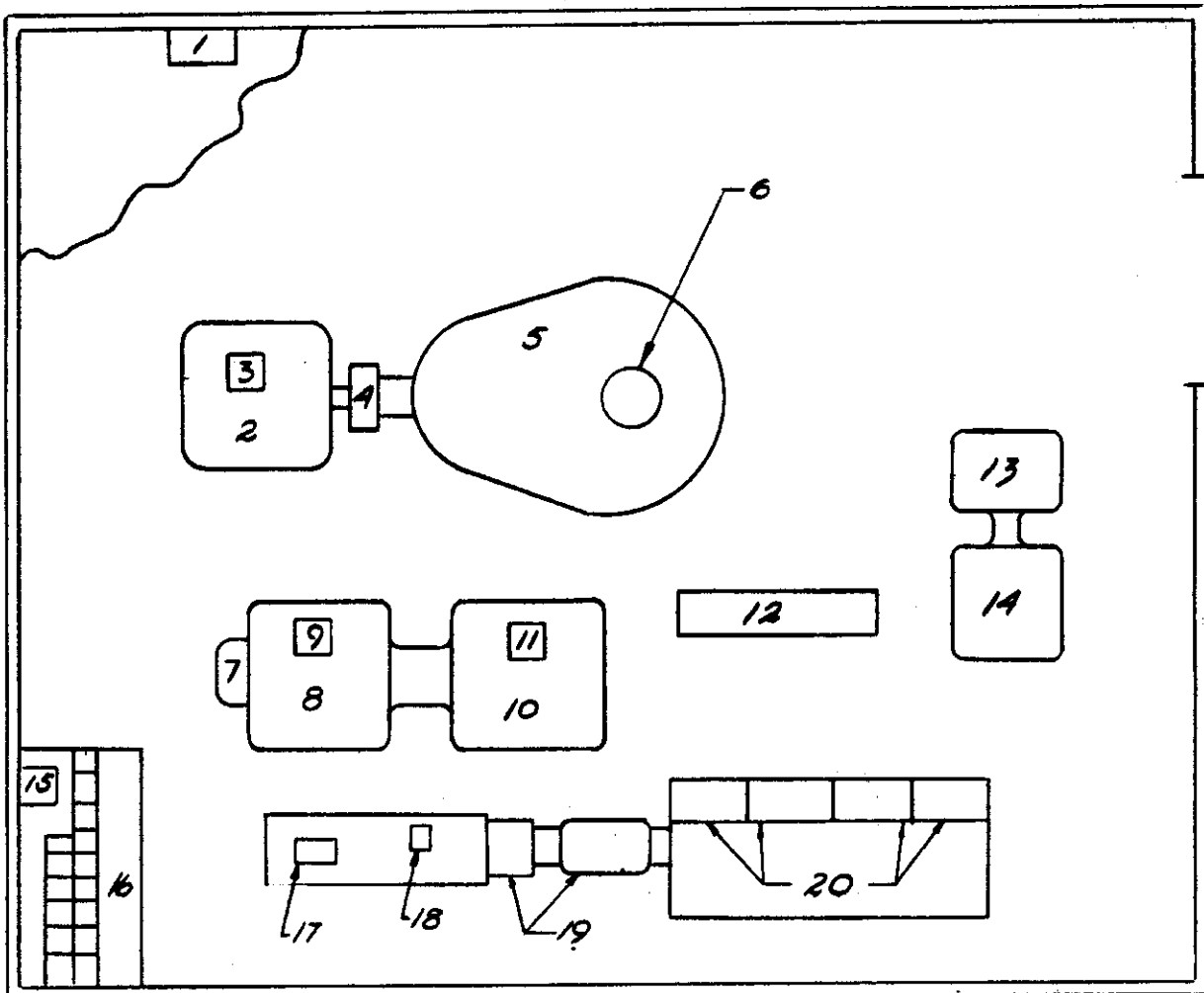
b) The lubricants and fluids required for tower components are readily available in standard commercial form. (It was necessary to establish the grades and amount required by consulting oil company representatives.) In the absence of detailed specifications, it was found expedient to obtain standard commercial products from local vendors. Supplies of these products, sufficient for more than two years normal operation, are available at the facility.

c) No special maintenance procedures, beyond normal industrial or military practice, are required except as outlined herein. It may be noted that the site of the facility is such that there is a continual sifting of sand into the tower, and that leakage of various lubrication-system units result in recurrent pools of waste oils and greases. Routine regular cleaning will, however, prevent abrasion of the machinery due to sand and minimize the fire hazard attending oil leakage.

2. Lubrication Requirements

a) Study of tower lubrication requirements by the contractor has established the following general procedure as sufficient to maintain the drive and control mechanisms of the tower. (Components are identified according to the symbols shown in Figure 1)

Fig. 1 - Schematic Plan for Lubrication and Maintenance



- | | |
|----------------------------|--|
| 1. Parking Brake Reservoir | 11. Blower Motor "DB" |
| 2. Main Drive Motor "P" | 12. Amplidyne Set "CPE"- "DMG"- "AMD"- "AMG" |
| 3. Blower Motor "PB" | 13. Generator Motor "TS" |
| 4. Reduction Gear Coupling | 14. Generator "G" |
| 5. Reduction Gear Housing | 15. Battery Charger |
| 6. Vertical Shaft | 16. Gould Batteries |
| 7. Tachometer Motor "TG" | 17. Tachometer Motor Generator "TMG" |
| 8. Frequency Converter "M" | 18. Rheostat Motor "70S" |
| 9. Blower Motor "MB" | 19. Pyranol Transformers |
| 10. Drive Motor "D" | 20. Oil Blast Circuit Breakers |

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1. Regular pre-operational inspection, and servicing as required
 - a) Reduction Gear System
 - b) Main Drive Motor ("P") and units "TS", "G", "D" and "M"
2. Inspection during tower operation
 - a) Reduction Gear System
 - b) Main Drive Motor ("P")
3. Daily Inspection and Servicing
 - a) Reduction Gear System
 - b) Main Drive Motor ("P") etc.
 - c) Auxiliary Motor Generator ("CPE"), and units "DMG", "AMD", "AMG", "PB", "MB", "DM", "D", and "TM"
 - d) Tachometer Generator ("TMG") and unit "TG"
 - e) Tower Vertical Drive Shaft Bearings
4. Weekly Inspection and Servicing
 - a) Reduction Gear System
 - b) Main Drive Motor ("P") etc.
 - c) Tower Vertical Drive Shaft Bearings
 - d) Main Battery Bank Test Cell
 - e) Oil Blast Circuit Breaker
5. Monthly Inspection and Servicing
 - a) Reduction Gear System
 - b) Main Drive Motor ("P") etc.
 - c) Auxiliary Motor Generator ("CPE") etc.
 - d) Main Battery Bank
 - e) Oil Blast Circuit Breaker
 - f) Transformers
 - g) Battery Charger
6. Semi-Annual Inspection and Servicing
 - a) Reduction Gear System

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- b) Main Drive Motor ("P") etc.
- c) Auxiliary Motor Generator ("CPE") etc.
- d) Vertical Drive Shaft
- e) Tachometer Generators
- f) Oil Blast Circuit Breaker
- g) Main Batteries
- h) Pyranol Transformers
- i) Battery Charger
- j) Parking Brake
- k) Rheostat Motor 70S
- l) Oil Pump and Oil Pump Motor

3. Lubrication Procedure

- a) Reduction Gear Mechanism

1. Before Operation

Before the tower main drive motor is started the satisfactory operation of the oil circulation system and of reduction gear coupling lubrication must be established by these steps:

- a) Check oil level gage for minimum reading of 7 inches. If necessary, add oil (5 parts calol to 1 part Vistac 28X) to maximum of 10 inches.

- b) Operate oil pump 20 minutes or until oil temperature gage shows constant temperature. Record temperature on data sheet.

- c) Check oil pressure gage reading to 55-60 pound range. Record pressure on data sheet.

- d) Verify oil flow by inspection of glass flow gages in sump room and four others on reduction gear housing.

- e) Using a pry-bar, turn the reduction gear coupling until the oil plug is up approximately one-third of the distance between top and bottom of the coupling. Remove the plug and check that the oil

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level inside the coupling is at, or above; the plug at this level.
Add oil as required (DTE heavy-medium Turbo oil).

f) Report any deviation from normal to the facility engineer.

2. During Operation

After each 30 minutes of tower operation check and record:

a) Flow of oil at the 13 glass flow gages indicated in 3(a)1a.

b) Oil temperature

c) Oil pressure

d) Oil level (Note: During tower run the circulation reduces the gage reading 1 to 2 inches)

3. Daily

Oil leakage occurs at all glass flow gages, and should be removed to reduce fire hazard.

4. Weekly

Remove waste oil from sump pit and record amount as a check on loss of oil from the gear system. Report any unusually large amount to the tower engineer.

5. Monthly

a) Draw a sample (one quart) of the oil from the reduction gear for analysis. The analyst's report will determine whether the oil is suitable for further use, or whether a change of oil is required. If the analysis discloses excessive amounts of sludge, or of metal particles, an individual check of each oil line is recommended to locate any plugged lines. The complete procedure for changing oil and checking oil lines follows. *If no line-check is required, steps 3 and 5 may be omitted.

1. Drop and lock Power Circuit Breaker No. 3

2. Close all oil line valves

*3. Remove both access covers adjacent to the flexible

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coupling on the housing

4. Start the oil pump
- *5. Inspect the interior inspection of mechanism if necessary

CAUTION: The interior inspection of the oil system requires three men. One man opens and closes individual oil line valves on direction. A second, the safety man, stands alert keeping continuous watch upon the third who enters the opened housing carrying a safety light. He directs the opening and closing of individual oil valves and watches the resultant oil flow until he is satisfied that all lines are operating properly or has located the line in which the oil circulation is faulty.

If disassembly of a line is required, consult the construction blue prints. When all lines are functioning normally, the system is ready to drain.

6. To drain, attach a hose to the drain plug on the stand-pipe in the sump room and pump the oil into drums placed to receive it.
7. When drainage is completed, four access covers on the bottom of the oil pan may be opened for inspection purposes.
 - a) Clean the oil filter in the sump room at the time oil is changed. If oil remains in the reduction gear reservoir, close the gate valves on the sides of the filter and bleed off air through the small valve on top. This relieves pressure on the filter element which can then be removed by loosening the hub nuts on the cap. Clean and rinse both the element and the casing (a drain plug is provided on the bottom of the

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casing) and replace and secure the element and cap.

6. Semi-Annually

a) Grease the four large gate valves in the sump room, using a hand grease pump to force new grease into the fitting on each valve until the old grease is extruded. Remove, and clean with gasoline, the two air filters provided on the top of the reduction gear housing.

b) Main Drive Motor "P", and Constant Speed Motor "TS", Generator "G", Frequency Converter Drive Motor "D" and Frequency Converter "M".

Inspection and servicing of these units is identical except for the numbers and locations of various parts and fittings. Lubrication procedure, detailed for Main Drive Motor "P" below, should be followed for the other units with such individual modifications as will be required.

It should be noted that the Tachometer Generator "TG" and the blower motors, which are part of the Frequency Converter Assembly, are not included in this listing. Their requirements are detailed under other headings.

1. Before Operation

Before starting the Main Drive Motor, check the supporting journal bearings for proper oil level through the bull's eye gage located in each journal support. When required, add oil through the bearing observation cups by opening the cup cover and removing the small plug attached to the cup chain. The recommended lubricant is a mineral oil such as commercial OC 15 Turbo Oil with viscosity of 270 to 325 Saybolt seconds at 100° F.

CAUTION: DO NOT USE AUTOMOTIVE OILS.

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2) During Operation

At regular intervals during the tower operating period, open the bearing observation cups, remove the plug and check the flow of oil. If oil flow is not evident, notify the facility engineer. Report any unusual noises detected during this inspection.

3) Daily

Inspect the exterior and interior of the unit for freedom from grit, metallic particles, oil or water. Use compressed air to remove debris from interior.

4) Weekly

Check the surfaces of commutators, collectors and brushes for undue wear, carbon or dirt accumulation. Check free movement of brushes in their blocks, and replace worn brushes. Use a clean, dry, lint-free cloth to wipe collector rings, brushes and brush connections. Measure air-gap clearances to detect worn bearings. Wipe coils clean carefully with a cloth saturated with a fifty percent mixture of white gasoline with carbon tetrachloride. This mixture is not inflammable but care should be taken to insure proper ventilation during the cleaning, and the commutators and collectors should be protected from exposure to the cleaning fluid and its vapors.

5) Monthly

Check tightness of such stationary parts as windings, frames and hold-down and foundation bolts, giving special attention to the tightness of bolts used to secure insulation. Inspect insulation of windings against grounding, and repair any failures of the insulation.

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Check alignment of couplings against possible shifting.

6) Semi-Annually

Replace oil in the supporting journal support by draining and refilling as indicated in section 1. Only the recommended lubricant should be used for flushing.

- c) Auxiliary Motor Generator Drive Motor "DMG" and
Auxiliary Motor Generator "CPE"
Amplidyne "AMD"
Amplidyne "AMG"
Main Drive Motor Blower Motor "PB"
Frequency Converter Blower Motor "MB"
Frequency Converter Blower Motor "DM"
Frequency Converter Drive Motor "D"
Tachometer Generator Motor "TM"

The units listed above are similar in construction; maintenance and lubrication requirements are functionally identical.

1) Daily

Inspect units for cleanliness and remove dust, dirt, oil, grease or water with a vacuum cleaner and a clean lint-free cloth. Do not clean with compressed air.

2) Monthly

Clean area around grease fittings with a clean cloth. Remove the relief plug and any hardened grease. Start the motor and add new grease equivalent to General Electric D6A2A3 for all units except the Auxiliary Motor Generator "CPE" for which grease equivalent to Type D6A1 is recommended. Continue running the unit until old grease is purged from the cavity and any excess of new grease has been expelled. Replace the relief plug

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Give constant care to protection of both grease and bearing housings from dirt contamination. Clean and polish collector rings with a lint-free cloth, and check freedom of brushes in their containers. Replace worn brushes as required. Add grease to flexible couplings until the old grease begins to extrude.

3) Semi-Annually

Although normal monthly lubrication purges old grease from the equipment, any residual grease should be removed whenever the unit is disassembled for general cleaning. Ball-bearings and races on units mounted horizontally can be cleaned without disassembly. Disassembled units can be washed in carbon tetrachloride but should be thoroughly rinsed in light mineral oil immediately after cleaning to prevent corrosion. Protect insulated windings against spilling or splashing of carbon tetrachloride. Clean insulation thoroughly before reassembling units. Clean exhaust air ducts from each blower fan with a vacuum cleaner during this inspection.

d) Main Vertical Drive Shaft Bearings

1) Daily

Inspect oil level of the top thrust bearing (located between the horizontal boom and the top shear plate of the tower) by removing the cap of the shorter of the two pipe sections. The oil level should be within one-quarter inch of the top. If necessary, add oil (An oil with viscosity of 315 Saybolt seconds at 100°F, such as DTE Heavy-Medium). Oil is added through the longer pipe

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section to the point of overflow. Remove all spilled oil to facilitate detection and location of leakage.

2) Weekly

Inspect the oil level in the Reduction Gear Coupling by removing the plug on top of the coupling. The oil level should be even with the bottom of the plug. Add Turbo Oil SAE 90 as necessary. Add grease, equivalent to Paragreeze BB-22, through the fittings provided on the remaining tower bearings. The two top radial thrust bearings are reached from the top tower landing. Three alignment roller bearings, provided with two fittings each, are reached from the first and second tower landings. After lubrication remove all excess grease and wipe each fitting.

e) Tachometer Generator "TMG" and Tachometer Generator "TG"

1) Daily

Inspect and blow out any dust that may have lodged in or around the windings. Clean the commutator as required with a lint-free cloth, using a few drops of kerosene on the cloth to remove any hardened deposit. The wool-packed sleeve bearings require occasional addition of oil. (Turbo Oil SAE 20 with viscosity of 150 to 200 Saybolt seconds at 100°F, or equivalent.)

f) Oil Blast Circuit Breaker

Located in each of the four high voltage cabinets is an oil circuit breaker of type FK250-300. The safety and successful functioning of connected apparatus depend upon proper and reliable operation of the oil circuit breaker. To ensure this, the unit must have systematic inspection and regular servicing.

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1) Weekly

Check oil level, and as necessary, add oil equivalent to G.E. No. 10c. Observe and correct any leakage.

2) Monthly

Each of the four units has an individual circuit-break counter. Record the number of times each counter has registered per month to establish the frequency of required maintenance. Test a sample of the oil from each unit at every 500 breaks registered by the counter. If the dielectric strength of the oil is 16,500 volts or less, it must be replaced. New or filtered oil with a minimum dielectric strength of 22,500 volts is a satisfactory replacement. Inspect the condition of breaker contacts monthly and report any unserviceable unit.

3) Semi-Annually

Remove oil and clean each tank and all insulating parts of all traces of carbon. The filtering system does not remove carbon which may adhere to these surfaces.

g) Main Batteries

1) Daily

Select any cell except the charge indicator cell as a "pilot cell" and record the floating voltage of the chosen cell twice daily; the specific gravity and temperature once daily. Keep the tops of the batteries clean, and inspect the level of the solution in each cell, adding distilled water as required to immerse the tops of the separators. Neutralize any spilled acid immediately with ammonia water or washing soda. Never add acid or battery "dope". Do not allow open flames

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near the batteries. Store distilled water for the batteries in clean containers of hard rubber, porcelain, or glass which will protect it from contact with metals.

2) Monthly

Record the floating voltage and specific gravity of all cells.

h) "HS" and "HTI" Pyranol Transformers

1) Monthly

Draw a sample of pyranol from the top of each transformer to test for dielectric strength. If test shows a dielectric rating of 30 kv or less, the liquid must be strengthened. This may be accomplished by the use of a filter press to restore the dielectric rating to above 30 kv. Pyranol must be handled in metal containers which are free of oil, grease, or dirt to avoid contamination of the liquid and a decrease in its non-flammable qualities.

i) Battery Charger

1) Monthly

The battery charger requires little attention after installation, but any accumulated dust should be removed to prevent overheating of the copper oxide rectifier stacks. The dust may be drawn out by a vacuum cleaner or blown out with compressed air.

j) Parking Brake

1) Semi-Annually

Add grease through the seven pressure fittings. Refill reservoir as required.

k) Rheostat Motor 70S

1) Semi-Annually

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Add Oil SAE 10 or 20 through two grease cups.

1) Oil Pump and Oil Pump Motor

Both units are designed to be self-lubricating and any servicing should be undertaken by the manufacturer.