25.

INFORMATION REPORT INFORMATION REPORT

CENTRAL INTELLIGENCE AGENCY

S-E-C-R-E-T

[redacted] 25X1

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Technical Report on MIG 15 BIS No. 1327, Part One, Airframe 25X1

Technical Report on MIG 15 BIS No. 1327, Part Two, Engine

Technical Report on MIG 15 BIS No. 1327, Part Three, Electronics

Technical Report on MIG 15 BIS No. 1327, Part Four, Armament

Technical Report on MIG 15 BIS No. 1327, Part Five, Electrical System

Technical Report on MIG 15 BIS No. 1327, Part Six, Manufacturing Methods 25X1

[redacted]

[redacted]

S-E-C-R-E-T

USAF, DIA, review completed.

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STATE		ARMY		NAVY		AIR		FBI		AEC					

(Note: Washington distribution indicated by "X"; Field distribution by "#".)

INFORMATION REPORT INFORMATION REPORT

25X1

TECHNICAL REPORT
ON
MIG 15 BIS
NO 1327

25X1

PART ONE
AIRFRAME

SECRET

25X1

SECRET

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PART ONE

AIRFRAME

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PART ONE

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[redacted]

PART ONE

AIRFRAME

SECTION I

FOREWORD

The following report is based upon information gained from examination of a Polish built aircraft (known as "FAGOT"), designated LIM-2 (Polish designation for the USSR MIG-15 Bis) [redacted] 25X1

The full report has been divided into six separate publications as follows:

- Part One - Airframe
- Part Two - Engines
- Part Three - Radio and Navigation
- Part Four - Armament
- Part Five - Electrical
- Part Six - Manufacturing Methods.

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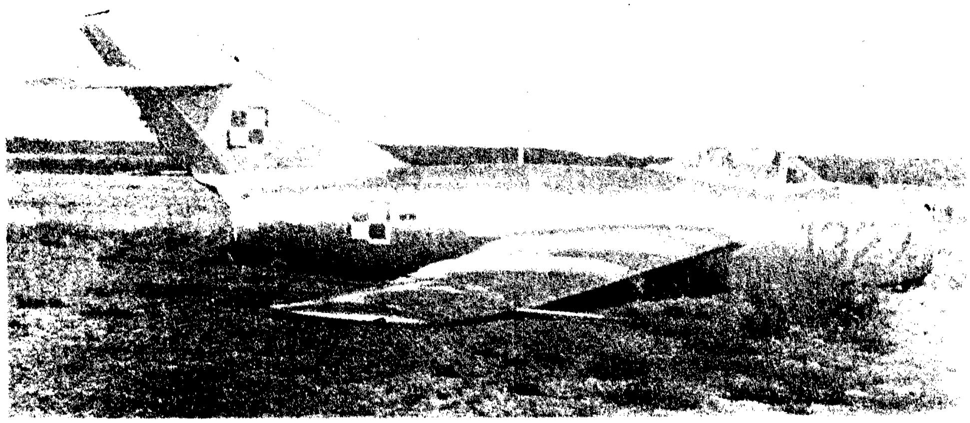

Photo no. 1 - Side view.

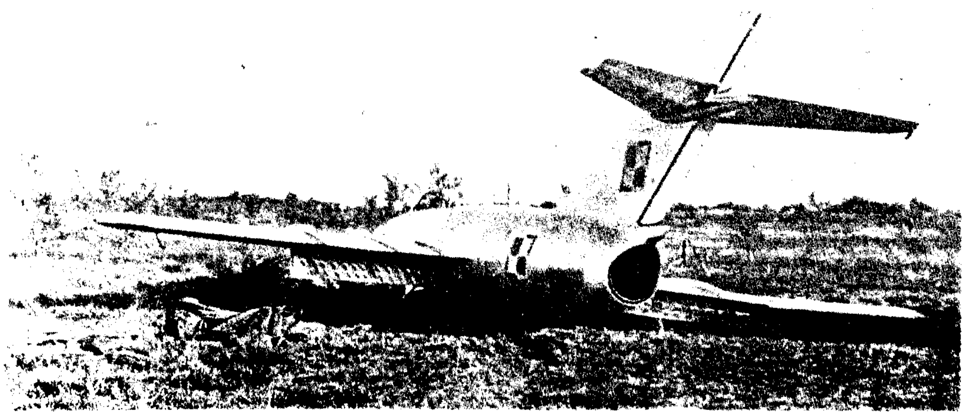

Photo no. 2 - Three quarter rear view.

SECTION II.

AERODYNAMICS.

A. General Description of Aircraft.

Engine designations (from engine plate) LIS 2 (Polish designation of VK1).

2. Wing incidence was adjustable on the ground within certain limits (see Section III Paragraph A.1.a.).

B. Mainplanes.

Wings.

Wing Body angle. Adjustable on the ground within small limits.

E. Fuselage and Air Intake.

1. Fuselage.

e. The position of the landing light has been transferred to the underside of the port wing.

General comments.

13. The following photographic sequence and sketch are included at this point to assist the analysis of emergency landing characteristics. The aircraft came to rest approximately 475 meters from point of touch down.
Conditions were as follows:
600 litres of fuel on board
flaps down
gear down but unlocked
full quantity of ammunition
soil was sandy and firm
air speed at touch down according to pilot was 280 kilometers per hour.

Photo no. 3 - Point of touvh down

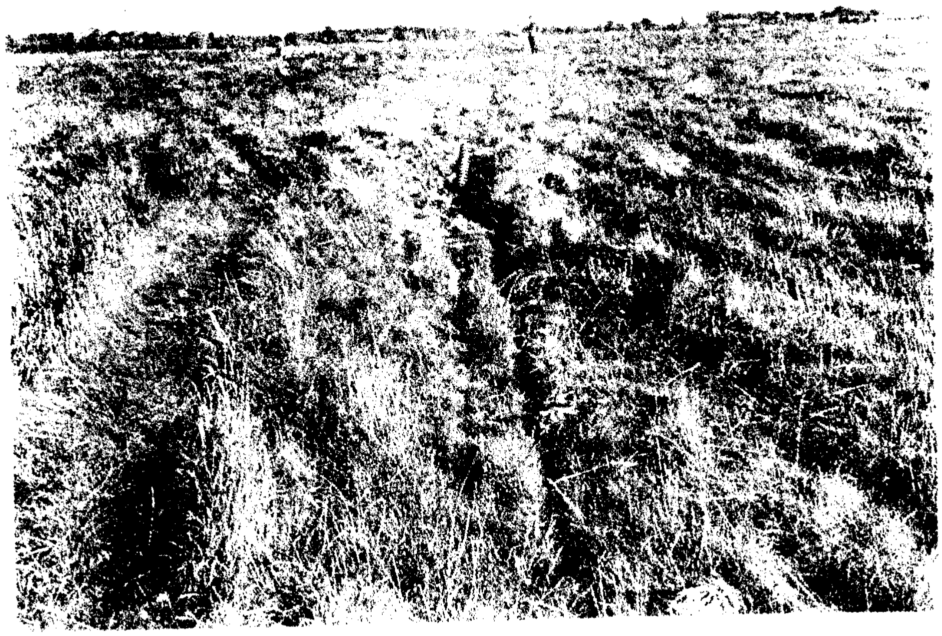

Photo no. 4 - 37 mm gun barrel
after nose gear collapse

SEC

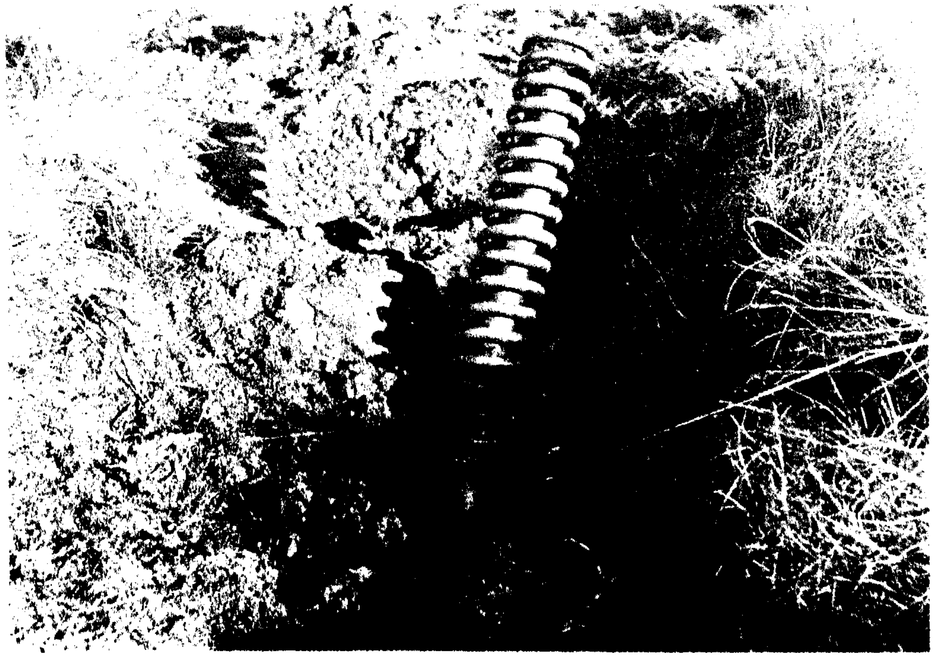

Photo no. 5 - 37 mm gun close-up

Photo no. 6 - Furrow caused by nose

Photo no. 7 - Traces

Photo no. 8 - Traces

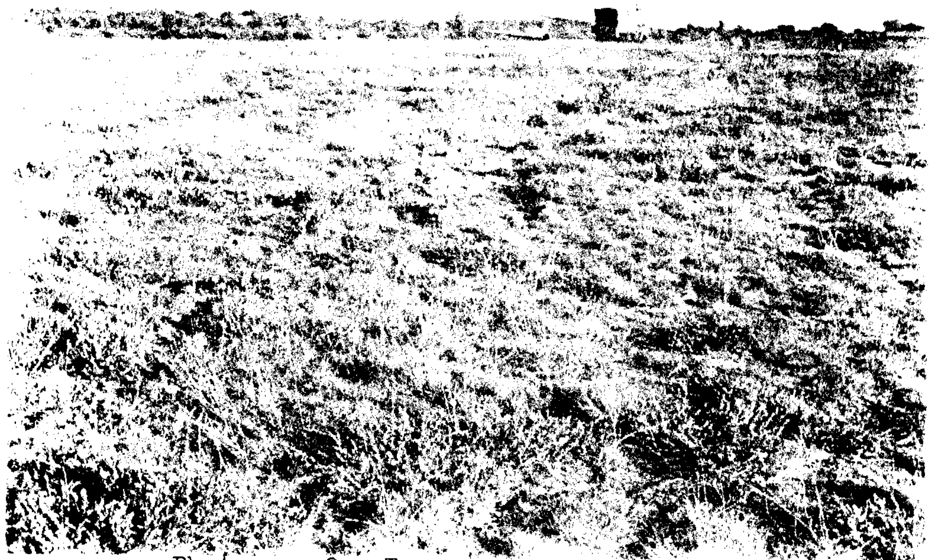

Photo no. 9 - Traces

Photo no. 10 - Traces

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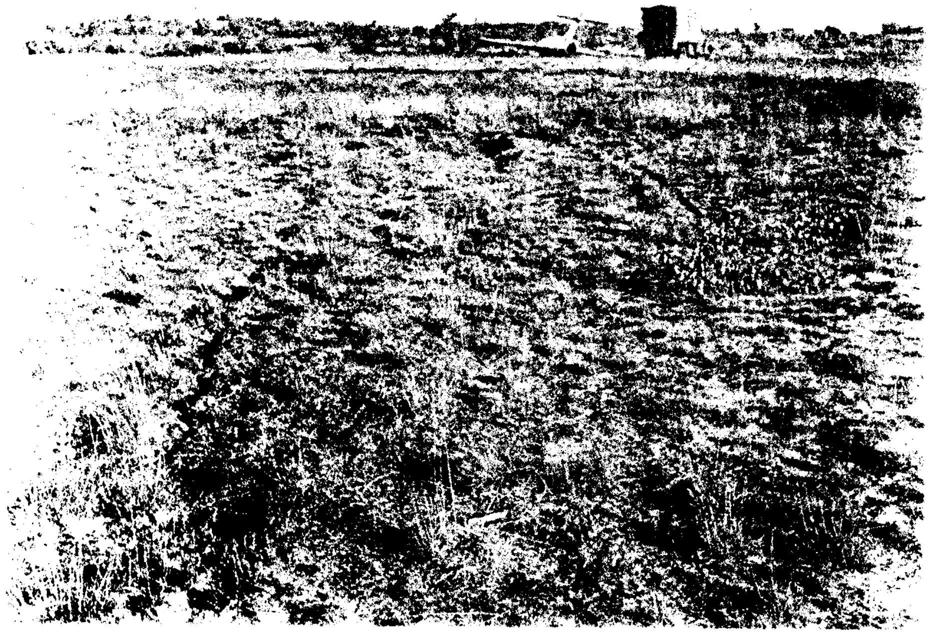


Photo no. 11 - Traces

Photo no. 12 - Traces

Photo no. 13 - Traces

Photo no. 14 - Nose section damage

SECTION III

STRUCTURE

A. General Statement on Structural Features

1. Wings

a. There were two other single pin attachments of the wing to the fuselage. One at about 12% chord and the other at about 35% chord. The center of the forward fitting was 2 cm below centerline and the center of the rear fitting was 0.7 cm below centerline, therefore both were load carrying. Each was fitted with an eccentric cam which can be rotated for making minor adjustments in the angle of incidence. The fit of all pins was moderately loose. The diameter of the forward pin was 18 mm and of the rear 12 mm. The adjusting arm of the forward eccentric cam could be moved through an angle of 120°, -60° or to +60° from the horizontal zero position. The arm could be locked at the zero position and at plus or minus 20°, 40°, and 60°. The eccentricity of the outside and the inside diameters was 1.5 mm, giving a maximum vertical movement of 1.3 mm at the 60° positions. The eccentricity of the rear cam was, of course, in proportion to and less than that of the forward cam. Note: Incorporation of the additional center pin would provide greater torsional strength to the wing root section.
Note: The modification was reported by the pilot to be accomplished at unit level. Close examination of the work confirmed this and further indicated the use of modification kits.

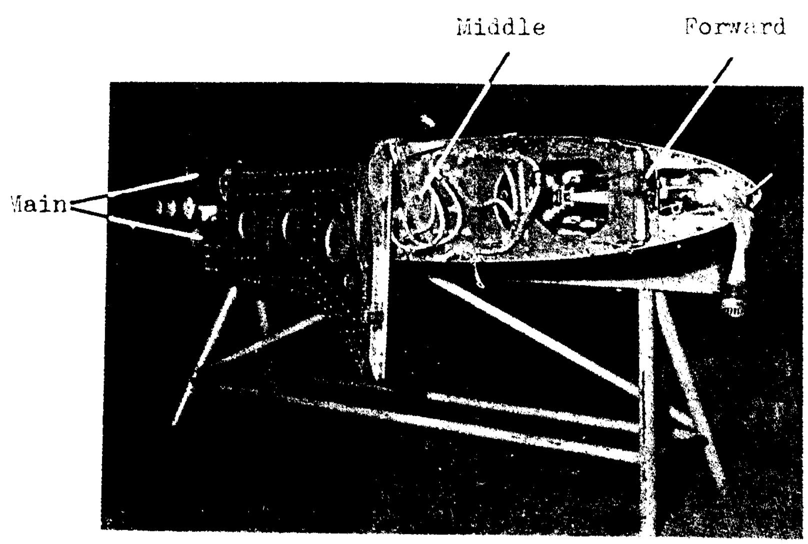


Photo no. 15. Wing to fuselage fittings.

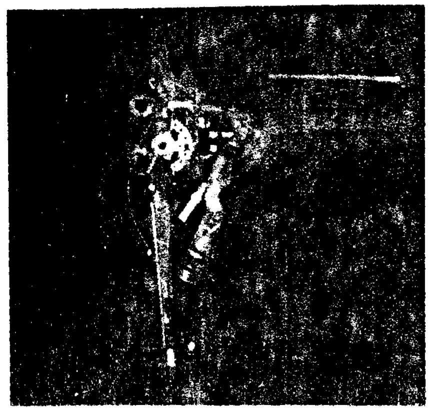


Photo no. 16. Forward Fitting.

Photo no. 17. Rear view of all Fittings.

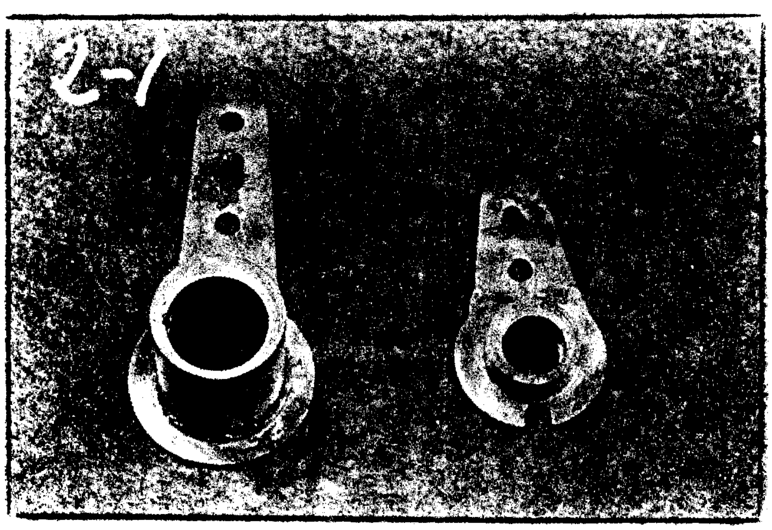


Photo no. 18. Eccentrics and adjusting arms.

b. Outboard of the main gear, wing construction consisted of transverse ribs and tapering spanwise stringers having an average pitch of 7 cm at mid span on the top surface and 8 cm on the bottom surface.

c. Double skin was used on both surfaces of the wing between the two spars and extending from the root to the area of the wing tank installation. The inner skin was extensively perforated with lightening holes from the outer wing fence to the wing tip. The outer skin was 1.7 mm thick and the inner skin was 1.4 mm thick. Skin thicknesses as shown in Drawing no. 49 of the July 1953 report are identical to those measured on this aircraft with these exceptions: the .064",.094", and .112" were measured as .055", .067", and .067" respectively.

2. Fuselage

b. Intake duct skin thickness was .032". An additional wing fitting has been installed at a position two feet and one inch behind the forward wing fitting. This was bolted through the skin to internal stiffness.

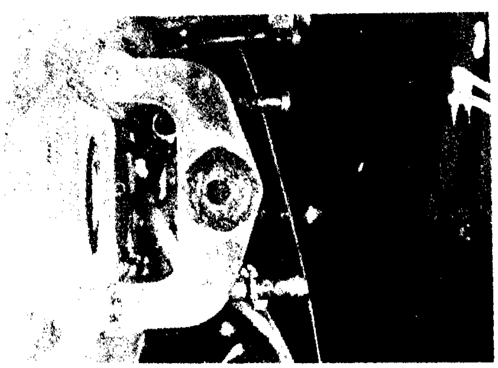


Photo no. 19. New Fitting.

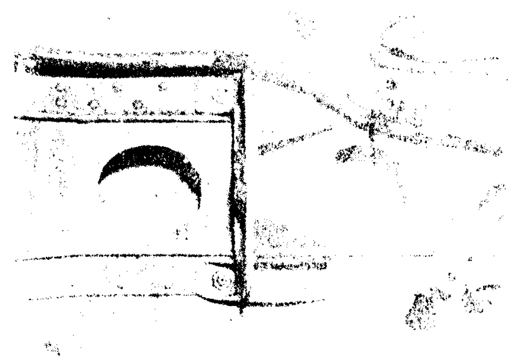


Photo no. 20. New Fitting.

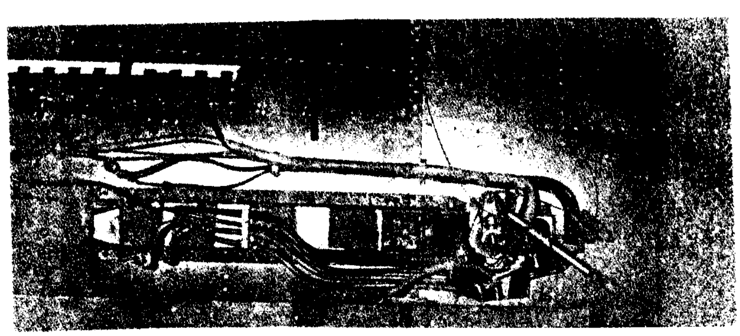


Photo no. 21. New and old Fittings.

3. Tail Unit

a. Dural plates about 10" long and .05" thick were attached to the bottom and top forward surfaces at the center section.

b. The elevators had mass balance weights at the tips and a larger mass balance weight at the center point. Elevator hinges were at ribs one and five (measured from the tips) and a main hinge was at the center point.

d. Skin thickness as shown on drawings no 48 and 49 of the July 1953 report are correct except for the upper tail which should read .039" instead of .029".

Mass balance

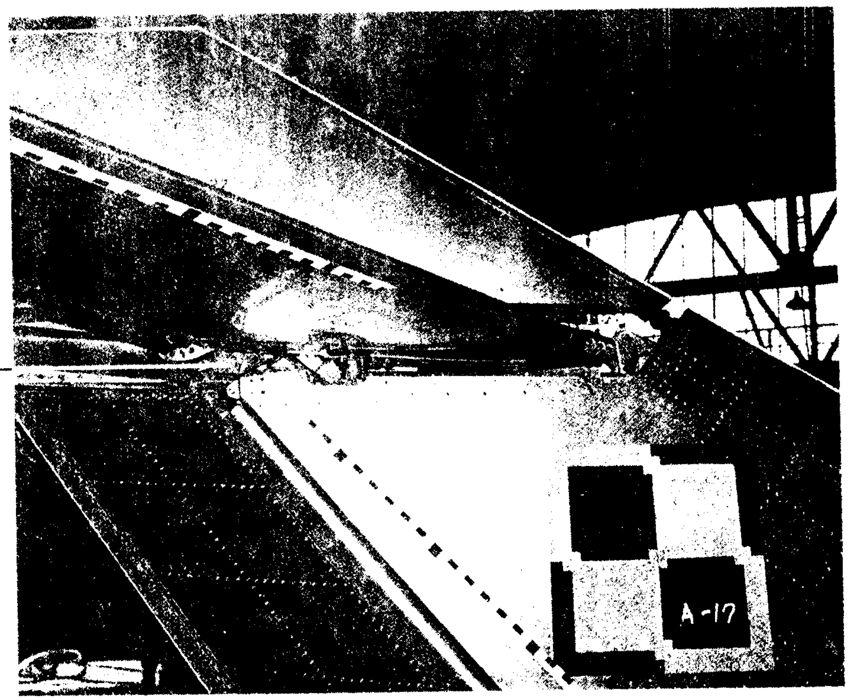


Photo no. 22. Tail unit.

4. Common Features

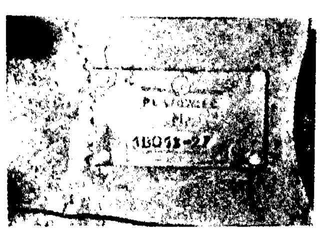
a. Delete the word "wings" and see paragraph A 1 a of this report.

B. Wings

8. See paragraph A 1a of this report.

C. Fuselage

2. See paragraph A 1a of this report.



Fuselage Serial No (Plate in left hand side of fuselage at the wing attachments)

Photo no. 23.

D. Horizontal Stabilizer

2. There were three stringers on the upper and three on the lower surface of the stabilizer. Between the second and the third stringers there was a forged main spar. A channel beam and a concave web, which accomodated the leading edge of the elevator, formed the rear spar.

3. See paragraph A 3c.

F. Landing Gear

1. Dimensional data

Main tire size	660 x 160 w
Right tire pressure	77 psi
Left pressure	80 psi

4. Nose Gear

   c. No instruction plate installed.

Tire pressure	34 psi

SECTION IV

COCKPIT INSTALLATION AND EQUIPMENT

25X1

A. Introduction.

1. For alterations in the cockpit layout [redacted] see photo 24 through 30 and the following text: 25X1

Starting at the left rear and proceeding forward:

a. A VHF power pack has been installed.
b. Items 6 and 8 have been removed and replaced by the signal flare discharger switch and firing buttons (items 7 and 9).
c. A VHF control box is now located where items 7 and 9 used to be.
d. Item 85 has been removed and incorporated in VHF control box.
e. Tripple toggle switch, item 8, has been replaced by a three position rotary switch.
f. Item 17 has been labelled "Drop Tank warning switch".
g. Item 15 removed.
h. Item 113 removed and a combined pressure gauge-flow meter was in place of item 114.
i. Undercarriage master switch has been installed to the left of the undercarriage selector lever.
j. Item 119 was installed on the right side of the gun sight and a turn and bank indicator installed in its former position.
k. Item 44 removed.
l. Item 55 moved slightly right.
m. Item 93A should be called "Control Column bearing housing".
n. An extra brake lever has been installed on the control column main bearing housing.
o. Under coaming, right of item 126, were three coupled toggle switches for external undercarriage warning lights.
p. Extra gun sight lamp holder installed above item 67A.
q. Master switch for landing light installed in blank space beside item 67.
r. A bank of three female electrical sockets installed to the immediate right of pilot.s position. Top one was unused and painted half white and half red. Middle one was marked "inspecting lamp". The bottom one was also half white and half red.

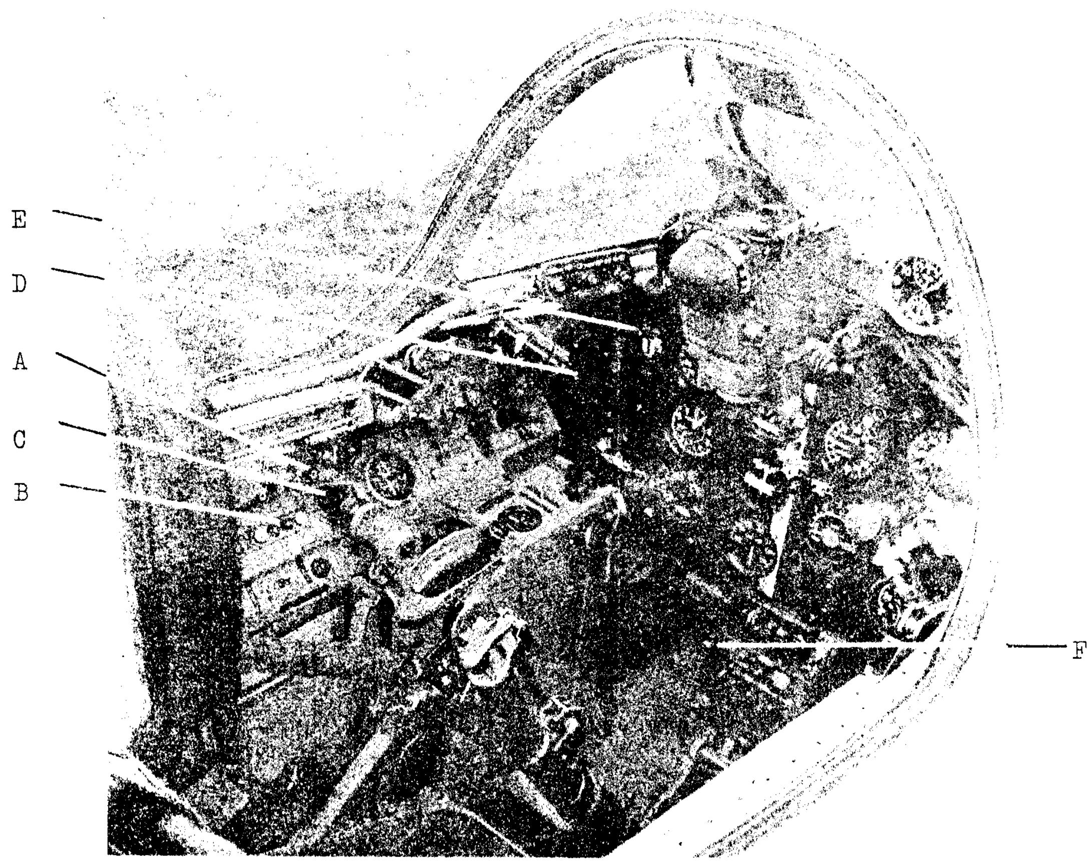


Photo no. 24 - Cockpit, Left console

A. VHF Control box
B. Signal Flare discharger
C. Three position rotory switch
D. Undercarriage master switch
E. Combined oxygen pressure gauge-blinker
F. Extra brake lever.

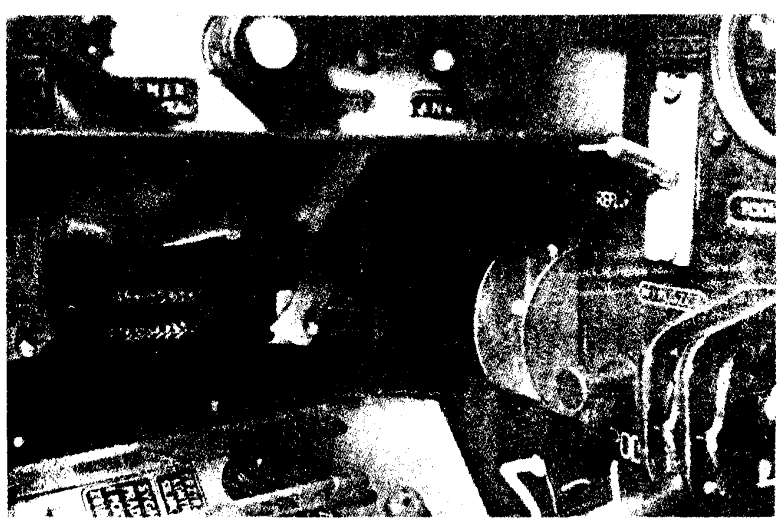


Photo no. 25 - Undercarriage master switch.

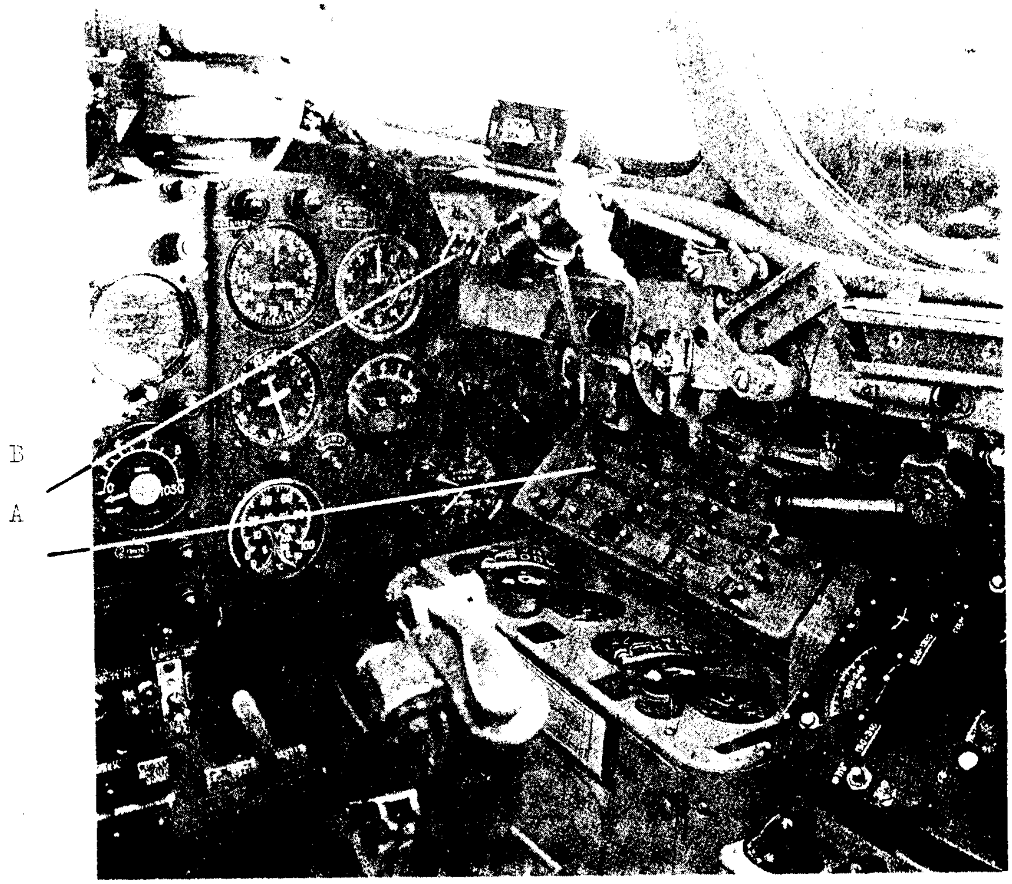


Photo no. 26 - Cockpit. Right hand console.
A. Master switch for landing light.
B. Switch for external undercarriage warning lights.

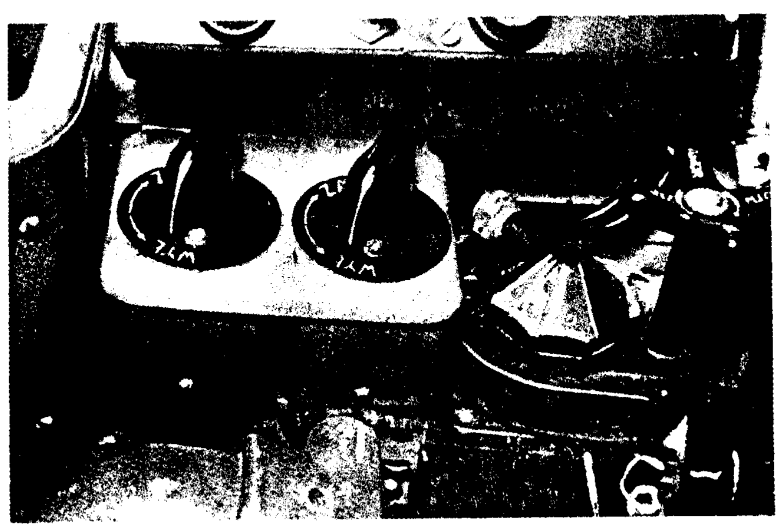


Photo no. 27 - New cockpit pressurization control.

6.b. Provision was made in the parachute pack for emergency oxygen system.

c. The emergency brake lever which was fitted on control column bearing housing could, if the control lock linkage was so designed, be used as a parking brake.

B. Field of view.

1. The field of view as described in the first report had been decreased by the repositioning of the clock to the right of the gun-sight.

D. Control Column.

1.f. Emergency Brake lever.
This lever had been fitted into the control column bearing housing. There was no provision for keeping it in the "on" position.

Photo no. 28
Forward vision

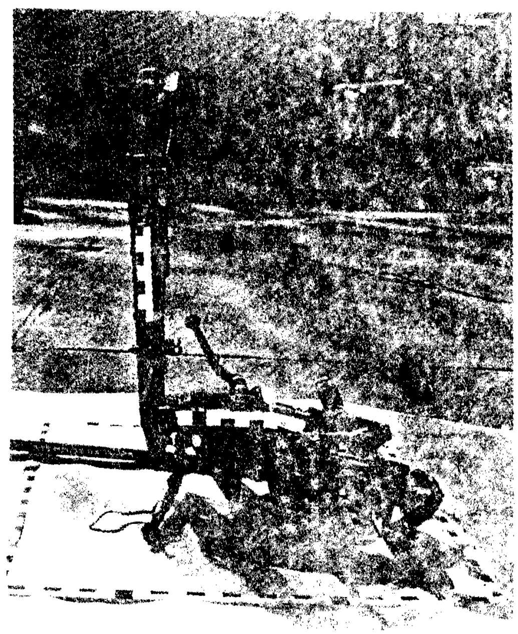


Photo no. 29
New parking lever

E. Rudder Pedals.

1. Each pedal was fitted with an adjustable rubber strap.

H. Undercarriage.

1. Although the selector lever appeared the same, it operated a three position toggle switch since the undercarriage selector was electro-hydraulic. Just to the left of the selector was a master switch (fitted with guard plates) for the undercarriage circuit.

In addition to this safety switch the selector lever was still fitted with a sliding mechanical lock.

3. The switches which controlled the external undercarriage down-lock lights [redacted] had been moved into the cockpit. Operation of this switch, with the undercarriage locked down, caused three green lights to go on: one under each wing and one in the position which had previously been occupied by the landing light. 25X1

I. Brakes.

2. See paragraph D.1.f.

J. Radio Navigational Equipment.

1. a. VHF Command Transmitter/receiver - This new equipment is described in detail in Part III, "Radio and Communication Equipment", of this report.

K. Instruments.

1. g. (i) A new electrically operated gyro horizon was fitted which also incorporated a wall-type side-slip indicator.

g.(ii) A separate turn and bank indicator was fitted.

2. a. The clock was fitted on the top of cockpit coaming.

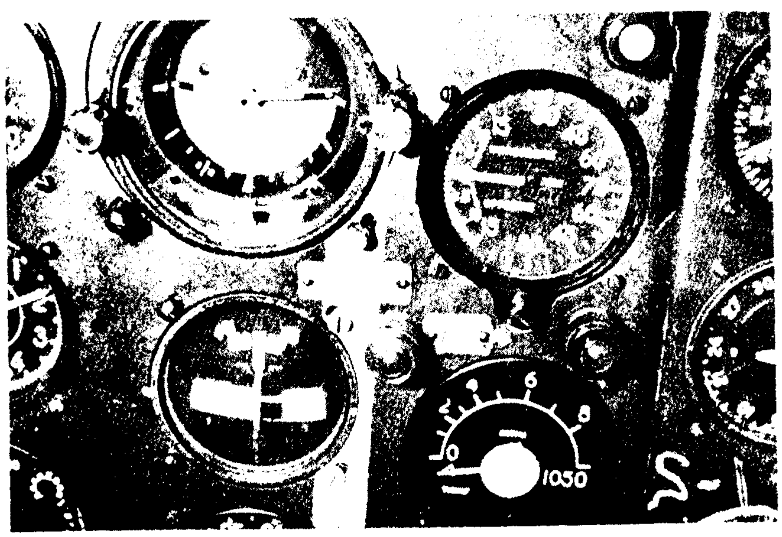


Photo no. 30 - New gyro horizon

M. Navigation Lights and Landing light.

3. The landing light was installed under the port wing. It was controlled by a two position switch fitted in the left hand side of the cockpit. A master switch controlling the system was fitted in the right hand console.

O. Engine Controls and Instruments.

1. g. This switch, although relabelled Drop Tank warning switch, still performs the same three functions.

SECTION V.

FLYING CONTROLS.

B. Control Column and Rudder Pedals.

4. Adjustable rubber straps were provided.

Photo no. 31. Column and pedals.

SECRET

PILOT SEAT.

25X1

A. Description.

1. Although this was an entirely new seat [redacted] Canopy and seat rejection levers were incorporated in each arm rest, permitting ejection with either hand. Total weight of the components listed in the July 1953 report has increased to 44,66 kg primarily due to the increased weight of the back armor. With the additional weight of 3,5 kg due to the piston, firing pin mechanism and yoke, the total weight of the seat as it is ejected was 48,16 kg.

B. Seat ejection.

1. 1. Remove ground safety pin.
   2. Move either right or left canopy release handle forward. This releases the canopy wich in turn pulls a secondary safety pin which is attached to the canopy. (See photo no. 36). The firing pin mechanism is now armed.

2. The weight of the various components were as follows:

Head armor with pad	8,98 kg
Back armor	14,68 kg
Seat, less armor	21,00 kg
Piston, firing pin mechanism and yoke	3,50 kg
Total	48,16 kg

Photo no. 32 - Seat and dummy.

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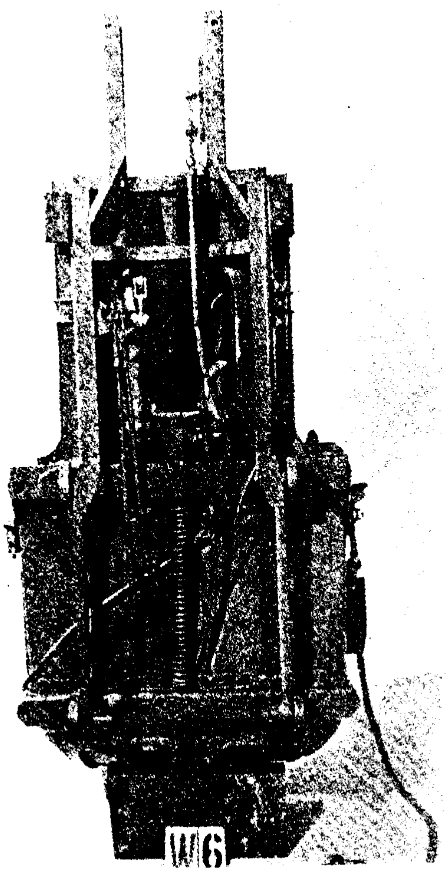

Photo no. 33 - Seat, rear.

Photo no. 34 - Seat, front.

SECTION VII.

COCKPIT CANOPY.

C.

2. When the canopy is either removed on the ground or jettisoned in the air, the canopy pulls out a safety pin from the firing pin mechanism. This pin is one end of a wire which is connected to the midframe of the canopy and coiled to form a long spring. This spring imposed a load upon the secondary pin and was therefore attached to the yoke by means of a safety wire.

The total length of this wire was 2 m.

If the canopy was jammed in the closed position, the pilot could eject through the canopy by reaching back and extracting the secondary safety pin. This can be done without breaking the safety wire.

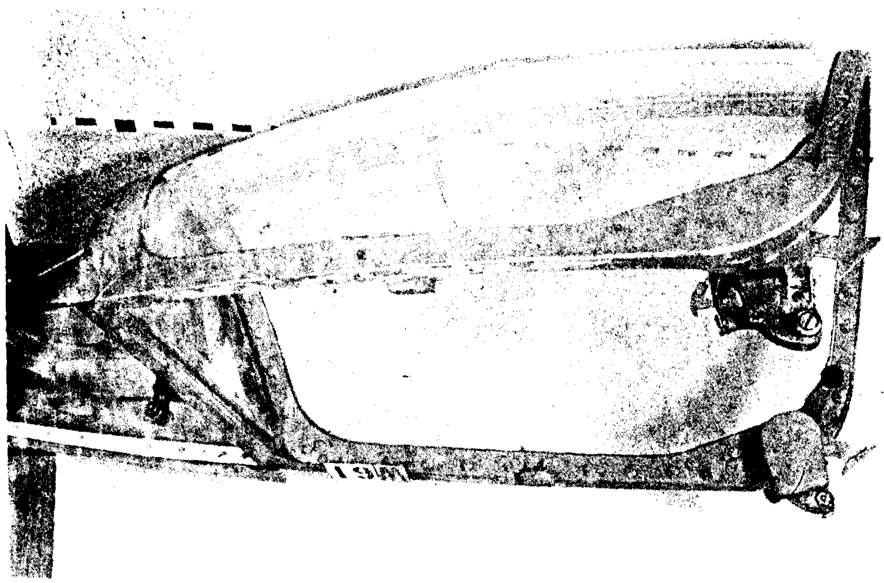

Photo no. 35 - Canopy.

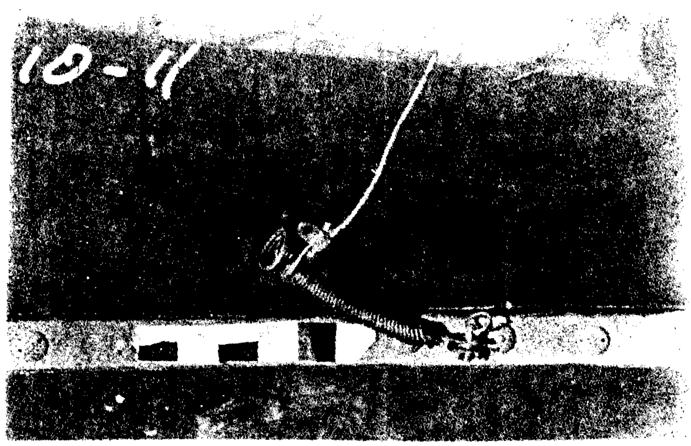

Photo no. 36 - Secondary safety pin cable.

SECTION IX

COCKPIT PRESSURIZATION AND AIR CONDITIONING SYSTEM.

B. Cockpit Pressurization.

2. The selector valve, located on the right hand side of the cockpit, had four positions (see photo A-29). These positions were: - closed (ZAM), cold (Z), Mixed (C) and hot (G). The cold, mixed and warm positions were marked by coloured segments of blue, yellow and red respectively. The valve could be placed in any intermediate position.

D. Cockpit Air Conditioning System.

1. The cool air nozzle in this aircraft had been moved slightly to the right and turned through 90° to make room for the clock, which had been repositioned.

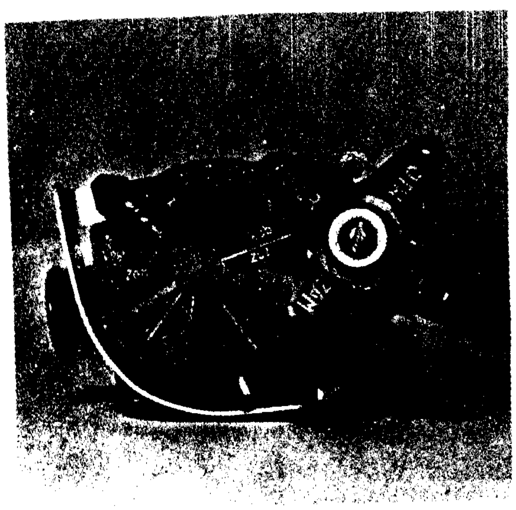

Photo no. 37. Pressurization selector valve.

Photo no. 38. Cool air nozzle.

SECTION X.

OXYGEN SYSTEM.

1. All piping used in the installation was copper, painted blue. Some piping in the nose section was chrome plated and painted blue. All high pressure pipes, after the main high pressure valve, were marked by an 1½" wide red band at each end of the pipe; all low pressure pipes were marked by a 1½" wide, green band.

2. Two plain steel, blue painted bottles were fitted. One of 4 litre capacity, the other of 2 litres. The weight of the bottles was 7 kg and 4.7 kg respectively.

5. A pressure pipe line was taken forward from the reducer valve to the pressure connection of a combined pressure gauge and flow blinker mounted on the instrument panel.
The pressure gauge read from 0 - 150 kg/cm^2 (0 - 2133 lbs/in^2). The gauge carried a danger mark in red just above the 150 kg/cm^2 mark. A pipe line from the low pressure side of the reduced valve also went forward to the combined gauge. The flow-indicator was of the blinker type.

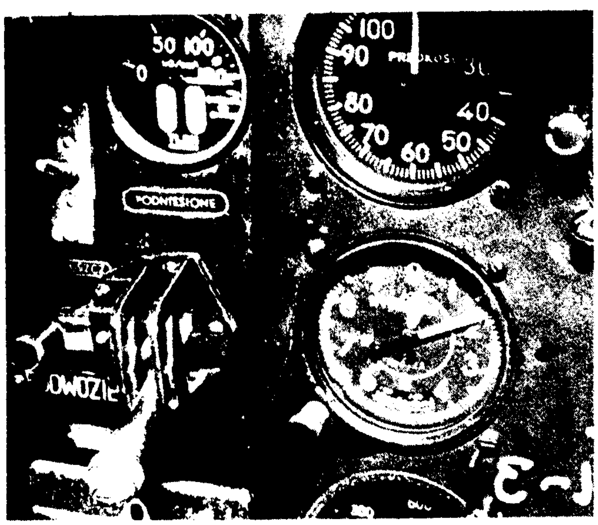

Photo no. 39. Oxygen Gauge.

SECTION XI.

HYDRAULIC SYSTEMS.

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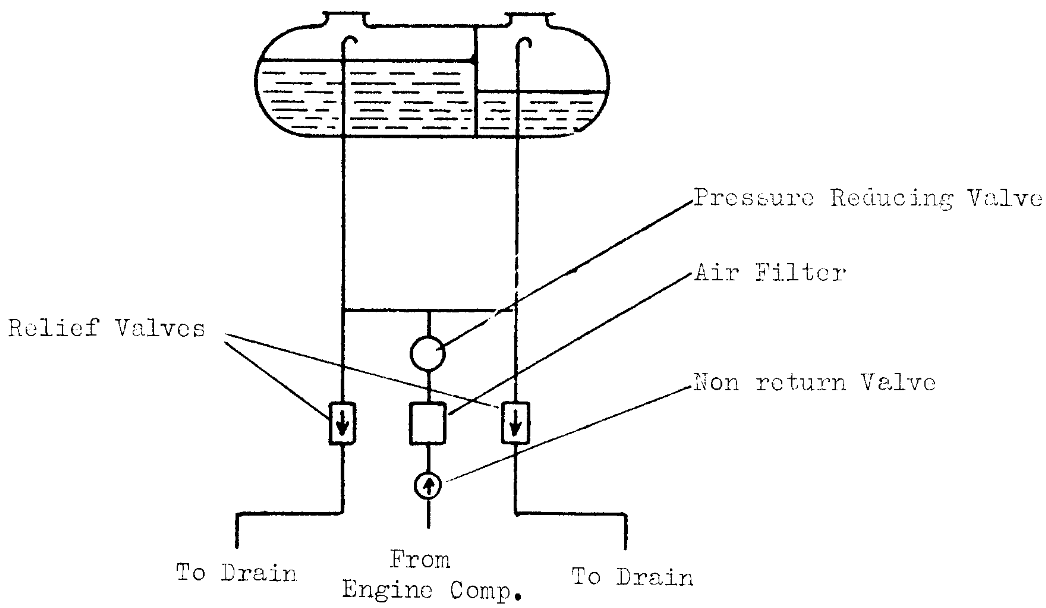
A. General description.

[redacted] the tank pressurisation system was as follows:



3. Air from the engine compressor was fed to the top of both hydraulic tanks by way of a filter and a pressure reducing valve. Two one-way relief valves were teed into the system to limit the pressure in the tanks. These last two valves are shown in photograph 15.2.88 in the July 1953 report. The filter bore a label which said that it must be cleaned every 25 hours of engine running.

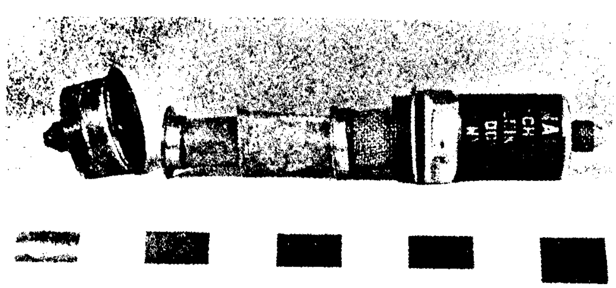


Photo no. 40 - Air filter

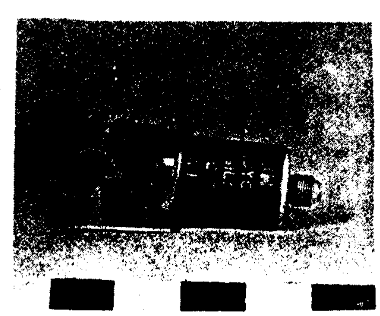


Photo no. 41
Filter, assembled

A. 5. The main pressure lines were coded with three black bands

6. The pressure lines in the booster system were coded with three black bands.

B. Main System.

2. A pressure line was taken from the accumulator to the electrically operated undercarriage selector valve located on the left hand side of the fuselage within the wing root. This valve had two solenoids - one for "gear up" and one for "gear down".

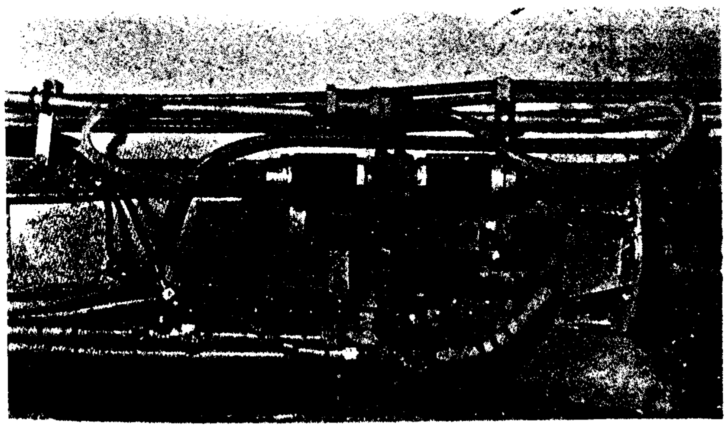


Photo no. 42 - Undercarriage selector valve.

4. A mechanical down lock was incorporated within the main undercarriage actuator. Test and results showed that a hydraulic pressure of 165 - 180 p.s.i. was required to unlock the gear. When the inner door was open it was locked in this position by a mechanical lock within the door actuator. A pressure of 90 - 100 p.s.i. was required to lock the door and a pressure of 150 - 160 p.s.i. unlocked it.

7. There were self-sealing couplings in the air brake pressure and return lines. These are located at the bottom of the fuselage just aft of the main fuselage break joint.

Photo no. 43 - Coupling

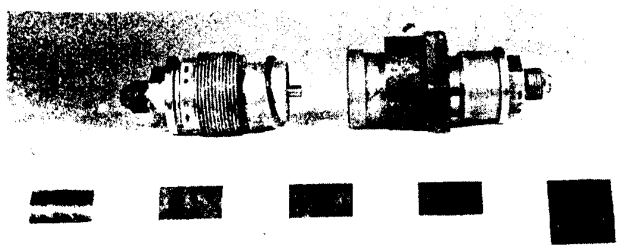


Photo no. 44 - Coupling

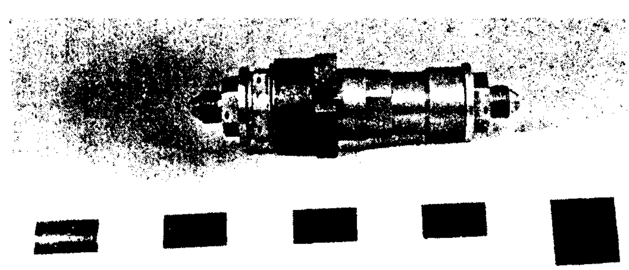


Photo no. 45 - Coupling

SECTION XIII.

INSTRUMENTS.

Introduction.

The instrument equipment was the same as found previously, with the following exceptions:

Gyro Horizon (new type).

Turn and Bank Indicator (added).

Gyro Magnetic Compass Transmitter (new type).

Oxygen Flow Indicator and Oxygen Pressure Gauge exchanged by a combined instrument.

In the addition to tests and examination of the new type instruments several tests were carried out on the other instruments.

CONTENTS

B. Flight Instruments.

1. Airspeed Indicator.

The airspeed indicator was exactly the same type as found previously.
The results of a scale test carried out are listed below:

Test Point km/h	Instrument Error km/h
108	-48
180	0
270	0
451	+19
631	+24
811	+29
992	+28
1082	+23

These errors are appreciably greater than found previously.

2. Rate of Climb Indicator.

The rate of Climb Indicator was exactly the same type as found previously.
Scale tests carried out showed an accuracy comparable to that found on the previous instruments.

3. Altimeter.

The altimeter was exactly the same type as found previously.
The following tests were carried out:

Leakage test: 15 p.s.i., no leakage.
Position error: max. 5 m.

Scale error test (Temp. 20° C):

Test point m	Error m asc.	Error m desc.	Friction error m
0	-35	-35	
1515	-15	+ 5	10
3030	-10	+30	25
6060	-20	+40	
9090	-50	+40	35
12120	-60	-10	
15150	-60	-20	
18180	0		

Scale error test (Temp - 40 C):

Test point m	Error m asc.	Error m desc.
-21	-24	- 3
3027	+15	- 5
6087	+ 3	+50
9087	+ 8	+39
12035	- 5	-75
15241	+49	

During the tests the pointer jumped about 300 m at approx. 6,5 km and 16,5 km.

4. Machmeter.

The machmeter was exactly the same type as found previously. A scale test carried out at mach numbers 0,5 - 0,6 - 0,7 - 0,8 and 0,9 at heights of 0 - 10 - 20 - 30 - 40 and 50.000 ft showed a max. error of 0,02.
The mach number warning switch was not installed in this aircraft either.

5. GYRO HORIZON INDICATOR.

Introduction.

The Gyro Horizon Indicator is entirely different from the type found earlier.

The instrument presentation (photo no. 46) is very similar to that found on f. ex. the USAF Type J - 1 Attitude Gyro Indicator, but the design is entirely different from the type J - 1 indicator.

The gyro rotor and housing has complete freedom of rotation about the roll-and pitch axis.

The design is unusual as it, instead of one, contains two gimbalrings, which are monitored by a small two-phase motor so they will always be at a right angle to the rotor housing. Manual caging of the instrument is possible only when the rotor is at rest, or running at low speed and only the outer gimbalring can be caged.

During flight tests carried out in a trainer aircraft the performance of the instrument was excellent.

The instrument is not driven from the gyro-magnetic compass inverter as earlier, but has its own inverter mounted behind the seat, the two inverters are started simultaneously from the same switch.

Detailed description.

The instrument is composed of the following main subassemblies:

1. Instrument housing incl. front panel and back plate.
2. Outer gimbalring.
3. Inner gimbalring.
4. Rotor and rotor housing.

1. Instrument housing.

The front panel is attached to the instrument housing by eight screws.

It has a circular opening through which a portion of the indicating sphere is visible.

Below this opening an ordinary ball-in-glass bank indicator is mounted (photo no. 46 pos. C).

On the left side of the front panel is situated the trim indicator adjusting knob (photo no. 46 pos. A).

The indicator is connected only in the left side (photo no. 48) pos. A) to a sliding mechanism driven up or down by a crank shaft mechanism (photo no. 48 pos. D) connected through a gear train to the adjusting knob.

On the right side of the front panel is found a push button (photo no. 46 pos. B), kept in its outer position by two small leaf springs. When it is pressed, a ball bearing (photo no. 48 pos. C) mounted on the shaft of the push button is pressed against the front edge of the outer gimbalring (photo no. 47 pos. B), this edge is curved with the "lowest point" in a position which corresponds to the normal position of the gimbalring (see dwg. no. 61).
In this way only the outer gimbalring can be erected, there were no provisions for caging the inner gimbalring or the rotor housing.

The caging action of the mechanism is rather weak and inaccurate, it is not possible to cage the ring when the gyro is running at normal speed.

The instrument housing (photo no. 48a pos. A) is cast in light alloy. On the side are four square holes which are normally hidden by a light cover, which slides on to the housing from the rear, also covering the back plate.

In the front part of the housing is pressed a steel ring (photo no. 47 pos. D) which carries three small ball bearings supporting the front part of the outer gimbalring.

The back plate is attached to the instrument housing by four mounting screws. To the plate are attached the following compoments: (photo no. 49)

Thermo switch (pos. A)
Two phase motor (pos. B)
4-pole supply plug (pos. C)
Brush assy. (6 brushes) (pos. E)
Two brushes (pos. F)
Resistor block (4 off) (pos. D)

The thermo switch is of the bimetallic type.

The two-phase motor is connected through a gear train, to a gearwheel mounted on the rear of the outer gimbalring.

Outer gimbalring. (photo no. 52)

The outer gimbalring is mounted inside the instrument housing. The rear part is carried by a ball bearing in the back plate and the protruding hollow rear axle is carrying six slip rings and a sliding circular contact plate corresponding to the abovementioned brushes.

To the rear part is furthermore attached a gearwheel driven by the two-phase motor.

On the sides are mounted two ball bearings opposite each other, carrying the inner gimbalring. At the left side ball bearing is mounted the rotor of the torque motor effecting the bank erection of the instrument, and two sliding contacts attached to the cover of this ball bearing.

A 4-brush assy. is attached to the right side.

Inner gimbalring.

This gimbalring is situated inside the outer gimbalring (photo no. 51 pos. B) carried by the abovementioned two ball bearings. To the left side is attached the Stator windings of the abovementioned torque motor, on the right side axle is found the slip ring assy, corresponding to the abovementioned brushes.

The front part is circular carrying the rotor (photo no. 50 pos. A) of the torque motor effecting the pitch erection of the instrument. Across this part is a bridge carrying the front bearing of the rotor housing, a 5-brush assy and contact plates (photo no. 51 pos. G), part of the outer gimbalring controlling system.

The gimbalring is made slightly pendulous by a small balance weight (photo no. 51 pos. C) attached to the ring.

Rotor Housing.

The rotor housing is carrying the following components.

A mercury switch (photo no. 52 pos. F), Stator windings of the pitch torque motor (photo no. 51 pos. H).

The contact assy. of the front bearing axle, protruding through the front bearing.

The indicating sphere is divided into two halves (photo no. 53 pos. A - B) each of which attached to two wheels (photo no. 52 pos. B) mounted on the front and rear axle of the rotor housing.

The rotor is a normal 3-phase squirrel cage motor with the stator windings attached to the inside of the rotor housing.

Electrical functioning.

(Refer to wiring diagram fig. no. 62).

The power for the instrument (36 volt, 400 cycle, 3-phase a - c) is supplied through the 4-pole receotacle on the rear of the instrument.

The supply for the gyro rotor is fed through yellow, green and brown leads through the sliding contacts to the rotor housing. The brown lead is connected directly to the gyro rotor stator windings the green lead is connected through the fixed-field windings of the pitch erecting torque motor, and the yellow lead is connected through the fixed phase windings of the bank erecting torque motor.

The erection to normal position is carried out by two normal two-phase torque motors effecting bank and pitch erection respectively.

The pitch motor is considerably greater than the bank motor.

The mercury switch controlling the voltages to the motors, is attached to the bottom of the rotor housing and is of a type similar to the one found on the earlier instruments. It works in exactly the same way (ref. dwg. no. 16 in first report).

When the gyro is in the normal position the white and black leads are all connected to the brown central tap and consequently voltage is fed to both signal windings of both motors. When the gyro is tilted to be left f. ex., the connection between the left white and central brown tap is disconnected, so only the one half of the signal-phase windings is energized, thereby producing a torque in the proper direction and consequently erecting the gyro. Voltage to the central tap of the signal-phase winding of the pitch torque, motor is fed through a 300 resistor on the top of the rotor housing from yellow phase.

Voltage to the central tap of the signal-phase windings of the bank torque motor is controlled in the following way. When the instrument is started the bimetallic thermoswitch on the back plate is closed. The green phase is then connected directly to the blue lead feeding voltage to the central tap, thus making the erection torque as big as possible.

The bimetallic leg of the thermo switch is continually heated by a small coil; when the switch opens the signal voltage is reduced through the 100 Ω resistor on the resistor block on the back plate, thus reducing the erection torque.

When the instrument is banked approx. 5 degrees the voltage is further reduced as the two brushes of the circular sliding contact move into the two isolated segments thus disconnecting the 100 Ω resistor and leaving only voltage to be fed through the 5,1 kΩ resistor.

The purpose of this is to reduce errors when centrifugal forces act on the mercury switch during turns.

The alignment of the outer and inner gimbalring is accomplished in the following way:

The two phase motor on the back plate rotates the outer gimbalring when energized. The fixed-phase windings are connected directly to brown and yellow phase.

The two signal phase windings are connected through the two 3,3 k Ω resistors to green phase.

The two violet leads are connected through the backplate slip rings to the two brushes on the left side of outer gimbalring. The contact plate is divided into two halves changing the connections when the instrument is rotated 90° in pitch. From here the violet leads continue and are finally connected to the two outer contact segments of the contact plate (photo no. 51 pos. G) on the front part of the inner gimbalring.

The corresponding brushes (photo no. 51 pos. F) are connected directly to green phase.

When the instrument is in its normal position the brushes are in contact with the isolated segment in the middle, so no voltage is fed to the violet leads. When the instrument is tilted the brushes come into contact with one of the outer segments, thus connecting the green phase directly to one of the signal-phase windings of the two-phase motor which levels the outer (and inner) gimbalring again.

This system is introduced presumably because the outer gimbalring is too heavy to be turned by the rotor alone. When the aircraft makes f. ex. half a loop and continues in inverted flight the connections must be reversed as the two-phase motor must turn in the opposite direction, this being effected by the reversing switch on left side of the inner gimbalring.

Contrary, when the aircraft is rolled into inverted flight the two phase motor works normally, this being correct too.

Test.

The following tests were carried out on the gyro horizon:

Bench tests:

Starting voltage: Less than 5 volts.
Starting current: approx. 0,9 amp.
Normal consumption in the three phases:
0,35 amp; 0,35 amp; 0,54 amp.

Instrument in normal position 20 secs after start.
Thermo switch opens after approx. $1\frac{1}{2}$ min.

Erection tests:

Pitch from 20° to 10° (down) : 2 min 15 secs.
Pitch from 20° to 10° (up) : 3 min 5 secs.
Bank from 30° to $22\frac{1}{2}$° (right): approx. 5 min.
Bank from 30° to $22\frac{1}{2}$° (left) : approx. 7 min.

Flight tests:

The instrument was mounted in a training airplane and flight tested.

The following manoeuvres were executed:

1. 180 degrees turns,
2. Roll,
3. Loop,
4. Stall Turn,
5. Spinn.

The following results were obtained:

<u>180 degrees turns.</u>

Several 180 degrees turns were made at different angular velocities and bank angles (rate 1, bank angle approx. 15°; rate 4, bank angle 25°).

After completion of each turn the aircraft was levelled and the position of the indicating sphere was noted.

No errors could be read during these maneoeuvres.

<u>Roll.</u>

These were carried out at approx. 11 secs pr. revolution.

Up to four rolls were executed continuously; after levelling the aircraft max. 2° errors were shown on the instrument.

<u>Loop.</u>

These were carried out at approx. 18 secs per revolution.

Up to four loops were carried out continously; after levelling the aircraft no error was shown on the instrument. During the loops the instrument normally prucessed 180° at vertical climb on dive attitude, but in some cases this did not happen, the instrument only seemed a little unstable at these attitudes.
The 180° prucession is quite normal for these type instruments (caused by the so-called "gimbal-lock").

<u>Stall Turn.</u>

After stall turns (max. 3) up to 2° errors were shown on the instrument.

<u>Spinn.</u>

A normal left spinn (2 turns) was carried out.

After levelling the aircraft 2° error in bank and turn was shown on the instrument.

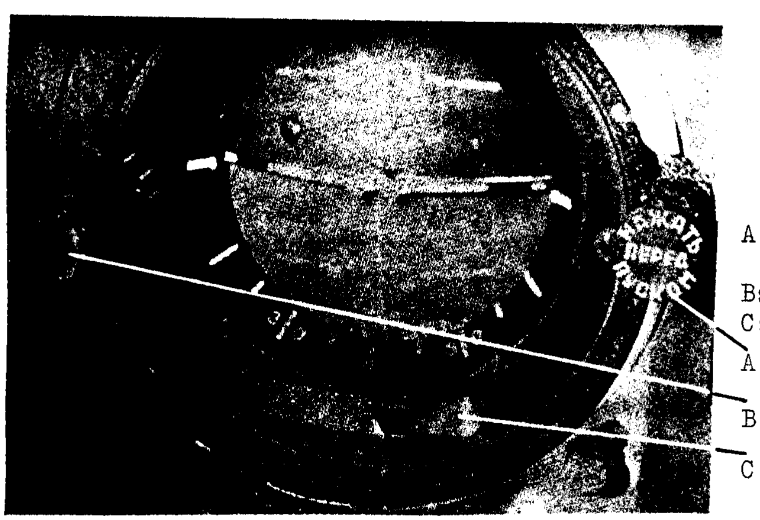


Photo no. 46.

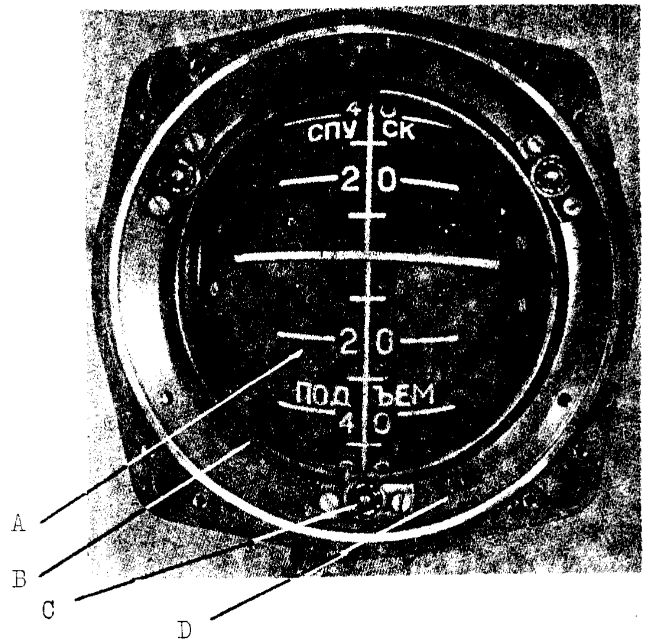
Gyro Horizon, Front View.

A: Trim Indicator Adjusting Knob.
B: Outer Gimbal Caging Knob.
C: Bank Indicator.

SECRET

Photo no. 47
Gyro Horizon (Front Panel removed)

A: Indicating Sphere.
B: Outer Gimbal Front Steel Ring.
C: Outer Gimbal Front Bearings.
D: Ball Bearing Support Ring.



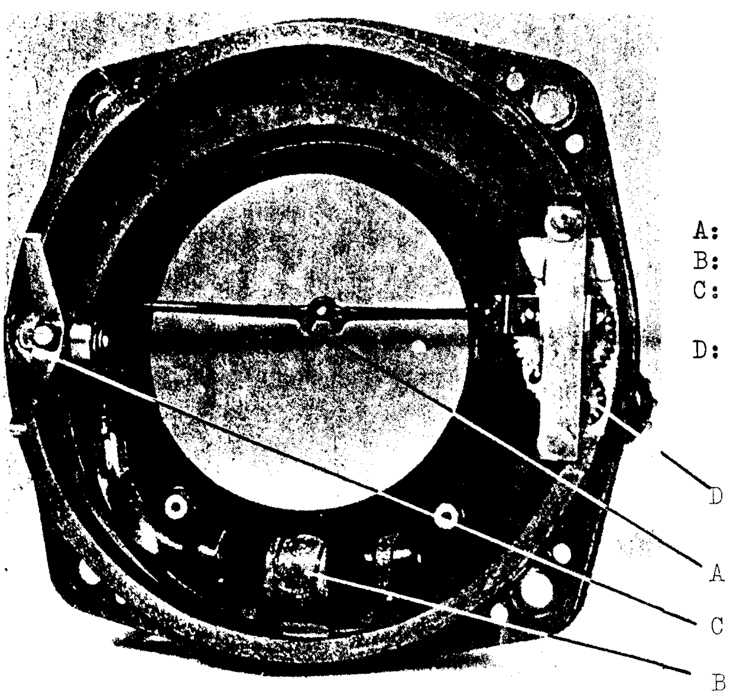


Photo no. 48.
Front panel
A: Trim Indicator.
B: Bank Indicator.
C: Caging Ball Bearing and Leaf Springs.
D: Adjusting Mechanism.

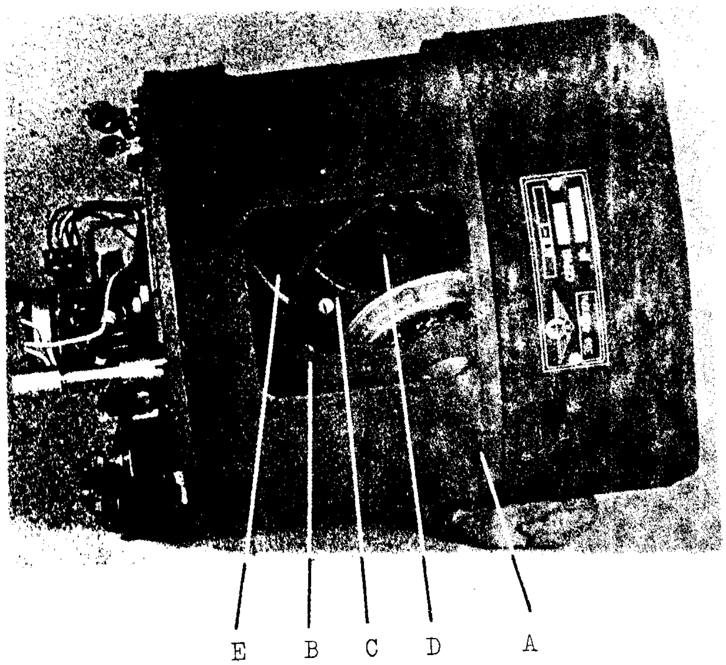


Photo no. 48 a
Instrument Housing.
A: Instrument Housing.
B: Outer Gimbal Ring.
C: Inner Gimbal Ring.
D: Rotor Housing.
E: Indicating Sphere.

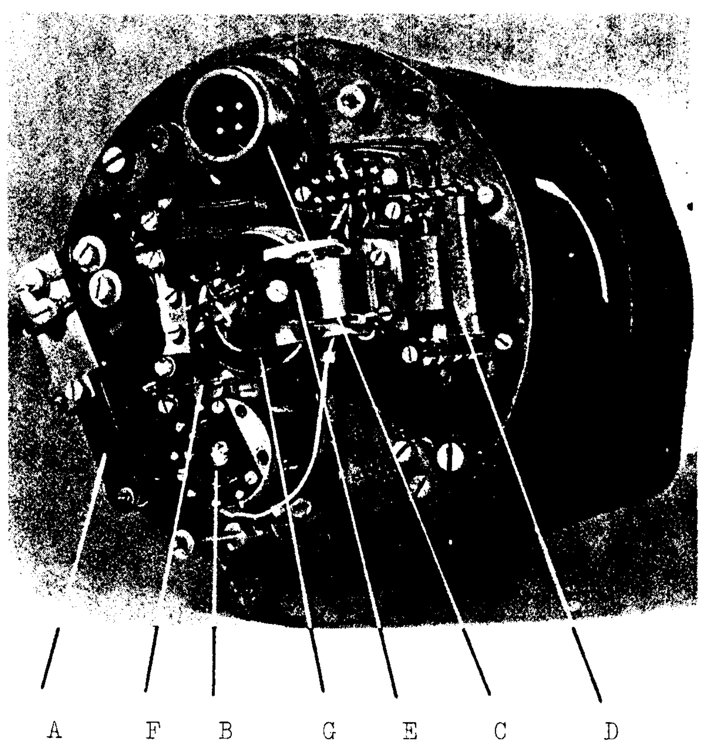


Photo no. 49
Back Plate.
A: Thermo Switch.
B: Two Phase Motor.
C: Receptacle.
D: Resistor Block.
E: Back Plate Brush Block
F: Roll Cut-out Brushes.
G: Roll Cut-out Contact.

Photo no. 50
Inner Gimbal Ring.

A: Bank Torque Motor Rotor.
B: Bank Torque Motor Stator.

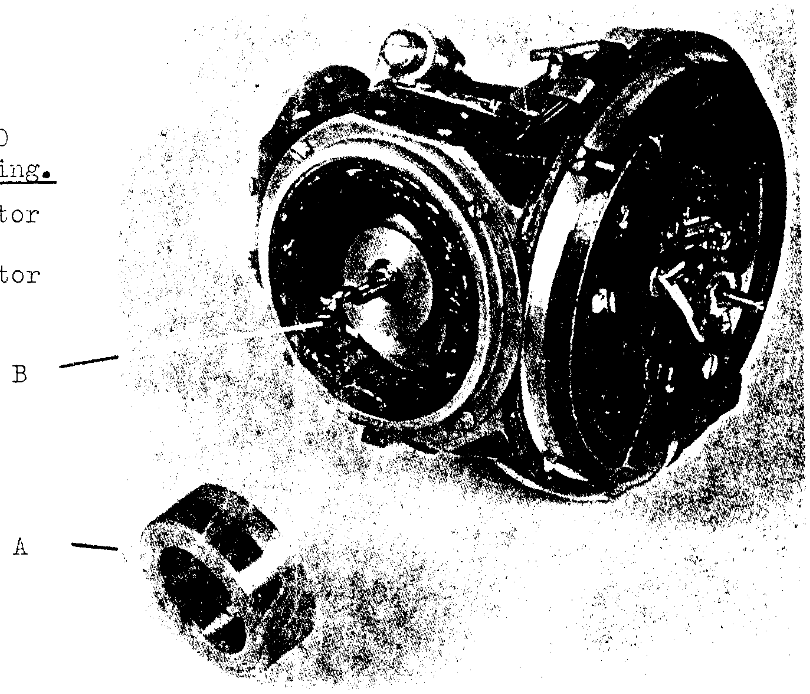
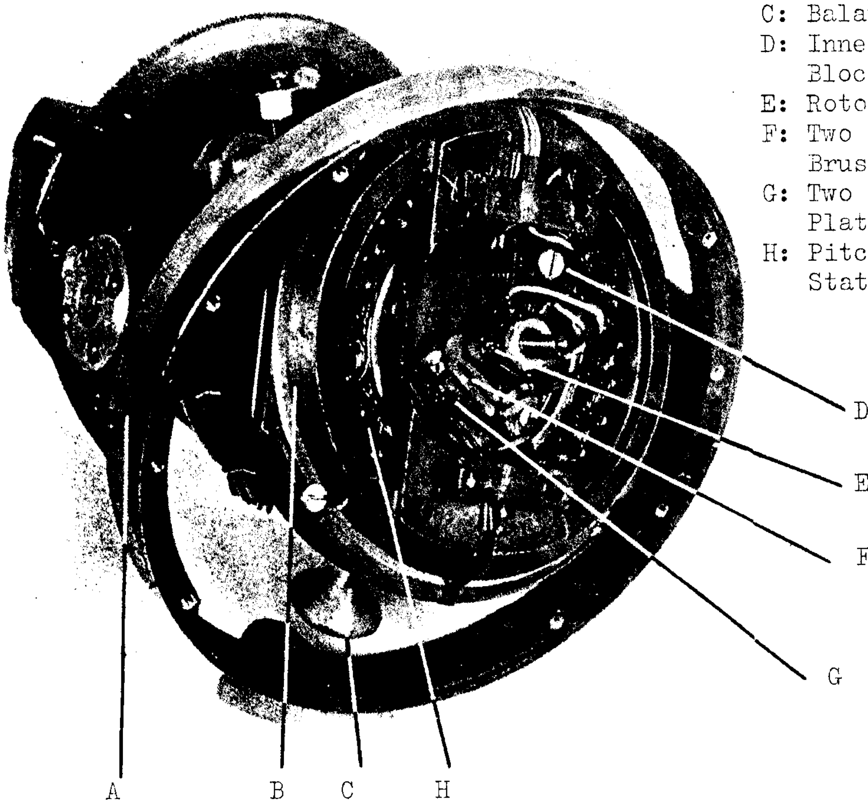


Photo no. 51.
Gimbal Rings.

A: Outer Gimbal Ring.
B: Inner Gimbal Ring.
C: Balance Weight.
D: Inner Gimbal Brush Block.
E: Rotor Housing Slip Rings.
F: Two Phase Motor Control Brushes.
G: Two Phase Motor Contact Plates.
H: Pitch Torque Motor Stator Windings.



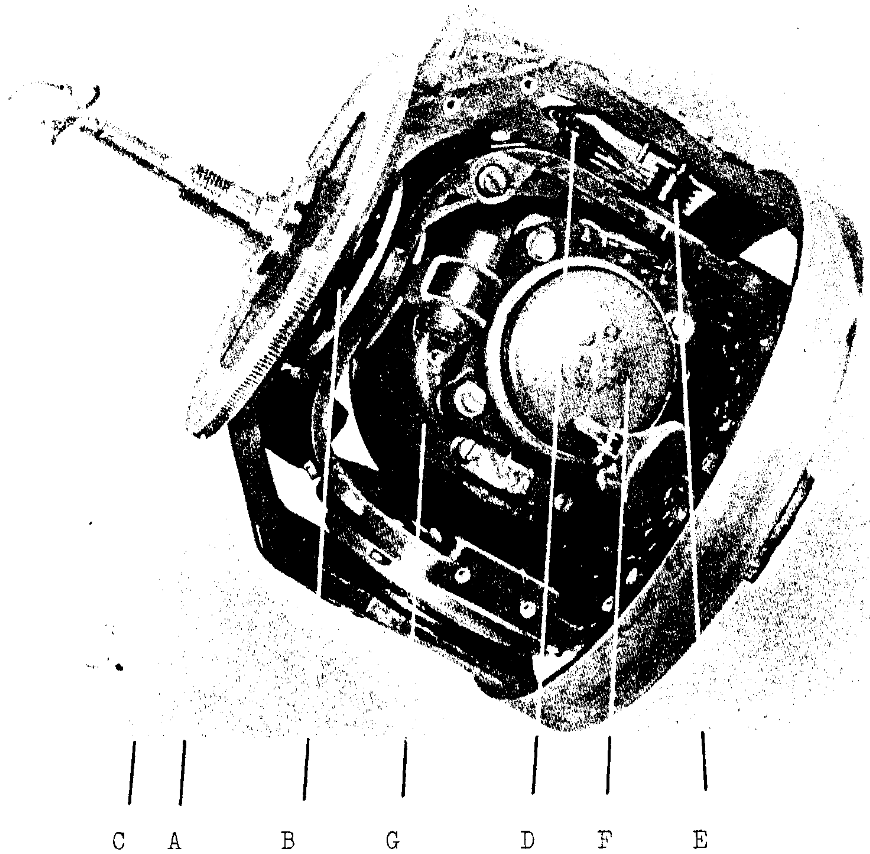


Photo no. 52.
<u>Gimbal Ring and Rotor Housing.</u>

A: Outer Gimbal Gear Wheel.
B: Indicating Sphere Mounting Wheel.
C: Outer Gimbal Rear Axle.
D: Inner Gimbal Brush Block.
E: Rotor Housing Slip Ring Block.
F: Mercury Switch.
G: Rotor Housing.

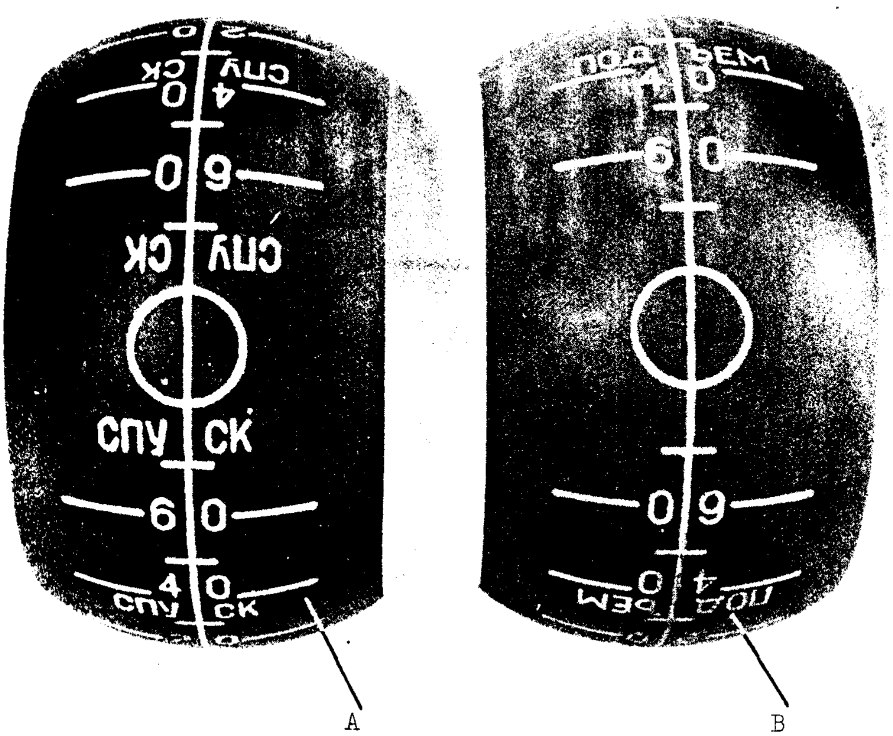


Photo no. 53.
<u>Indicating sphere.</u>

A: Upper Half Part (Brown).
B: Lower Half Part (Blue).

5. A. TURN AND BANK INDICATOR.

Introduction.

The turn and bank indicator is a normal electrically driven type. The dial presentation is normal with three scale markings for left and right turn respectively (photo no. 54). The bank indicating mechanism is of the ball-in-glass type.

Description.

The instrument consists of the following two major sub-assemblies:

1. Instrument Frame and Cover.
2. Rotor Housing.

The instrument frame (photo no. 55) is cast in light alloy, with different components attached to it.

Inside the front part is found the pointer axle supported in a bearing bushing (photo no. 55 pos. E). mounted on a Ushaped bracket (photo no. 55 pos. F). The fork-shaped pointer axle arm (photo no. 56 pos. C) is connected to a spigot attached to a circular plate mounted on the rotor housing.

The calibrating spring and the damping cylinder are attached to the frame as shown on photo no. 56.

To the rear part of the frame are attached suppressor condensers, suppressor coils and the two-pole receptacle (photo no. 57 pos. A-B-C).

The rotor housing ball bearings are supported by spigots attached to the frame.

The rotor housing consists of two parts cast in light alloy.

To the front part is attached a circular disc on which is mounted the pointer movement spigot, the connecting arm for the damping unit, onto which the calibrating spring is anchored.

The rotor housing ball bearings are pressed into recesses outside the housing.

The rotor (photo no. 59 pos. A) is bell-shaped with windings and commutator situated inside the bell. Into the space between the rim of the rotor and the windings is situated a light alloy cylinder (photo no. 58 pos. C) with two cast-in pole cores in connection with two semi-circular permanent magnets (photo no. 58 pos. D). The rotor ball bearings are pressed into recesses inside the rotor housing.

The instrument frame is covered by a presumably soft-iron screen (photo no. 55 pos. B) and outside this the normal cover (photo no. 55 pos. A) slides on the frame from behind.

Electrical Functioning (Wiring diagram dwg. no. 63).

Power for the instrument (27v d-c) is supplied through the two-pin receptacle on the rear of the instrument. The two leads from here are connected to a terminal block on the rear of the frame through a suppressor system consisting of two coils and two condensers as shown on the wiring diagram.

This terminal block is connected to a terminal block on the rotor housing through two soft springs (photo no. 57 pos. D) and from here the leads continue directly to the two brushes. The brushes protrude through the three openings in the magnets (photo no. 58 pos. D), and slide on the vertical surface of the commutator (photo no. 58, pos. B) and not on the sides as shown on the wiring diagram.

No rotor speed regulator was included in the instrument.

Tests.

The following tests were carried out on the instrument:

Rotor starting voltage: 22 v.
Consumption at 27 v: 0,13 amp.
Rotor rpm: 1200.
Scale test: The results of this test are shown on dwg no. 63.
Full deflection (against stop) was obtained at:
30°/sec clockwise
27°/sec counterclockwise.
Full deflection of bank indicator ball was obtained at 10° bank angle. Weight of the instrument: 900 grs. 25X1

Comments.

[redacted]

When the pointer, during turns, deflects to the outer marks the bank angle of the aircraft must not exceed 45°. At deflections to the second or first mark, the bank angle must not exceed 30° or 15° respectively.

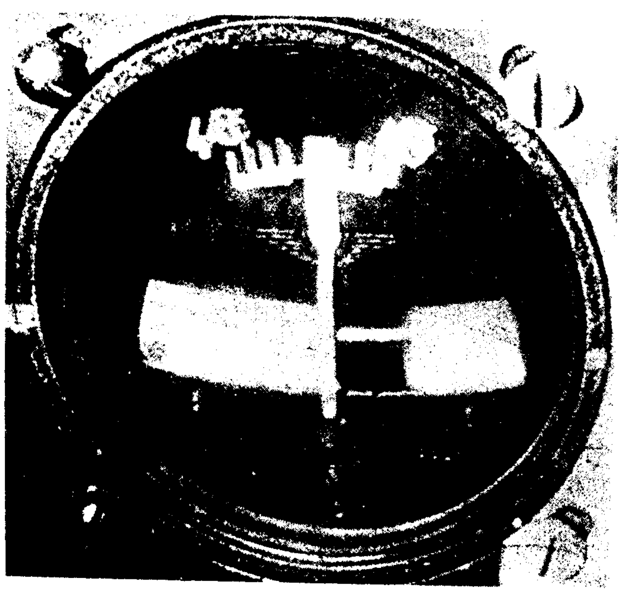


Photo no. 54.
Front view of the Turn and Bank Indicator.

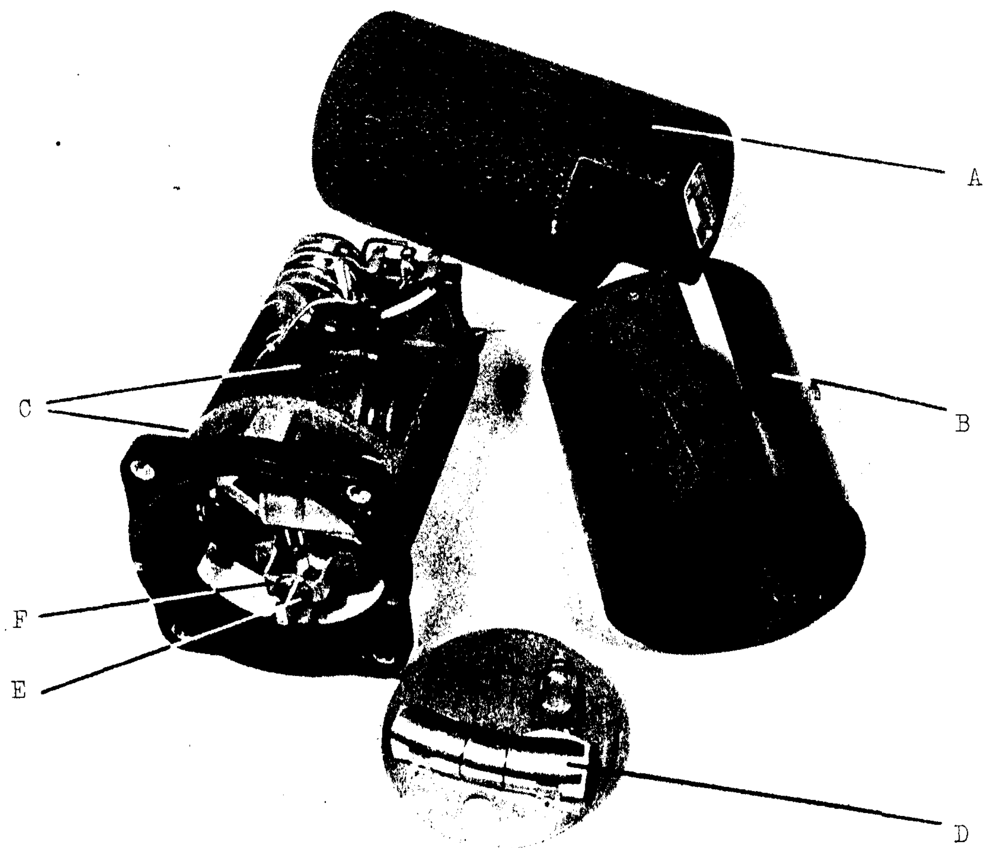


Photo no. 55.

A: Cover.
B: Screen.
C: Instrument Frame and Rotor Housing.
D: Bank Indicator (from the rear side).
E: Pointer Axle Bearing Bushing.
F: Mounting Bracket.

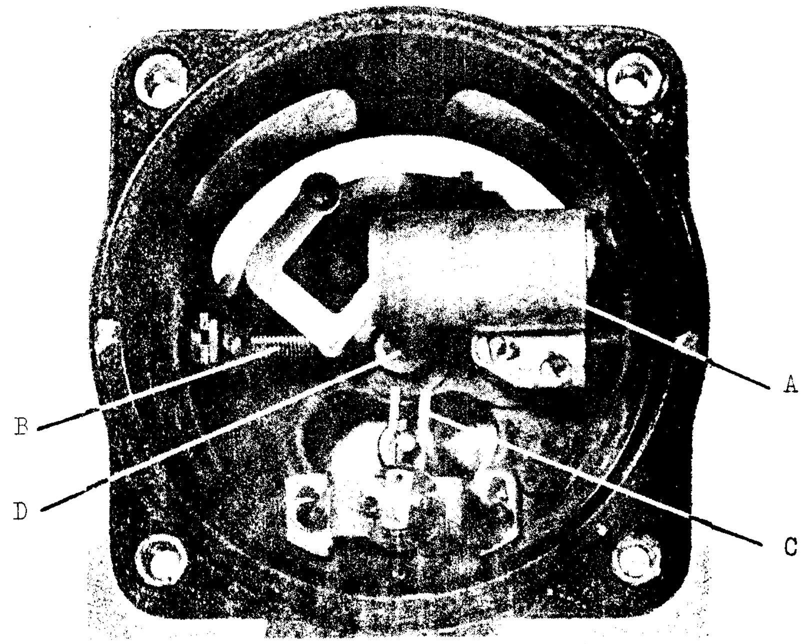


Photo no. 56.

Front Part of Instrument Frame.

A: Damping Cylinder.
B: Calibrating Spring.
C: Pointer Arm Fork.
D: Rotor Housing Bearing Spigot.

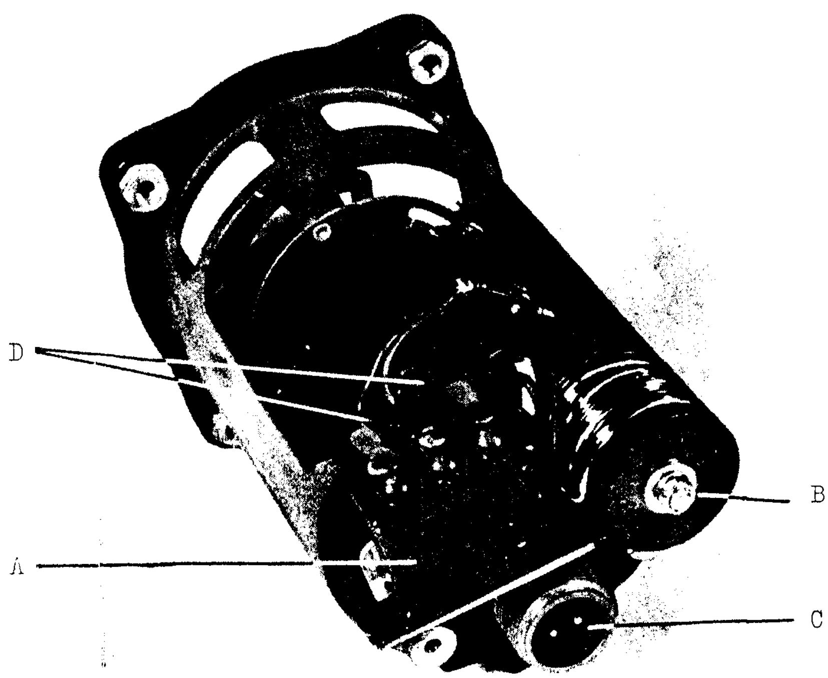


Photo no. 57.

A: Suppressor Condensers.
B: Suppressor Coils.
C: Supply Receptacle.
D: Connecting Springs.

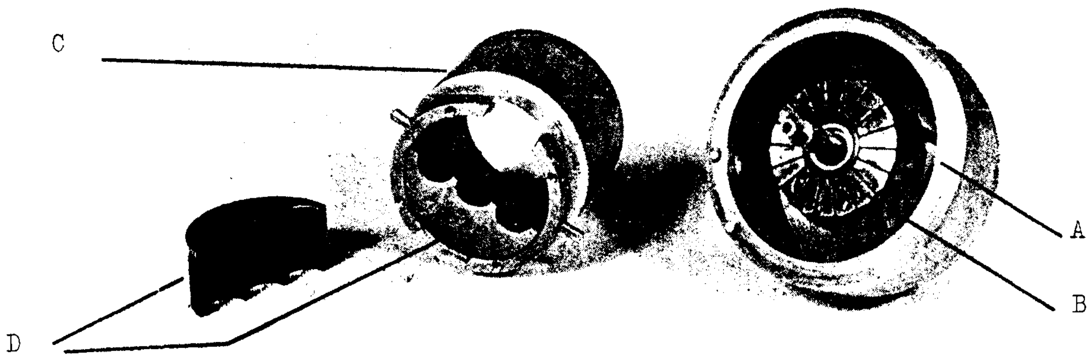


Photo no. 58

A: Gyro Rotor.
B: Commutator.
C: Magnet Cylinder.
D: Permanent Magnet.

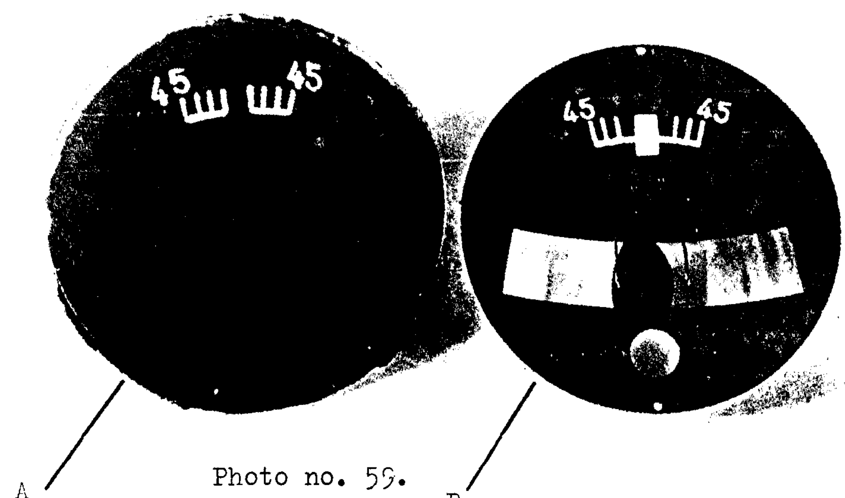


Photo no. 59.

A: Front Glass.
B: Instrument scale.

6. GYRO MAGNETIC COMPASS.

Introduction.

The components of the gyro magnetic compass were the same as found previously, with the exception of the transmitter (photo no. 60), which was a new design, but working on the same principles as the earlier type.
The transmitter was mounted in the starboard wing at the same place as earlier with no vibrations damping outside the transmitter.

Description.

The transmitter consisted of the following main parts:

Mounting Flange
Compass Transmitter Housing
Magnet Mounting Spider
Magnet and Damping Unit.

The compass transmitter housing is clamped to the mounting flange on which is found scale ranging from -12° to $+12^{\circ}$, used for A-coefficient compensation during compass swinging.
The compass housing is divided into an upper and lower part, forming a hermetically sealed unit.
The lower part is mainly a bowl (photo no. 62) with eight damping springs enclosed in rubber blocks, equally spaced along the inside.
On the top of the upper part of the transmitter is situated the compensator, which is of the normal type, consisting of two pairs of permanent magnets at right angles to each other.
The compensator shafts are locked together as shown on photo no. 66.
Through a small circular aperture in the top, part of the compass scale is visible.
Two small copper tubes on the top is used presumably for filling the transmitter with an inert gas.
Inside the upper part is mounted a four legged spider (photo no. 63 pos. A) in eight non-magnetic springs connected to the inside walls.
Furthermore the spider is connected through 16 smaller springs to a ring attached inside to the top of the bowl (photo no. 63, pos. B).
Through a universal joint (photo no. 63 pos. C) a bridge (photo no. 63, pos. D) is connected to the damping ring (photo no. 64 pos. A), which also serves as magnet support.
The damping ring is made of an al.alloy and carries the magnet bearing in its centre (photo no. 65 pos. D). This bearing is a high quality ball bearing designed as shown on dwg, no 65 (Scale 5:1).
The magnet system (photo no. In. 21 pos. C) consists of a pair of relatively big magnets attached to a circular compass scale (photo no. 63 pos. E).

Electrical functioning.

The two-pin and three-pin plugs are the same as those found previously, but the connections inside the transmitter are slightly different (dwg. no. 66).
The leads from the three-pin plug are connected directly to the circular potentiometer whereas the leads from the two-pin plug via two sliding contacts on the magnet system are connected to two brushes sliding on the potentiometer 180° apart.
The functioning is exactly as on the earlier type.
The magnets are damped by eddy currents generated in the damping ring when the magnets are rotated.

Tests.

The gyro-magnetic compass was removed from the aircraft and the interconnections between the components were made according to the wiring diagram in the first report (dwg. no. 9).
When started, the compass functioned irreproachable.
When the magnets of the compass transmitter was deflected, it returned to the original position within one degree (with vibration).
The friction error was approximately 2°. The magnets were aperiodically damped and after a deflection of 90°, the magnets returned to the original position within 5 secs.
The weight of the transmitter was 2,5 kgs.

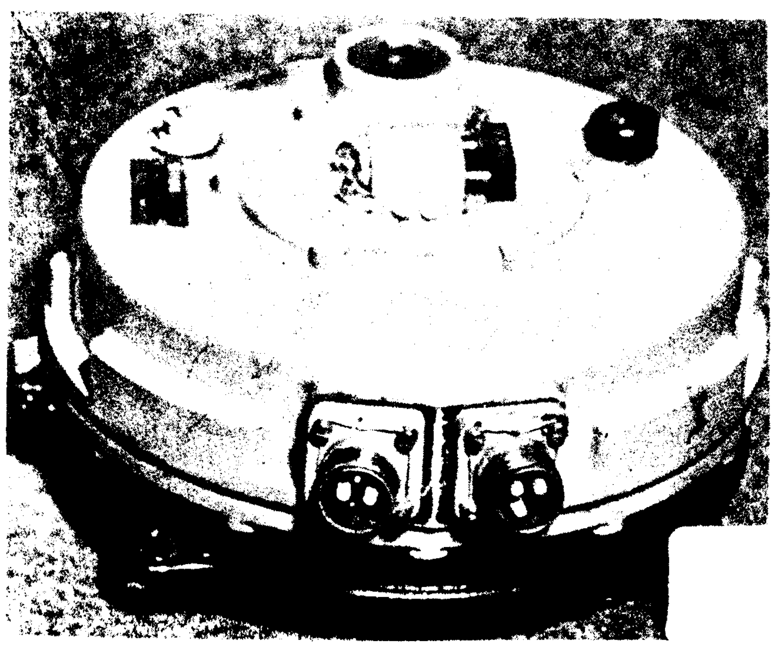


Photo no. 60.

Front view of the Gyro Magnetic Compass Transmitter.

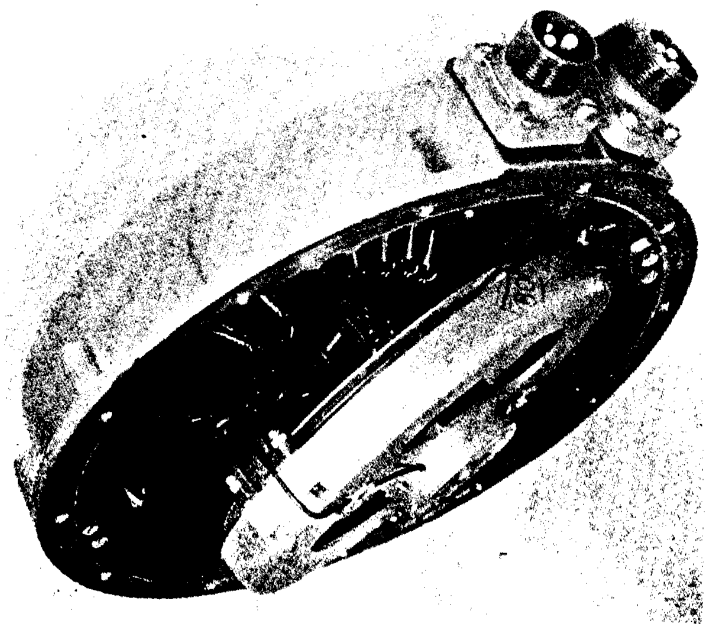


Photo no. 61 - Compass Bowl, upper part.

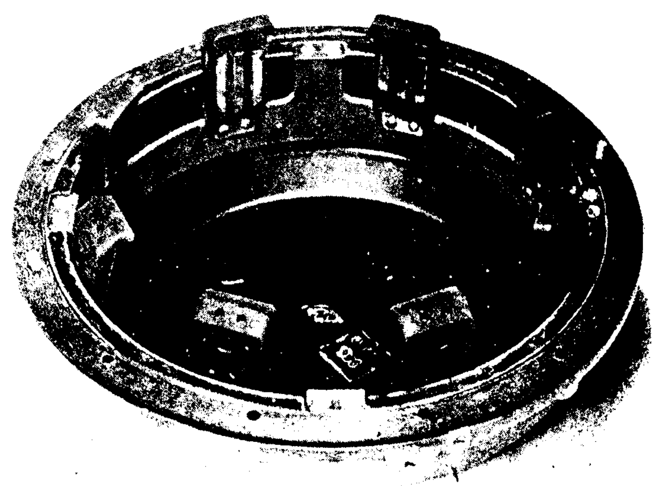


Photo no. 62 - Compass Bowl, lower part.

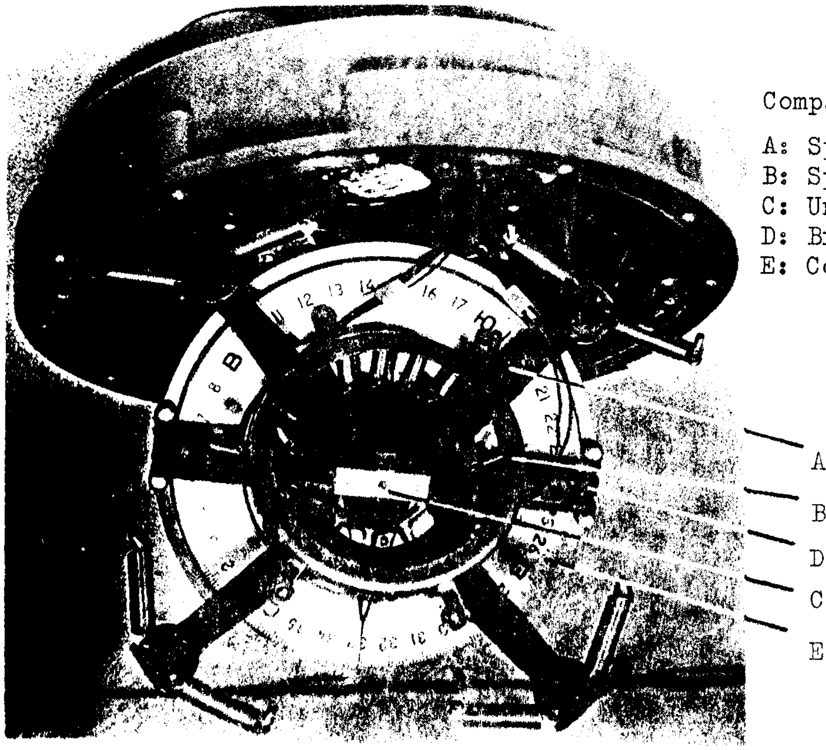


Photo no. 63.

Compass Bowl, upper part.

A: Spider.
B: Spring Mounting Ring.
C: Universal.
D: Bridge.
E: Compass scale.

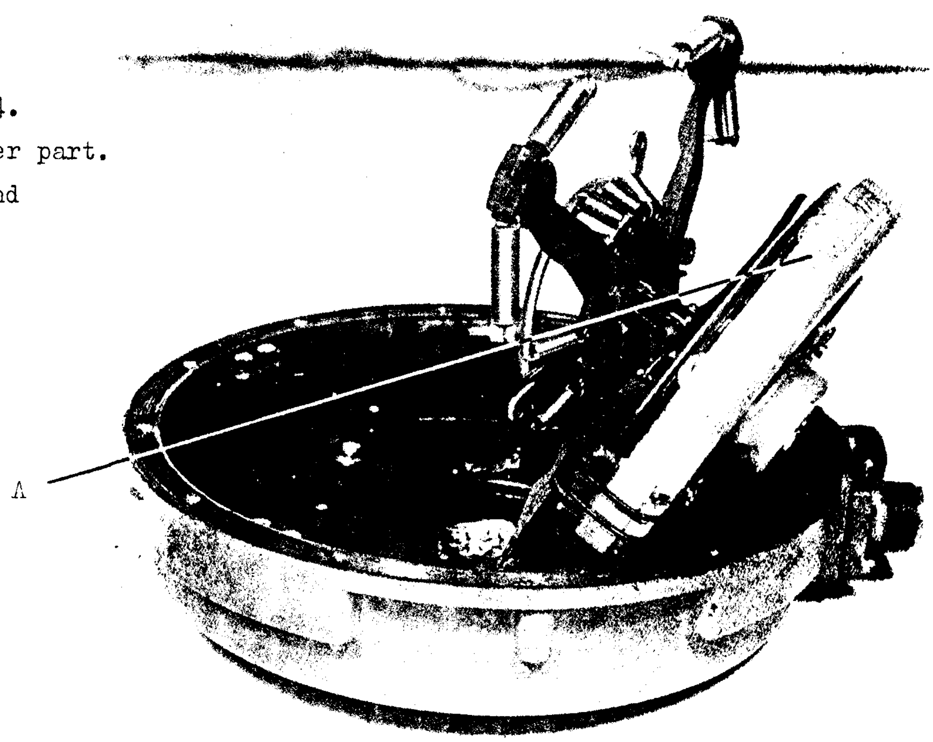


Photo no. 64.

Compass Bowl, upper part.

A: Damping Ring and
Magnet Support.

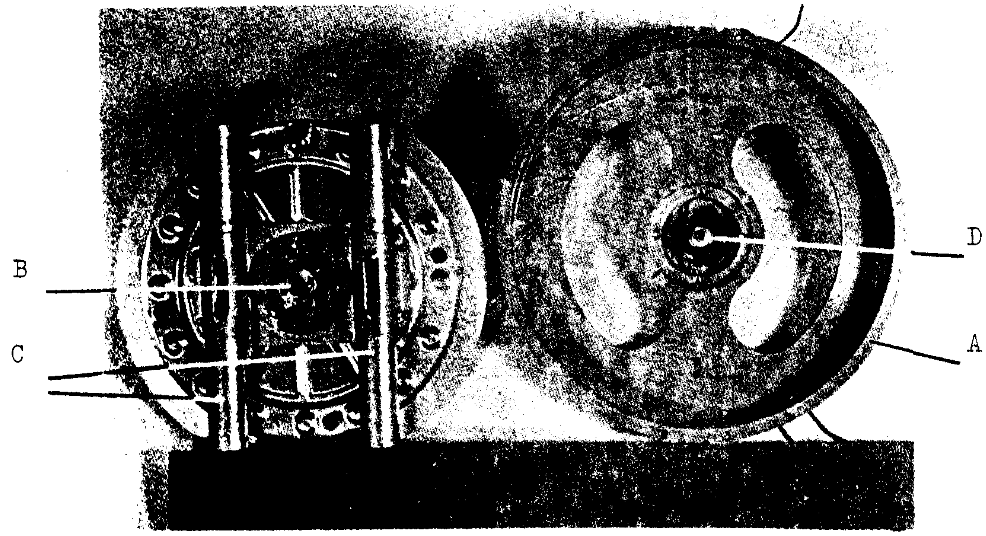


Photo no. 65.

Magnets and Damping Ring.

A: Damping Ring.
B: Magnet Bearing Bushing.
C: Magnet System.
D: Magnet Ball Bearing.

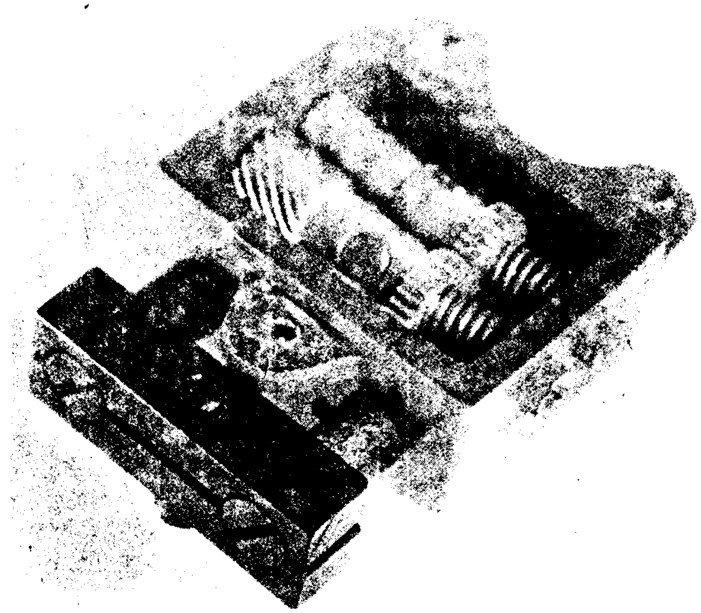


Photo no. 66.

Compensator unit.

C. 2. Jet Pipe Thermometer system.

The temperature indicator, the thermocouples and the leads were of the type as found previously.
The indicator was tested as millivoltmeter with the results shown on dwg. no. 67, showing practically linear relation between m. V. and instrument indication between 400 and 900° C. One of the thermocouples was tested in an electric oven at temperatures between 90 and 600° C.

The thermo-electric force of the thermocouple was measured by compensation, and the temperatures were measured by mercury thermometers.
The values obtained are shown on dwg. no. 68.
These show two reversals of the thermoelectric force, the first at approx 90° C, the second at approx 260° C. This explains why no cold junction compensation is necessary as the normal variations of the cold junction temperature only produces minor variations in EMF.
As shown on photo no. 15-361 (first report) the scale of the instrument is compressed between 0 and 400°.
This is explained as the relation between hot junction temperature and voltage is not linear below a temperature of approx. 350° C.
An analysis (spectral and chemical) of the material of the thermocouple gave the following results:

1. 80,7% nickel, 15 % cobalt, 2 % manganese, 1,3 % silicum, 0,1 % copper, 0,9 % aluminium.

11. 97 % nickel, 1,3 % manganese, 1,1 % silicum, 0,3 % aluminium, 0,1 % copper.

Fuel Contents System.

2. The fuel contents system was the same as found previously, with the exception that the fuel transmitter top and bottom stops were positioned on the fixed transmitter arm (photo no. 67.)
The transmitter and indicator was connected according to the wiring diagram shown in the first report dwg. no. 5. and the system was tested with the results shown on dwg. no. 69.

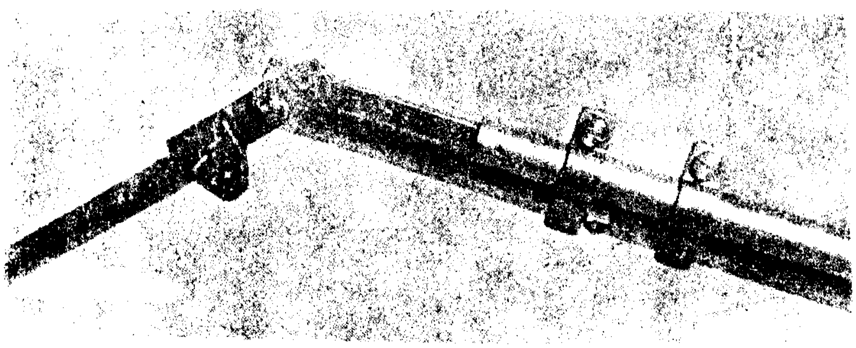


Photo no. 67.

Fuel Transmitter Stop.

SECTION XIV

FUEL SYSTEM

A. General Description.

No significant changes in tankage, layout or operation of fuel system as described in the earlier reports were found, but two new points of interest were:

(a) The fuel filler necks of both the main and rear tanks had a small light-alloy 'cup' containing a paste ("Bluish" in the main tank, "reddish" in the rear tanks) attached by four or five inches of thin, flexible cable to the neck flange. It appeared that this 'cup' was permitted to hang inside the gauze filter of the filler neck when the filler cup was replaced. The significance of these 'cups' and their paste was not readily apparent since the paste did not appear to react to moisture, and the 'cups' could only reach the surface of the fuel in full tanks, but samples of the paste were obtained for chemical analysis.

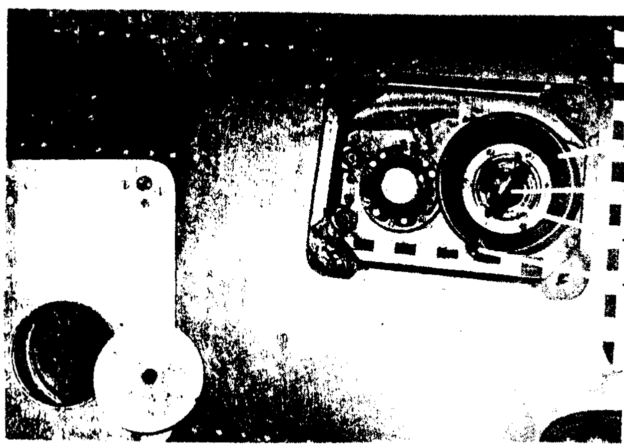


Photo no. 68. Main Tank Filling Point.

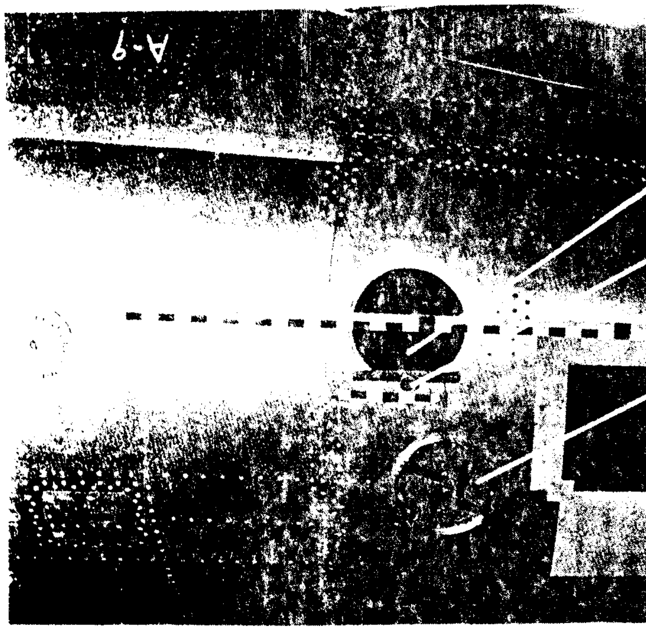


Photo no. 69. Rear Tanks Filling Point.

(b) An electrical modification, incorporating a new switch, was found embodied in the drop-tank jettison circuit. This modification did not affect the fuel system operation and is fully described in Part 5 (Electrical System) of this report.

SECTION XV

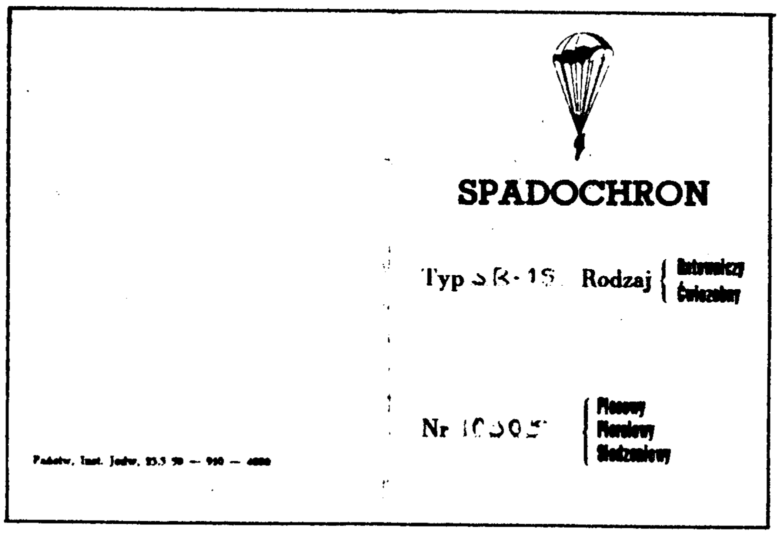
PERSONAL EQUIPMENT

B. Emergency Oxygen in Parachute.

There was space provision for emergency oxygen pack at the base of the parachute but no oxygen pack was carried.

C. Parachute.

[redacted] The photos show the parachute log card. 25X1

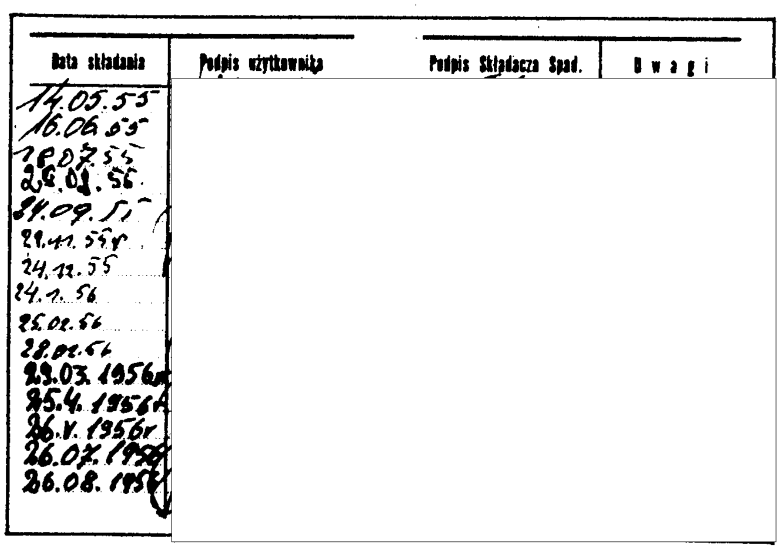


SPADOCHRON

Typ SR-15 Rodzaj { Ratowniczy / Ćwiczebny

Nr [illegible] { Plecowy / Piersiowy / Siedzeniowy

Photo no. 70. Parachute log card.



Data składania	Podpis użytkownika	Podpis Składacza Spad.	Uwagi
14.05.55	[redacted]		
16.06.55			
12.07.55			
28.08.55			
24.09.55			
21.11.55r			
24.12.55			
24.1.56			
25.02.56			
28.02.56			
23.03.1956r			
25.4.1956r			
26.V.1956r			
26.07.1956			
26.08.1956			

25X1

Photo no. 71. Parachute log card.

D. Oxygen mask.

[redacted]

The photos show the mask.

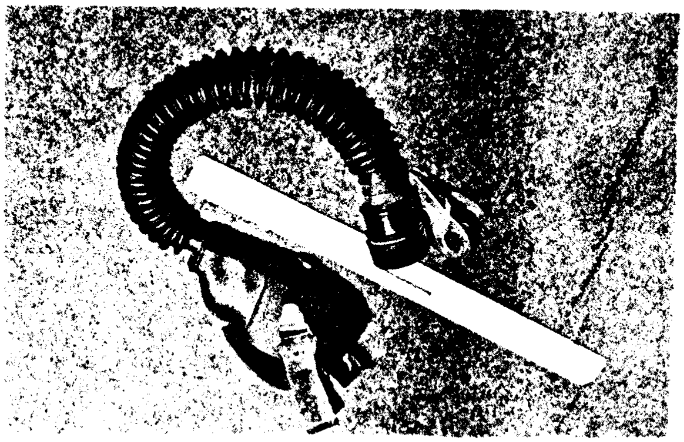


Photo no. 72. Oxygen mask.

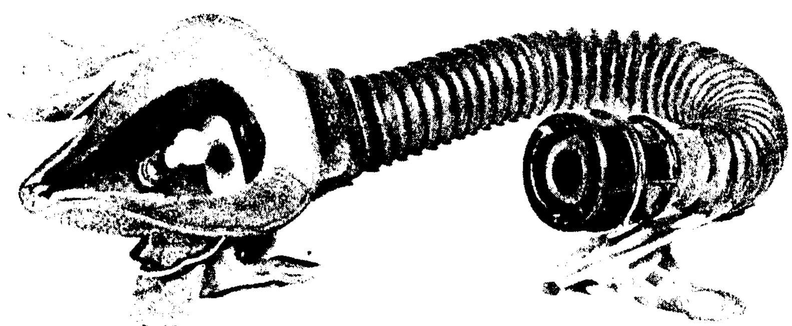


Photo no. 73. Oxygen mask.

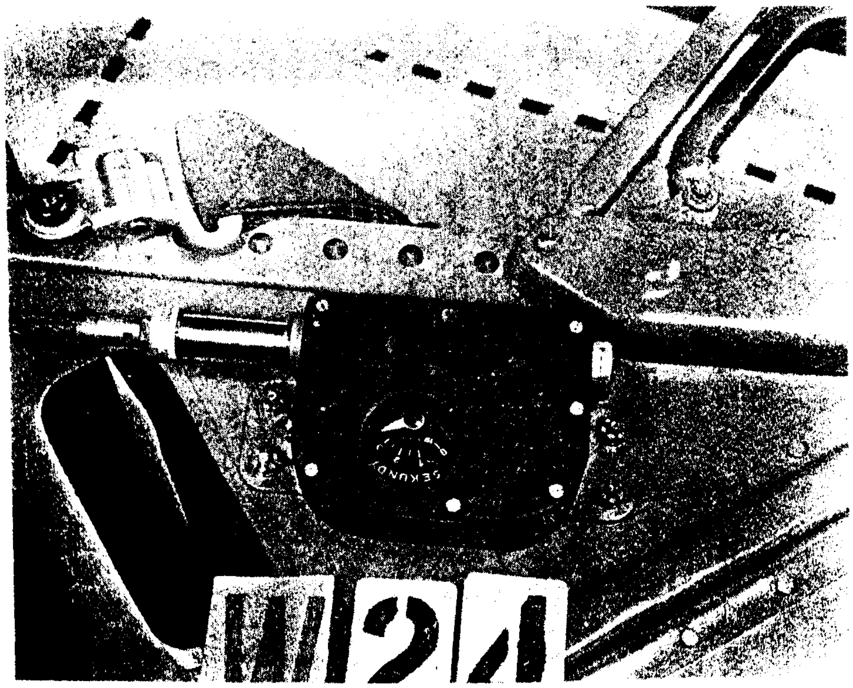


Photo no. 74. Automatic harness release.

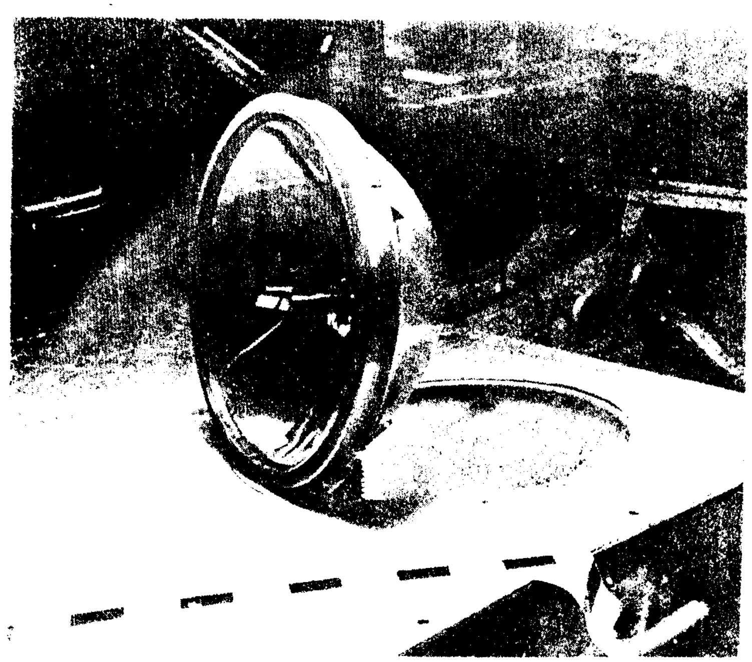


Photo no. 75. Landing lamp.

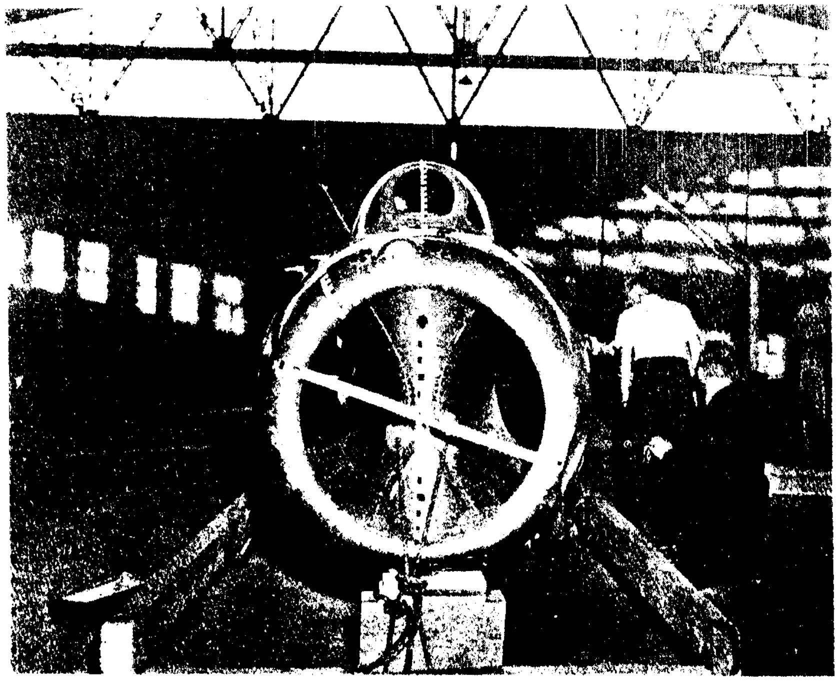


Photo no. 76. External nose gear
down lock light.

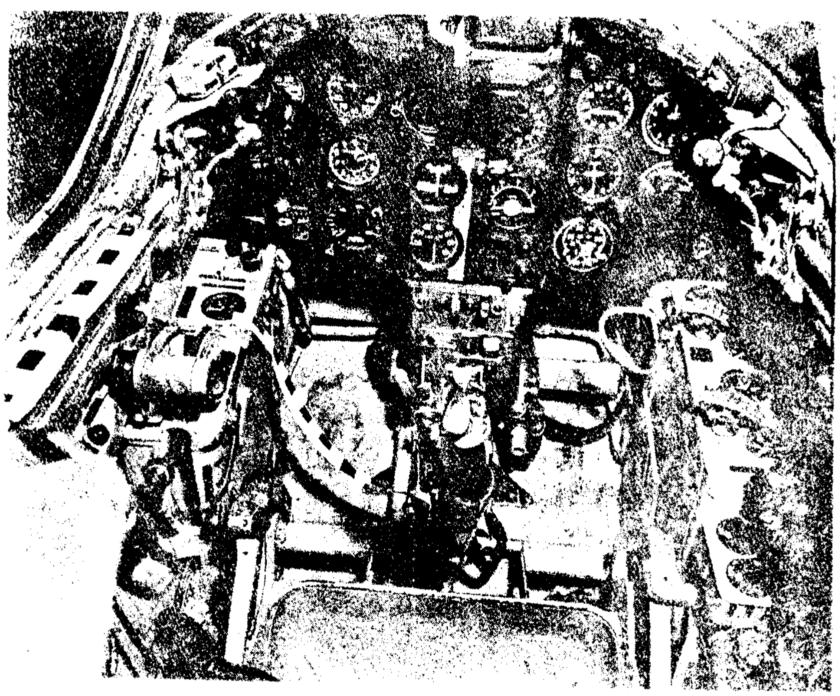


Photo no. 77. Cockpit.

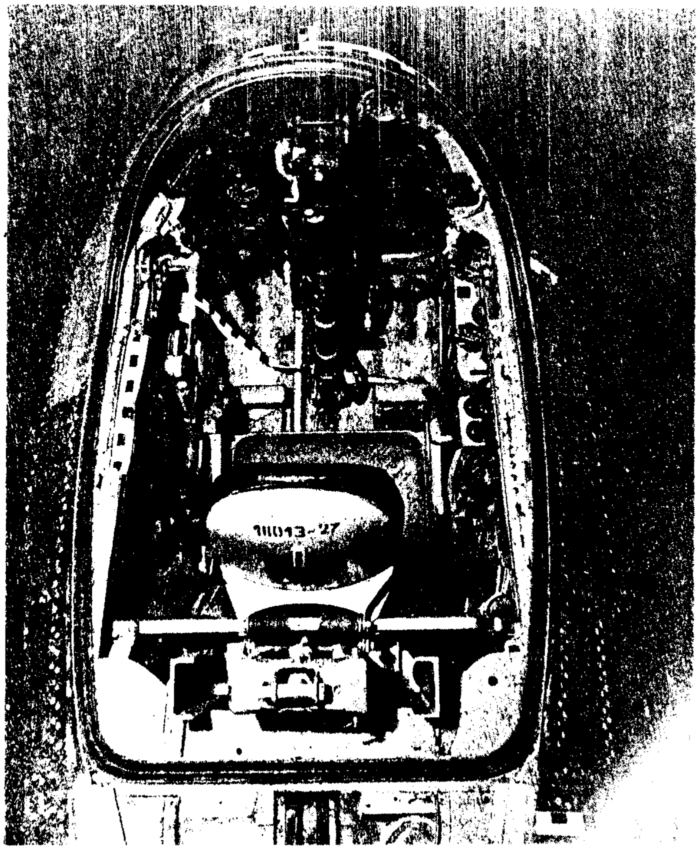


Photo no. 78. Cockpit.

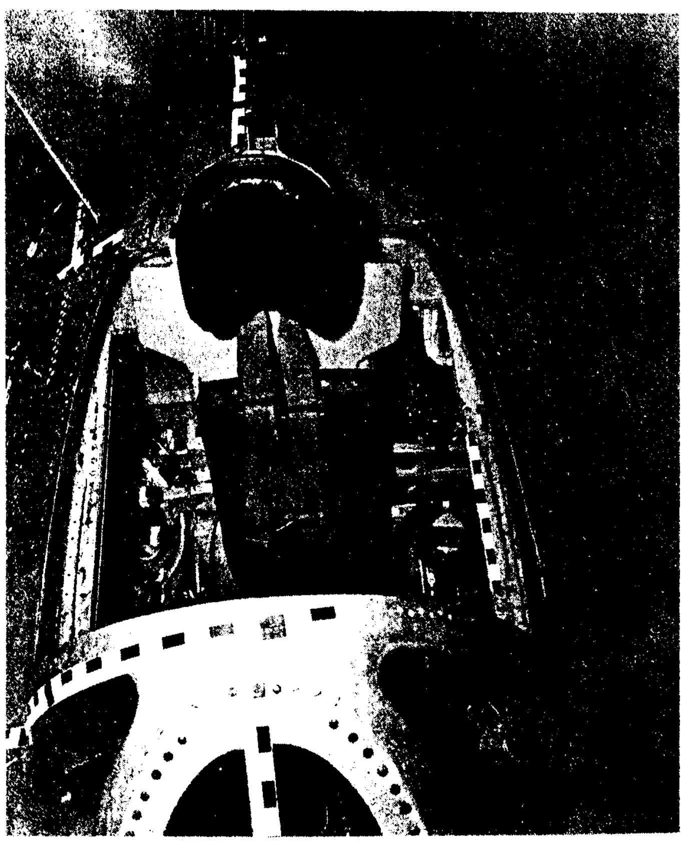


Photo no. 79. Cockpit.

25X1

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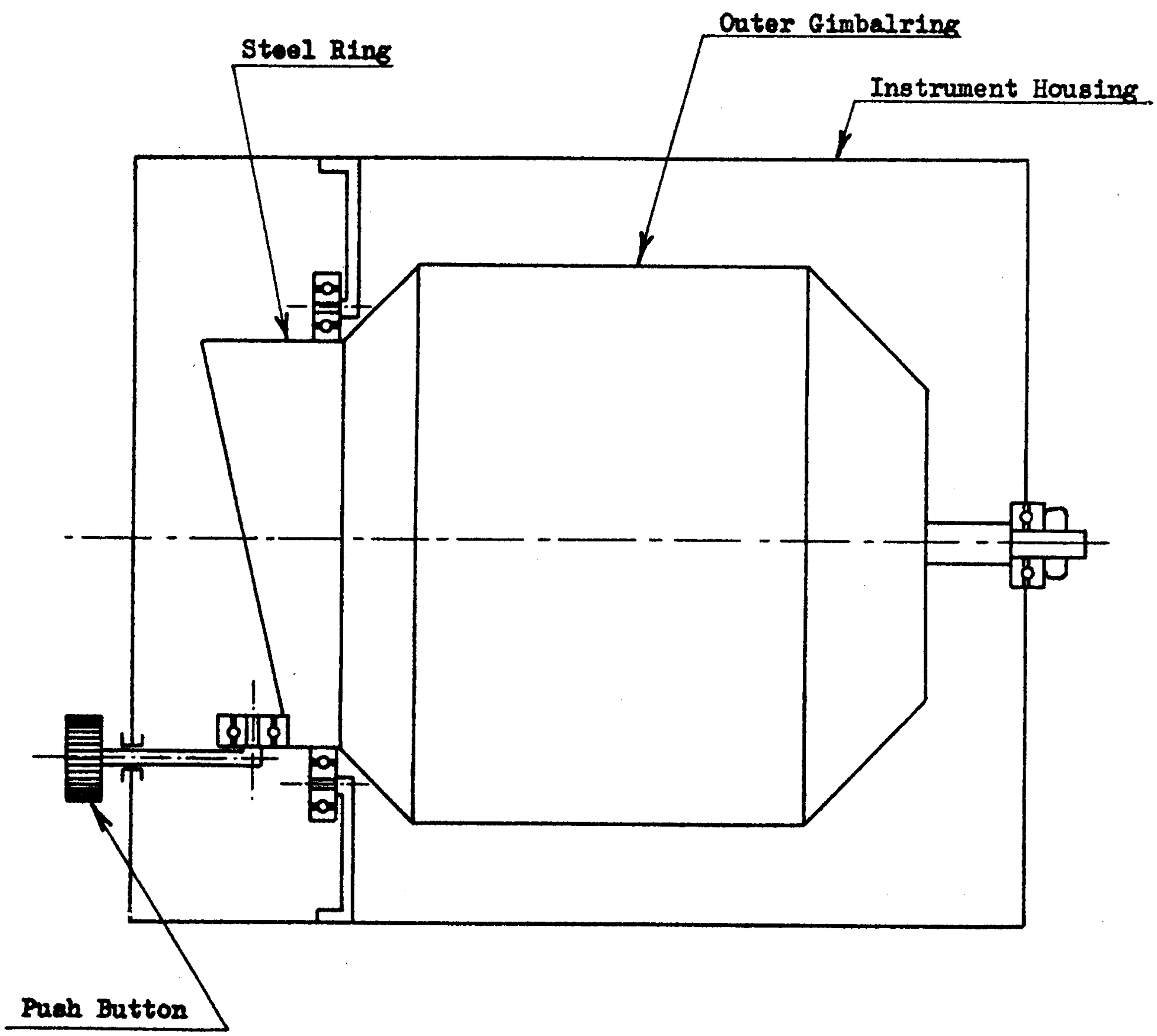
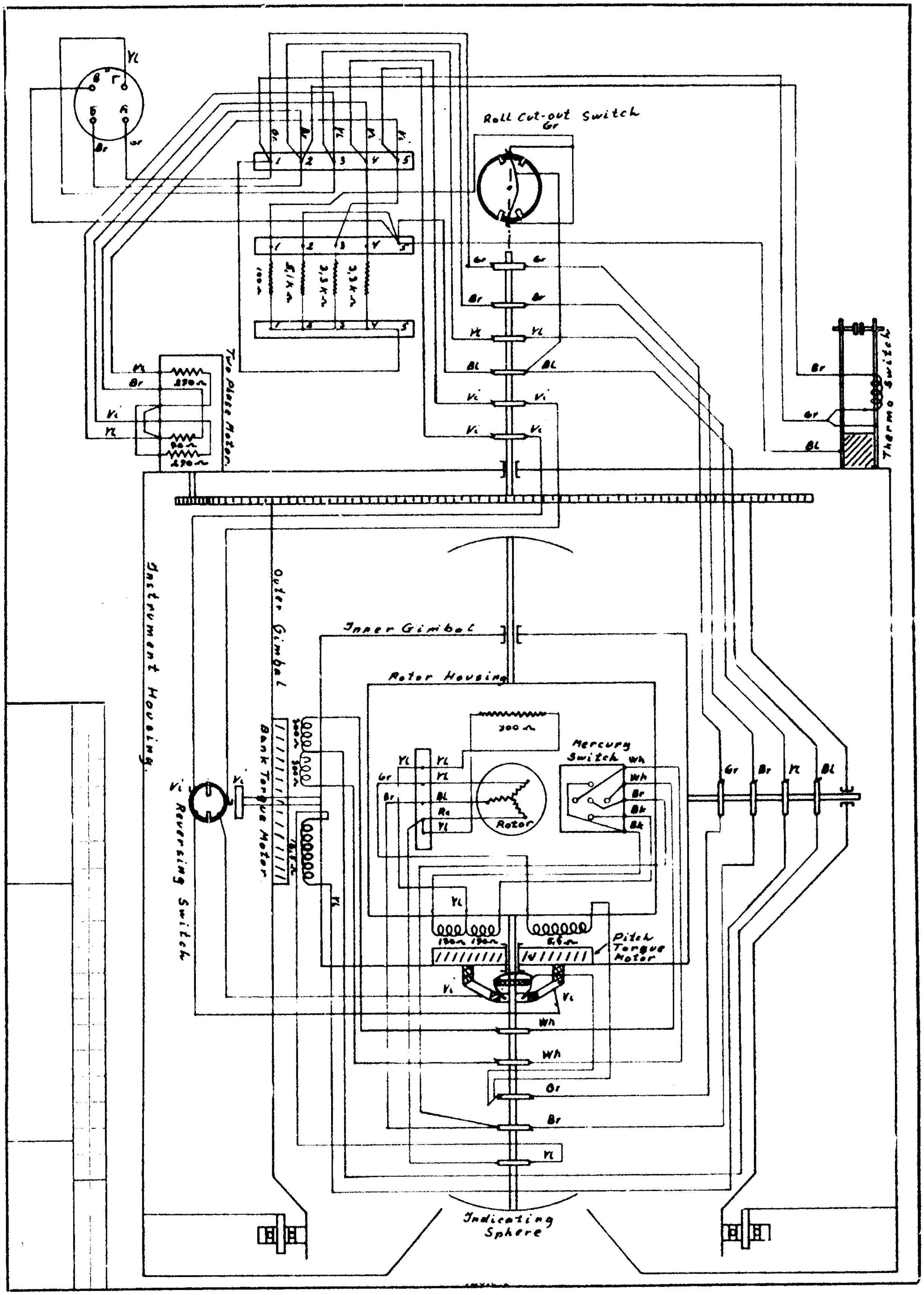
Outer Gimbal Caging Mechanism

Schematic.



Dwg. no. 61.

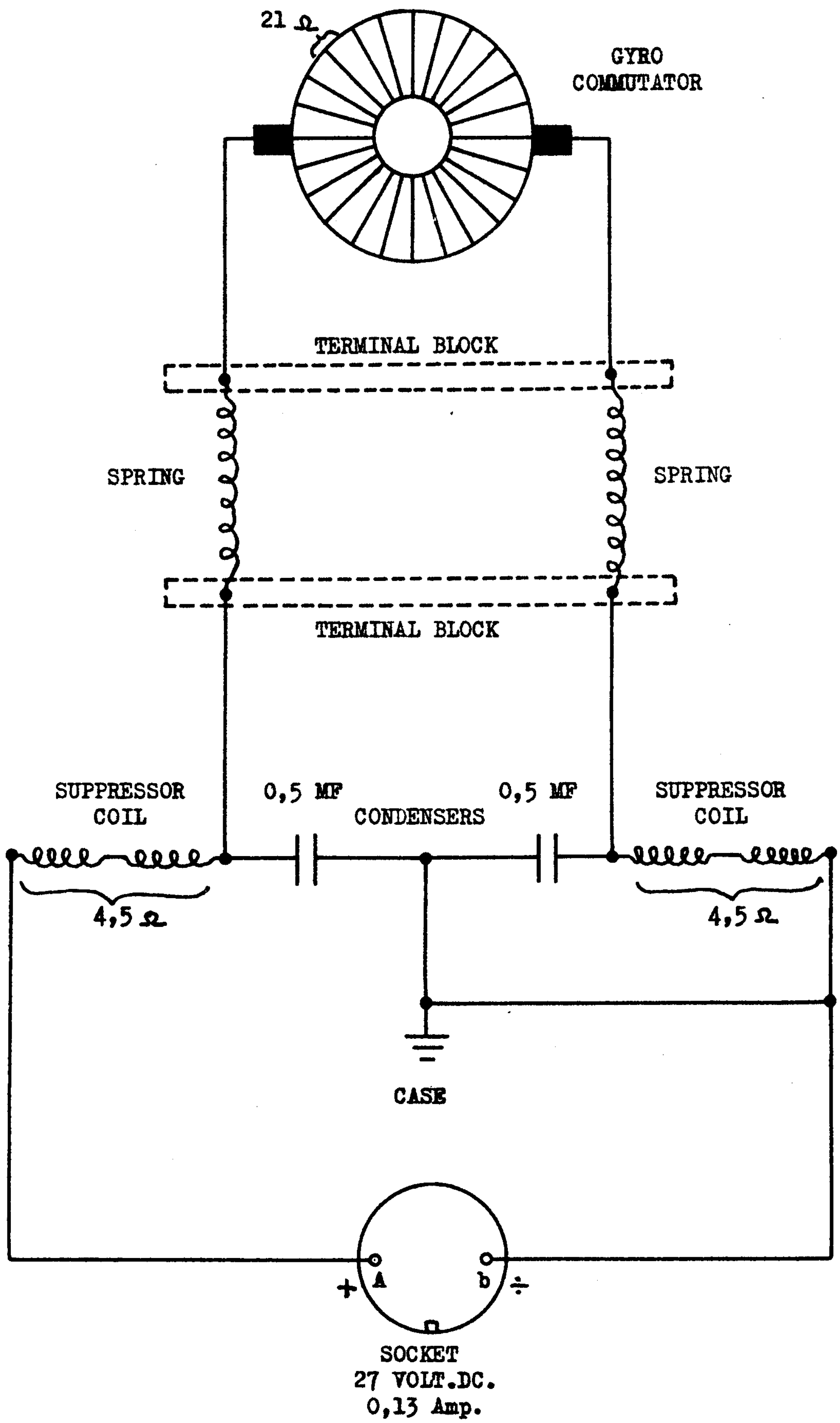
Gyro Horizon Wiring Diagram.



Dwg. no. 62.

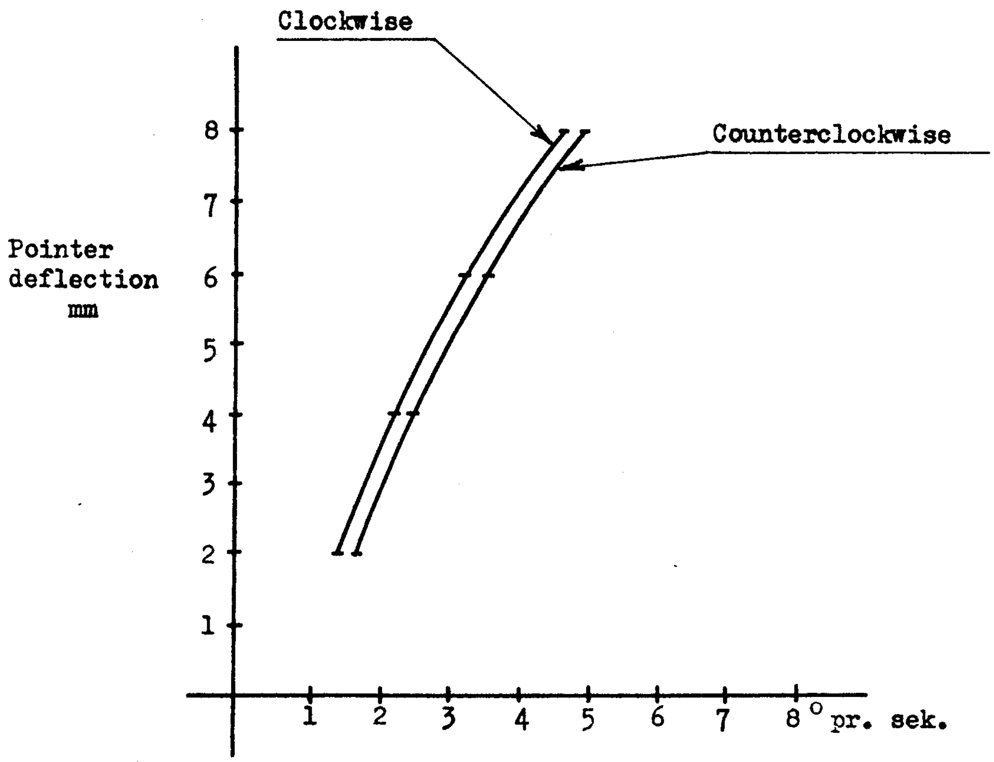
Turn and Bank Indicator.

Wiring Diagram



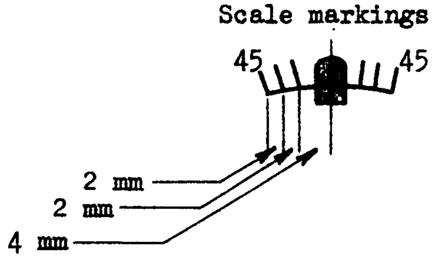
Dwg. no. 63.

Turn and Bank Indicator



Angular velocity °/sec.

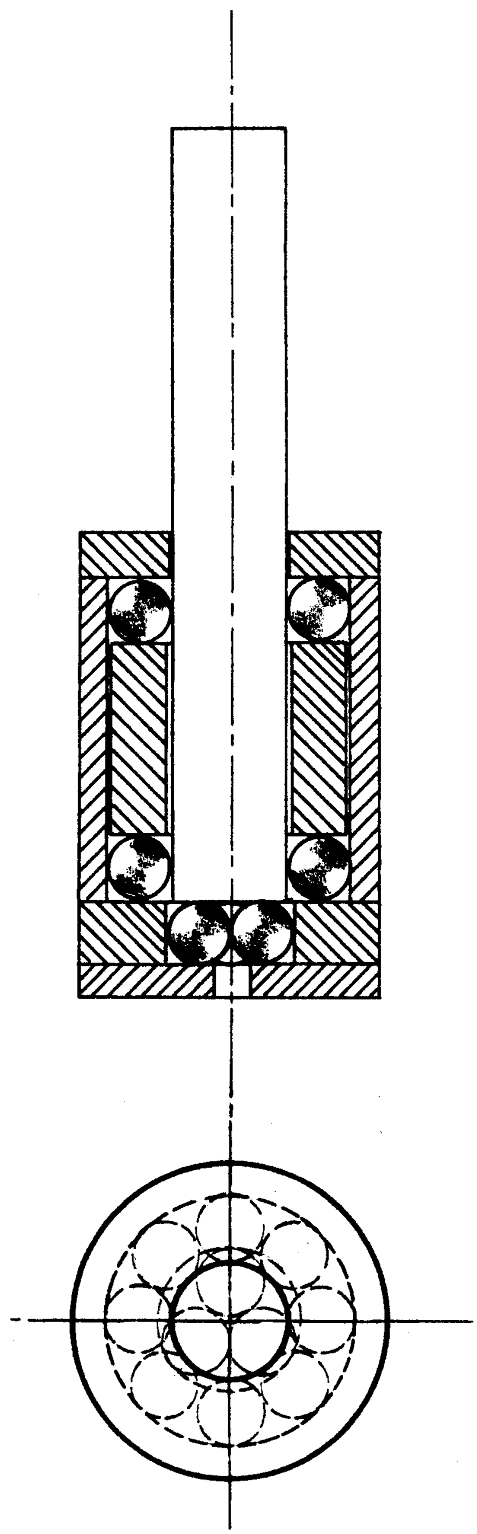
Scale markings.



Dwg. no. 64.

Compass Transmitter

Magnet Bearing

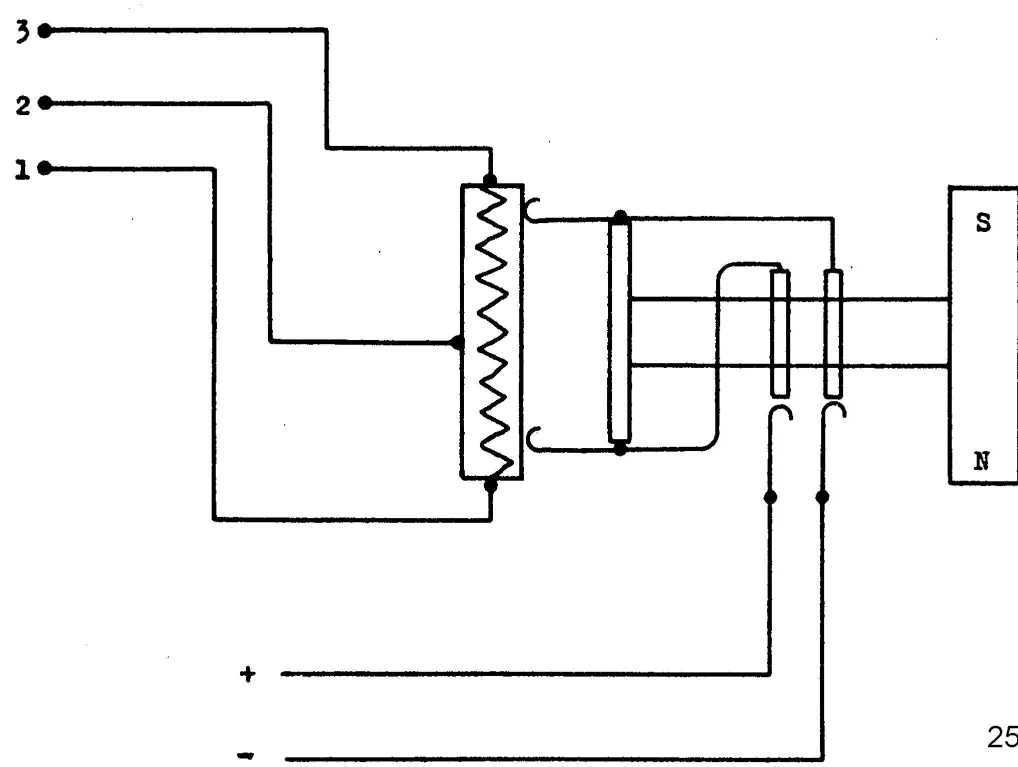


Dwg. no. 65.

25X1

Compass Transmitter

Wiring Diagram.



25X1

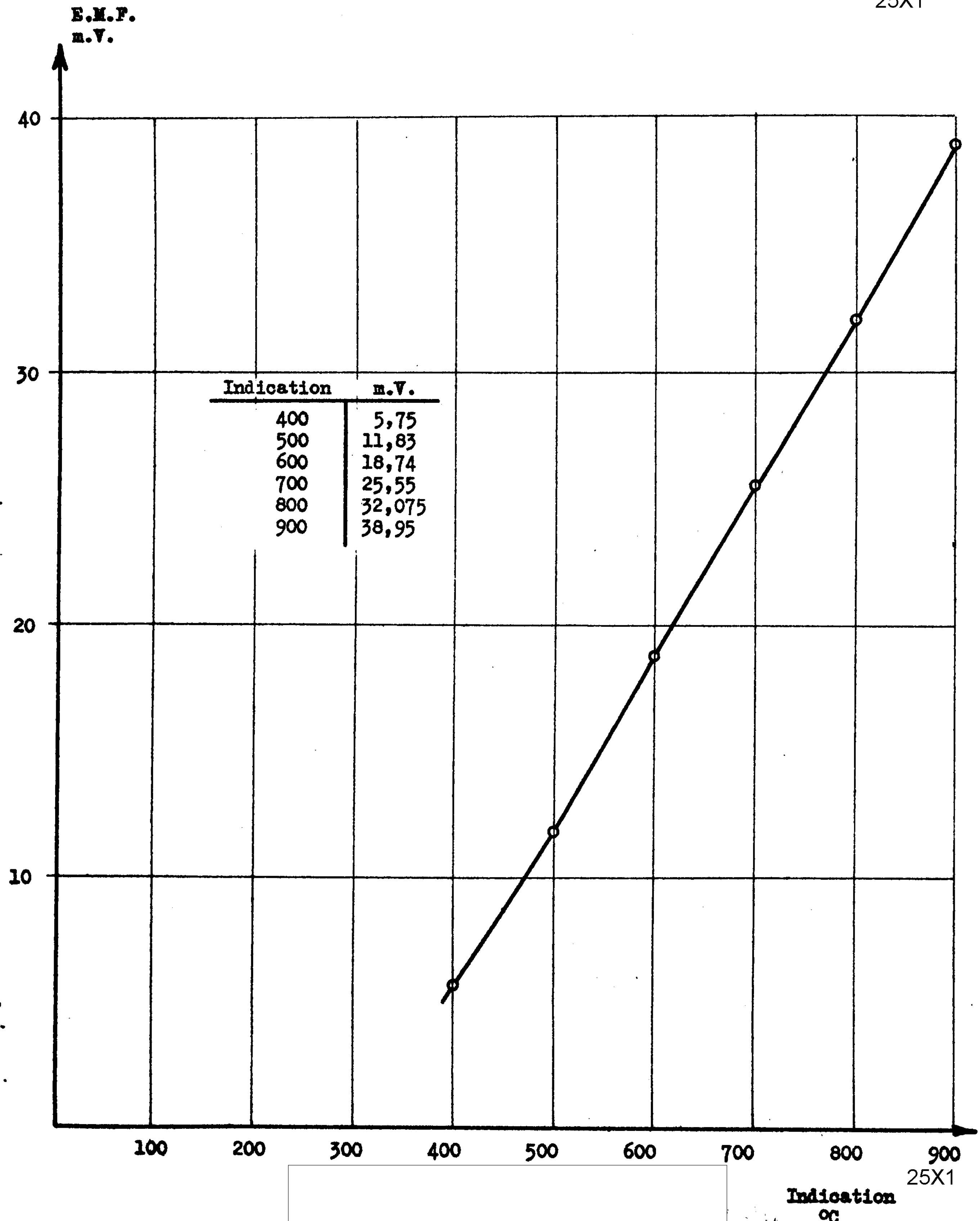
Dwg. no. 66.

SECRET

[redacted]

of Jet Pipe Thermometer and EMF.

25X1



Indication	m.V.
400	5,75
500	11,83
600	18,74
700	25,55
800	32,075
900	38,95

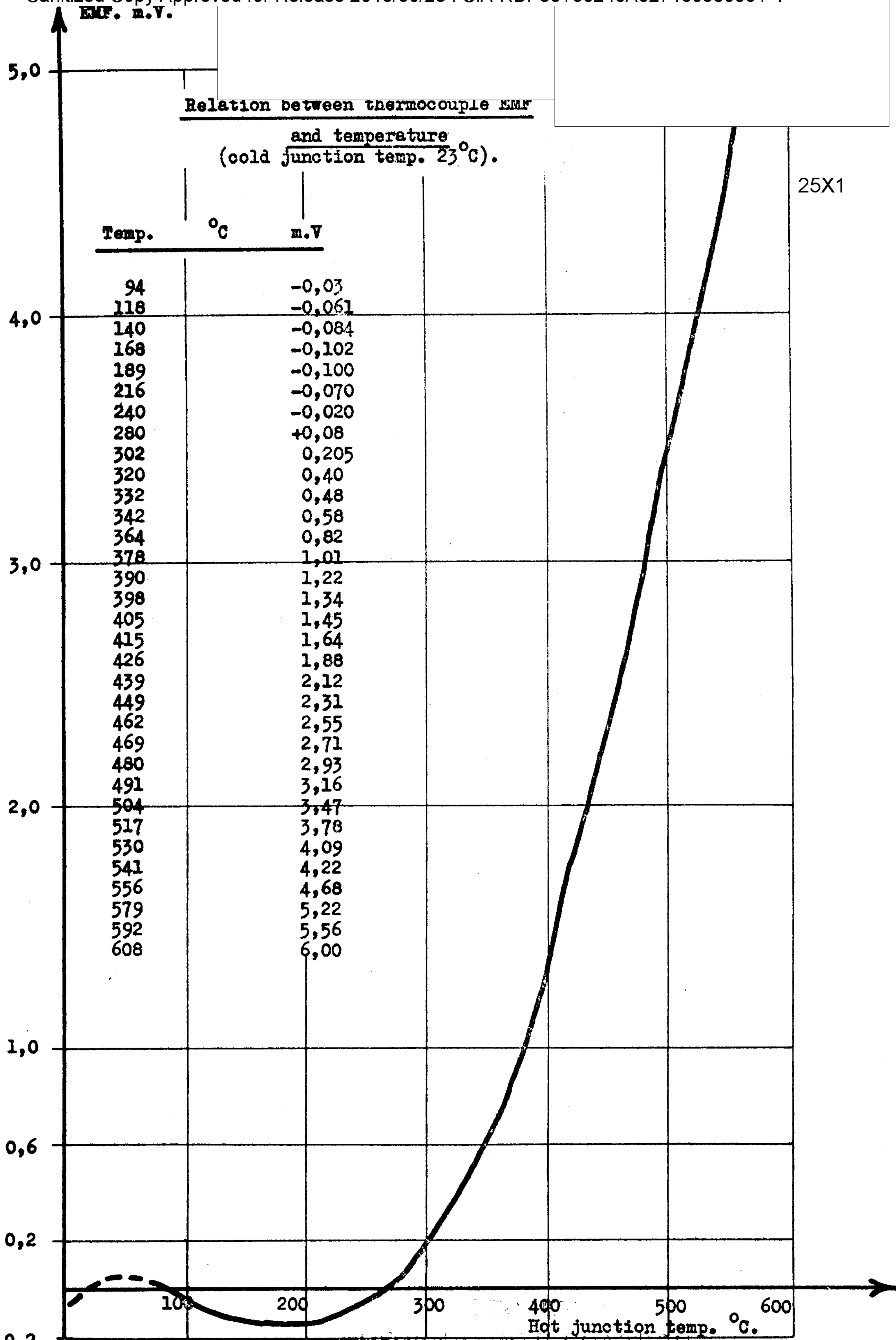
25X1

[redacted]

Dwg. no. 67.

25X1

Relation between thermocouple EMF and temperature
(cold junction temp. 23°C).



Temp. °C	m.V
94	-0,03
118	-0,061
140	-0,084
168	-0,102
189	-0,100
216	-0,070
240	-0,020
280	+0,08
302	0,205
320	0,40
332	0,48
342	0,58
364	0,82
378	1,01
390	1,22
398	1,34
405	1,45
415	1,64
426	1,88
439	2,12
449	2,31
462	2,55
469	2,71
480	2,93
491	3,16
504	3,47
517	3,78
530	4,09
541	4,22
556	4,68
579	5,22
592	5,56
608	6,00

SECRET

Dwg. no. 68.

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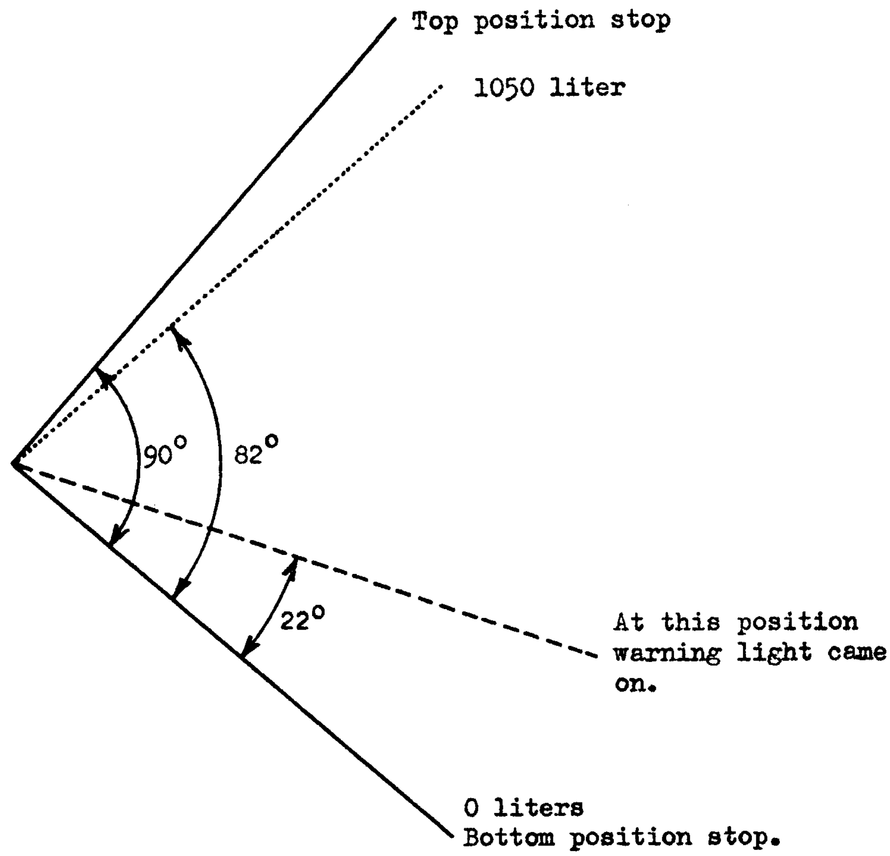
Fuel contents transmitter unit.



Dwg. no. 69.

25X1

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25X1

TECHNICAL REPORT ON

MIG 15 BIS

NO 1327

25X1

PART TWO

ENGINE

25X1

SECRET

[redacted]

25X1

PART TWO

ENGINE

[redacted]

25X1

SECRET

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25X1

PART TWO

ENGINE

The following report is based upon information gained from examination of a Polish built aircraft (known as "FAGOT"), designated LIM-2 (Polish designation for the USSR MIG-15 Bis) 25X1

25X1

25X1

SECTION I

TABLE OF CONTENTS

25X1

SECRET

25X1

25X1

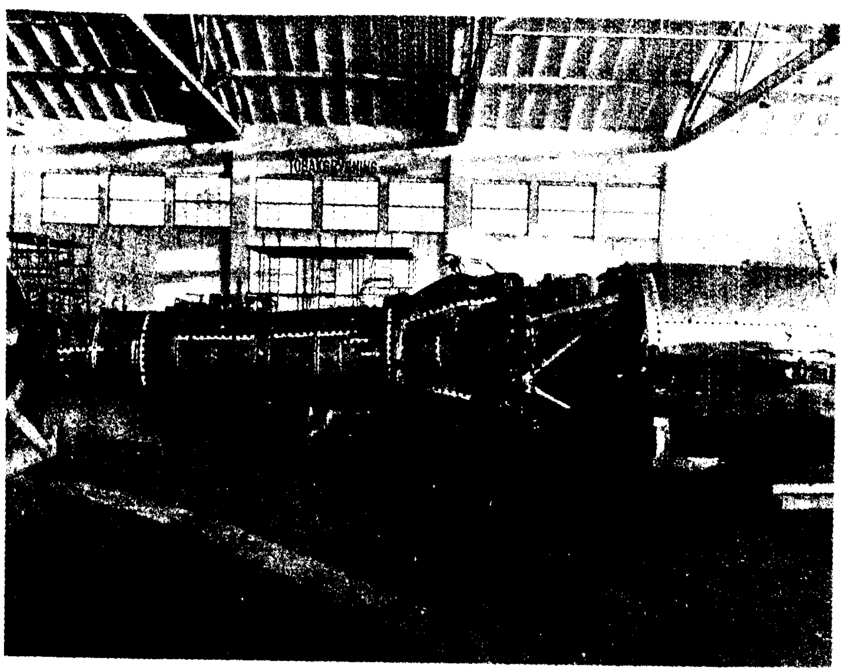
SECRET

SECTION II

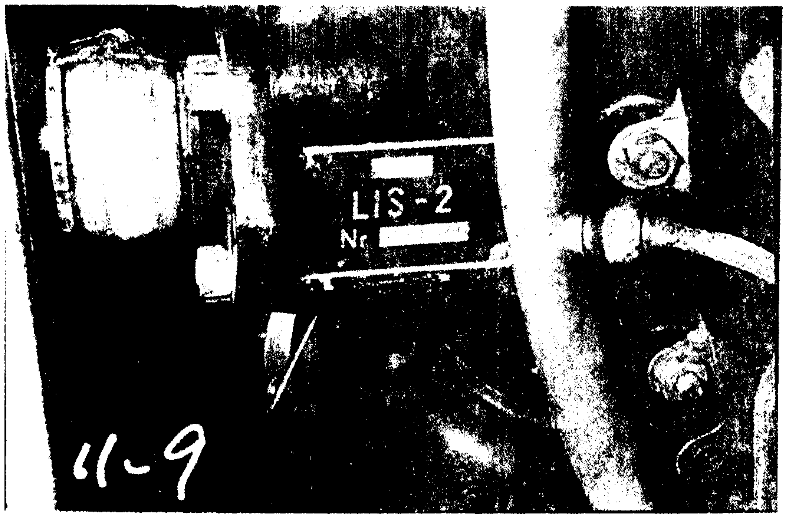
INTRODUCTION

25X1

The engine installed in this aircraft was, with few exceptions, identical to those reported in the previous [redacted] reports. [redacted]



Photograph 1. LIS-2 Engine - General View.



Photograph 2. Engine Dataplate.

SECTION III

ENGINE DATA

A. General

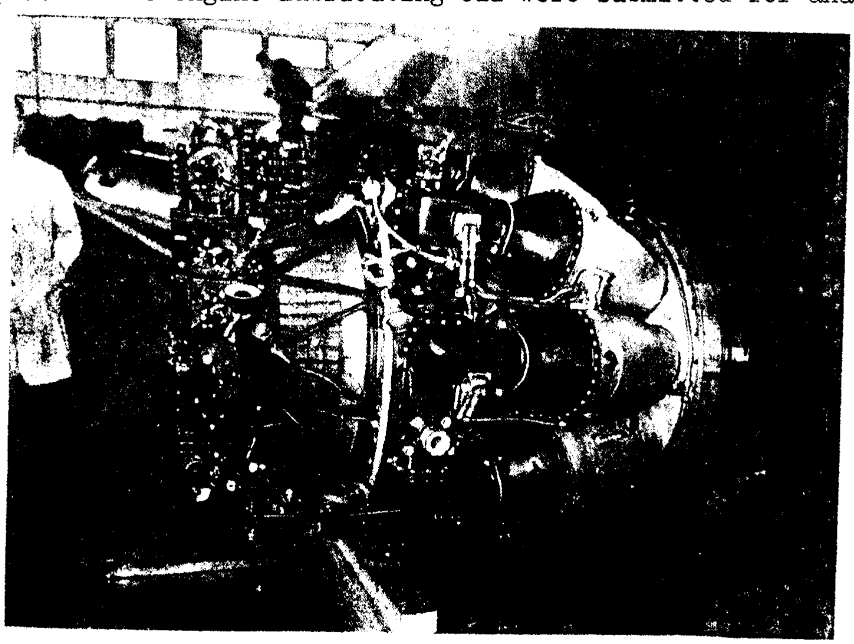
Designation of engine............................LIS-2

D. Fuel Specification

A sample of the fuel obtained from the aircraft was taken and forwarded for analysis.

E. Oil Specification

Samples of the engine lubricating oil were submitted for analysis.



Photograph 3. LIS-2 Engine - Left Side View.

SECTION V

INSTALLATION NOTES

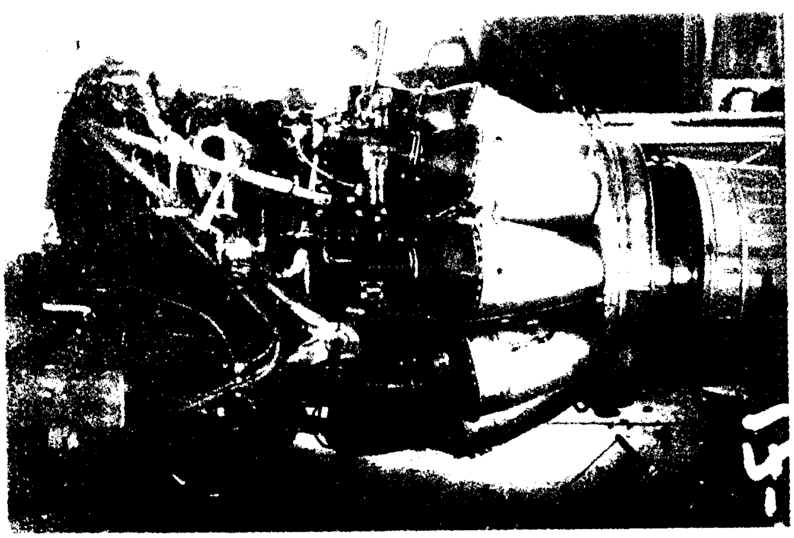
A. Dimensions

The propelling nozzle diameter (in millimetres) was found etched on the nozzle as ϕ 542.4.

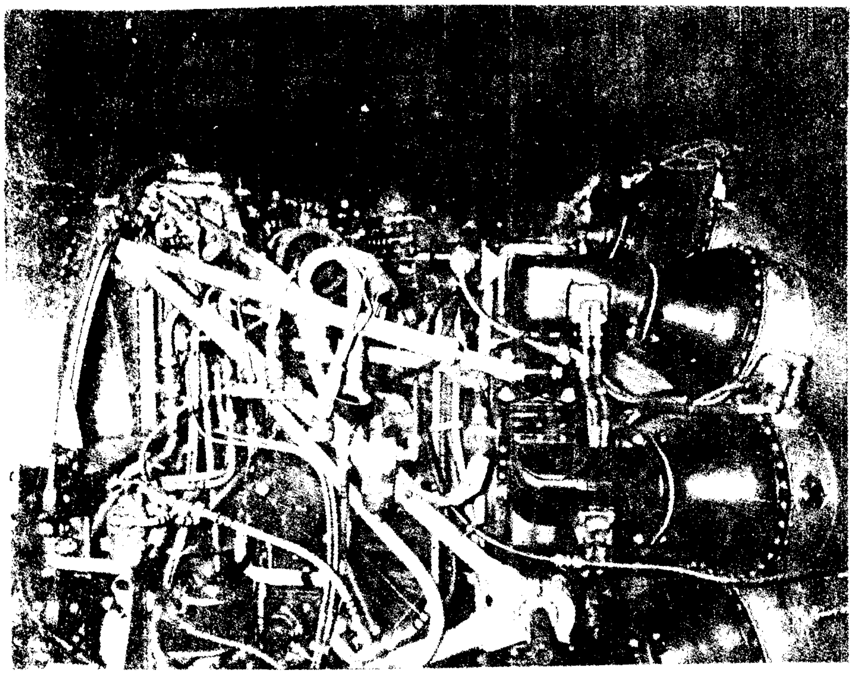
B. Engine Mounting Attachment Points

25X1

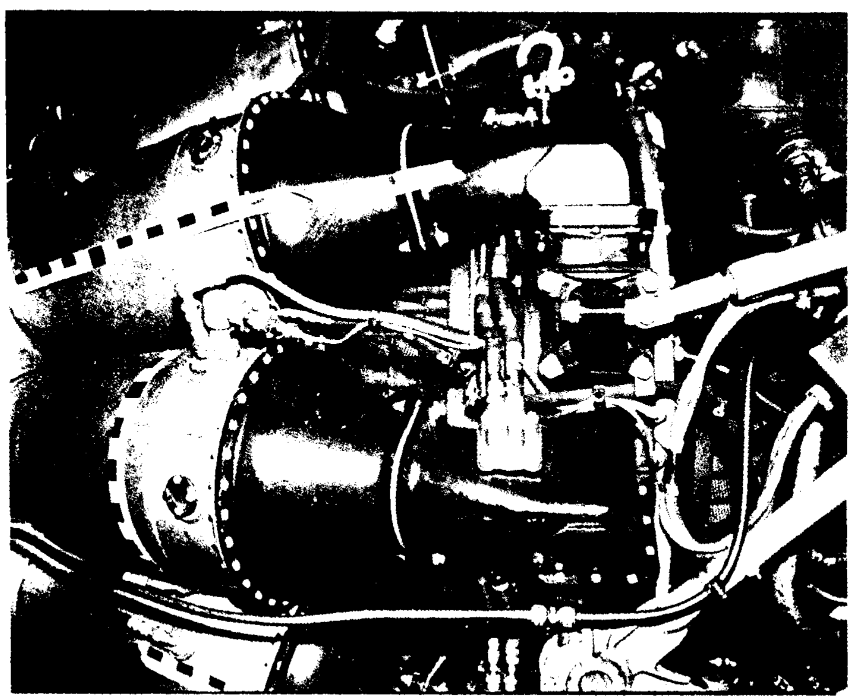
The method of engine mounting was identical to the previous cases, except for slight dimensional differences in lengths of supporting members. [redacted] the upper supporting strut in this case was measured to be 31.25". The intermediate support was 41.0" and the lower support 36.5" in length, center to center.
The vertical distances between mounting points on both engine and fuselage were found to agree with those previously measured i.e. 16.25" and 41.0" respectively.



Photograph 4. LIS-2 Engine - Attachment Points.

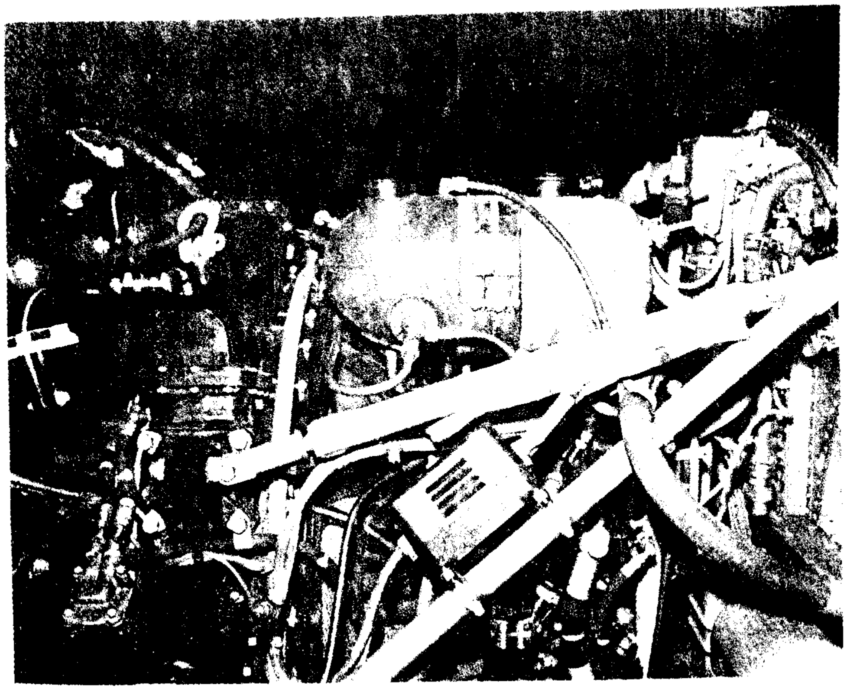


Photograph 5. LIS-2 Engine - Installation Details.

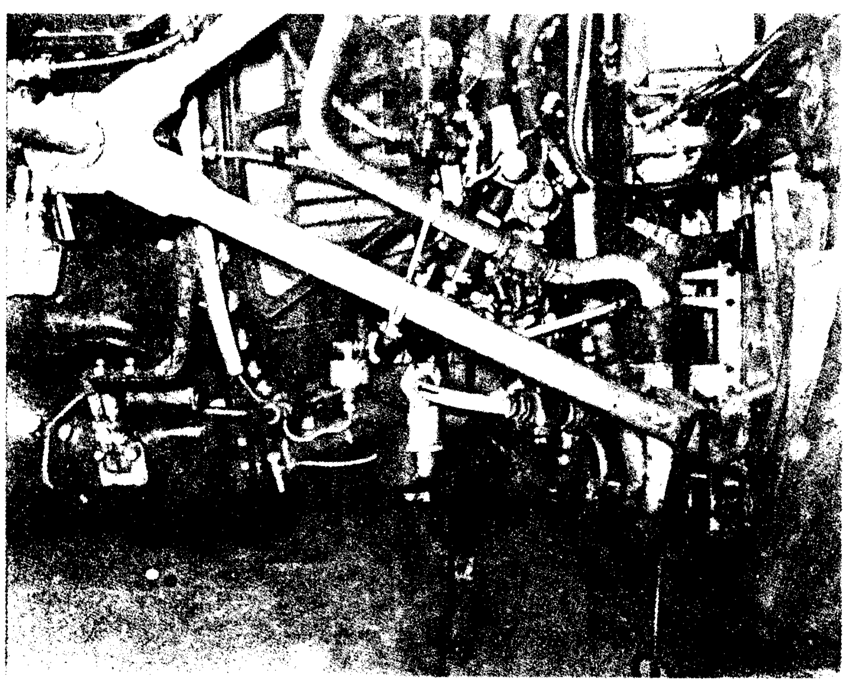


Photograph 6. LIS-2 Engine - Installation Details.

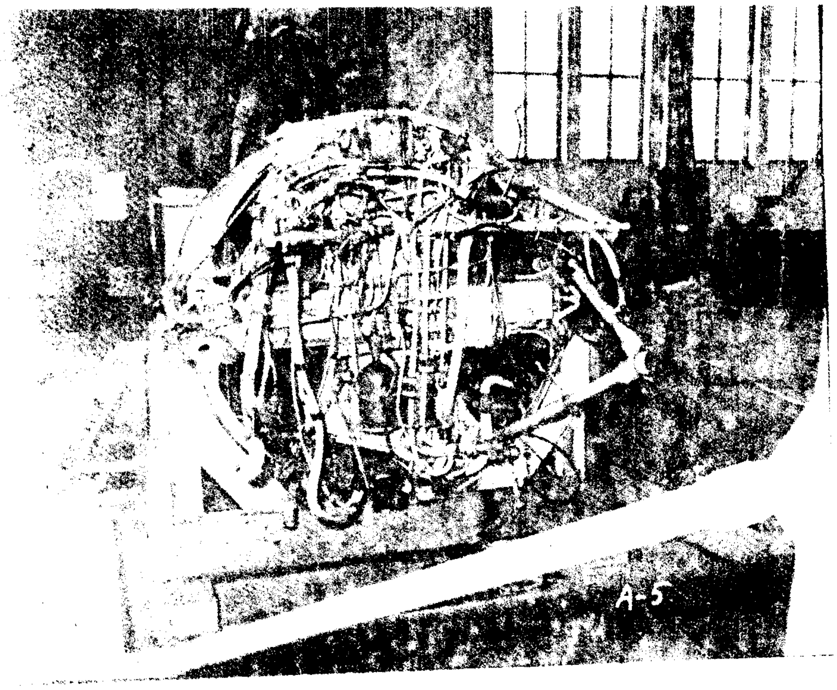
SECRET



Photograph 7 LIS-2 Engine Installation Details.

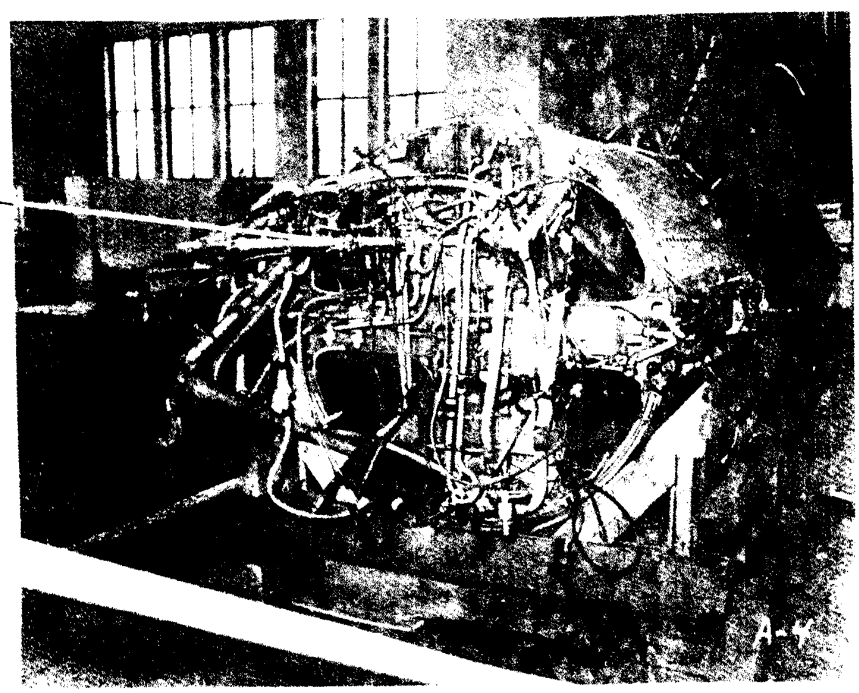


Photograph 8 LIS-2 Engine - Installation Details.



Photograph 9 Fuselage at Frame 13.

A



Photograph 10 Fuselage at Frame 13.

A. Auxiliary Gearbox Drain Valve.

SECRET

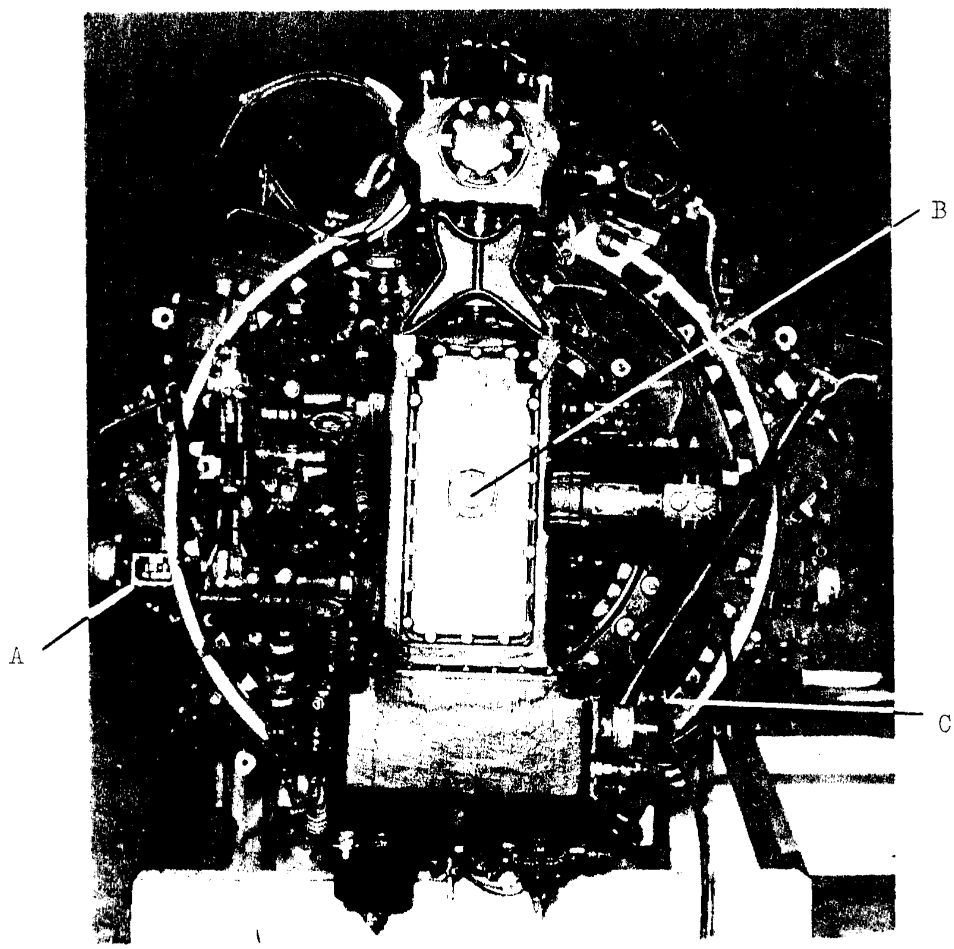
SECTION VI

ENGINE DESCRIPTION

A. Wheelcase

The breather on this engine was located in the central pad on the front face of the wheelcase [redacted] The breather tube [redacted] was not present on this aircraft.

25X1



Photograph 11. LIS-2 Engine - Front View

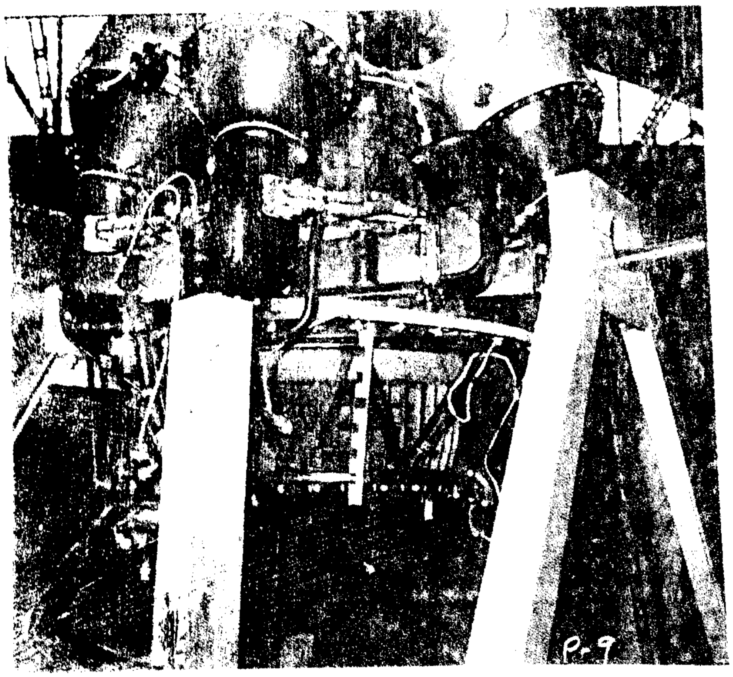
A. Engine Data Plate
B. Breather
C. Push-button Oil Level Valve.

25X1

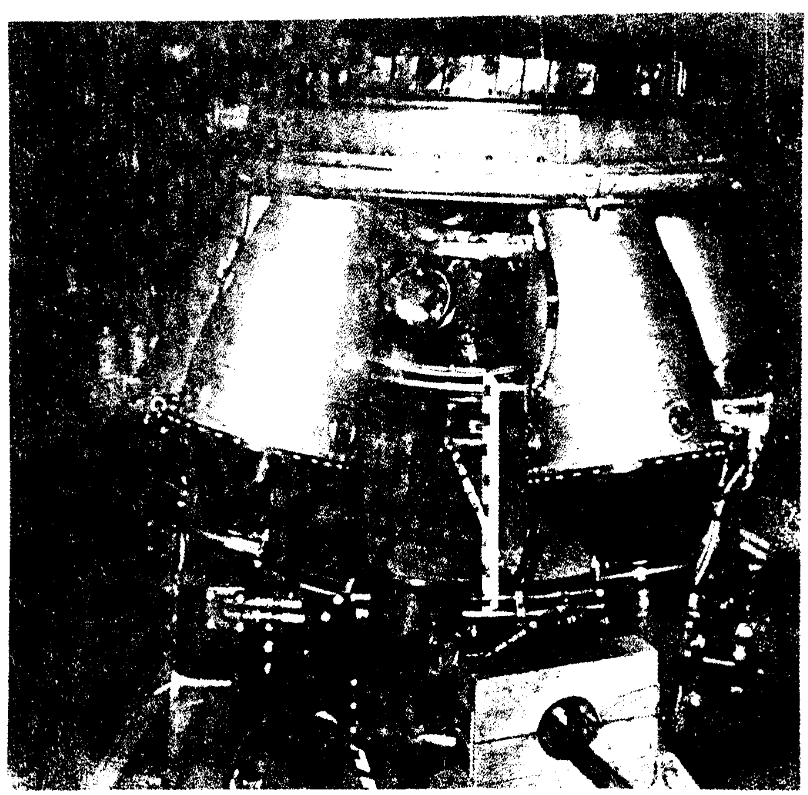
B. Compressor Section

1. Air Intakes

The dimensions of the airintake screens [redacted] as being overall dimensions, 25X1 were found, on this engine, to be the dimensions of the open mesh, i.e. not to include the sheet metal rims. This difference is not thought to indicate a change in design but is considered to be due to error in the production of those earlier drawings.



Photograph 12.
Front Air Intake



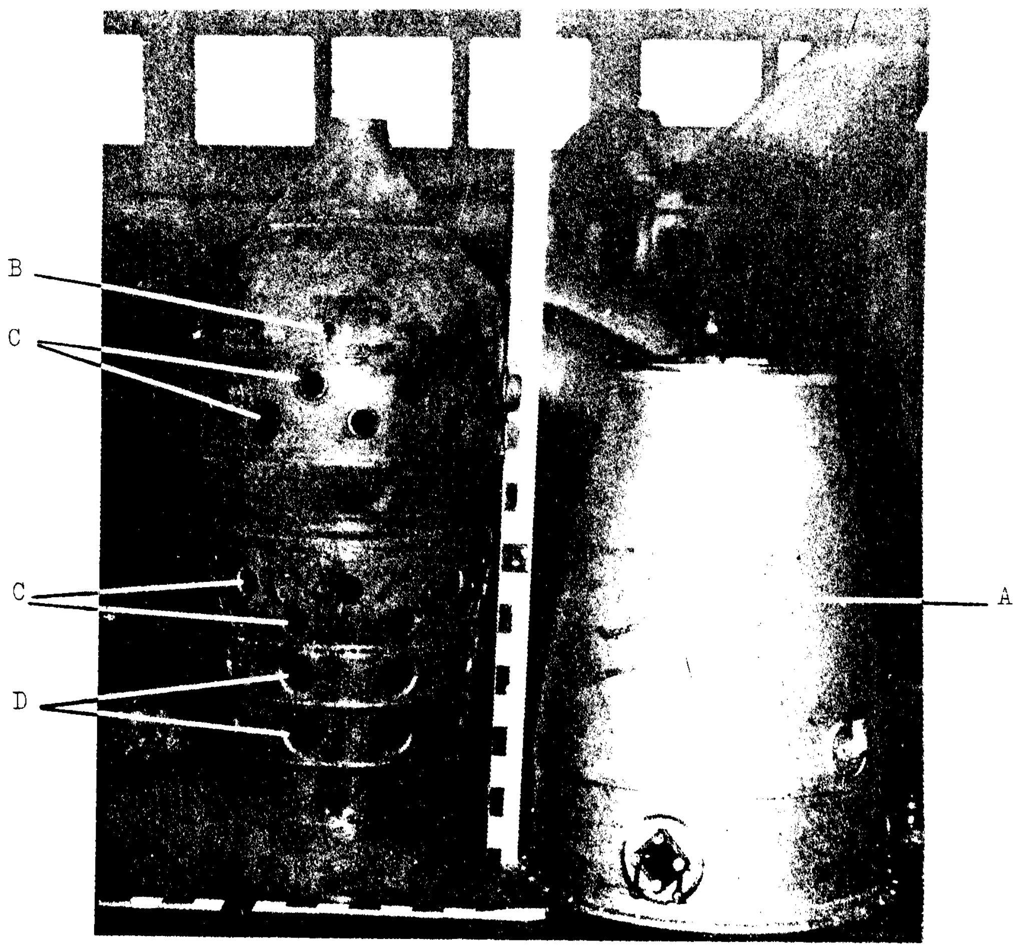
Photograph 13.
Rear Air Intake

SECRET

C. Combustion Assembly

2. Air casing

Although the dimensions of the air casing remained the same as previously, a different fabrication technique was employed. Instead of the helical weld construction of the previous cans, these air casings were made of two sections joined by a circumferential seam. Each of the two sections was apparently formed by deep drawing from a single piece. The seam joining the two sections was overlapping, spot welded, and brazed to seal the joint. The front flange on the casing was also attached by this method, i.e. spot welded and brazed. The rear flange was attached by means of a continous resistance weld.



Photograph 14. Air Casing and Flame Tube

A. Single-piece conical section of air casing.
B. Dimpled keyhole slots.
C. Reinforcing eyelets.
D. Flanged holes.

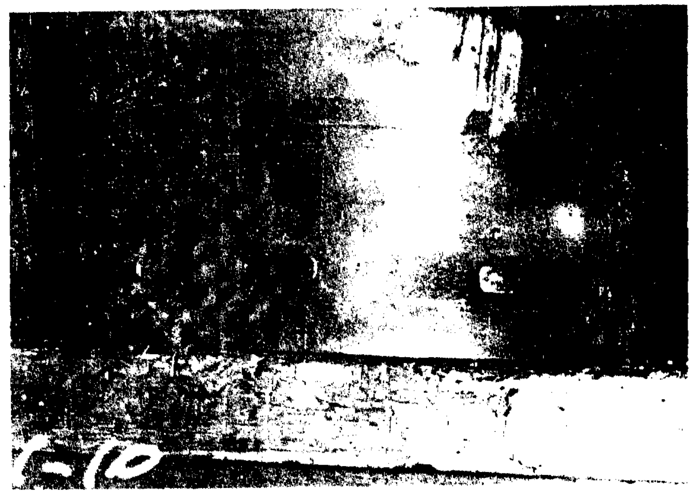
3. Flame Tube

The following differences were noted on flame tube construction (see photograph 14):

a. The edges of the holes in the rear two rows were turned inwards to form a stiffening flange.

b. Four rows of holes were eyelet reinforced similar to rows 3 and 4 of the previously observed engines.

c. The keyhole slots in the front conical section were dimpled slightly inward at the rounded end of the slot.



Photograph 15. Flame Tube Rear End.

E. Exhaust Duct

The exhaust cone assembly was found to have slightly different dimensions [redacted] 25X1
The differences may be attributable to measuring techniques, but a new drawing showing the currently measured dimensions is shown in Dwg. no. 16.

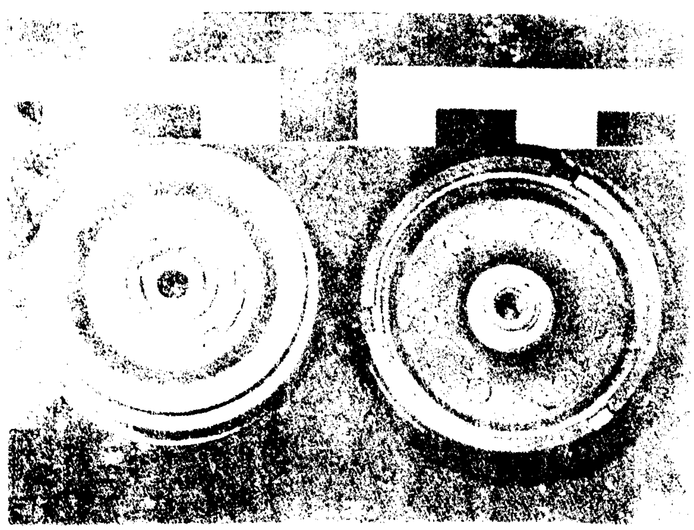
Photograph 16. Exhaust Duct Assembly.

25X1

F. <u>Engine Lubrication System</u>

A spring-loaded valve (push-to-open) was installed at the base of the oil filler neck to permit easy draining of surplus oil. (See photograph 11). This valve was also installed on the earlier MIG aircraft reported on [redacted]

The pressure oil filters in this LIS-2 were identical to those previous reported [redacted] 25X1



Photograph 17.
Pressure Oil
Filter Element

Photograph 18.
Pressure Oil
Filter Element

SECRET

25X1

H. Starting System

1. General

[redacted] a redesigned starter panel and an improved starter motor were fitted.

These two components are fully described in part 5 (Electrical System) of this report.

SECTION VIII

AUXILIARY GEARBOX

A spring-loaded valve (push-to-open) was fitted in a pipeline leading from the auxiliary gearbox to an overboard drain point. Operation of this valve ensures against overfilling by draining off any surplus. 25X1

[redacted]

A. Generator.

See part 5 (Electrical System) of this report.

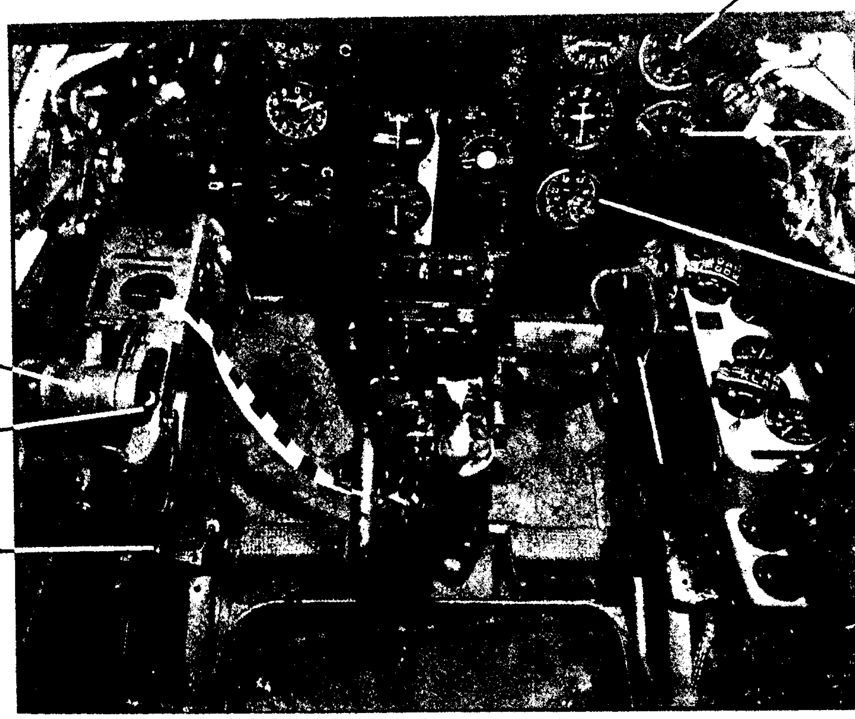
SECTION IX

ENGINE INSTRUMENTS AND CONTROLS

A. Engine Controls and Switches

The only point of difference in engine controls and switches between this aircraft and those previously reported on, was that the throttle locking or friction lever had the reverse method of operation to that described on page 95 in Section IX of the April 1953 report, (and shown in photograph 15-79 on the same page).

In this aircraft the operation was:
"Down" for freedom.
"Up" for locked.



Photograph 19. LIM-2. Cockpit Layout

A. Throttle lever friction control (In "free" position).
B. Engine starter button on throttle lever.
C. Throttle lever in closed position.
D. R.P.M. Indicator.
E. Jet Pipe Temperature gauge.
F. Engine gauge unit.

C. Engine Instruments

The only significant points of difference between the engine instrument presentation in this aircraft and those previously reported, lay in the colours painted on the instrument bezels. The functioning of all instruments is fully described in Part I of this report, and the position in the cockpit of engine gauges is as described in earlier reports and as indicated in photograph 19.

1. Engine Gauge Unit

This compound gauge has three indicating dials and their ranges and colour bands are as follows:

a. Top Main Scale - Pilot Fuel Nozzle Pressure

Reading	-	kg/cm^2
Range	-	0 to 100
Markings	-	0 to 56 Blue 56 to 100 Red

b. Left Bottom Scale - Oil Pressure

Reading	-	kg/cm^2
Range	-	0 to 10
Markings	-	0 to 2 Yellow 5 to 10 Red

c. Right Bottom Scale - Oil Temperature

Reading	-	^{o}Centigrade
Range	-	-50 to +150
Markings	-	-50 to +100 Blue 100 to 150 Red

2. Jet Pipe Temparature Gauge

Reading	-	°Centigrade	
Range	-	40 to 900	
Markings	-	0 to 680	Blue
		680 to 700	Yellow
		700 to 900	Red

3. RPM Indicator

Reading	-	RPM x 1000	
Range	-	0 to 15	
Markings	-	5 to 11.2	Blue
		11.2 to 11.6	Yellow
		11.6 to 15	Red

In addition, on this instrument, an inner ring of blue extended from 11.4 to 11.7

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SECTION X

MATERIAL ANALYSES

B. Combustion Chamber Inner Liners (Flame Tube).

Approximate composition found:

Chromium.....20%
Iron......... 1%
Titanium.....a little
Nickel.......remainder

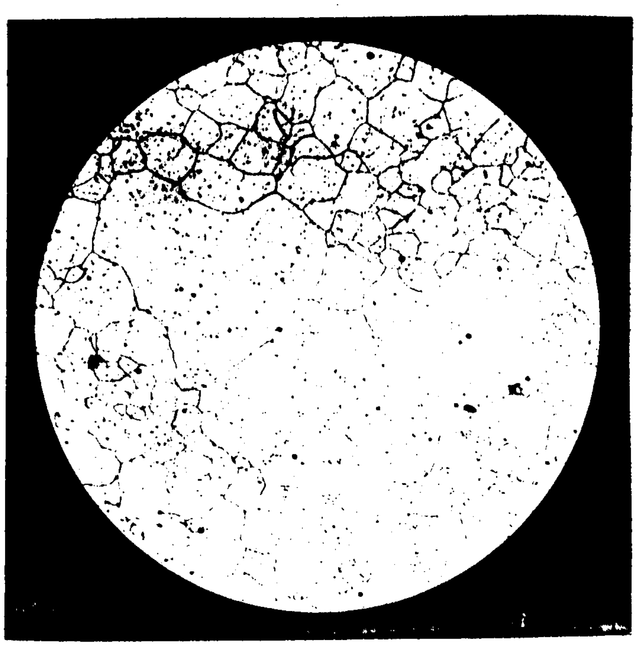
Type of material: A Nimonic type, probably Nimonic 75.

C. Turbine Disc.

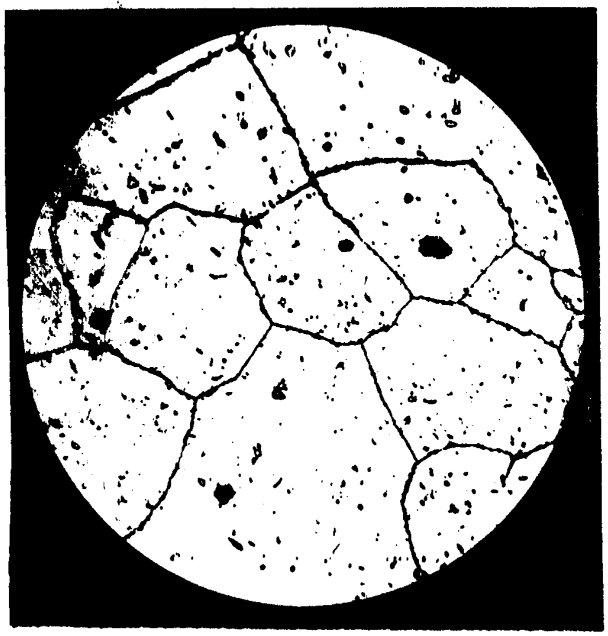
The turbine disc is made from a magnetic steel with the following approximate composition:

Chromium.....3½%
Manganese.... 1%
Vanadium..... 1%
Molybdenum... ½%
Carbon....... 0,24%
Sulphur...... 0,024%
Iron......... remainder

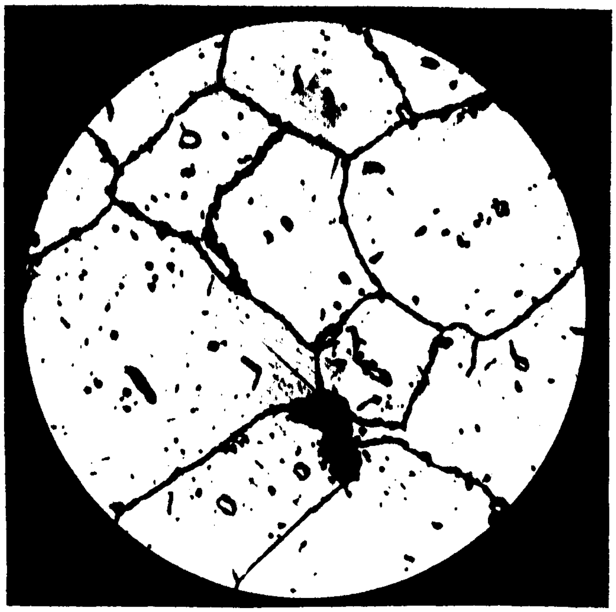
D. Turbine Blade.



Photograph 20.
Turbine Blade x 75
(Diamond-polished, etched with HNO3 - HCl.



Photograph 21.
Turbine Blade x 400
(Polished and etched as in photograph 20)



Photograph 22.
Turbine Blade x 750
(Polished and etched as in photograph 20)

1. Spectrographic and Chemical Examination

Approximate composition:

Nickel..............	75%
Chromium.............	23%
Iron................	1½%
Titanium more than	1%
Manganese	a little
Nickel..............	remainder

(Similar to Nimonic 80A)

2. Microscopic examination

As it is to be seen from photograph 20 the grain size is very irregular. From photographs 21 and 22 the second phase will appear.

3. Hardness test: 402 Vickers, 500 grammes load.

E. Nozzle Guide Vane.

1. Spectrographic and Chemical Examination

Approximate Composition:

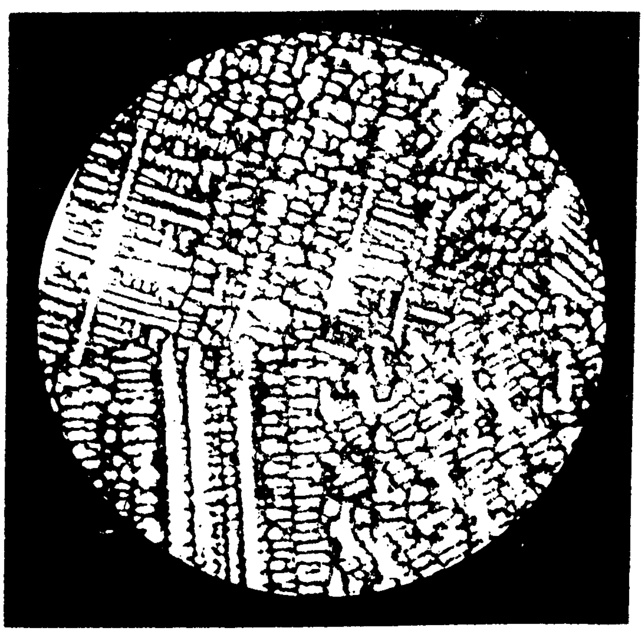
Iron............	31%
Chromium........	20%
Tungsten........	8%
Silicon.........	½%
Titanium........	a little
Nickel..........	remainder

2. Microscopic examination

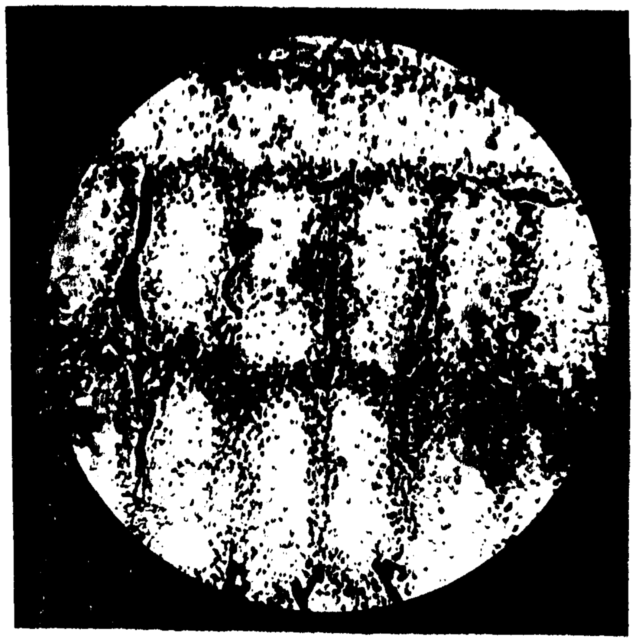
As is to be seen from photograph 23, the guide vanes show a casting structure with coarse dendritic formations. By greater enlargment, see photographs 24 and 25, it is to be seen that the mixed carbides between the primary dendrites have been more or less dissolved, as it seems that the material has been exposed to a kind of solution heat-treatment with a following re-segregation of the carbides into fine particles.

Therefore it is most probable that after casting the guide vanes were heat-treated in order to achieve a better relative strength.

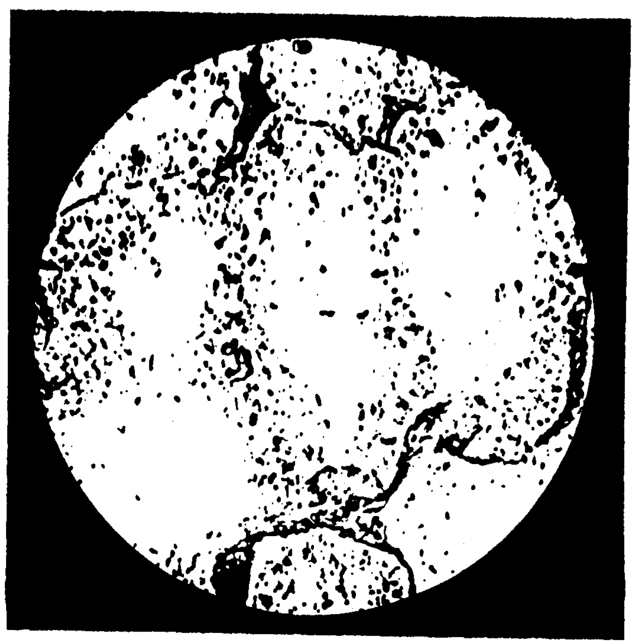
3. Hardness: 276 Vickers, 500 g load.



Photograph 23.
Nozzle Guide Vane x 75
(Electro-polished and etched in Knuth-electrolyte A2).



Photograph 24 Nozzle Guide Vane x 750
(Polished and etched as in photograph 23)



Photograph 25 Nozzle Guide Vane x 1500
(Polished and etched as in photograph 23)

SECTION XI

MISCELLANEOUS

Fire Extinguisher System

The only difference in this system from those previously reported lay in the steel CO2 bottles which were marked in Polish, and whose weights and capacities varied slightly from those marked in Russian on the earlier MIG aircraft.

A translation of the Polish wording is:

	Bottle 1	Bottle 2
Weight of cylinder	4408 g.	4124 g.
Capacity	2914 cm^3	2955 cm^3
Quantity of CO2	1981 g.	2008 g.

Photograph 26. Engine Fire Extinguisher Bottles.

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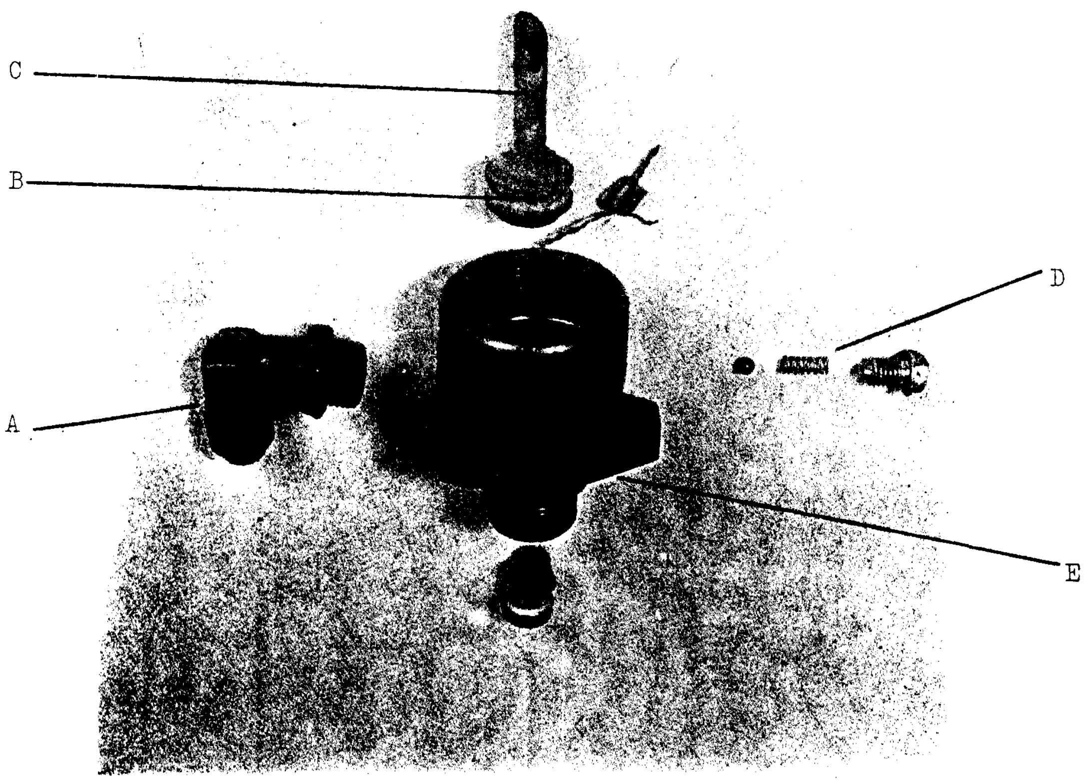
[redacted] the exploded view in photograph 27 is included to clarify its build-up and operation.



Photograph 27. Fire Extinguisher Bottle Head.

A. Outlet elbow to spray pipes.
B. Circumferential groove.
C. Hollow diaphram-piercing knife.
D. Spring-loaded ball for restraining free movement of knife.
E. Body of head fitting.

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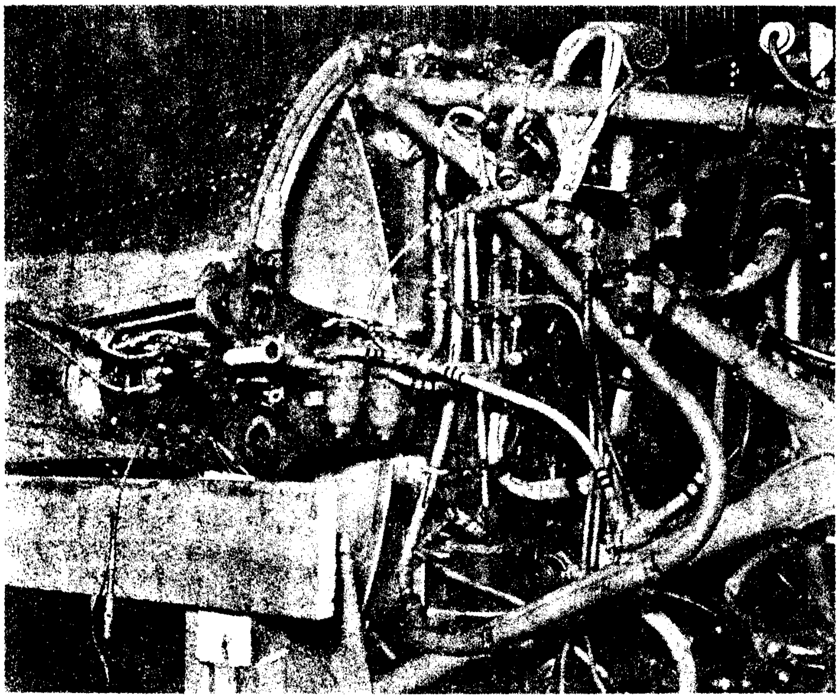
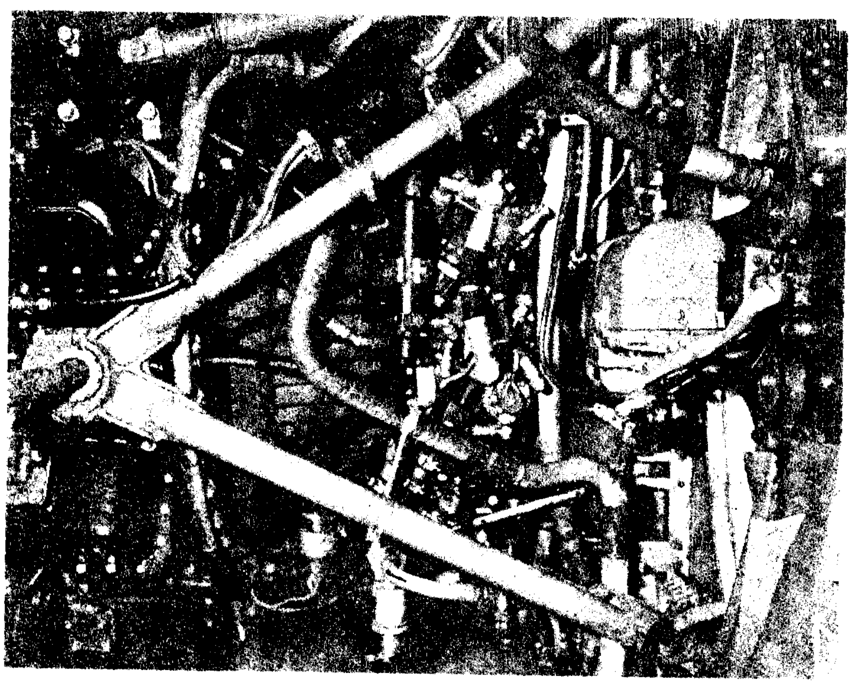
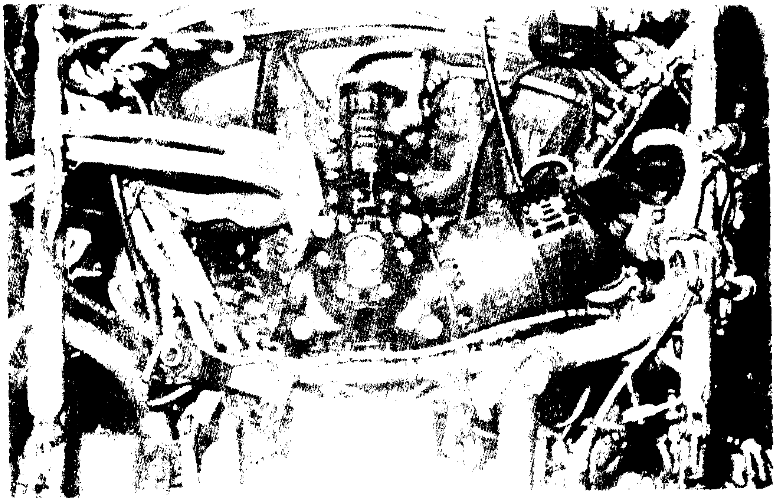
SECTION XII



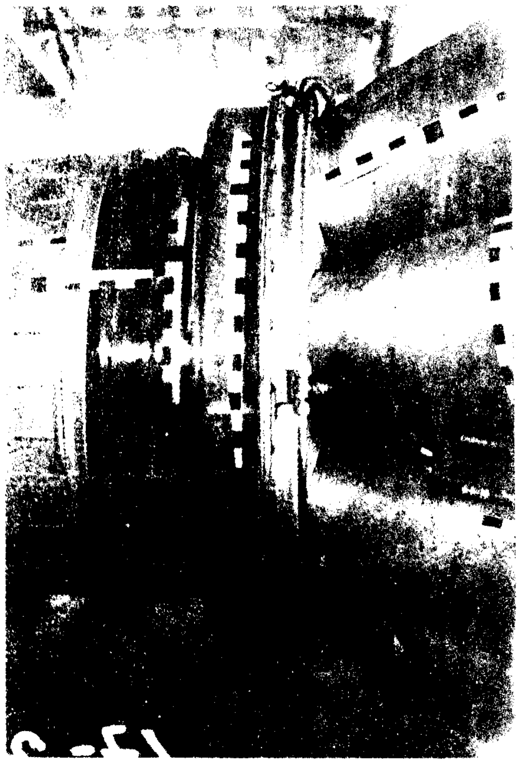
Photograph 28 LIS-2 Installation



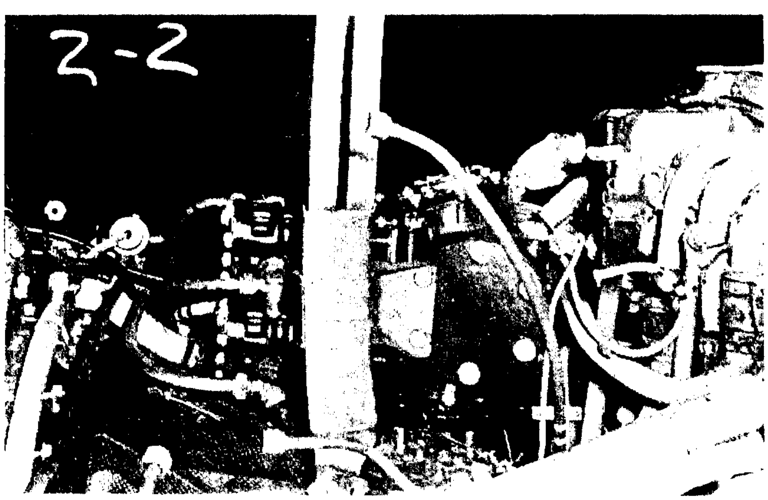
Photograph 29 LIS-2 Installation



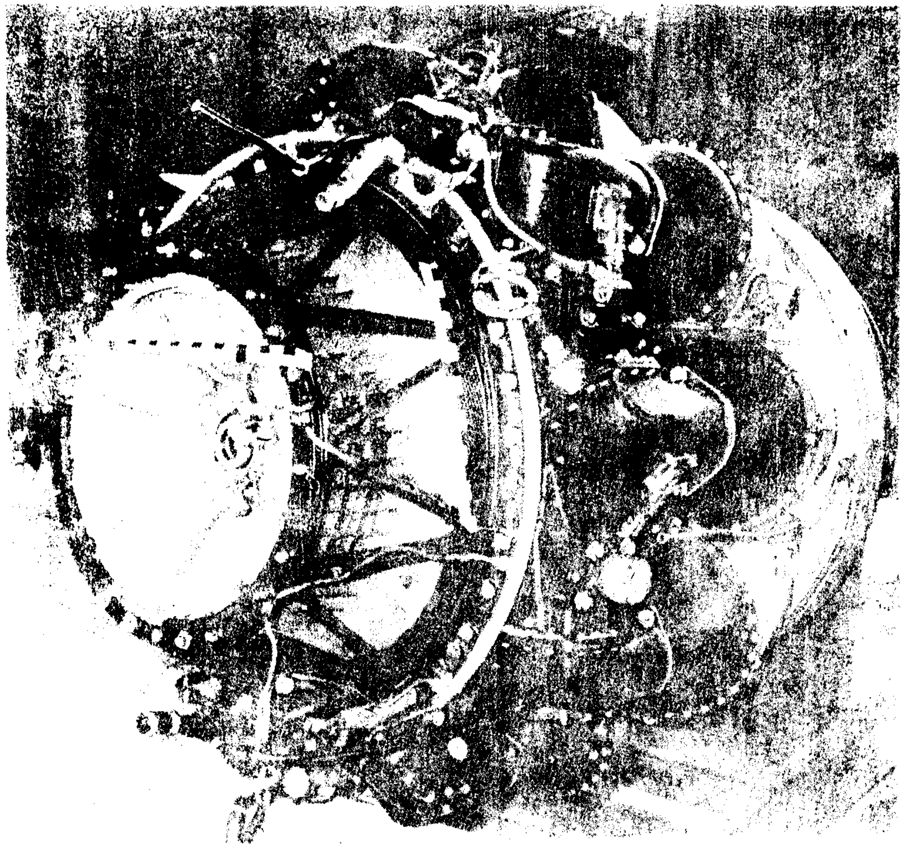
Photograph 30
Installation Top View



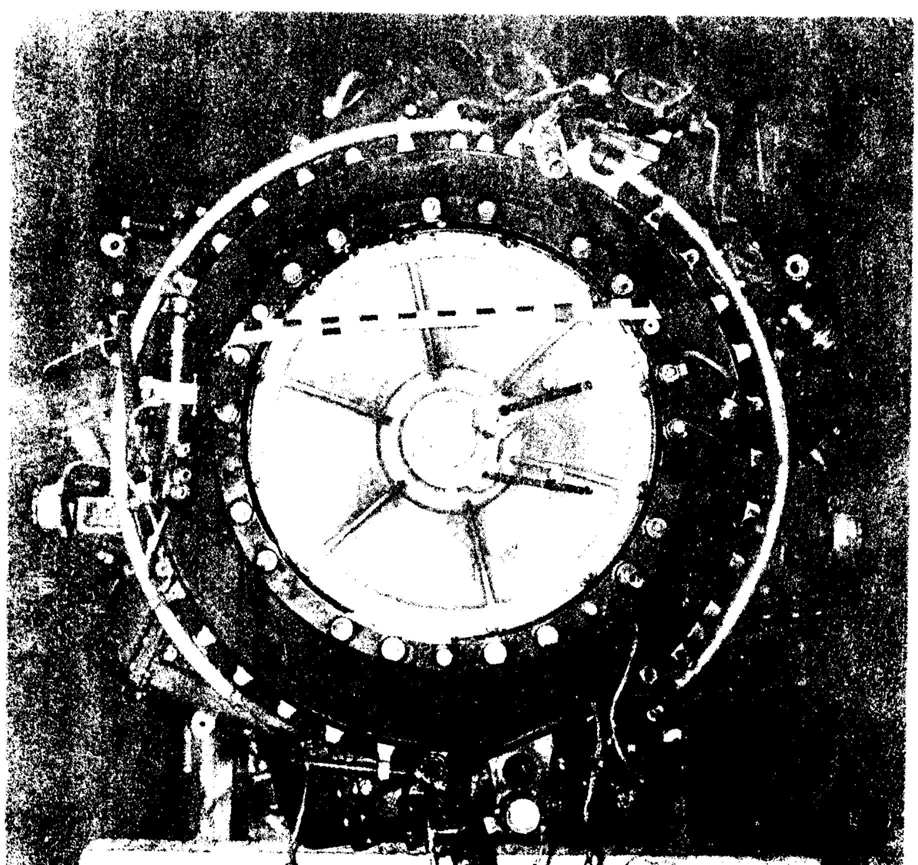
Photograph 31
Nozzle Box Assembly



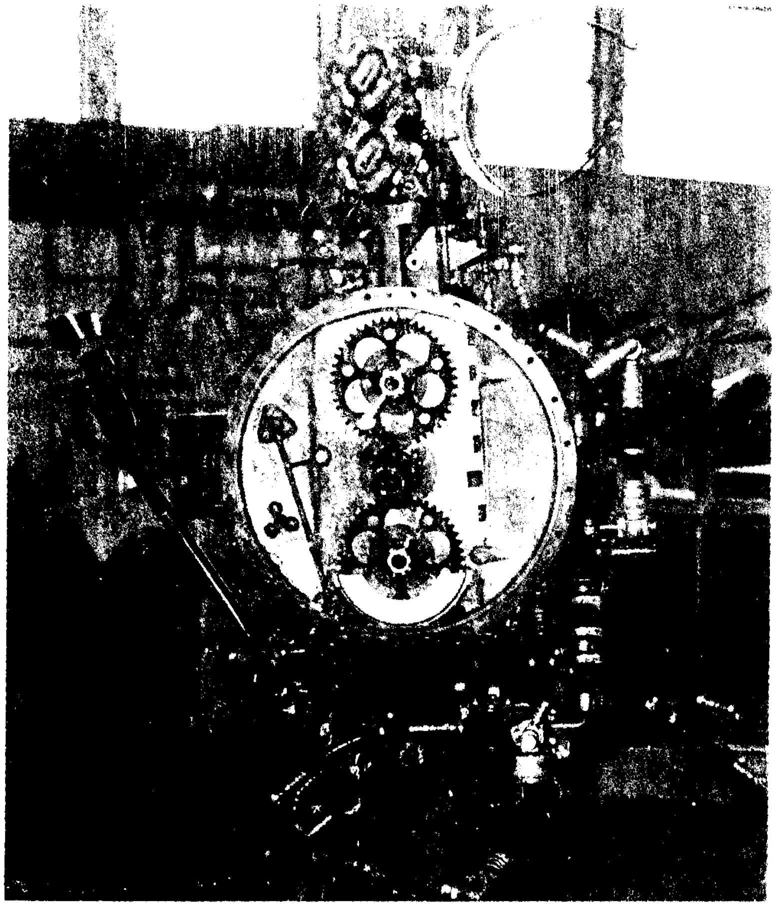
Photograph 32
Installation Top Right View



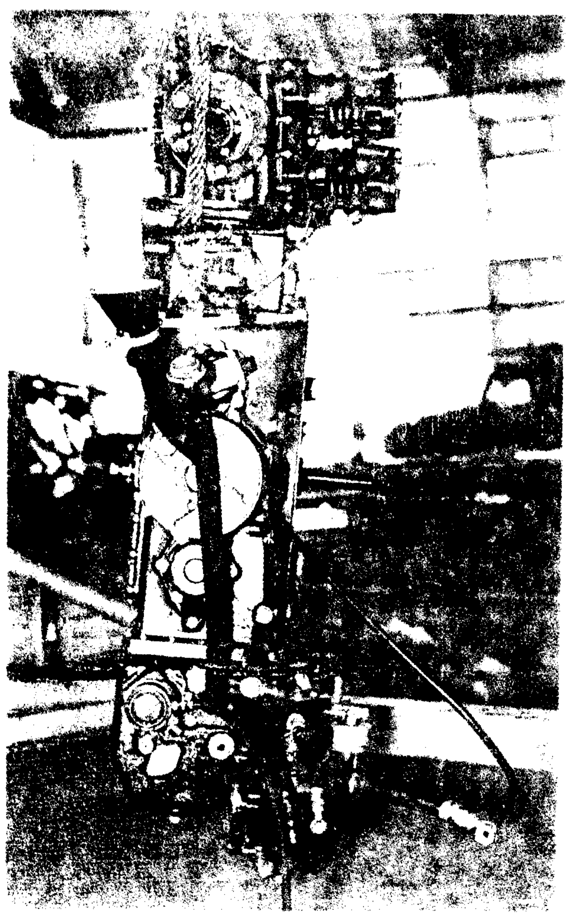
Photograph 33 LIS-2 Engine.



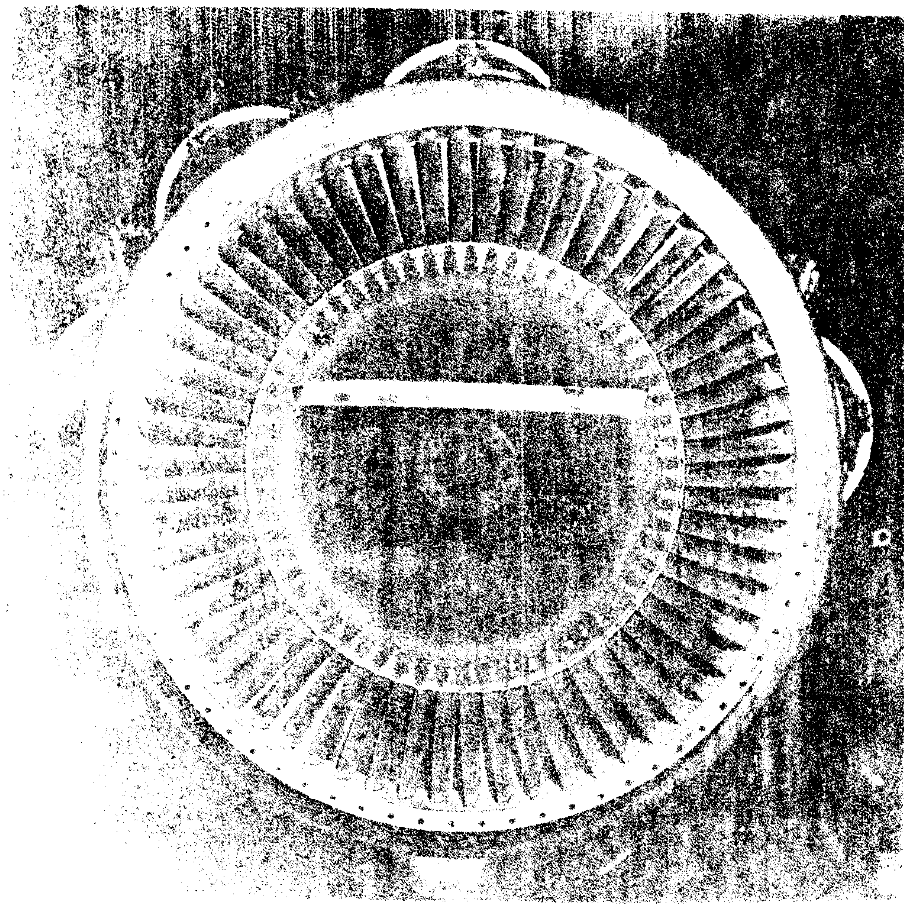
Photograph 34 LIS-2 Engine.



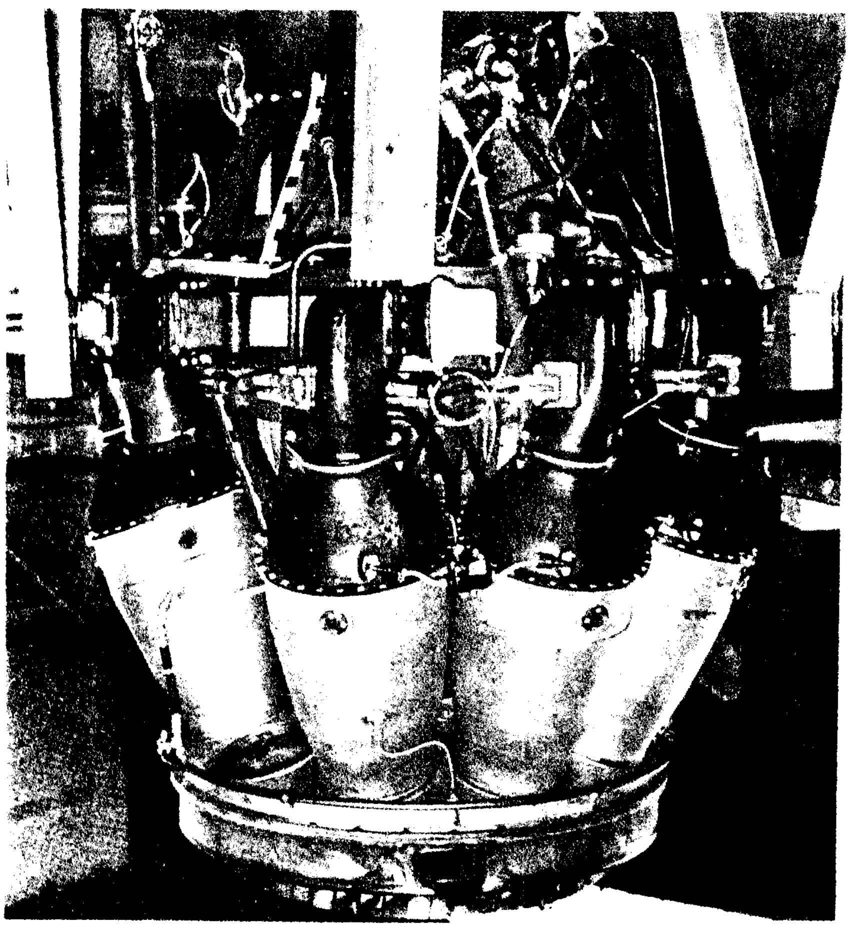
Photograph 35
Wheelcase -
Rear View



Photograph 36
Wheelcase -
Left side View.



Photograph 37
Turbine
Assembly



Photograph 38
LIS-2 Engine

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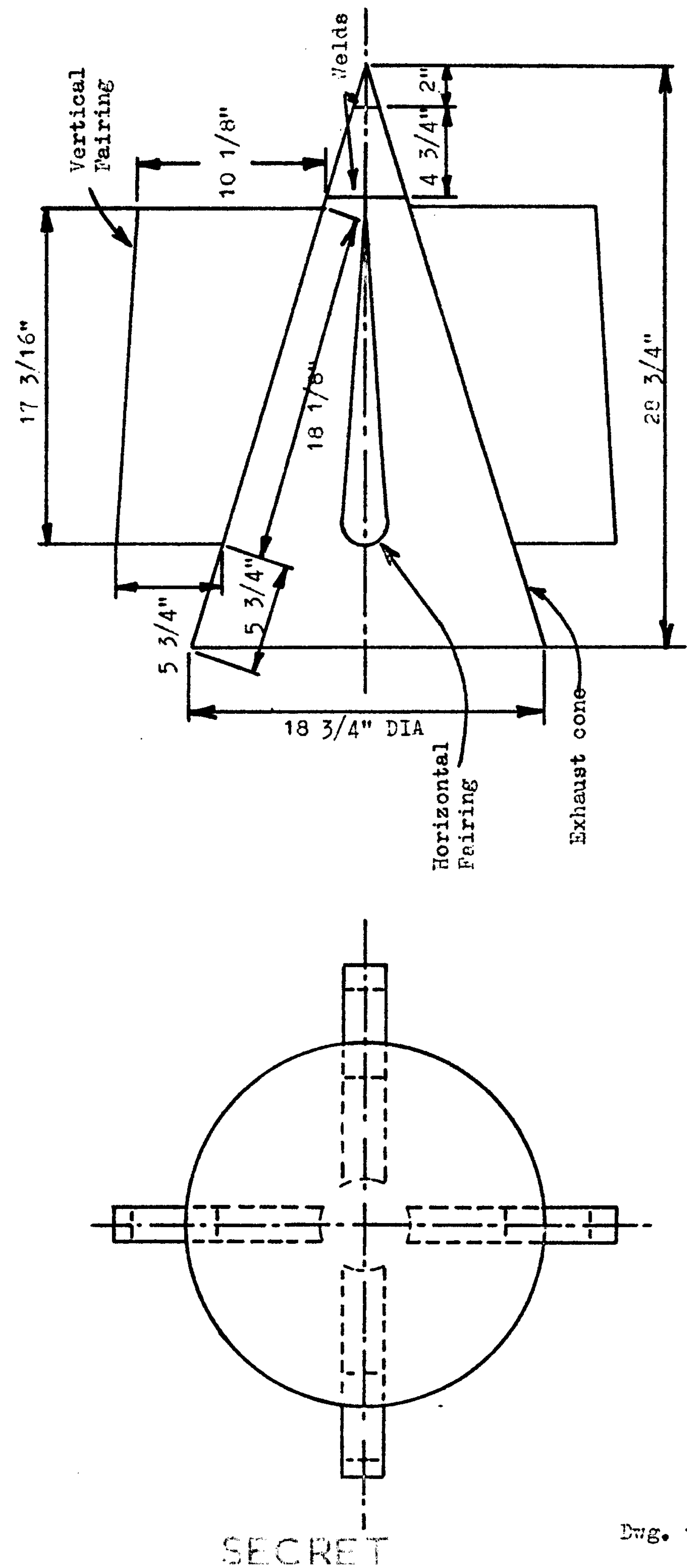
EXHAUST CONE ASSEMBLY



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TECHNICAL REPORT
ON
MIG 15 BIS
NO 1327

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PART THREE
ELECTRONICS

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PART THREE

ELECTRONICS

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LIST OF DRAWINGS

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PART THREE

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ELECTRONICS

SECTION I

FOREWORD

The following report is based upon information gained from examination of a Polish built aircraft (known as "FAGOT"), designated LIM-2 (Polish designation for the USSR MIG-15 BIS)

The full report has been divided into six seperate publications as follows:

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- Part One - Airframe
- Part Two - Engines
- Part Three - Radio and Navigation
- Part Four - Armament
- Part Five - Electrical
- Part Six - Manufacturing Methods

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SECTION II

GENERAL SUMMARY

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A. General

1. The radio installation of the MIG-15-BIS (Polish designation LIM-2) No. 1327, consist of:

    (a) VHF Command Transmitter Receiver Type RSI-U-3M.
    (b) Radio Altimeter Type RV 2.
    (c) Radio Compass Type ARK 5.
    (d) Marker Beacon Receiver Type MRP-48-P.

2. All the electronic equipment was of Russian manufacture except the Marker Beacon receiver, which was Polish. There is evidence of the modification of some equipment e.g. Radio Altimeter, since it was exploited in 1953. The equipment had differing dates of manufacture, the latest being some time in August 1955.

3. Available space throughout the aircraft appeared to be extensively utilized. However, more space could be made available in the nose compartment, if the accumulator and oxygen bottle be repositioned elsewhere, this could allow the installation of a simple gun ranging radar in addition to the present equipment.

B. Electronic Installations.

1. Command Transmitter Receiver RSI-U-3M. This equipment is a four channel crystal controlled VHF set, operating in the frequency range 100 to 150 MCS. The installation comprises separate transmitter and receiver units, and seperate power, inverter, and control units. It uses a sword type antenna. The power supply, obtained from the aircraft supply, is converted to 115 volt 400 cps AC in the inverter and is rectified by the power unit to provide the various voltages required by the transmitter and receiver. Channel selection is by the push button method on a control box. The power output of the transmitter is approximately 5 watts.

2. Radio Altimeter RV 2. This installation was similar to that exploited in 1953 except for some minor modifications and the inclusion of an additional filter unit in the LT supply.

3. Radio Compass ARK 5. This installation was similar to that exploited in 1953 except for minor modifications including the redesign of the filter units in the dynamotor.

4. Marker Beacon MRP-48-P. This installation was similar to that exploited in 1953, but was of Polish manufacture.

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C. Installation and Servicing.

1. The radio equipment in the MIG-15-BIS is installed in four regions of the aircraft:

   (a) Underneath the rear fuel tank in the last section,
   (b) between the bulkheads at airframe stations 8 and 9 at the rear of the gun bay,
   (c) within the cockpit,
   (d) in the nose compartment.

2. Apart from that installed in the nose compartment most of the equipment was most inaccessible. Each equipment, including sub-assemblies, was sealed with mounting fasteners locked in position by wire; in most cases this had obviously been done either at the factory or on the production line. In addition the VHF receiver tuning and crystal access cover was wired in position and all bulkhead plug and socket connections were secured in positions by locking wire metal seals.
In one case, the VHF inverter, all instruments on the centre instrument panel had to be removed before the unit could be taken from the aircraft. It is unlikely that the installations were intended to be removed for servicing.

D. Aircraft Electronic Cabling.

1. Connectors are clamped together using polythene straps and a collar stud fastener, but no attempt was made to bond these cables to the airframe. In many cases cables were much too long, the slack being taken up by doubling the cable back on itself.

2. At least four different types of plug and socket are in use in the electronic installations.

3. The negative low voltage power supply connection in all cases was via the airframe, a single wire system being in use throughout the aircraft except on armament installations, where a two wire system was used.

SECTION III

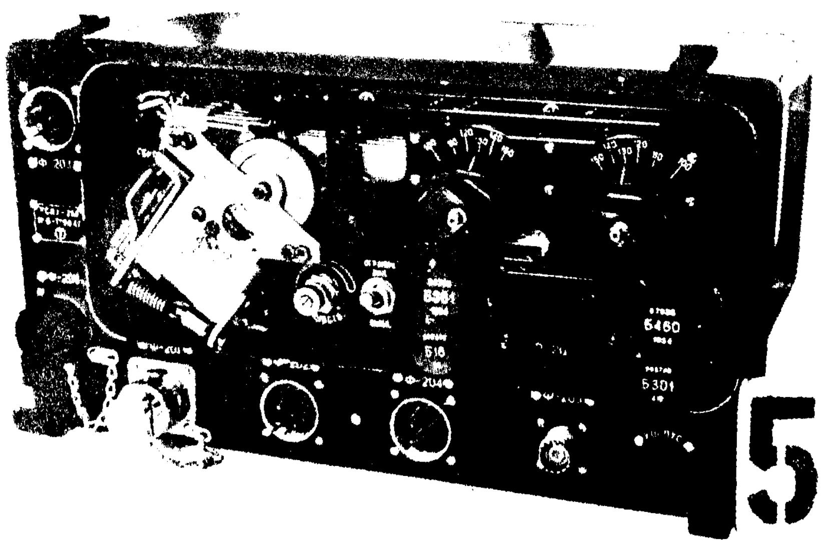
COMMAND TRANSMITTER AND RECEIVER RSI-U-3M(PCИ-Y-3M).

A. General Description.

1. The command transmitter and receiver set, RSI-U-3M was a Soviet-built airborne VHF set, operating in the frequency range of 100-150 mcs. It has four preset crystalcontrolled channels. Channel selection was accomplished in a similar manner to that in the American set, SCR-522, which probably had been the model which inspired the RSI-U-3M, although the Soviet equipment differed completely in many respects from the SCR-522.

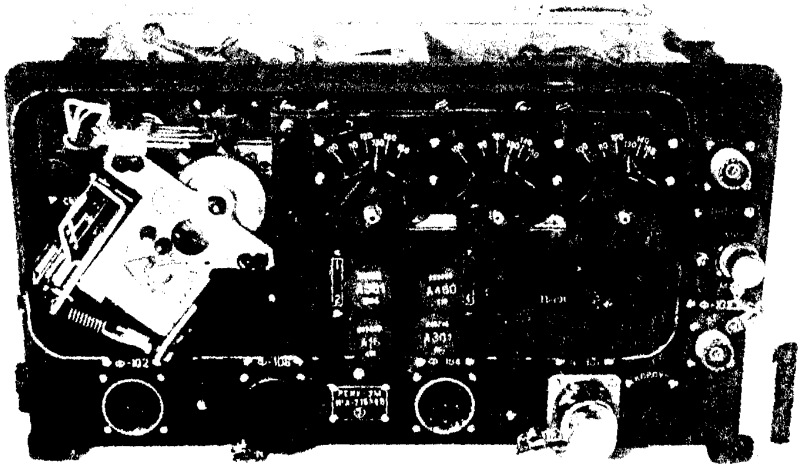
2. The RSI-U-3M consisted of the following units:

(a) Transmitter RSI-U-3M(PCИ -Y-3M) (Fig.3-2), weight 9,5 kg
(b) Receiver RSI-U-3M(PCИ - Y-3M)(Fig. 3-1), weight 11,3 kg
(c) Power Supply Type VM(BM) (Fig. 3-3), weight 5,8 kg
(d) Inverter MA-100-M(MA-100-M) (Fig. 3-4), weight 7,1 kg
(e) Control Box Type P(TИП - П) (Fig. 3-5)
(f) VHF Stub Antenna (Fig. 3-6), weight 1,3 kg
(g) Mounting Tray for Transmitter and Receiver, weight 1,3 kg.

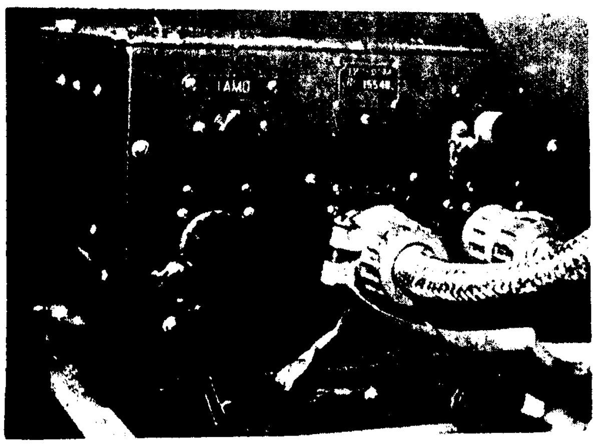


(Fig. 3-1)

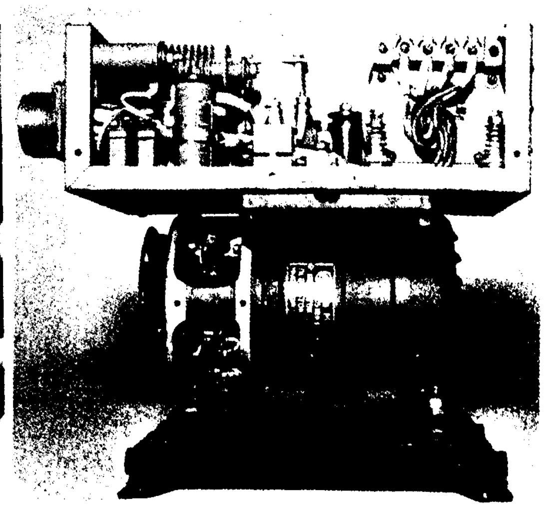
Receiver RSI-U-3M.



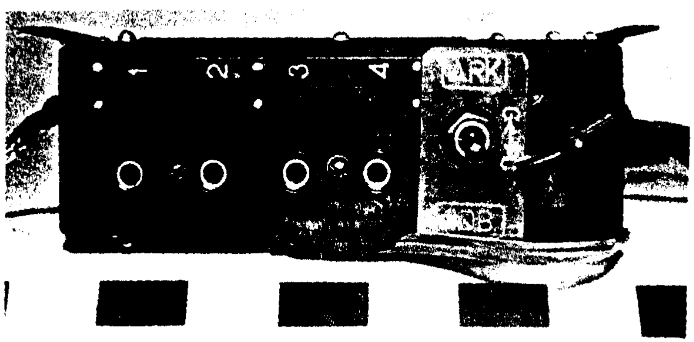
(Fig. 3-2)
Transmitter
RSI-U-3M.



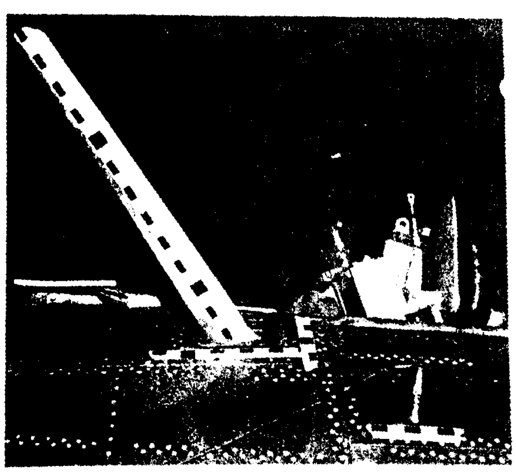
(Fig. 3-3)
Power Supply Type VM



(Fig. 3-4)
Inverter Type MA 100 M.



(Fig. 3-5)
Control Box
Type P



(Fig. 3-6)
VHF Stub Antenna.

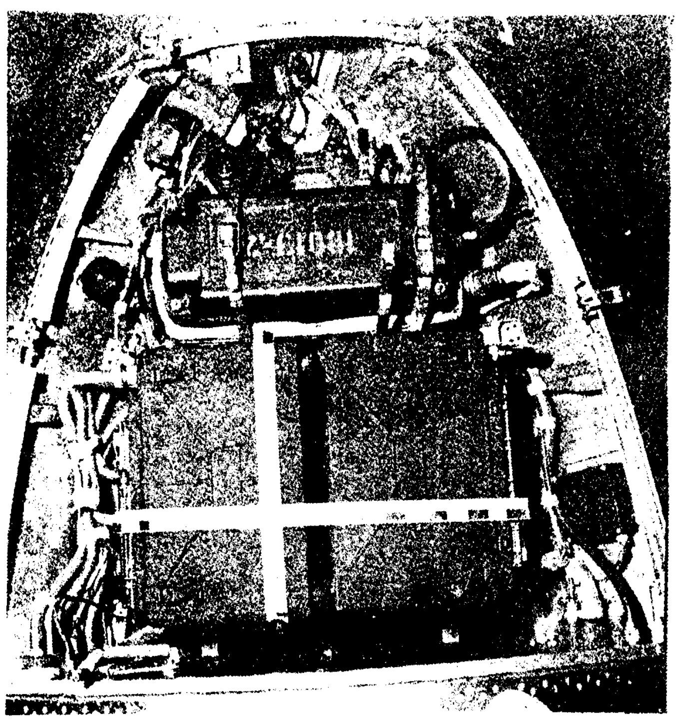
3. The receiver and the transmitter were each housed in separate boxes, back to back, port to starboard, on a tray in the nose compartment between the cockpit bulkhead and the battery. The power supply was installed on the port side of the cockpit bulkhead and the battery. The power supply was installed on the port side of the cockpit, just aft and to the left of the pilot's left arm. In previously investigated "Fagots" this area was utilized for the RSI-6-M-1 receiver.
The inverter was installed behind the central instrument panel and the central instrument complex leads had to be removed, one by one, to permit removal of this inverter. The control box was mounted on the port side of the cockpit, easily accessible to the pilot's left hand. The VHF antenna, a quarter-wave sword, was mounted just starboard of the top centerline of the aircraft, immediately aft of the cockpit canopy.

4. The face of the control box was equipped with four push buttons for the four channels marked 1,2,3 and 4; a volume control and a switch for selecting the audio output of either the radio compass or the VHF. A push button on the end of the box permitted the disengaging of any channel selector button engaged at the time. The channel selector windows were equipped with a luminous slide, identifying the channel selected.

5. The VHF set RSI-U-3M was capable of transmitting and receiving amplitude modulated signals in the frequency band 100-150 mcs. No facility existed for transmitting MCW signals.

6. The RSI-U-3M appeared remarkably clean and new inside. Markings on resistors and capacitors were easily discernable and

Receiver



Transmitter

Fig. 3-7.
RSI-U-3M Transmitter and Receiver Installation.

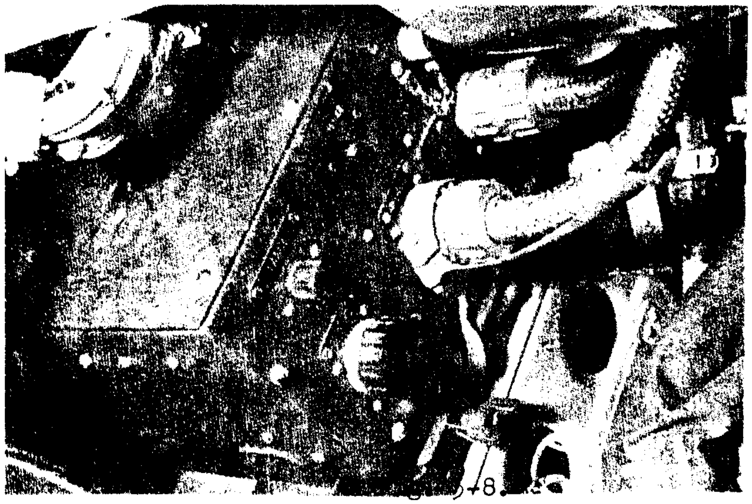


Fig. 3-8.
VHF Power Supply Port Side Cockpit.

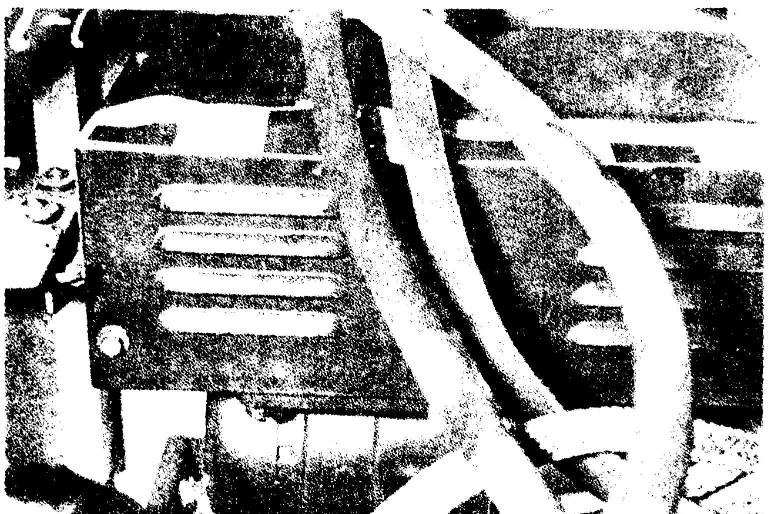


Fig. 3-9.
VHF Inverter Behind Instrument Panel.

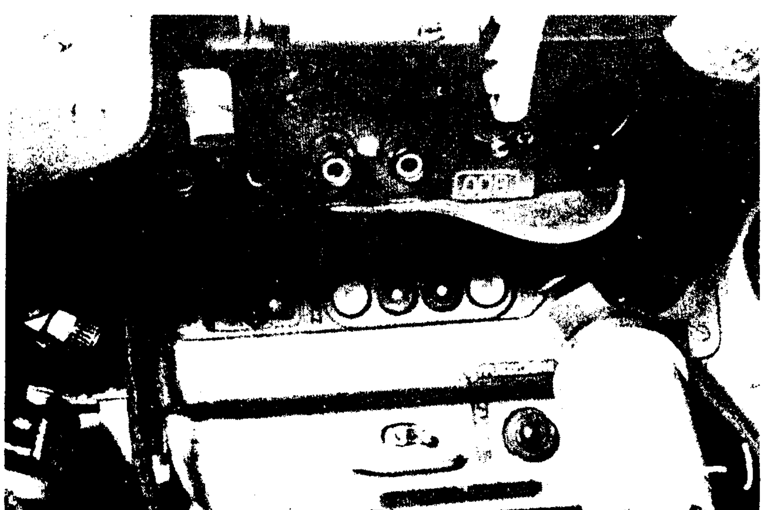


Fig. 3-10.
VHF Controller Port Side Cockpit.

showed no signs of being discoloured or burned through use. The interiors were free of dust and chassis were not corroded.

B. Technical Data.

1. Transmitter RSI-U-3M (See Fig. 3-11 below).
Transmitter RSI-U-3M consisted of an oscillator (Л -101, 6 Л 6C), which served as a frequency doubler as well and fed a tripler (Л-102, 6 Л 6C) which, in turn, fed another tripler (Л -103, Г У -32), push-pull amplifier stage, making a frequency multiplication of eighteen in all. At this point, the signal was introduced into the push-pull power amplifier (Л -104), Г У -32). The RF output went to the antenna switching relay P-101, which changed over the antenna between receiver and transmitter. A small portion of the RF output was fed to a pentode (Л -105, 6 Ж 3 Л), wired as a diode detector, and the detected signal was fed to the receiver audio amplifier to provide sidetone in the pilot's headphones. The audio section of the transmitter consisted of a speech amplifier (Л -151, 6 Г 2), which amplified the microphone output and, in turn, fed the push pull modulators (Л -152, Л -153; 6 Л 6 C). No facility existed for using the audio part of the transmitter as an intercom system. Channel switching was accomplished with a ratched motor pushing 4 slides which turned 3 tuning shafts. The tuning shafts were locked to their frequency settings by means of a locking knob with an indicating dial calibrated from 100 to 150 mcs.

2. Receiver RSI-U-3M (See Fig. 3-12 overleaf).
Receiver RSI-U-3M was a 4 channel, 13 tube crystal controlled superheterodyne receiver with one RF stage and a 12 megacycle intermediate frequency (IF). The crystal frequency was determined as follows:

$$f_{crystal} = \frac{f - 12}{18} \text{ mcs} = \left(\frac{f}{18} - 0.6667\right) \text{ mcs}$$

The oscillator functioned as a tripler and fed another tripler. The RF signal and the 9th harmonic were mixed in the first mixer; the second mixer combined the outputs of the first mixer and the ninth harmonic of the crystal giving an output of:

$$(f - 9 f_{crystal}) - 9 f_{crystal} = 12 \text{ mcs}$$

The signal was then amplified in a 3 stage IF amplifier and was detected in a diode detector, after which it was amplified in an audio amplifier, which, in turn, fed the output tube. The receiver was equipped with a squelch circuit, making the receiver "dead" when no signal was being received. The AVC was amplified in an AVC amplifier, which was applied to the RF, 1st mixer, 1st IF and 2nd stages.

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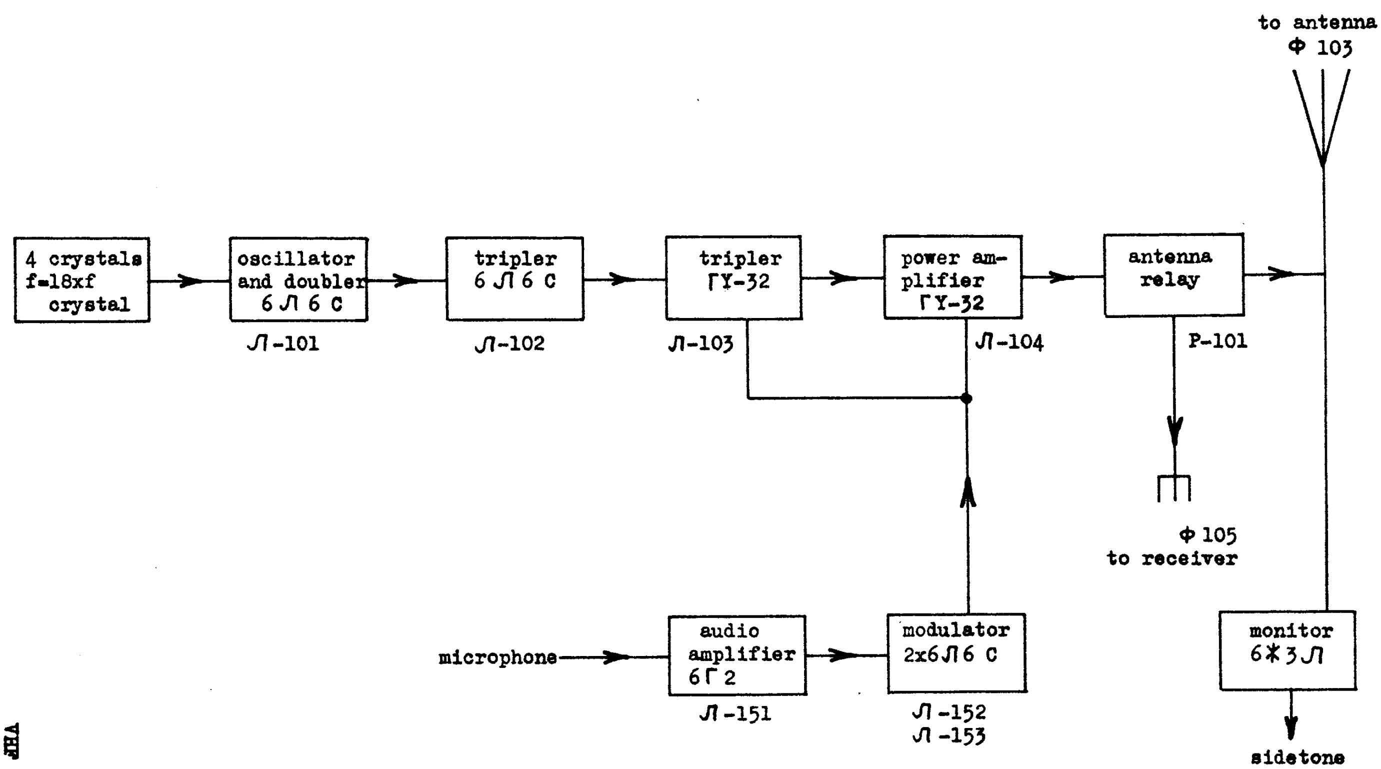

Fig. 3-11.

VHF SET RSI-U-3M.
BLOCK DIAGRAM OF
TRANSMITTER.

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VHF SET RSI-U-3M.

BLOCK DIAGRAM OF RECEIVER.

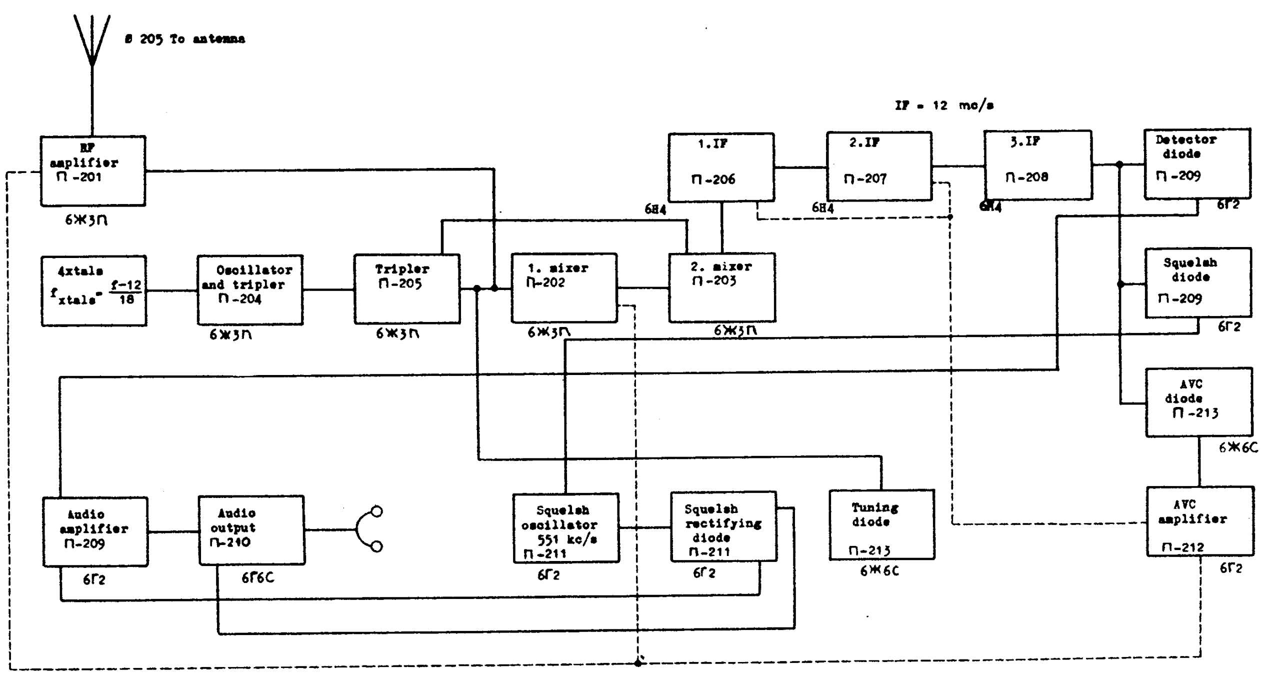

Fig. 3-12.

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14.

3. Inverter MA-100M.

Inverter MA-100M was a rotary inverter fed with 28 volts DC and producing 115 volts AC, 400 cycles.

4. Power Supply BM.

Power supply BM was a rectifier producing high voltage for the receiver and transmitter and negative bias for the transmitter.

5. VHF Antenna.

The antenna for the VHF set was of the $\frac{1}{4}$ wavelength ground-plane type, mounted on the upper starboard side of the aircraft fuselage. It was of the sword type, solid and swept back at an angle of 60 degrees with the horizontal.

It was composed of an aluminium alloy, type 24-S.Spectroscopic test revealed it to be approximately 90% aluminium, 5% copper, 2% magnesium, 1% manganese and its surface was anodized. It weighed 1.33 kg and was of sturdy construction. (See Fig. 3-13 for analysis report and Fig. 3-13-2 to 5 for construction).
The antenna was removed and mounted on an insulator in a similar manner to that on the aircraft, then mounted on a 1 m^2 aluminium plate, which was horizontally placed 2 metres above ground. The antenna was then fed through a 7 meter RG-8 cable, and the standing wave ratio of the entire system was measured with a 50 ohm reflection coefficient meter, type 136 B manufactured by the American Sierra firm.

The tabular and graphical results of this test are included herein. (See Figs. 3-14 and 3-15 overleaf). They reveal the VHF antenna to be broadbanded from approximately 120 to 220 mcs with standing wave ratio rising rapidly beyond the frequency limits stated. It appears that the physical length of the antenna is a little too short for the 100 to 150 mc band. No means of tuning the antenna were included on the aircraft.

Test of: Antenna.

for examination of: Type of Material and Surface Treatment.

Results of test:

Material: Aluminium Alloy.

Analysis of Alloy components:

Iron.........	ca. 0.2%
Copper.......	ca. 5%
Chromium.....	Traces
Magnesium....	ca. 2%
Manganese....	ca. 1%
Titanium.....	0.3%
Zinc.........	ca. 0.2%

(Fig. 3-13-1)

Analysis Report on VHF Antenna

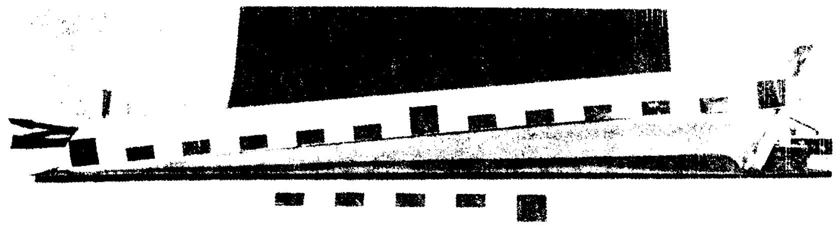

Fig. 3-13-2
VHF Antenna

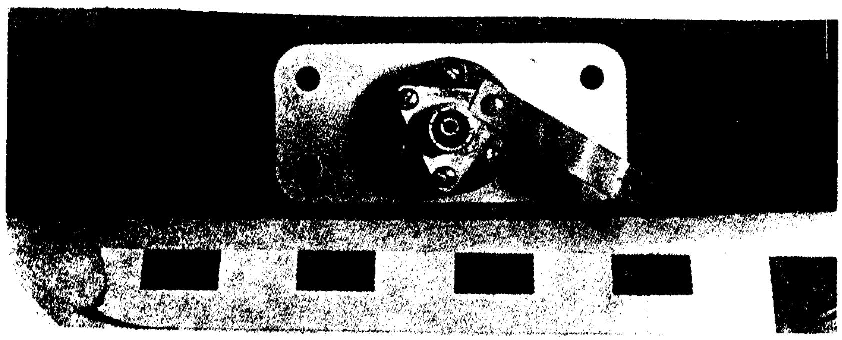

Fig. 3-13-3
Base Mounting VHF Antenna

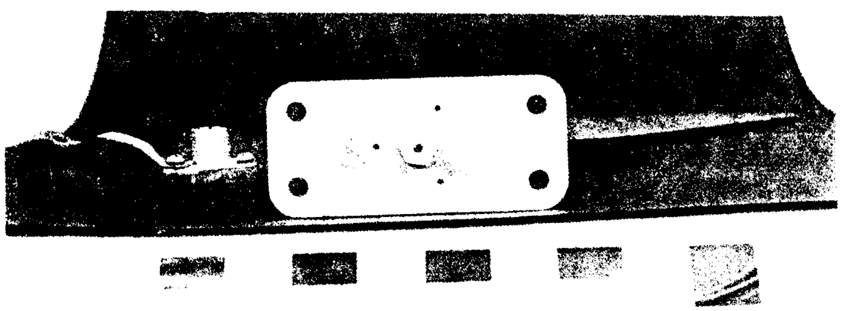

Fig. 3-13-4
Base Mounting VHF Antenna Removed

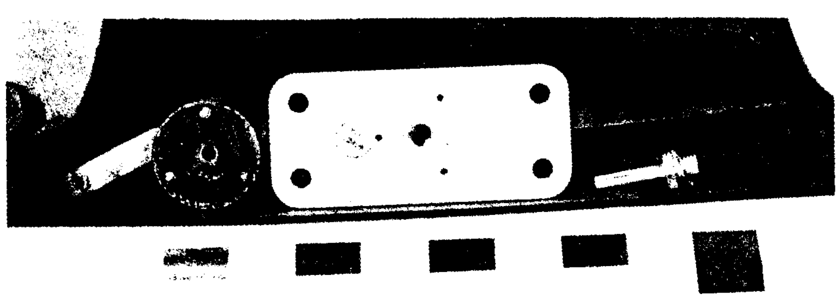

Fig. 3-13-5
VHF Antenna Central Connecting
Pin Removed

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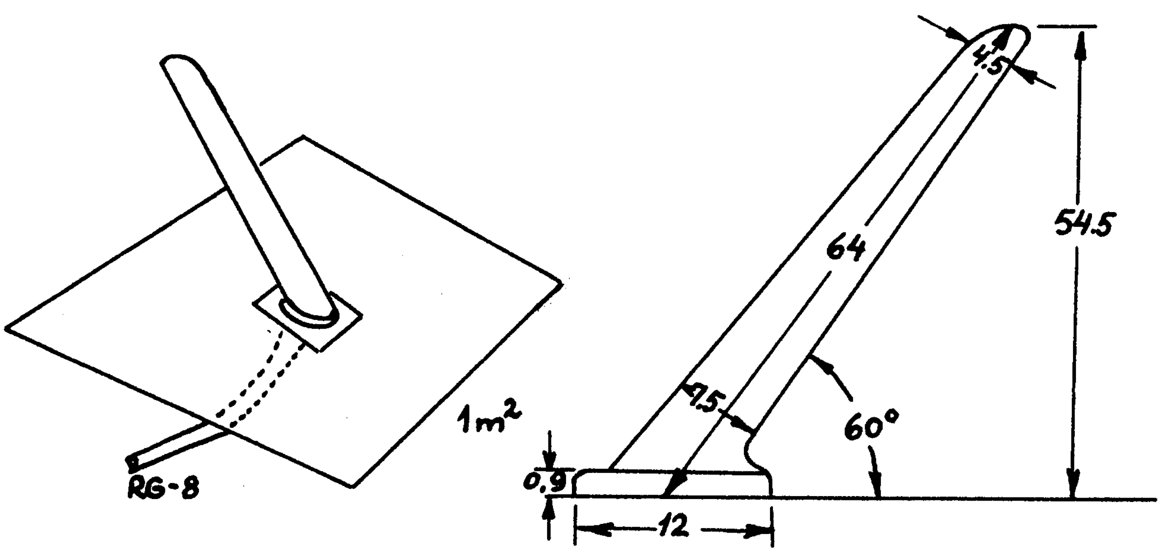
DATA SHEET

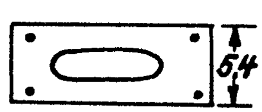
MEASURE OF STANDING WAVE RATIO OF VHF ANTENNA.

RSI-U-3M VHF SET

FREQUENCY (mcs)	SWR	FREQUENCY (mcs)	SWR
75	20 (approx.)	165	2,9
80	14 (approx.)	170	3,2
85	15 (approx.)	175	3,0
90	11	180	2,6
95	10	185	3,0
100	9	190	3,0
105	6	195	2,7
110	5	200	3,0
115	4,1	210	2,9
120	3,1	220	3,5
125	3,6	230	3;3
130	3,0	240	3,6
135	2,8	250	4,1
140	3,1	260	4,6
145	2,8	270	5,5
150	2,8	280	4,5
155	3,0	290	7
160	2,9	300	5



WEIGHT = 1,33 kg.



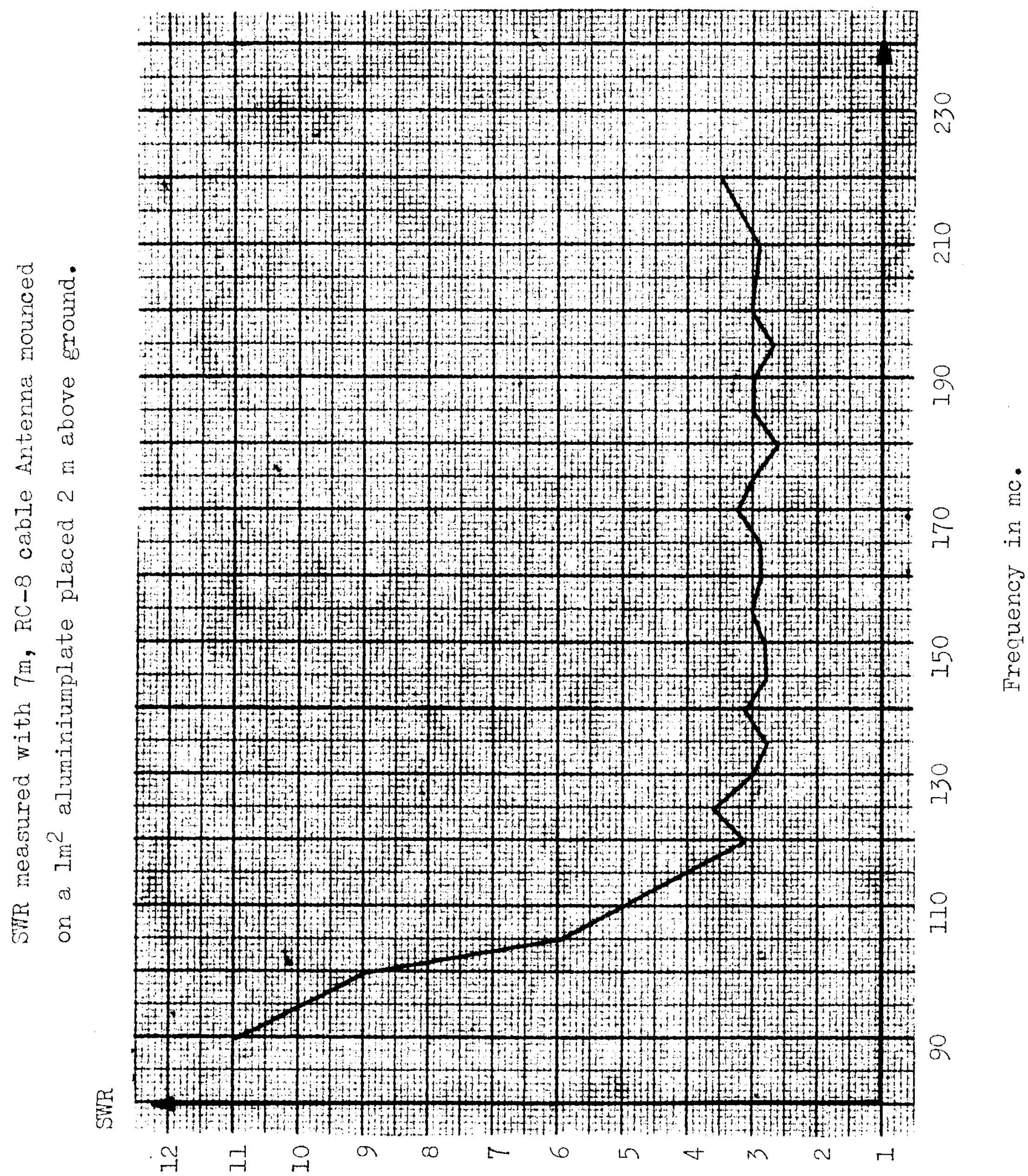
ALL DIMENSIONS IN CM
UNLESS OTHERWISE NOTED

Fig. 3-14.

SECRET

VHF SET RSI-U-3M.

SWR. FOR VHF ANTENNA.



Standing Wave Ratio.

Fig. 3-15.

SECRET

6. Crystals.

a. Findings:

Both the transmitter and the receiver had sockets for 4 crystals each and external boxes for storage of 12 spare crystals each. Crystals for each of the four operating channels were included in the set but the spare crystal storage boxes were empty except for a crystal inventory list which contained a listing of 16 crystals (4 for the operating channels and 12 spares) (See Fig. 3-16). The 4 crystals in the transmitter [redacted]

25X1

Список кварцев

Кварцы блока А		Кварцы блока Б	
№№ п-п	Условные №№ кварцев (каналов связи)	№№ п-п	Условные №№ кварцев (каналов связи)
1	A1	1	Б1
2	A16	2	Б16
3	A25	3	Б25
4	A61	4	Б61
5	A76	5	Б76
6	A172	6	Б172
7	A301	7	Б301
8	A313	8	Б313
9	A337	9	Б337
10	A349	10	Б349
11	A361	11	Б361
12	A376	12	Б376
13	A460	13	Б460
14	A481	14	Б481
15	A505	15	Б505
16	A520	16	Б520

Упаковщик 8

Контролер ОТК

(Fig. 3-16)

Crystal Inventory List

Transmitter Crystal	Frequency (KCS)	Receiver Crystal	Frequency (KCS)
A 16	5625.2	B 16	4958.5
A 301	6944.8	B 301	6277.2
A 361	7222.6	B 361	6555.3
A 460	7681.1	B 460	7013.9

All crystals were mounted in identical heavy bakelite holders, fitted with 2 banana pins. Measurements were made under controlled temperature conditions over the range from -20° to 70°C, with test points at every 3 degrees. The oscillator used was a Quartz Activity Test Set QC57A (also marked type BW 670) built by the British firm G.E.C... The instrument measured directly the parallel impedance of the crystal with a capacitive load of 30 mmf. The crystal frequency was measured with a Hewlett-Packard Electronic Counter, Model 524 B. The counter was connected to the test set QC 57A and was calibrated against the NPL 200 KC standard frequency from the Droitwich station. In this way an accuracy of 2 parts per million was expected.

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The results are given in the Graphs in Figs. 3 17 - 3 24 inclusive.
The Test Set QC 57A specification cards required a minimum parallel impedance of:

16.5 Kohms for 5 mcs crystals
14.5 Kohms for 6 mcs crystals
12 Kohms for 7 mcs crystals
9.3 Kohms for 8 mcs crystals

b. Speculations:

The graph (Fig. 3-25) has the frequencies from 100 to 150 mcs plotted along the ordinate and the A numbers from 0 to 600 plotted along the abscissa. The four known A crystal numbers are plotted in the system and lie along a straight line which intercepts the 100 and 150 mcs points.

The resulting frequency distance between successive A numbers is revealed to be 83.33 KC, providing 600 available channels.

The crystal inventory card, Fig. 3-16, reveals that only channel numbers which correspond to multiples of 250 KC (3 x 83,33 KC) were included in the spare crystal kit.

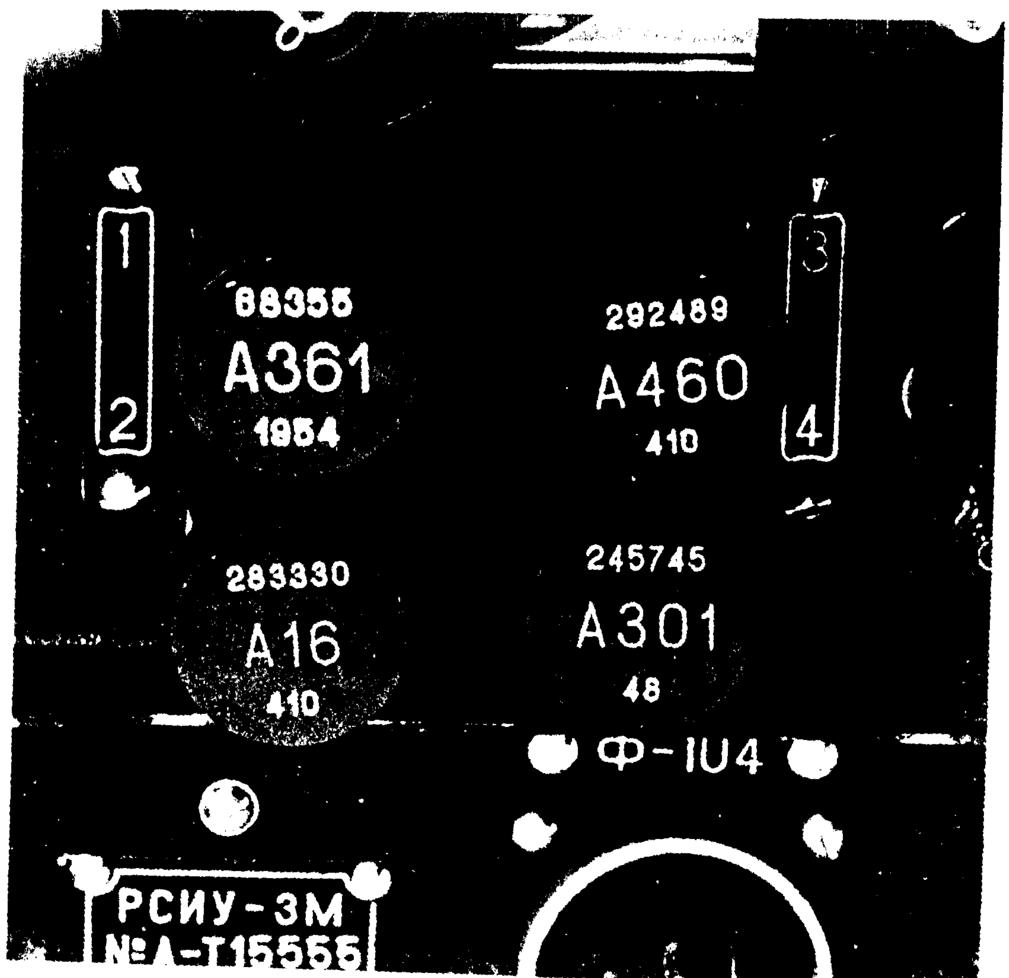

Fig. 3-16-1
Transmitter Crystals.

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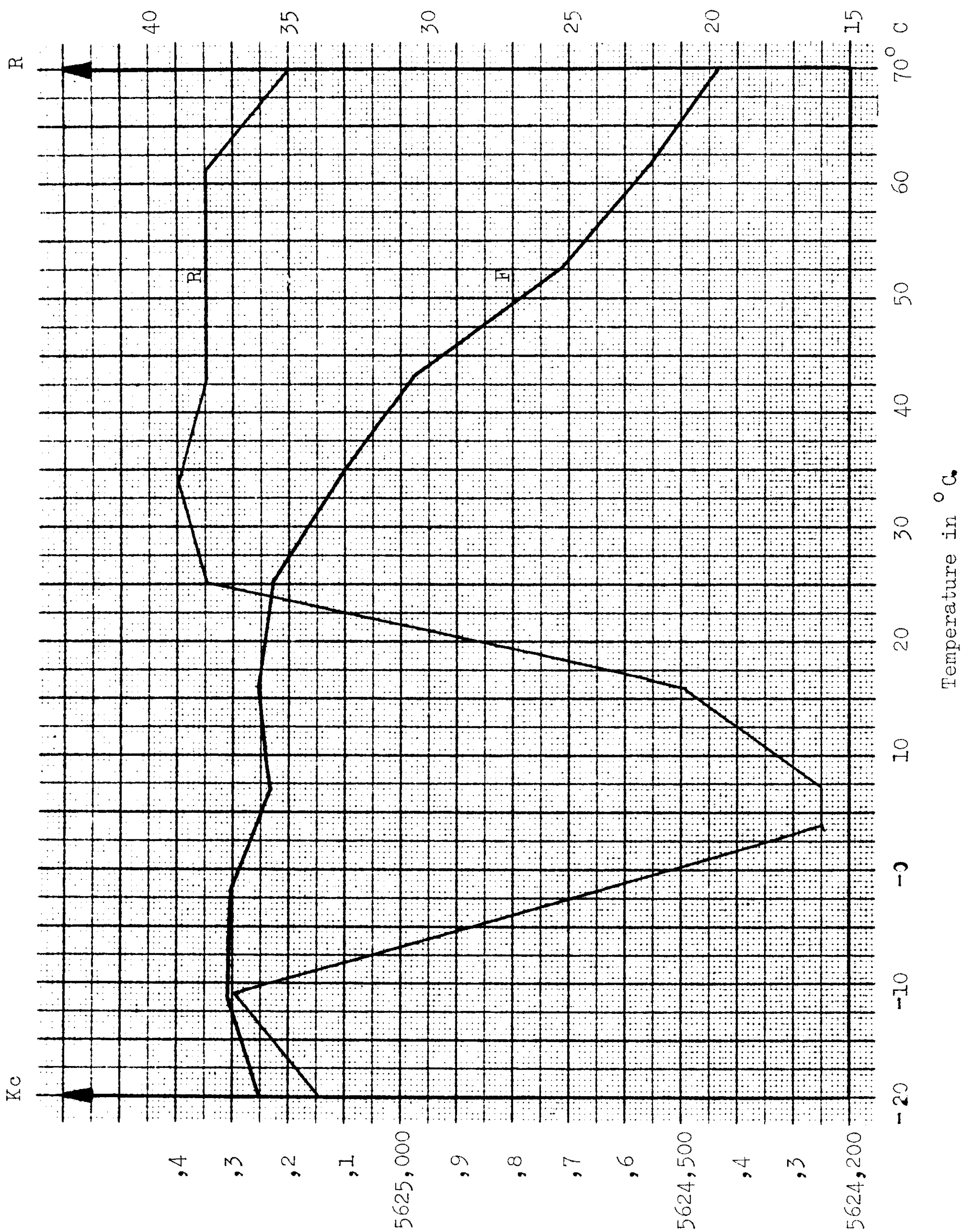
VHF SET RSI-U-3M.

QUARTZ CRYSTAL NO.A.16.

Parallelimpedance in K Ω



Frequency in kc.

Fig. 3-17.

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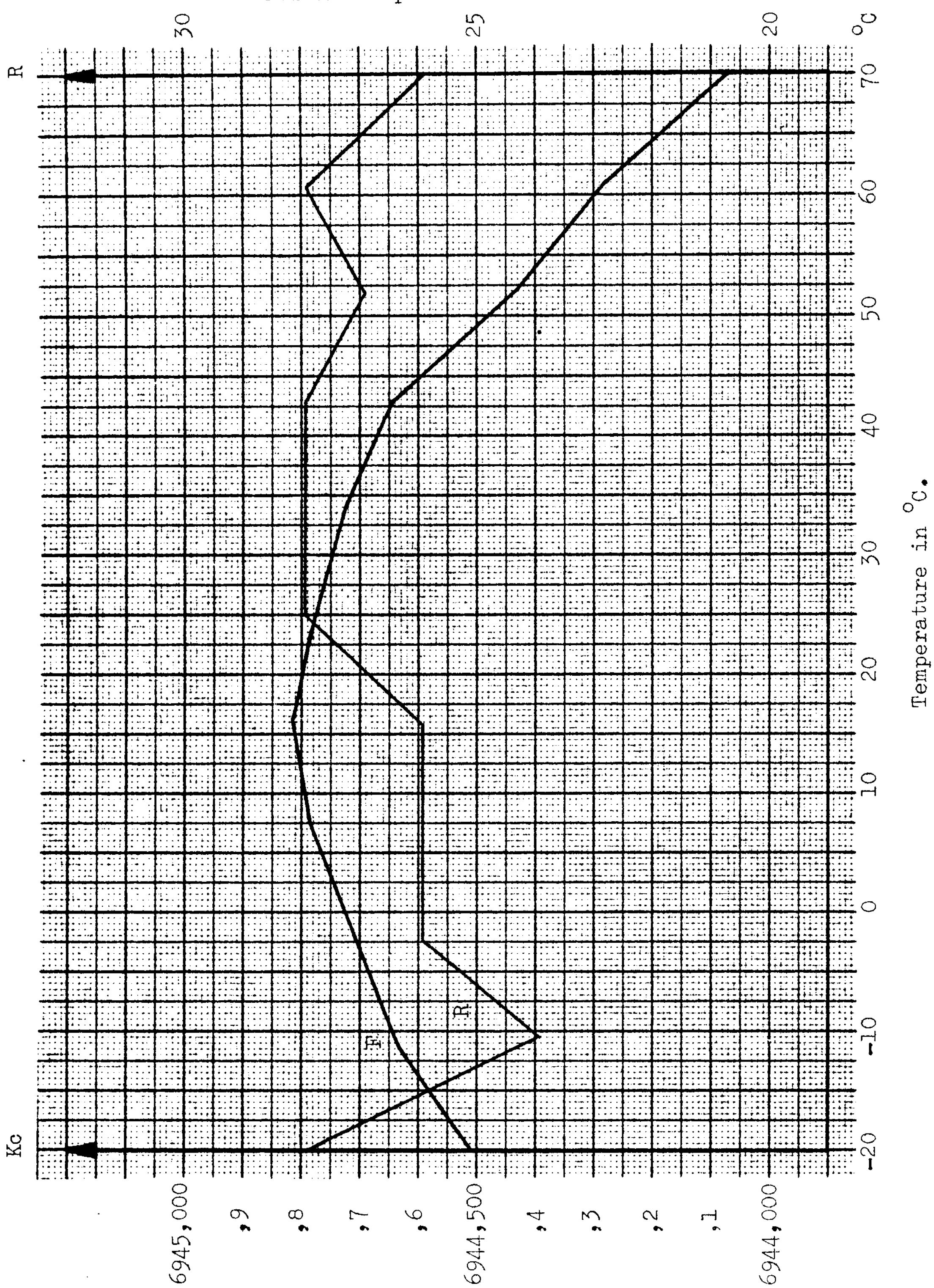
VHF SET RSI-U-3M.

QUARTZ CRYSTAL NO. A.301.

Parallelimpedance in K Ω



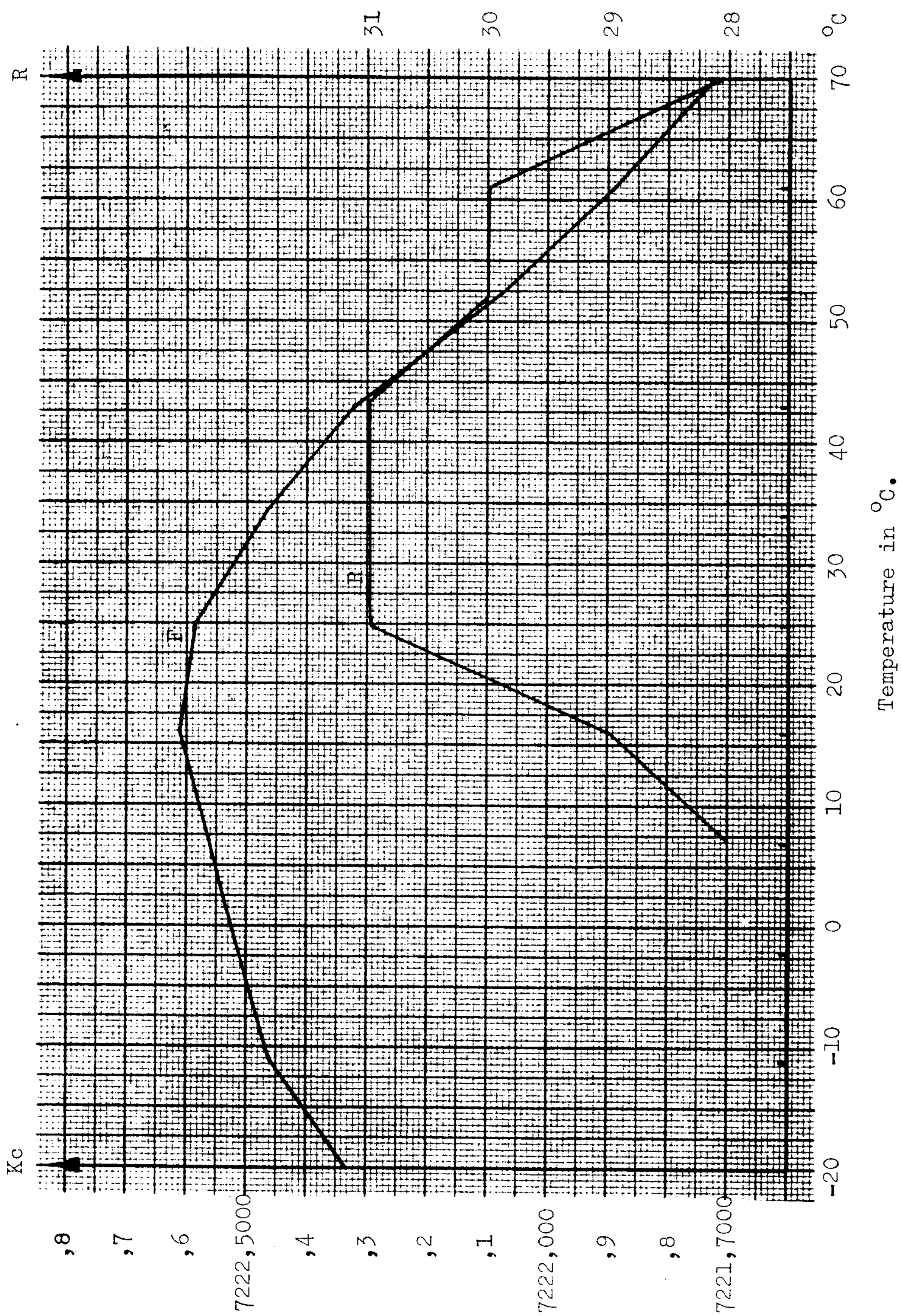
Frequency in kc.

Fig. 3-18.

VHF SET RSI-U-3M.

QUARTZ CRYSTAL NO.A. 361.

Parallelimpedance in K Ω



Frequency in kc.

Fig. 3-19.

VHF SET RSI-U-3M.

QUARTZ CRYSTAL NO. A.460.

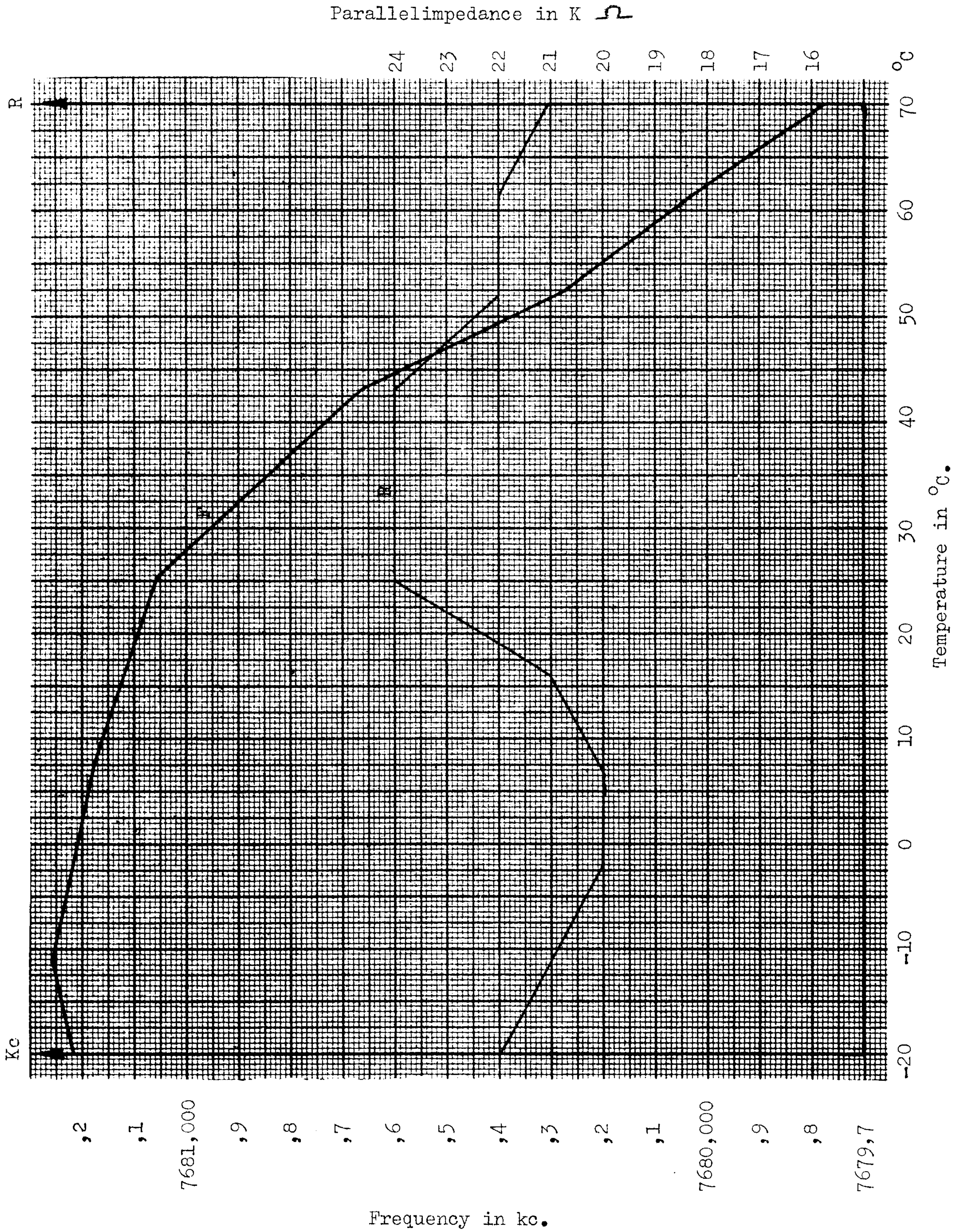


Fig. 3-20.

VHF SET RSI-U-3M.

QUARTZ CRYSTAL NO. B.16.

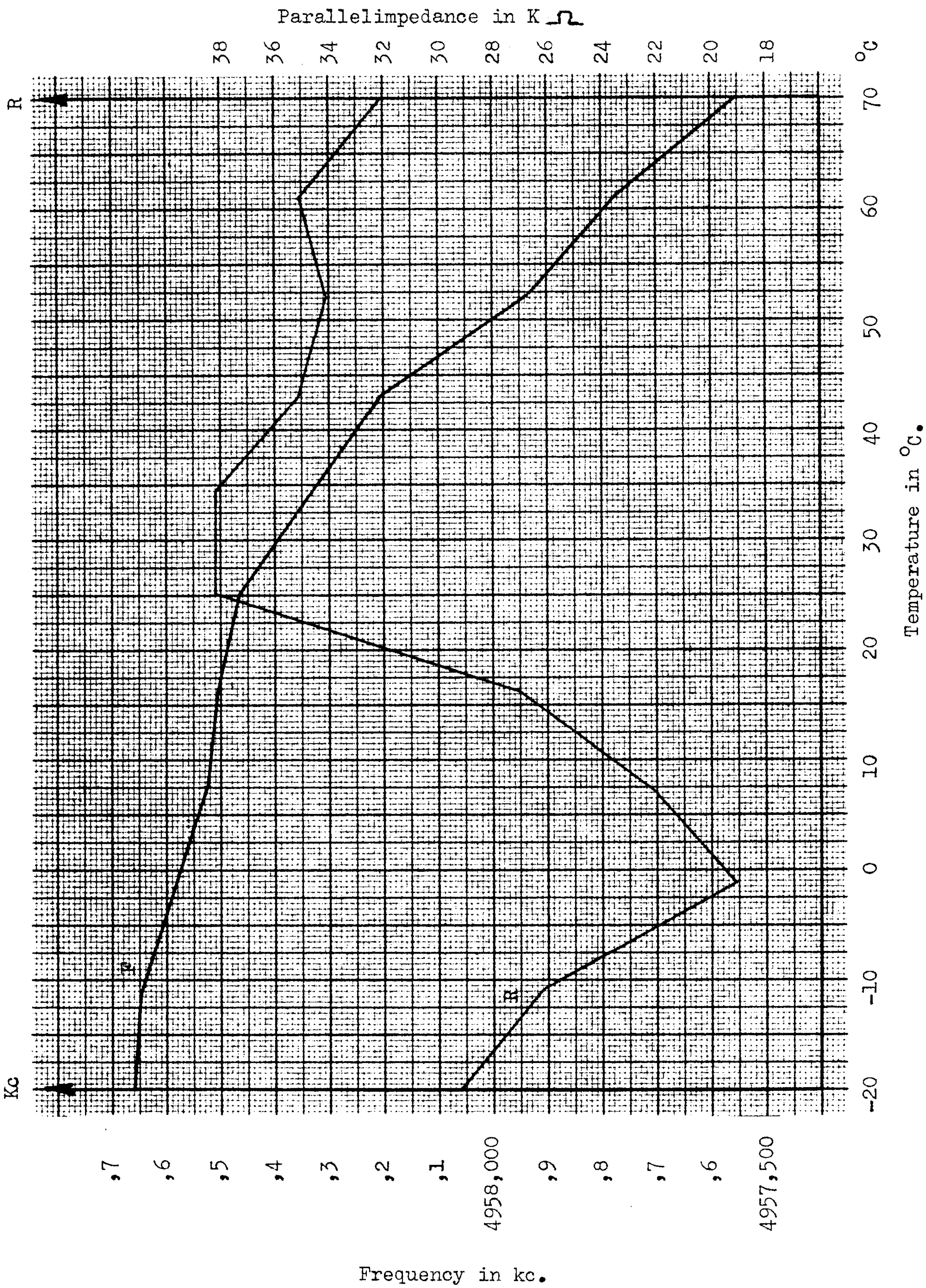
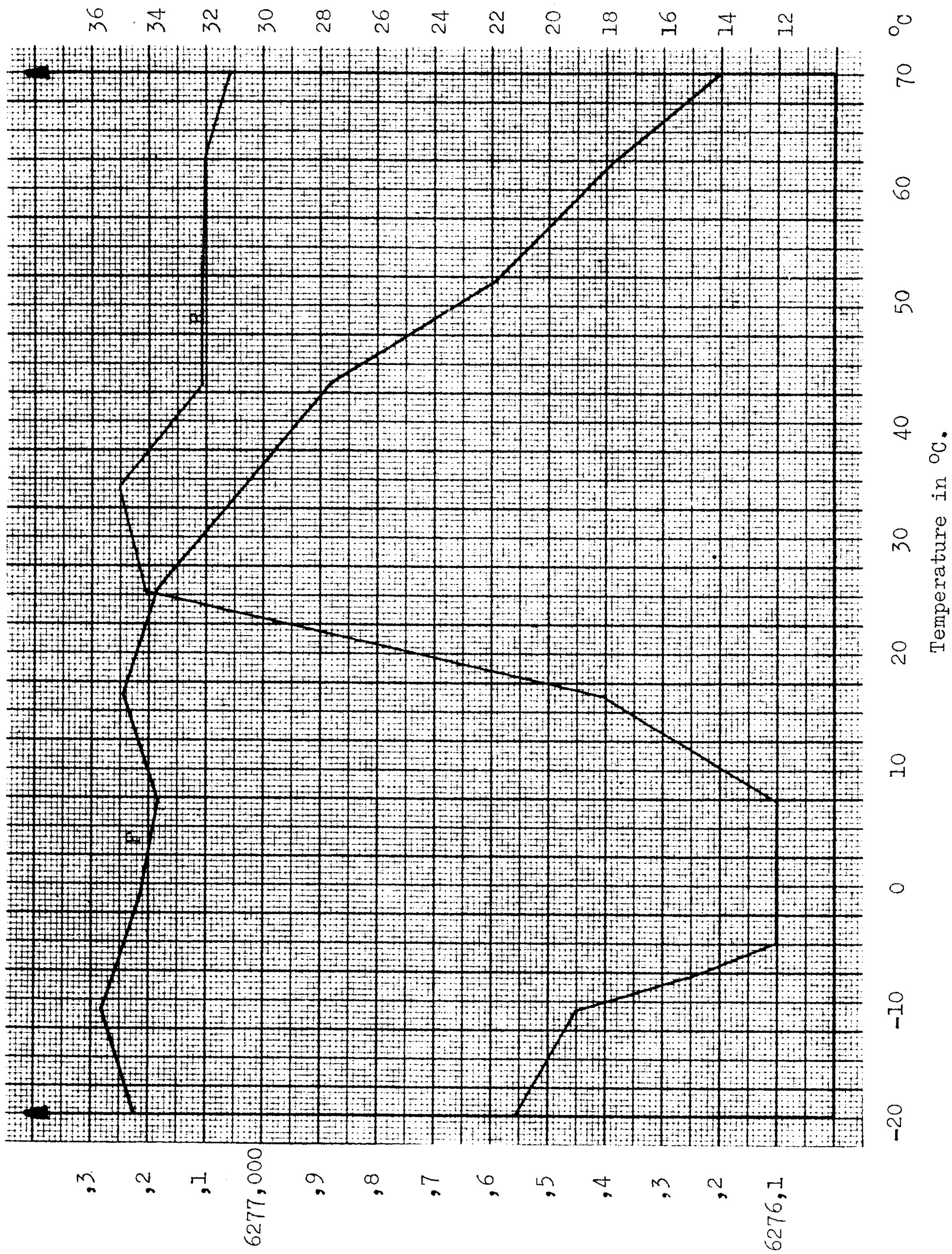


Fig. 3-21.

VHF SET RSI-U-3M.

QUARTZ CRYSTAL NO. B.301.

Parallelimpedance in K Ω



Frequency in kc.

Fig. 3-22.

VHF SET RSI-U-3M.

QUARTZ CRYSTAL NO. B.460.

Parallelimpedance in K Ω

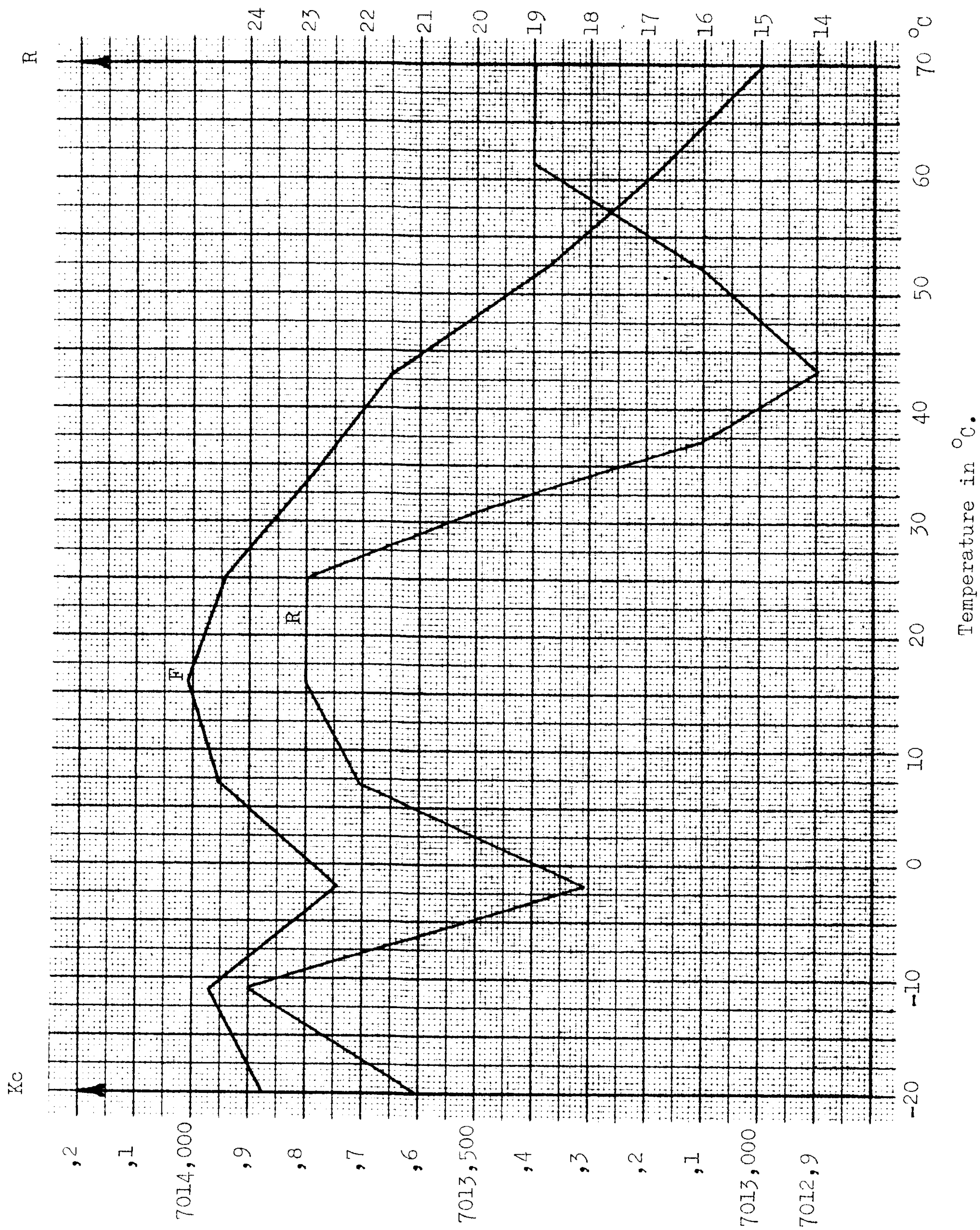


Fig. 3-23.

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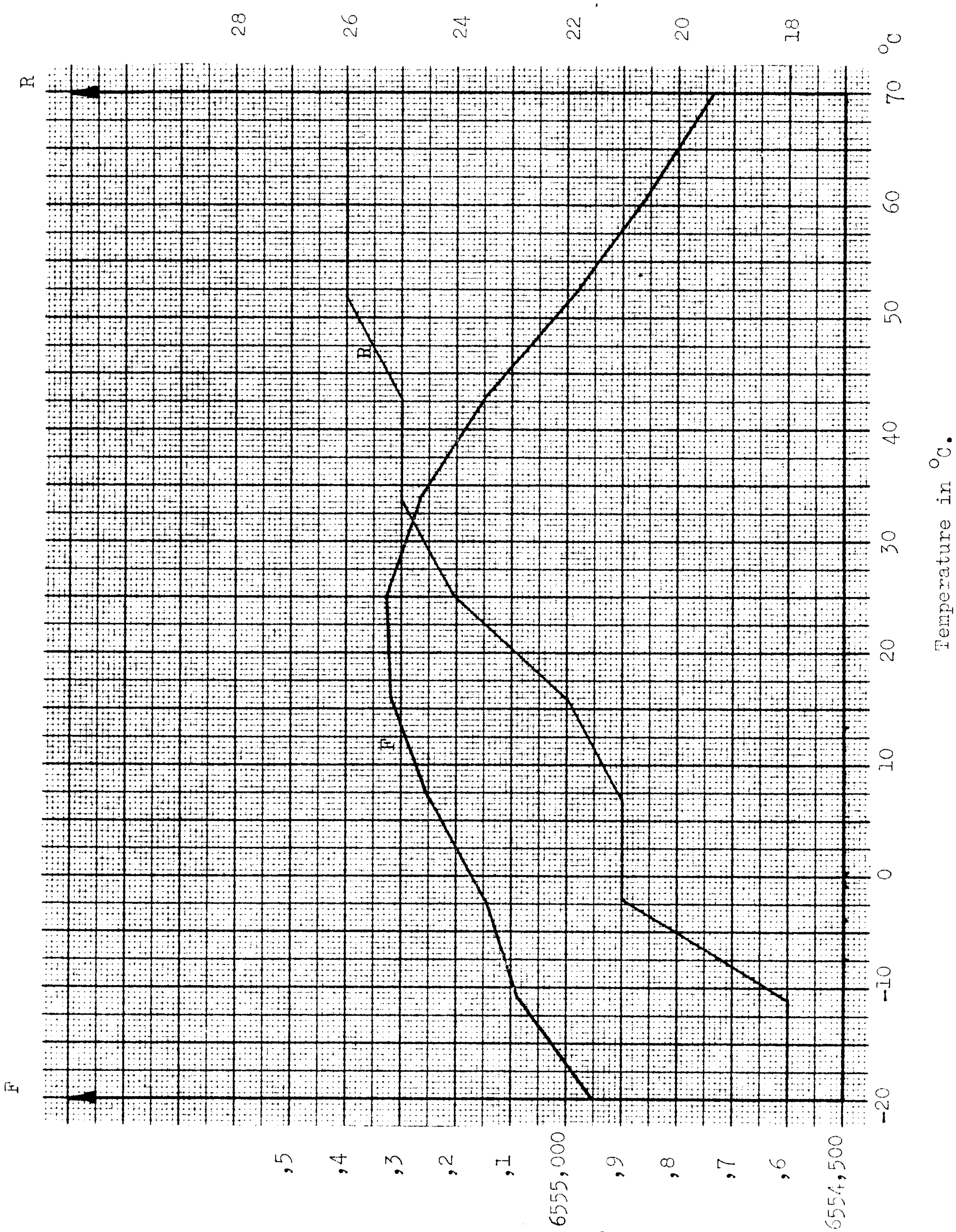
VHF SET RSI-U-3M.

QUARTZ CRYSTAL NO. B.361.

Parallelimpedance in K Ω

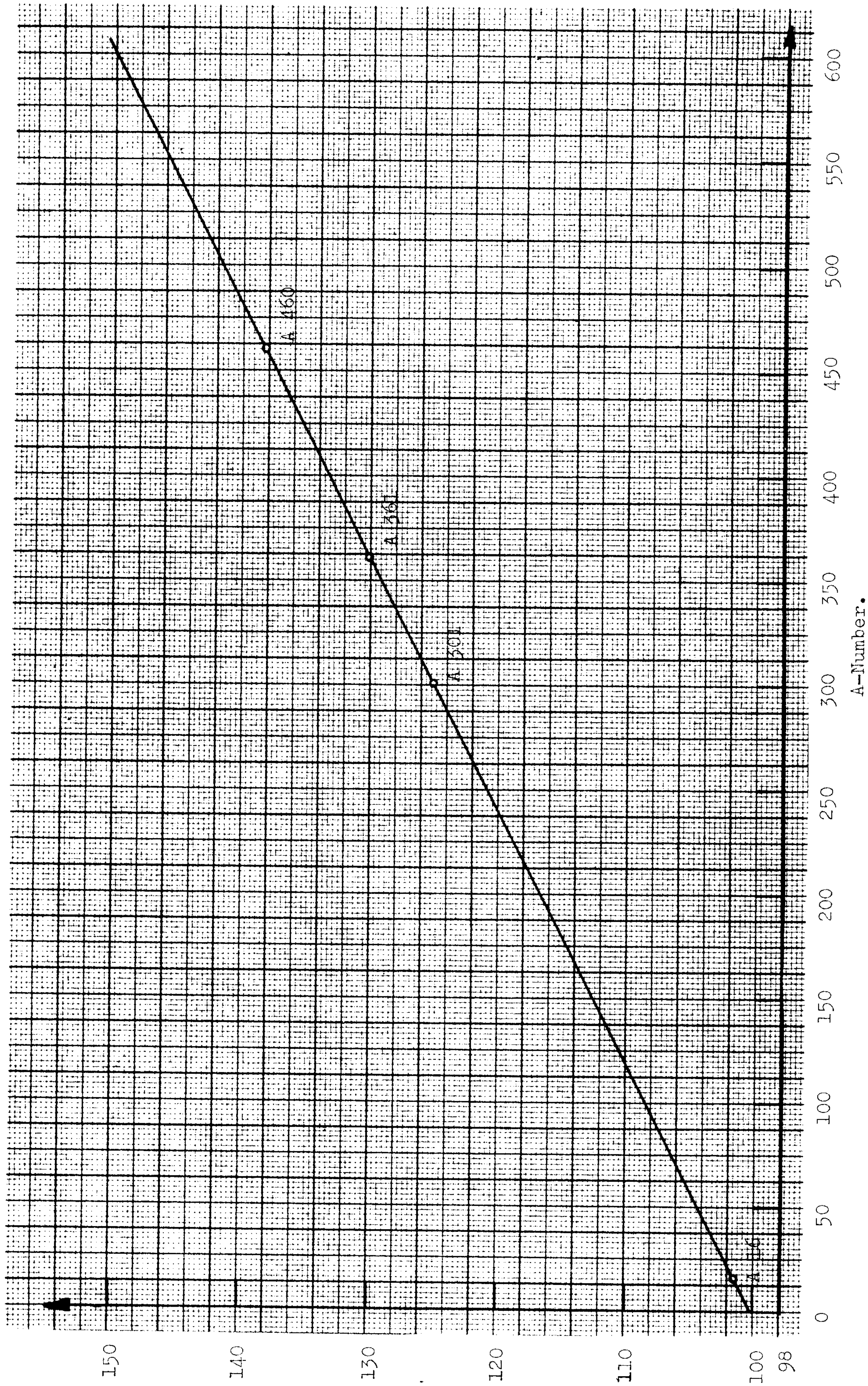


Frequency in kc.

Fig. 3-24.

VHF SET RSI-U-3M.

POSSIBLE CHANNEL ALLOCATION.



Frequency in mc.

Fig. 3-25.

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C. Circuitry and Cabling.

1. Transmitter RSI-U-3M (see circuit diagram, drawing No.1)

a. Oscillator (Л-101, 6Л6С)
Tube Л-101 (6 Л 6С) was the oscillator tube in the crystal oscillator circuit. The anode circuit was tuned to the second harmonic of the crystal frequency. Tuning of the anode circuit was accomplished with a variable condensor which was ganged with the tuning condensor in the anode circuit of tube Л-102, the first tripler stage. The cold side of the grid resistor (33 K ohms) was grounded by the antenna switching relay, P-101, when in the transmit position. In the receive position, negative grid bias was applied to prevent oscillation.

b. First Tripler (Л-102, 6Л6С)
Tube Л-102 functioned as a tripler. The cold side of the grid resistor (56 K ohm) was grounded as was that of the oscillator during transmitting and negative bias was applied during receiving by the antenna switching relay, in order to cut-off the tube.

c. Second Tripler (Л-103, Г Y32)
Tube Л-103 operated as a push-pull tripler and was the Soviet type ГY-32, similar to the American type 832 tube used in the SCR-522. The anode circuit was tuned to the 18th harmonic of the crystal frequency by means of the variable condensor, C-118 which was set by means of its own tuning shaft and tuning knob. Grid bias was applied to this tube from the negative grid bias supply produced in the power supply unit and applied to pin 3, plug 104 on the transmitter.

d. Power Amplifier (Л-104, Г Y-32)
Tube Л-104 functioned as a push-pull power amplifier and was the Soviet ГY-32, equivalent to the American type 832 tube as was the second tripler. Here, as in the second tripler stage, the anode circuit was tuned with a variable, condensor which was set by means of its own tuning shaft and tuning knob. Coupling and the output was fed to the antenna through the antenna switching relay, P-101.

e. Monitor (Л-105, 6 Ж 3)
The monitor tube Л-105 was a pentode, wired as a diode. A sampling of the RF output voltage to the antenna was detected in this stage and the detected signal was used in tuning the transmitter to the desired channel and for sidetone in the pilot's headset.

f. Speech Amplifier (Л-151. 6 Г 2)
The speech amplifier, Л-151, employed a triode, type 6 Г 2 (Tube 6 Г 2 is a multipurpose tube a duodiode triode, but the diode plates were connected externally to the cathode and amplified the output from the microphone transformer B-13075-502. A carbon throatmicrophone was used. The microphone was connected through the control box to pin 8

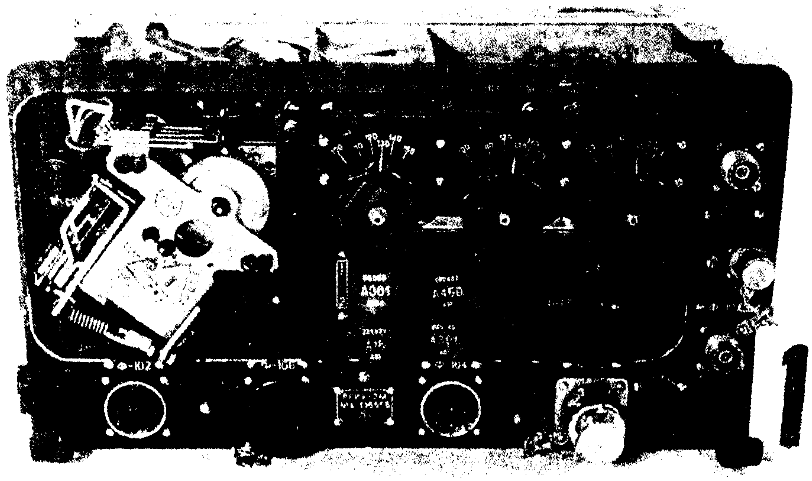

Fig. 3-26. RSI-U-3M. Transmitter. Front.

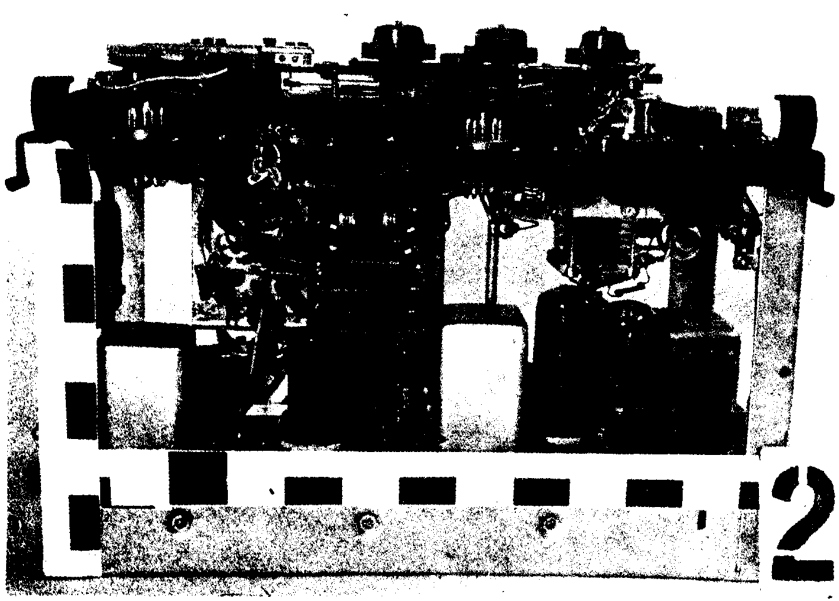

Fig. 3-27. RSI-U-3M. Transmitter. Bottom.

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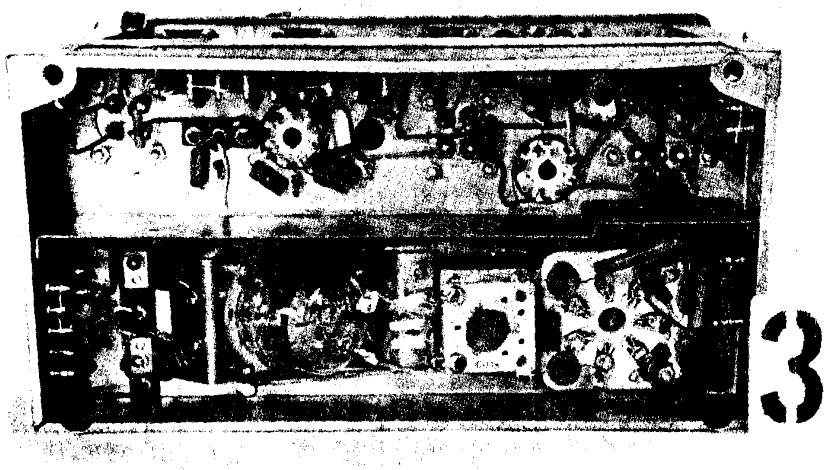

Fig. 3-28. RSI-U-3M. Transmitter. Back.

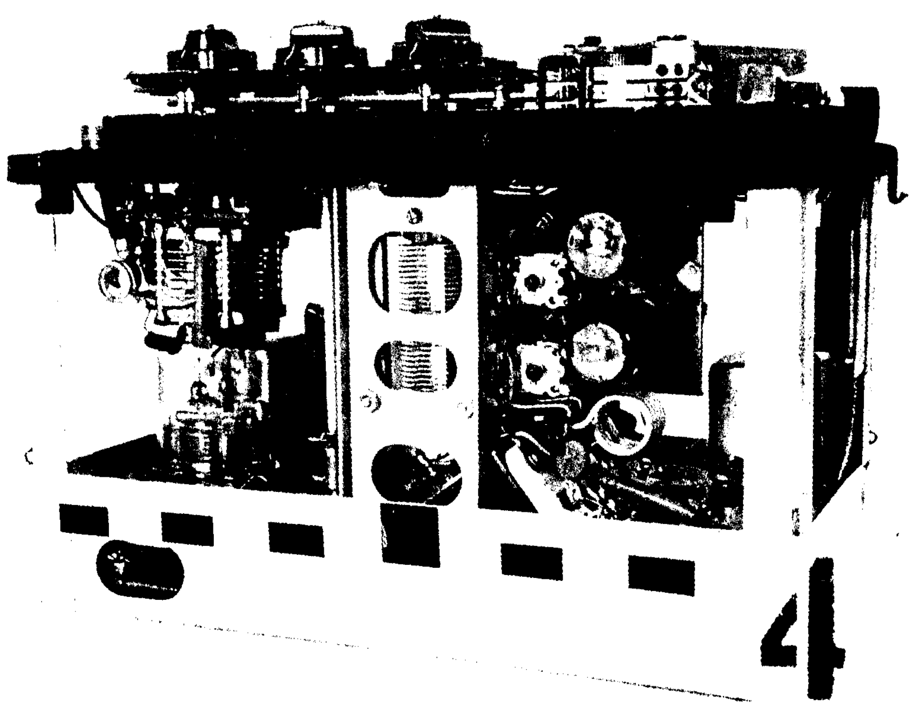

Fig. 3-29. RSI-U-3M. Transmitter. Top.

on plug 102. Microphone voltage was applied to pin 4 on the microphone transformer through pin 5 on plug 104 on the transmitter from whence it had come through the receiver from pin 5 on plug 402 on the power supply in which it was obtained from a voltage divider which provided the microphone voltage from the 28 volt supply. Microphone voltage was present only when transmitting. Grid bias to Л-151 was taken from the negative grid bias supply, and the desired grid bias voltage was obtained from a voltage divider consisting of an 82 k ohm and a 1 k ohm resistor in the grid return circuit in the transmitter.

g. Modulator (Л 152, Л 153, 6 Л 6C)
The audio transformer B - 13058 - 501 fed the push-pull modulator tubes Л 152 and Л 153 (two 6 Л 6C tetrodes). Grid bias was applied to these two tubes from a voltage divider consisting of a 46 k ohm and a 10 k ohm resistor which provided the proper voltage from the negative grid bias supply.

Transformer B - 13036 - 501 served as the modulation transformer and the modulation was applied to the anodes and screen grids of the power amplifier and the screens of the second tripler.

h. Plugs.
Transmitter RSI-U-3M was equipped with 4 plugs. Plug 101, fitted with a metal friction grip cap, was used in all probability for connecting a test meter to the transmitter to measure different voltages and current to the tubes, thereby enabling the radio mechanic to tune the channels and test the tube voltages and operation. Plug 106 was not in use on this particular transmitter and was covered with a plastic cap. Although the intended use of this plug was not evident, it was obvious that channel selection could be accomplished from this plug with an external control box, a microphone could be connected to pin 8, and the push to transmit function was possible by connecting pin 2 and 8 through a microphone. This plug was probably used for control and operation of the transmitter during tuning and testing.

2. Receiver RSI-U-3M (See circuit Diagram)

a. RF Stage (Л -201, 6Ж3П)
The antenna signal entered the receiver through plug 205 by coaxial cable from the transmitter at which point the coaxial transmission line from the sword antenna had entered the set. The signal was applied the RF amplifier Л -201 where it was amplified and in turn, applied to the grid of the first mixer. Tuning was accomplished by means of a three section, ganged tuning condensor, two sections of which tuned the grid anode circuit of the RF amplifier, and the third anode of oscillator.

b. Oscillator (Л -204, 6Ж3П)
Each of the four receiver crystals could be connected in the grid circuit of the crystal oscillator, the anode of which was tuned to the third harmonic of the crystal frequency.

c. Tripler (Л -205, 6Ж3П)
In this frequency tripling stage, the 9th harmonic of the crystal frequency was produced. The anode circuit of this stage was tuned by one section of the 3 section ganged tuning condensor.

d. First Mixer (Л -202, 6Ж3П)
The 9th harmonic of the crystal frequency and the antenna signal were mixed in this stage and the anode of this circuit was tuned to the difference between these two frequencies. The 9th harmonic of the crystal frequency was brought to the screen grid of this tube by means of a tuned circuit, inductively coupled to the anode circuit of the first Tripler stage (Л -205).

e. Second Mixer. (Л -203, 6Ж3П)
To the grid of the second mixer were brought two signals, the 9th harmonic of the crystal frequency and the antenna frequency minus the 9th harmonic of the crystal frequency i.e. $9f_{crystal}$ and $f_{antenna} - 9f_{crystal}$), which were capacitively coupled from the screen grid circuit and the anode circuit, respectively, of the First Mixer stage. The difference between the frequencies of these two signals was the IF, 12 MCS (i.e. $f_{antenna} - 18f_{crystal} = 12$ mcs).

f. IF Amplifiers (Л -206, Л -207, Л -208) (type 6 H 4)
Three stages of IF amplification (12 MCS) were provided utilizing tubes Л 206, Л 207 and Л 208; all were 6 H 4 type valves. The following inscriptions in relative positions shown were found on the four IF cans and may give some insight into their content.
Results of selectivity measurements are included in section III C 7, Laboratory measurements.

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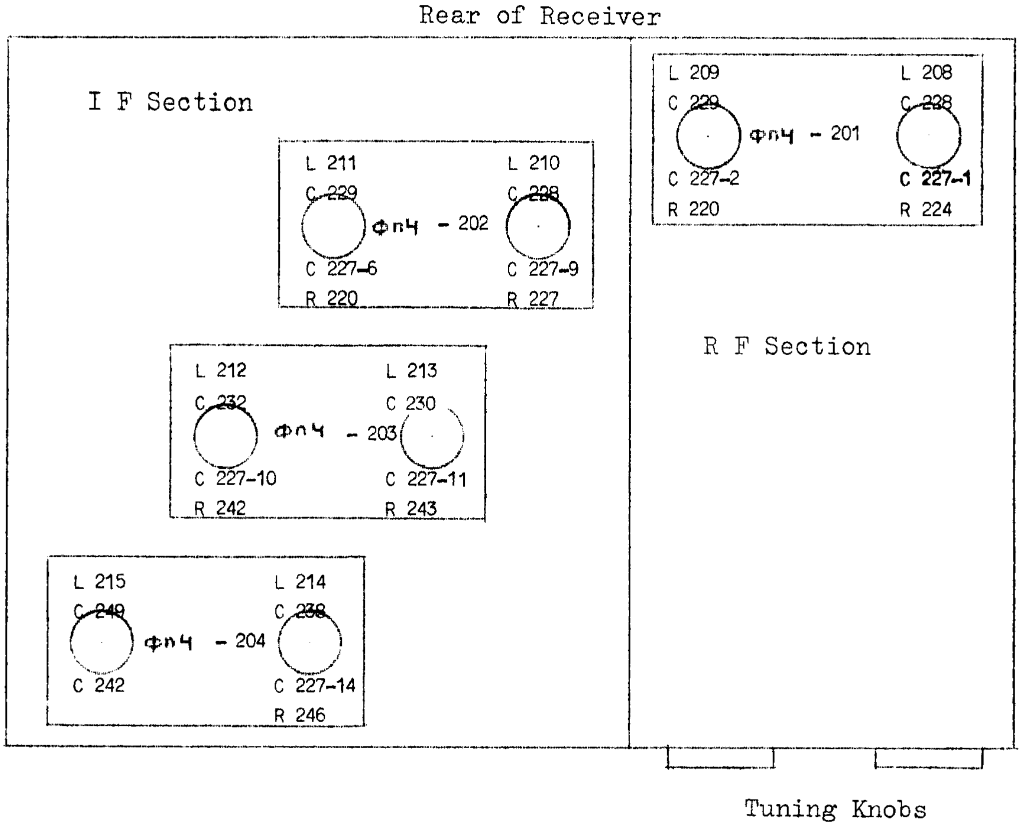

The IF cans were hermetically sealed units and it was not possible to investigate their interiors. However, it was suspected that they were entirely conventional double tuned networks with RC decoupling to decouple the IF.

g. Audio Section; Detector and Audio amplifier (Л 209, 6 Г 2), Audio Output (Л 210, 6 Л 6 С). The IF signal was detected in the right hand diode of tube Л-209, a duo-diode triode, Soviet type 6 Г 2 tube. The detector load consisted of 3 resistors (200 k ohm, 82 k ohm and 8.2 k ohm). The audio voltage was applied to the grid of the audio amplifier (the triode portion of tube Л-209). The sidetone from the transmitter was introduced between the 82 k ohm and the 8.2 k ohm resistors and amplified in the audio amplifier. The audio signal from the audio amplifier was applied to the grid of the audio output tube, Л -210 through a coupling condensor. The final audio was applied to the audio output transformer TP-201 and thence to the high impedance pilot.s headphones. (14.5 k ohms at 800 cycles).

SIMPLIFIED DRAWING OF AVC CIRCUIT.

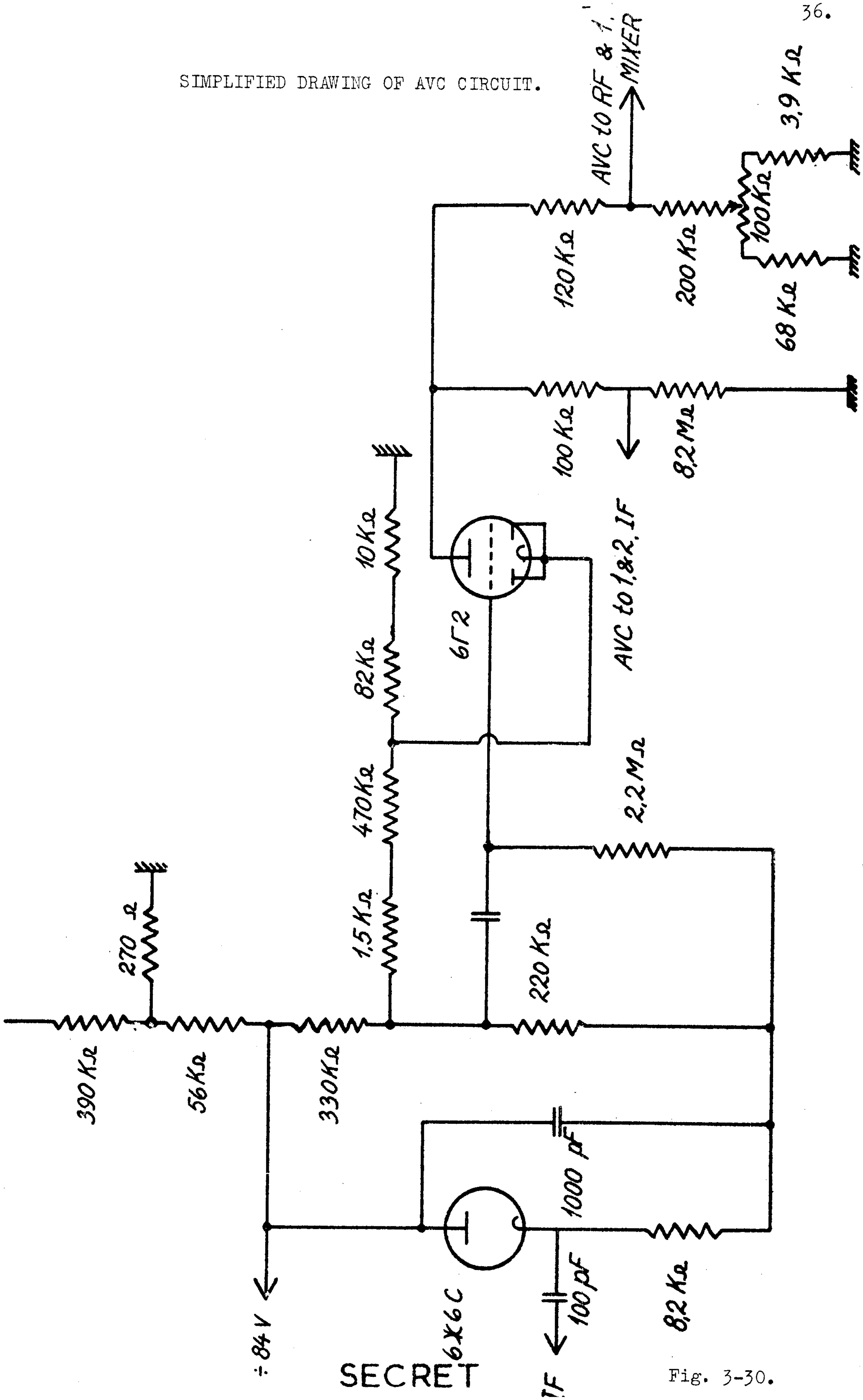

Fig. 3-30.

Fig. 3-31. Receiver RSI-U-3M. Top.

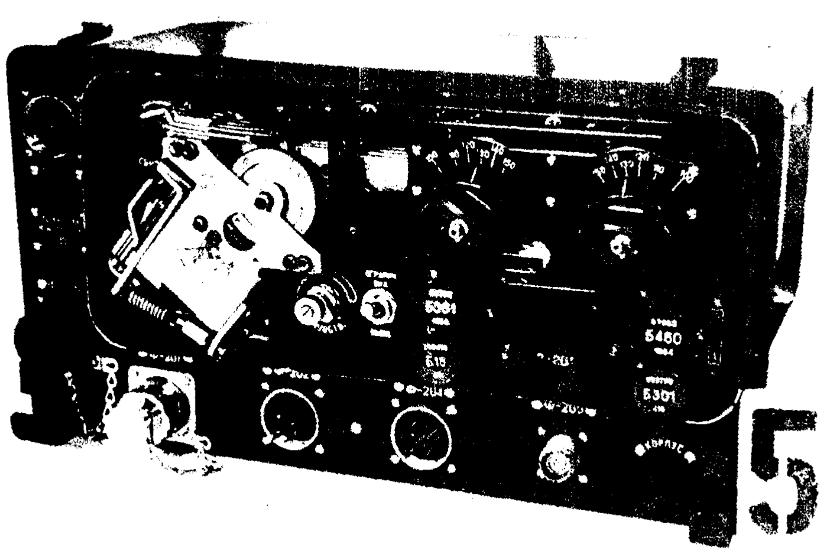

Fig. 3-32. Receiver RSI-U-3M. Front.

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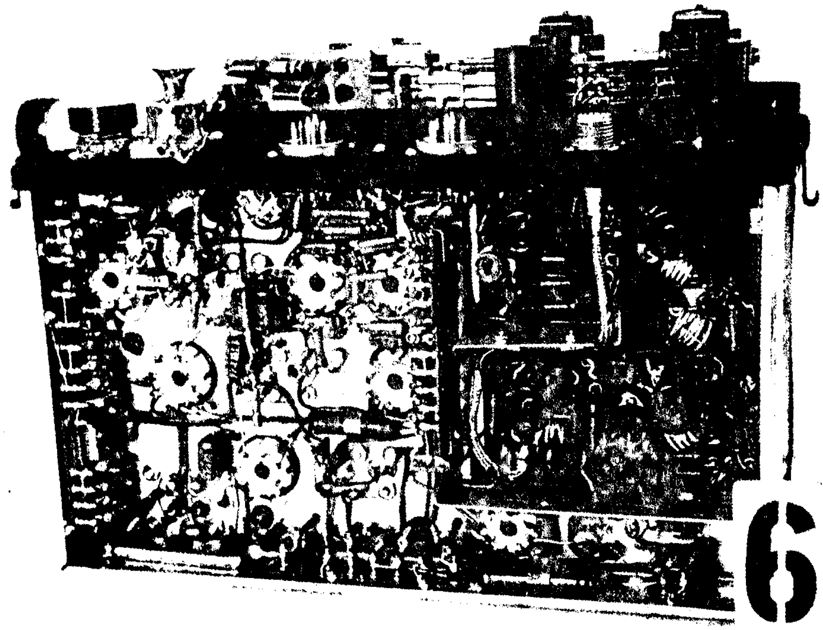

Fig. 3-33. Receiver RSI-U-3M. Bottom.

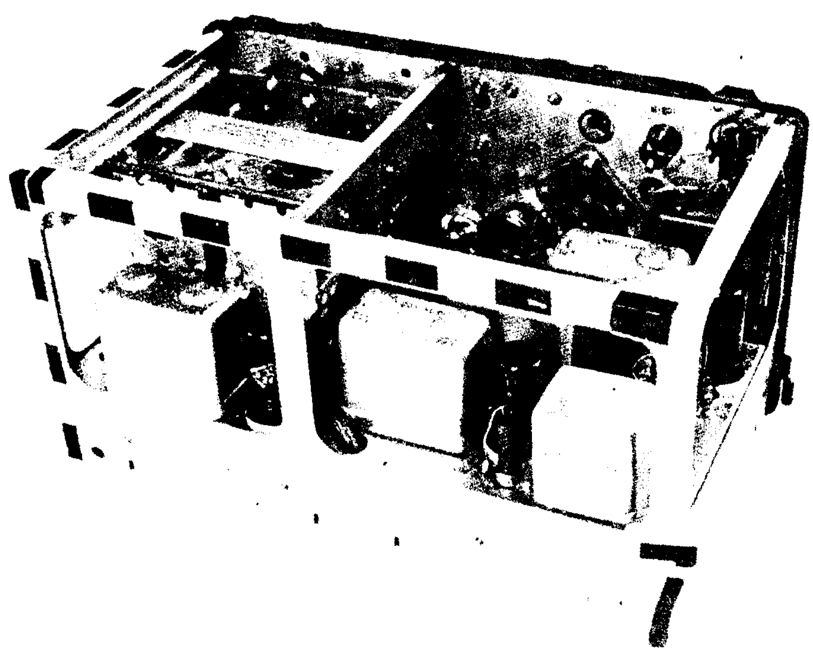

Fig. 3-34. Receiver RSI-U-3M. Back.

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h. Squelch Circuit (Л 211 and left diode of Л 209) (6 Г 2)
The squelch circuit consisted of an oscillator operating on 551 Kcs (triode position of Л-211). The 551 kc signal was rectified in the right hand diode of Л-211. The load of this diode consisted of a 100 k ohm and 1 k ohm resistors. When the oscillator was in oscillation, a negative voltage was produced and applied to the grid of the audio amplifier (Л-209) cutting this tube off. Oscillation was stopped when a signal was received and rectified in the left hand diode of Л -209 and a negative voltage was developed across a 390 k ohm resistor and applied to the grid of the squelch oscillator. The squelch circuit could be put out of operation, by a switch, removing the high voltage from the squelch oscillator tube.

i. AVC Circuit (Л 213 and Л 212) (6Ж 6 C, 6 Г 2).
The left hand diode of tube Л 212 was the AVC diode. The IF output was applied to the cathode of this tube through a 100 mmf condensor. The AVC voltage was amplified in tube Л 212 and AVC voltages were obtained from the anode loads of this tube. Strong AVC was applied to the first and second IF amplifier tubes. A weaker AVC voltage was applied to the RF and first mixer tubes. The AVC could be varied by means of a preset potentimeter marked У YBCTB (Sensitivity).

j. Plugs.
The receiver was equipped with 6 plugs. Plug 205 was a coax plug where the antenna signal from the antenna switching relay in the transmitter was introduced into the receiver. Plug 201, covered by a metallic friction cap (see section III, C,1 (h)) was used for connecting a test meter to measure different voltages and currents in the set, enabling the radio mechanic to test the receiver and tune it on the various channels. Plug 202 was used to apply the various voltages from the power supply to the receiver.
Plug 204 was connected through a cable to the transmitter and brought the power supply voltages to that unit. Plug 203 was connected to the control box enabling the pilot to select channels. Plug 206 was not in use in this particular receiver and was covered with a plastic cap. The function was evidently the same as that of plug 106 on the transmitter, to enable local control of the receiver during testing and tuning (see section III, C,1 (h)).

3. Channel Selection and Push to Talk Circuit.

Channel selection was accomplished from the control box (see photo and circuit diagram of control box DWG no. 4). The control box (type P) was equipped with 4 push buttons, one for each channel, marked 1.2.3. and 4. The control box was fitted with a switch enabling the pilot to select either the output of the VHF receiver or the radio compass, and a volume control which permitted setting the audio output of these equipments at a suitable value. The control box had 4 plugs. Plug 304 connected the pilot.s headset to the control box. Plug 301 was connected to the push-to-talk button on the throttle handle and through a Y splice to the output of the radio-compass receiver. Plug 302 was connected to the transmitter and plug 303 to the receiver. Channel selection was accomplished by grounding the lead to the appropriate channel contact on the ratchet motor housing. For example for channel 1, pin 3 on plugs 302 and 303 was grounded, starting the ratchet motor until the channel slide was pushed in and its channel contact was broken by the channel contact disengaging throw, stopping the motor. A button marked C6POC was found on both the transmitter and the receiver. When depressed ground was applied to the ratchet motor and it was placed in operation. A similarly marked button on the control box had no electrical function but mechanically disengaged channel selector buttons. If this were done, the C6POC button on the receiver and transmitter could be used to control the ratchet motor until slides were in a desired position e. g. in position for a desired channel or completely disengaged for manual, local tuning and locking.
These buttons started the motor and kept it running as long as they were depressed.

The push-to-talk button was placed on the throttle handle. When it was depressed, antenna switch over relay P 101 in the transmitter and the transmit voltage relay in the power supply were actuated.

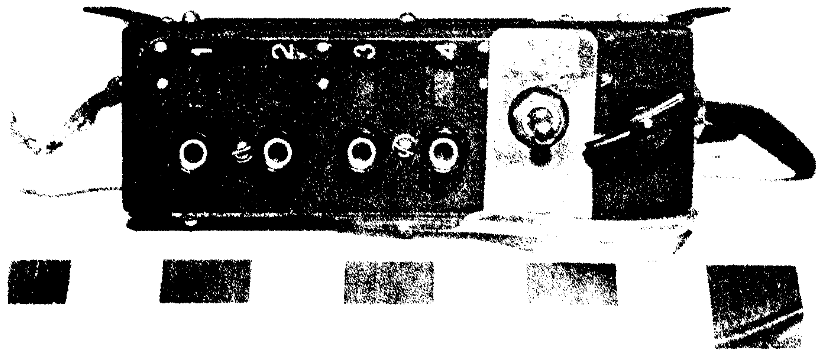

Fig. 3-35. Control Box Type P. Front.

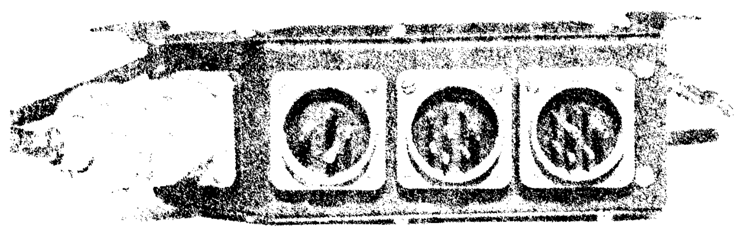

Fig. 3-36. Control Box Type P. Back.

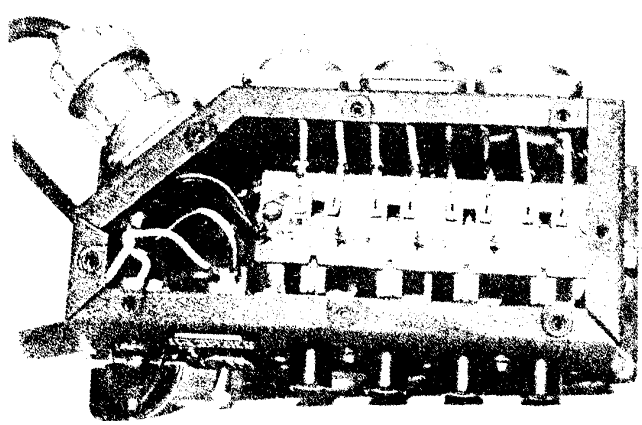

Fig. 3-37. Control Box Type P. Top.

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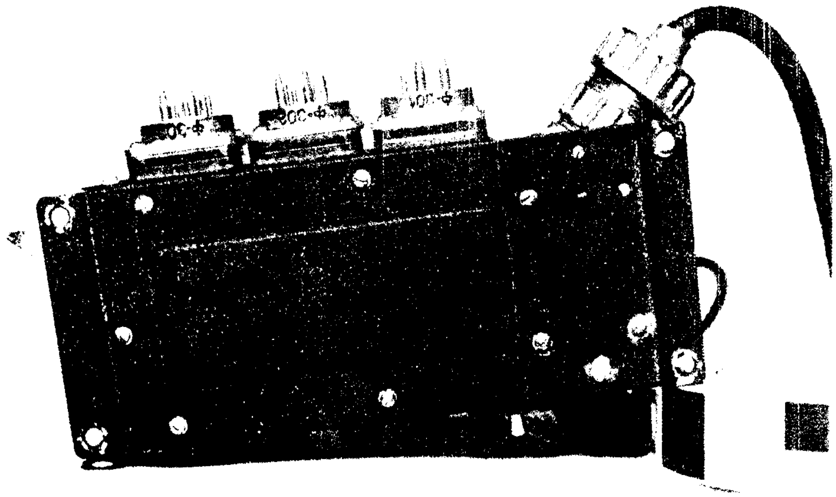


Fig. 3-38. Control Box Type P. Bottom.

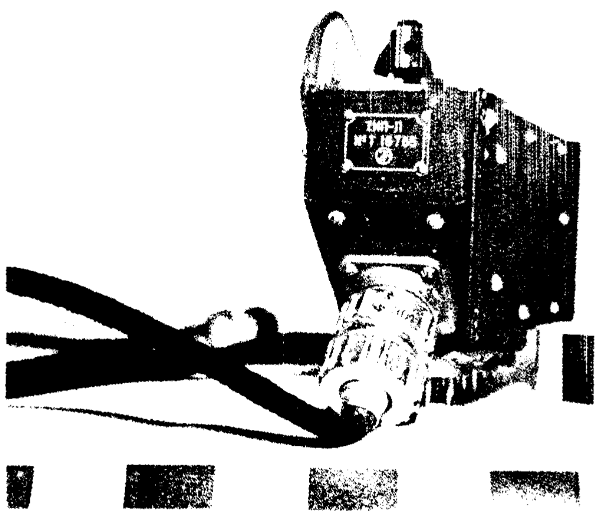


Fig. 3-39.
Control Box Type P.
Right end.

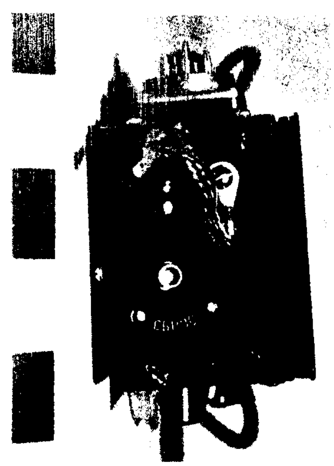


Fig. 3-40.
Control Box Type P.
Left end.

4. <u>Inverter.</u> (See Circuit Diagram DWG. no. 7)

The Inverter, type MA-100 M was fed from the battery and delivered AC power to the VHF power supply BM. It was similar to the inverter type MA-250M, but with smaller capacity rotary transformer. Nameplate inscription revealed the following specifications:

E 5 4436593

Input 27 volt - 11 amp

Output 115 volts - 0.87 amp - 1 phase - 400 cps - cos Ø = 0.9.

Loading experiments produced the following results:

a. Output regulated to 115 v/ 0 amp, F = 430 cps with 6% 3d harmonic and less than 1% other harmonics.

b. Output regulated to 115 v/ 0 56 amp F = 400 cps with 10% 3 d harmonic and less than 1% other harmonics.

c. Output regulated to 115 v/ 0 87 amp, F = 380 cps with 10% 3 d harmonic and less than 1% other harmonics.

The weight of the inverter was 7.1 kg with shock mountings. The motor housing was sealed and access to the interior was not possible so tracing of some of the connections was necessarily made from the terminal strip.
Therefore, it is suggested that the diagram be considered with care since some inaccuracies may be contained.

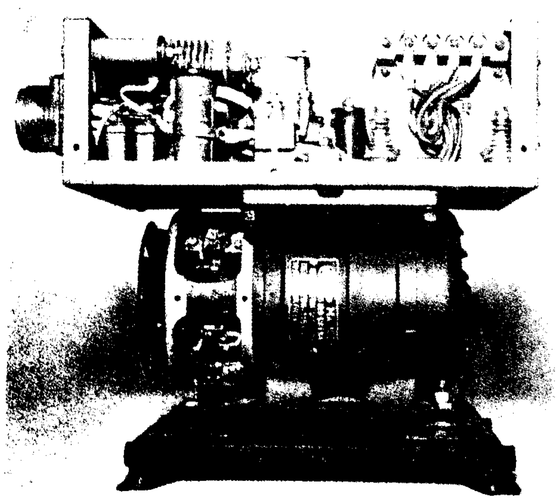


Fig. 3-41.
Inverter MA 100 M.
Front.

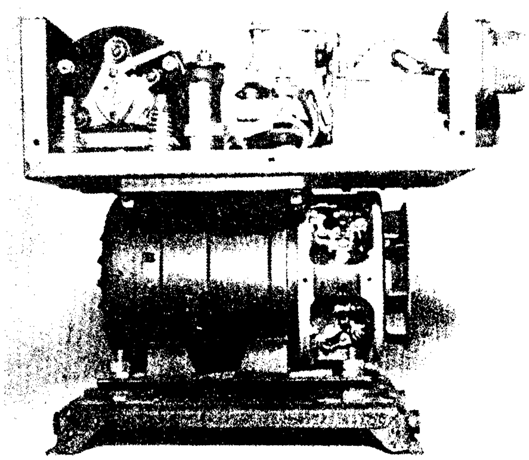


Fig. 3-42.
Inverter MA 100 M.
Back.

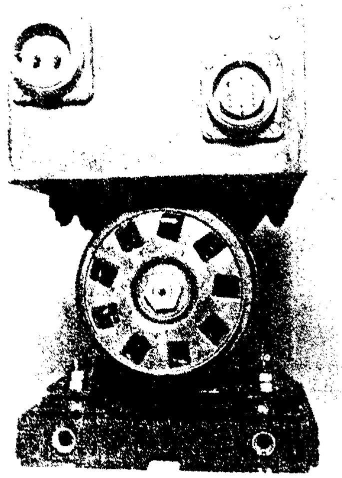


Fig. 3-43.
Front (cover removed)
Inverter MA-100-M.

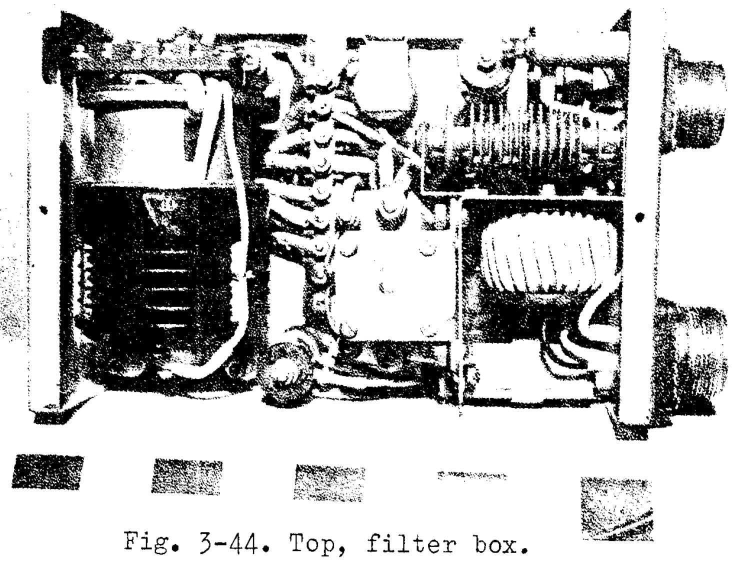


Fig. 3-44. Top, filter box.
Inverter MA-100-M

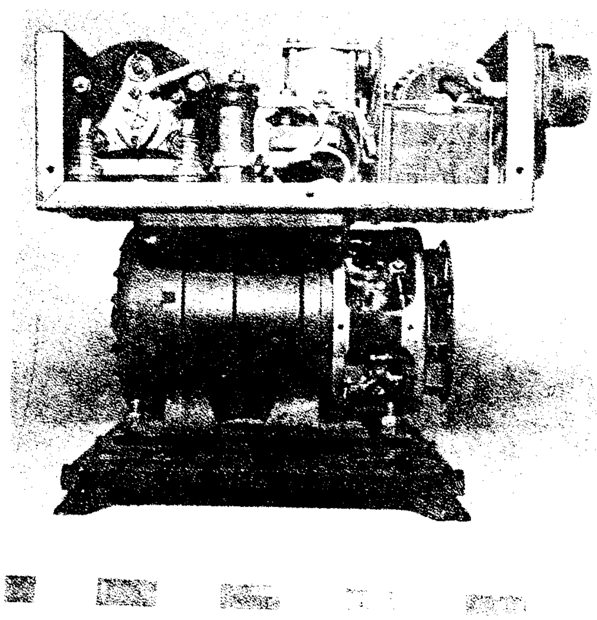


Fig. 3-46. Side. Inverter MA.100-M.

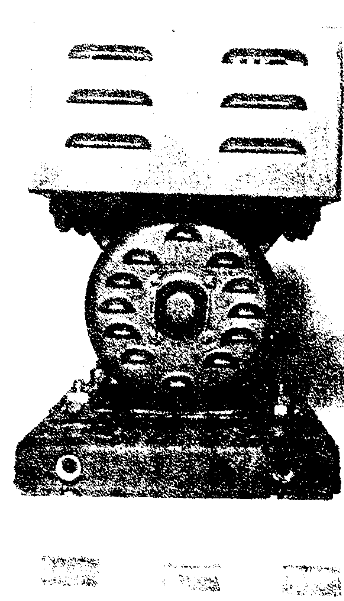
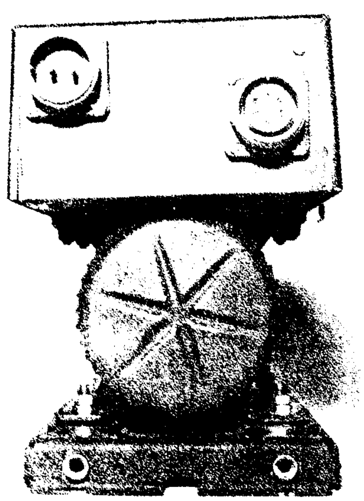


Fig. 3-45.
Rear. Inverter
MA-100 -M. →

Fig. 3-47.
Front. Inverter
MA-100-M.
←



5. Power Supply Type BM (VM) (See Circuit Diagram, DWG. no. 6)

The power supply received 28 volts DC and 115 volts, 400 cycles AC from the inverter unit. The power supply had two rectifiers, one providing high voltage to the transmitter and receiver and the other giving the negative grid bias. The relay in this unit increased the high voltage and grid bias during transmit. A variable preset resistor of 326 ohms total value, accessible from the front plate, was set to provide an output of 115 AC from the inverter. A voltage divider was included from which the microphone voltage was picked off with two capacitors, C 406 and C 405 providing the necessary filtering. The 115 volts AC was fused with a 1 ampere fuse. On the front plate, protected by a cover fastened by bolts, was a switch connecting the negative side of the high voltage to ground or placed it in series with the 28 volt DC supply. When found, the switch was in the latter position.

The power supply was equipped with 3 plugs, plug 401 connected to the inverter, plug 402 to the receiver, and plug 403 which was covered by a plastic cap was evidently used as a connection for a test meter.

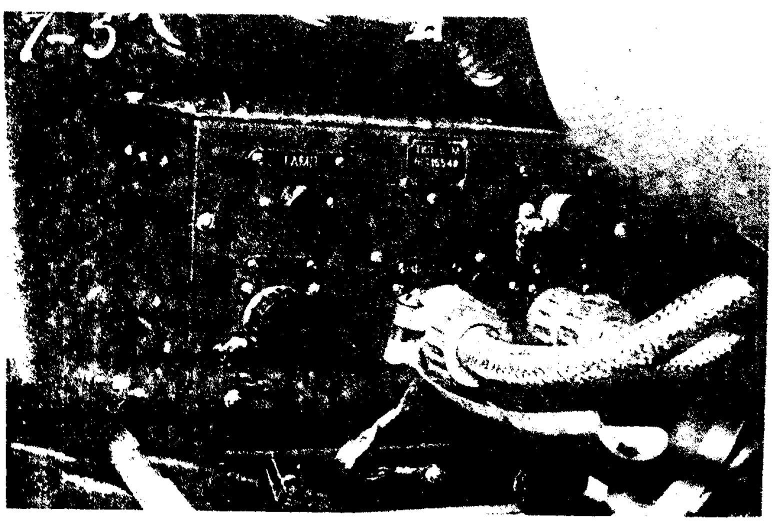


Fig. 3-48.
Power Supply Type VM.

Fig. 3-49. Power Supply Type VM.

6. Tuning Procedure of the Receiver and Transmitter.

Tuning of the receiver was accomplished by connecting a test meter to plug 201, pin 5, and ground, pin 1 (during this investigation, but in all probability by plugging in a test set designed for this equipment into plug 201 during tuning by Soviet and Bloc Country radio mechanics). The two tuning knobs were set to the appropriate frequency on the indicating dial and final adjustment was accomplished by adjusting the two knobs to produce maximum deflection on the tuning meter. Tuning of the receiver was also possible by switching off the squelch and adjusting the tuning knobs to provide maximum noise. The transmitter was wired with three internal meter shunts, enabling the radio mechanic to measure the different tube currents in the transmitter. Between pins 6 and 7 on plug 101, across a 1 ohm resistor, the PA plate and screen grid current and the screen grid current on the second tripler could be measured. Tuning of the transmitter was accomplished by adjusting the first two tuning knobs to provide maximum current in the PA stage evident by maximum meter deflection when connected between pins 6 and 7 on plug 101. The anode circuit of the PA stage could be tuned by connecting a meter between pins 1 and 5 on plug 101 and adjusting knob 3 for maximum deflection.

7. Laboratory Measurements.

a. Crystalization.
The VHF set was crystalized as follows when it was removed from the aircraft. Frequencies were determined as explained in Section III, B, 6.

Channel Number	Crystal Number	Transmitter Frequency (MCS)	Receiver Frequency (MCS)	Pilot.s Stated use
1	361	130.01	130.00	Directional Guiding
2	16	101.25	101.25	Manouvre Flying
3	460	138.26	138.25	Flights over larger territories
4	301	125.01	124.99	Polus - lost or in danger.

b. Transmitter Power Output.
Power output of the transmitter was measured with the VHF set installed in the aircraft and external power applied to the aircraft. Power was measured on a Bird Termaline Type 67 (0-15, 0-60 watt ranges) RF power meter.

Channel	Frequency (MCS)	Power Output (Watts)
1	130.01	3.4
2	101.25	4.0
3	138.26	3.9
4	125.01	5.6

c. Receiver Measurements.

(i) IF Measurements.

The IF was measured in the laboratory and was found to be 11.98 mcs. IF sensitivity was measured to 3.5 u volts with a resulting signal to noise ratio of 6 db (modulation 400 cycles at 30%). A 12 mcs signal was then applied to the antenna plug and a 16 mv signal (400 cycle, 30% modulation) gave a signal to noise ratio of 6 db.

IF selectivity test produced the following:

50 kcs	10 db down	(Signal introduced through a DC blocking capacitor to anode of 2d mixer and output measured across headsets)
100 kcs	30 db down	
180 kcs	70 db down	

(ii) RF Sensitivity Measurements.

The RF sensitivity of the receiver was measured using 400 cycles, 30% modulation and the following data was obtained, with a signal to noise ratio of 6 db in the audio output maintained. Signal strength applied to the antenna, which opened the squelch was also recorded.

Frequency (mcs)	Sensitivity (u v)	Squelch Opens (u v)
125.0	0.8	1.5
130.0	0.8	1.6
138.3	0.7	2.0
101.2	1.6	2.3

(iii) Audio Characteristics of Receiver.

Audio characteristics were measured. Results are plotted on the accompanying graph.

(iiii) Headsets and Microphone.

Resistance of the pilots carbon throat microphone ranged between 500 and 2000 ohms. Headset impedance measurements yielded the following results:

Frequency (cycles)	Impedance (K ohms)	Phase Angle Ø (Degrees)
DC	4.5	-
50	4.6	11
800	14.5	55
10.000	100	44

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VHF SET RSI-U-3M.

AUDIOFREQUENCY CARACTERISTIC OF RECEIVER

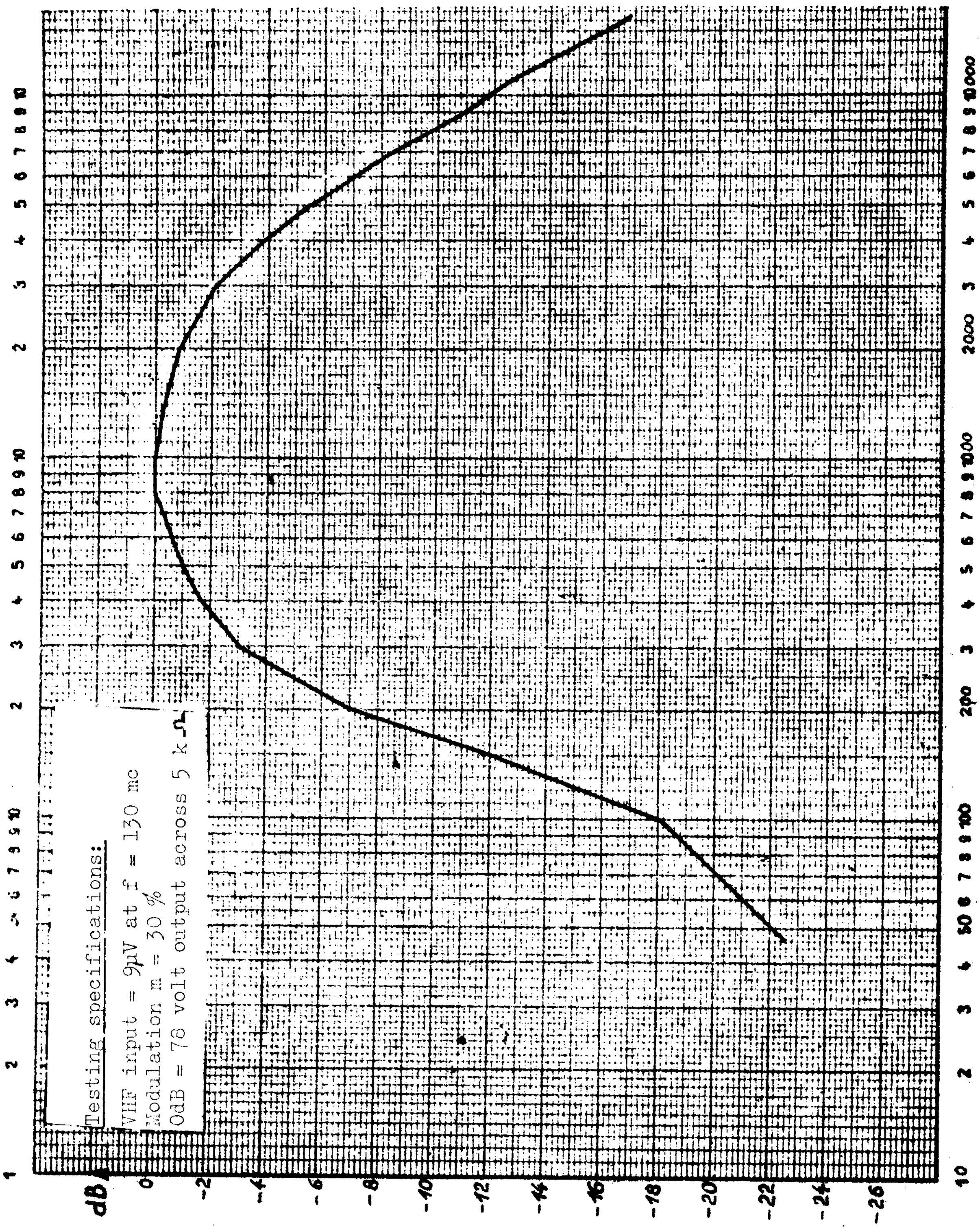

Fig. 3-50.

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8. Cabling.

Cables between units of the VHF set were all shielded and terminated with female plugs. These plugs were marked with the same designation as the male sockets to which they were connected. Only one type of plug and socket was utilized in the VHF set, apart from coax connector, and it is displayed below. Pins on plugs and sockets were numbered from 1 to 8. All sockets on the transmitter were numbered in the 100 series, on the receiver in the 200 series, on the control box in the 300 series, on the power supply in the 400 series and on the inverter in the 500 series. Sockets that were connected by cable to another unit were marked with the corresponding digit each unit, e.g. plug 104 on the transmitter was connected by cable to plug 204 on the receiver. Only one splice was noted in the VHF cabling, that which joined the leads from the audio output of the radio compass to the cable from socket 301 on the control box to the push-to-talk button on the throttle handle. General applicable remarks cabling may be found in Section II D.

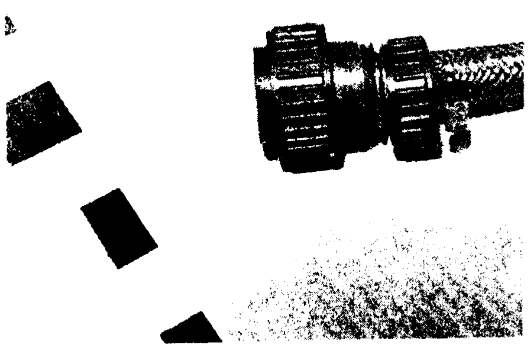

Fig. 3-51.
Cable Connector from VHF set.

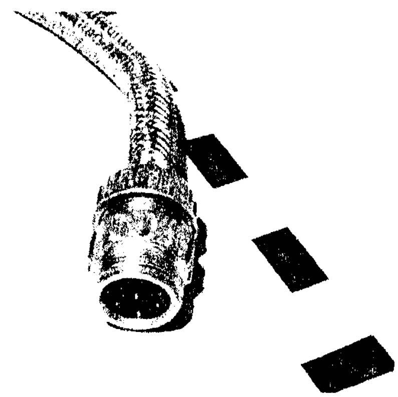

Fig. 3-52.
Cable Connector from VHF set.

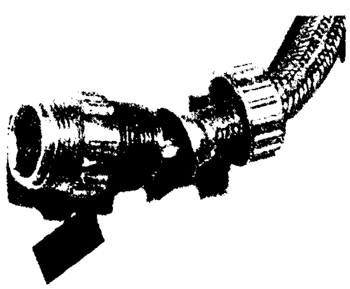

Fig. 3-53
Cable Connector from
VHF set

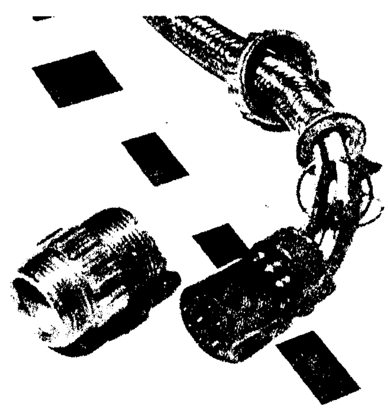

Fig. 3-54
Cable Connector from VHF set.

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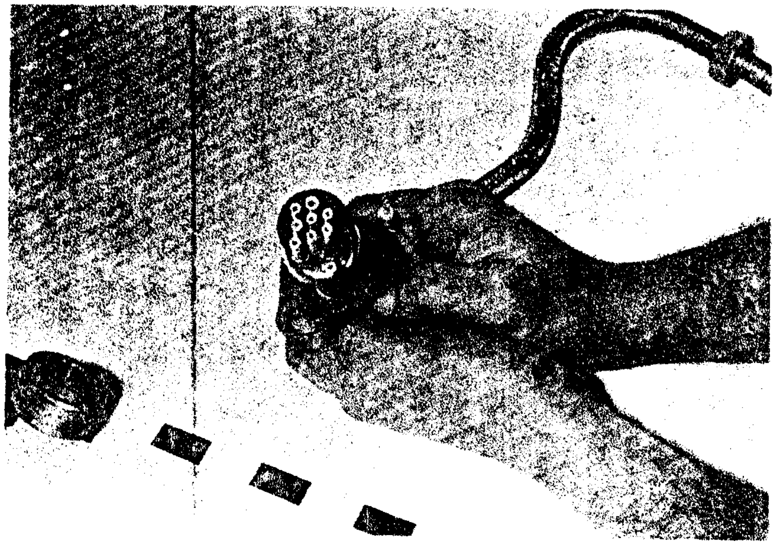

Fig. 3-55. Cable Connector from VHF set.

9. Vacuum Tubes.

The following types of tubes were utilized in the equipment. Their nearest Western equivalent are also listed. All tubes were of Soviet origin.

Receiver		Transmitter	
Soviet Type	Western Equivalent	Soviet Type	Western Equivalent
6 Ж 3 П	6 A K 5	6 П 6 C	6 V 6
6 Г 2	6 S Q 7	Г У 3 2	8 3 2
6 Ж 6 C	6 H 6	6 Ж 3	6 A K 5
6 П 6 C	6 V 6	6 Г 2	6 S Q 7
6 H 4	6 S G 7		

All tubes were checked and the pin connections and tube characteristics were verified. Western equivalent were determined in this manner.

D. Operating Procedures.

Operation of the equipment was quite simple. The pilot merely switched on the RADIO switch on the switch panel on the starboard side of the cockpit. This connected the positive side of the aircraft 28 volt supply to the VHF inverter and operation of the set began. Audio output could be adjusted to the desired level by means of the volume control potentiometer on the control box. The volume control was adjacent to a metal plate across the front of the control box. It bore the inscription G ⇔ G. Turning the volume control in the direction of G increased volume, and in the direction of C, diminished it.

A toggle switch mounted on the front panel of the control box in a circular hole in the metal plate mentioned above switched pilot.s headset between the VHF receiver output and that of the radio compass. These two positions were marked ARK and ODB and the switch had to be in ODB position to enable monitoring of the VHF receiver. The desired channel was selected by pushing the appropriate channel selector push button on the control box. To transmit, the push-to-talk button on the center of the throttle handle was depressed. The channel button could be disengaged by depressing the button marked CEPOC on the end of the box.

The pilot stated that reception on VHF was always loud and clear and he had never experienced any difficulties with it. He explained the use of the various channels as follows:

1 Directional Guidance

2 Manouvre Flying

3 Flights over larger territories

4 "Polus" - lost or in danger

He stated that the VHF range was the following:

Altitude (meters)	Distance (km)
1000	60
5000	120
10000	180

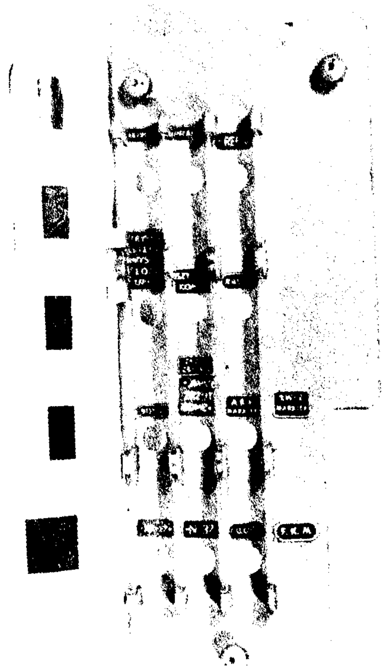

Fig. 3-56.
Pilot.s Switch panel.

E. Comments.

This VHF equipment was very well built and sturdy. Though not elaborate, it appeared to be functional and efficient. Internal wiring was neat, orderly, and terminals were well soldered. However absolutely no new or unusual techniques were noticed. Regardless of how dependable, sturdy or easily tunable the set was, the fact remained that it was still a bulky and heavy piece of gear with only a four channel capacity. Had it been produced in 1924 it could have been justly a source of pride of its originators. At this moment, by Western standards, it is twelve years behind the times.
For remarks concerning servicing of this equipment in the aircraft and accessability, see Section II, C.

SECTION IV.

RADIO ALTIMETER TYPE RV-2

A. General Description.

This installation was similar [redacted] except for some minor modifications, the inclusion of an additional filter unit in the L.T. supply, and the mounting of the Dynamotor upside down.

25X1

B. Technical Data.

1. Mounting.

The Dynamotor was mounted in a similar fashion to that reported previously except that the mounting brackets were upside down. In addition an input L.T. filter unit was mounted on the starboard side of the gun compartment. (See Fig. 4-1). This filter was secured to a mounting plate by four screws.

Fig. 4-1
L.T. Input Filter

2. Description of Components.

The L.T. filter unit consists of an L F choke and a 10/u F condensor. The circuit can be seen in Fig. 4-2.

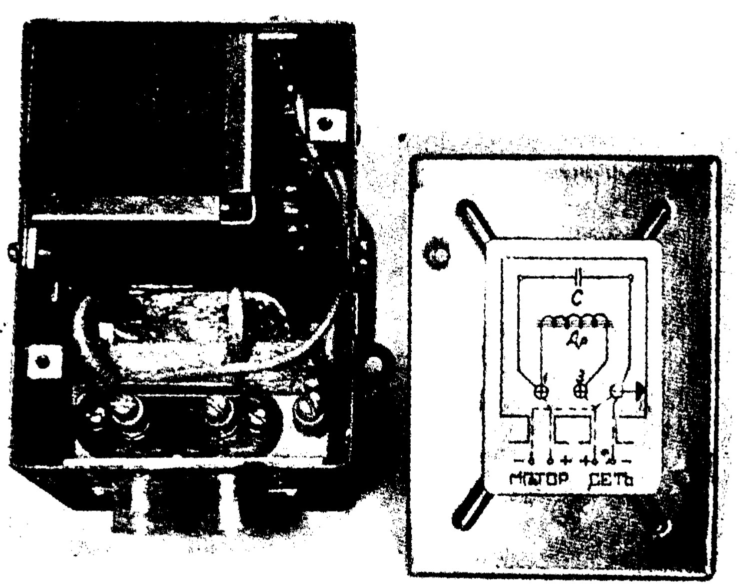

Fig. 4-2
L.T. Input Filter

3. Performance Figures.

It was possible to do a number of running checks on this occasion, the following figures were obtained.

Freq. Deviation	High 438 - 445 mcs Low 415 - 455 mcs
Output Power	350 mw
Sweep Freq.	125 cps.

C. Circuitry.

Only minor modifications were noted. A revised circuit diagram is shown in drawing no. 8.

D. Operating Procedure.

No change.

E. Comments.

1. The inclusion of an additional filter would appear to indicate interference problems through it is doubtful whether this could be a cure in view of other problems that must exist and which are discussed in Section VII.
2. Photographs of the RV 2 unit are shown in Figs. 4-3 to 4-5 overleaf.

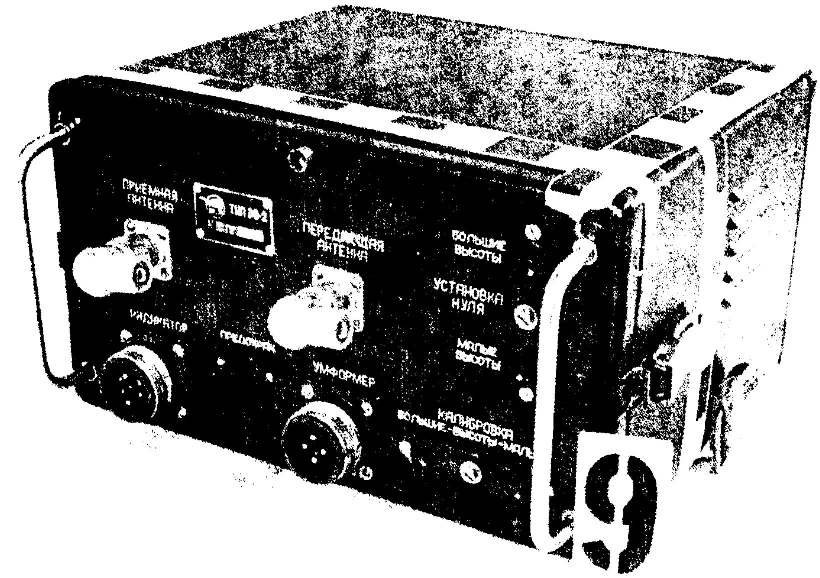

Fig. 4-3.
Radio Altimeter RV-2.

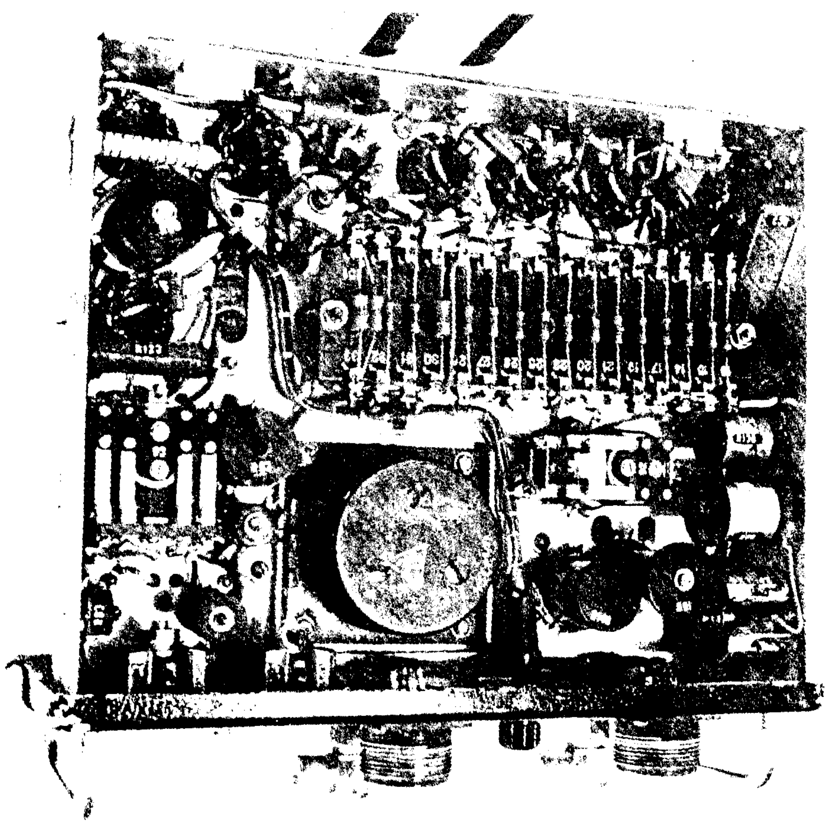

Fig. 4-4.
Radio Altimeter Lower Chassis.

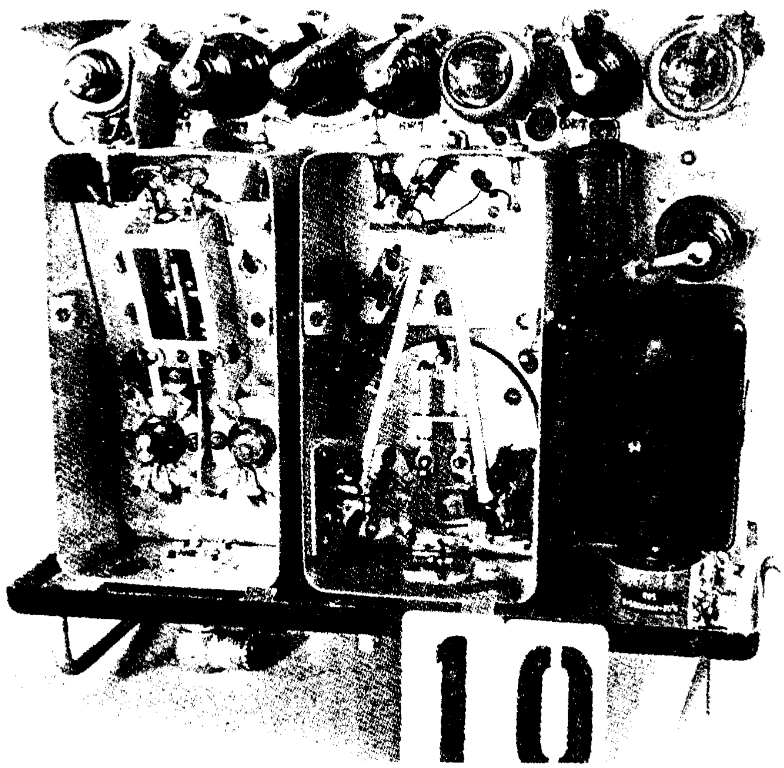

Fig. 4-5.
Radio Altimeter Upper Chassis.

SECTION V

RADIO COMPASS ARK-5

A. General Description.

The radio compass installation was the same [redacted] 25X1 [redacted] except for some minor modifications and that a modified inverter MA 250 M was used, the data of manufacture of this item was June 25X1 1955. In addition arrangements were made for either the output of the radio compass or the VHF to be monitored by the pilot (See Section III).
The deviation curve for the compass is shown in fig. 5-1.

B. Inverter MA-250M.

This new inverter was similar to the MA-250 previously exploited except for the following differences:

1. Changes in input filter, in that more chokes and different value condensers were used.
2. The starting relay number 2444 was of heavier construction and relay number 3995 was removed.
3. A 200 ohm potentiometer R 3 and a switch was connected between pins 1 and 2.
4. Drawing no. 15 of previous report should have had a connection between contact of relay 2444 and transformer marked 1:3.8. This connection is also shown in the drawing of the modified inverter, i.e. between terminals 3 and 4.

C. Circuitry.

Circuitry of the ARK-5 installation was the same as that in 1953, except for the modifications shown in fig. 5-16. The circuit of the modified inverter is shown in drawing number 11. Photographs of modified inverter are shown overleaf (Fig. 5-2 to 5-4).

D. Operating Procedures.

No change.

E. Comments.

1. The redesign of the filter unit again probably indicates that interference problems have been experienced. The pilot in his interrogation also indicates that his needle hunted between a maximum of + and ÷ 5 degrees.
2. A working test showed that the switching frequency used was 50 cycles per second.
3. Photographs of the other radio compass units are shown in fig. 5-5 to 5-15.

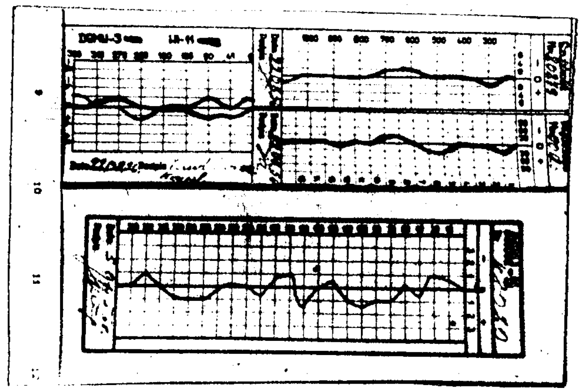

Fig. 5-1.
Radio Compass Deviation Chart.

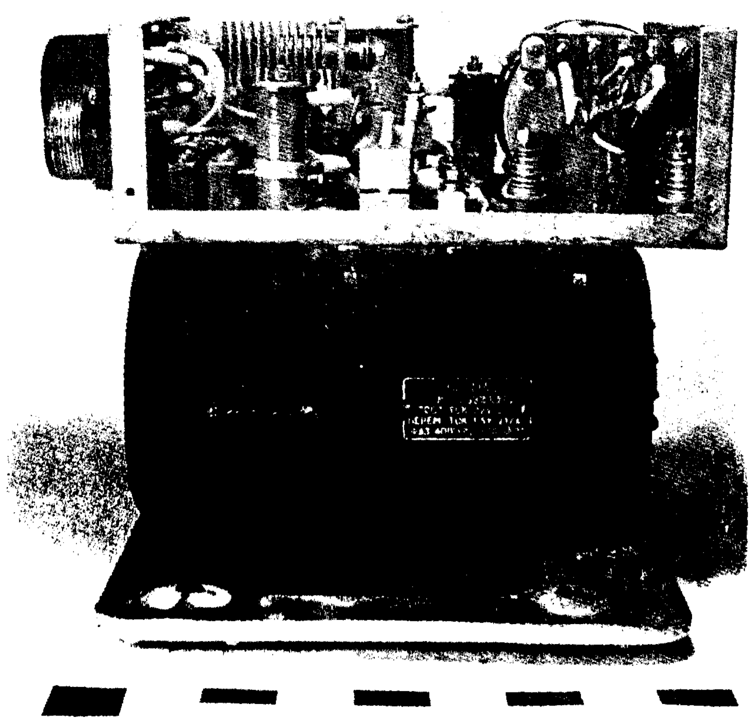

Fig. 5-2.
Radio Compass Inverter Type MA-250M.

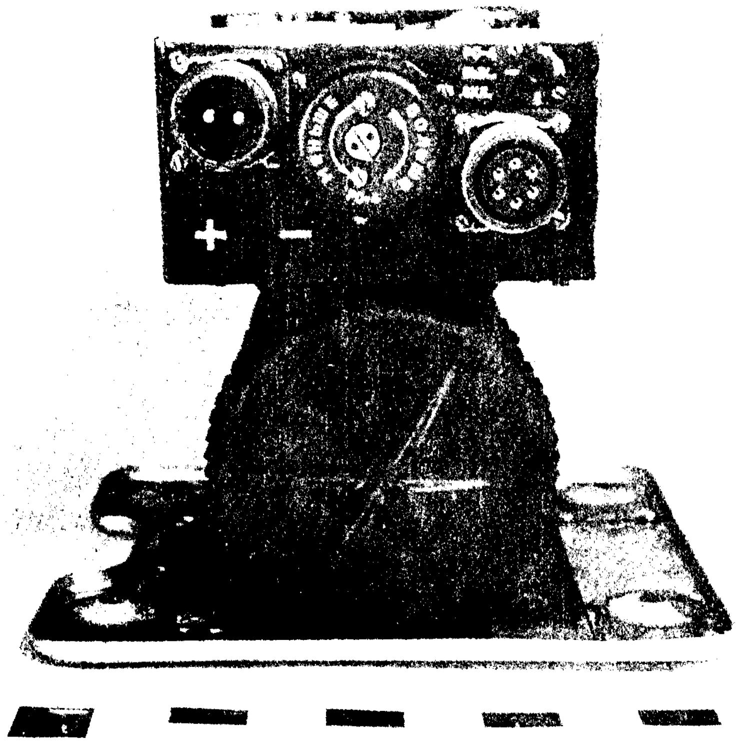

Fig. 5-3.
Inverter Type MA-250M.

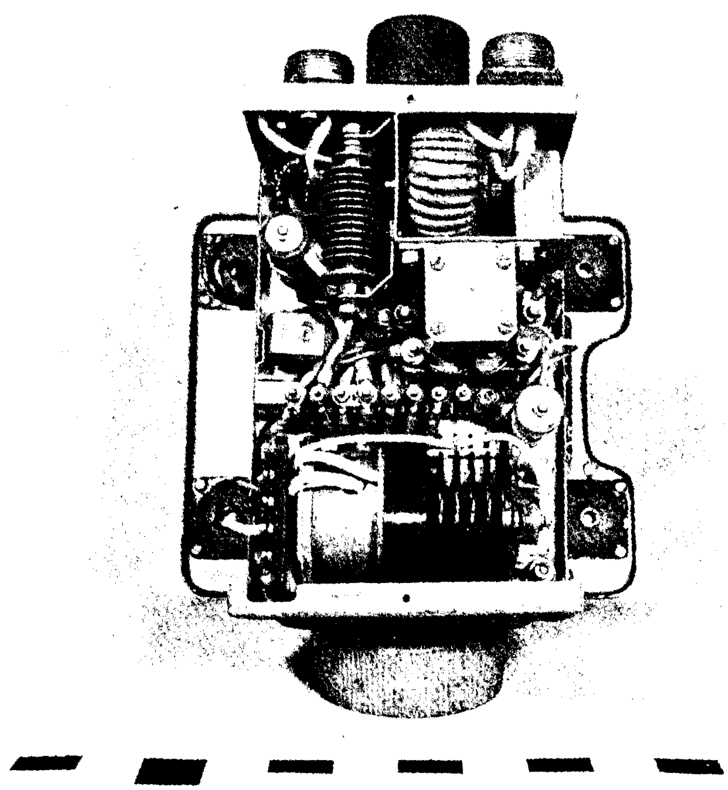

Fig. 5-4.
Inverter Type MA-250M.

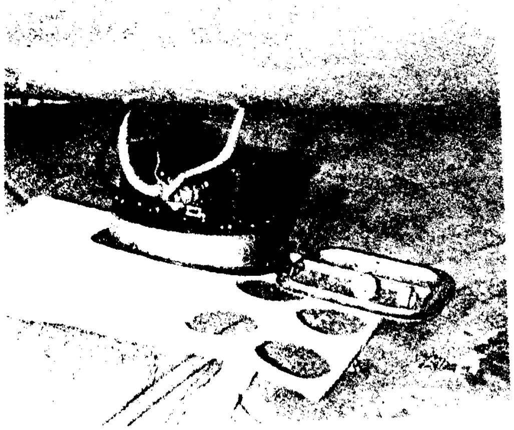

Fig. 5-5.
Radio Compass Loop still
attached to aircraft cabling.

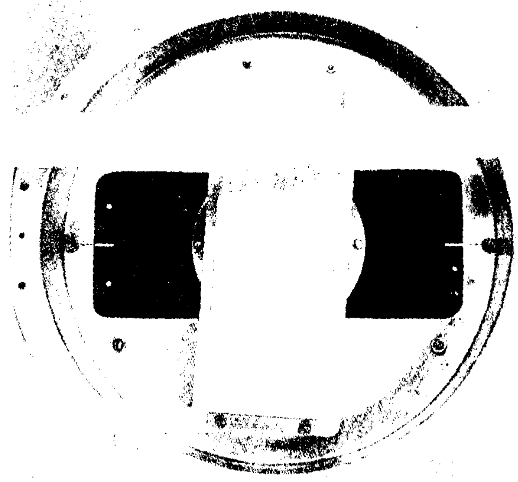

Fig. 5-6.
Underside radio compass loop

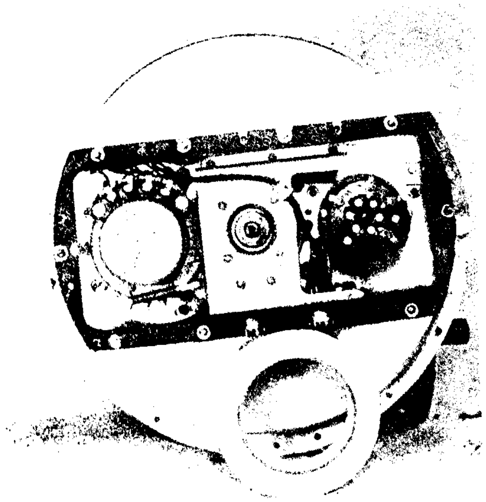

Fig. 5-7.

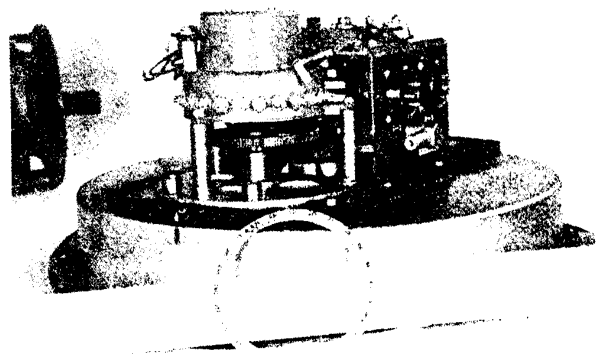

Fig. 5-8.

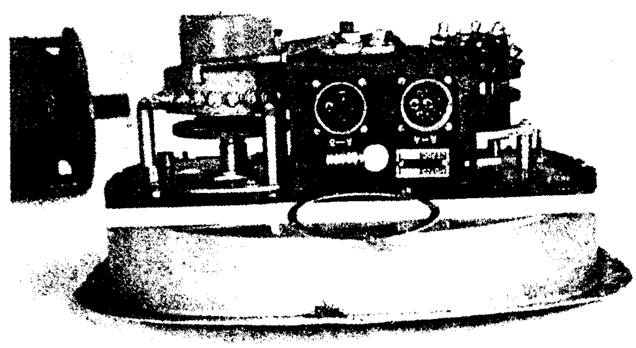

Fig. 5-10.

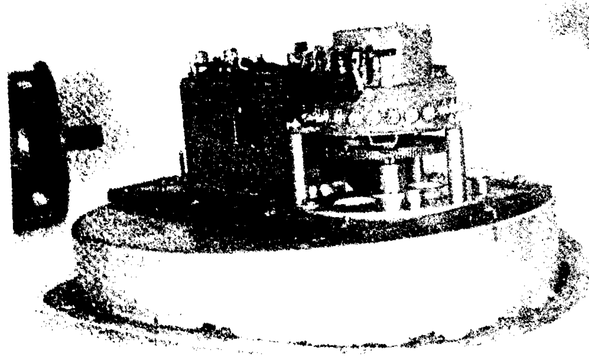

Fig. 5-9.

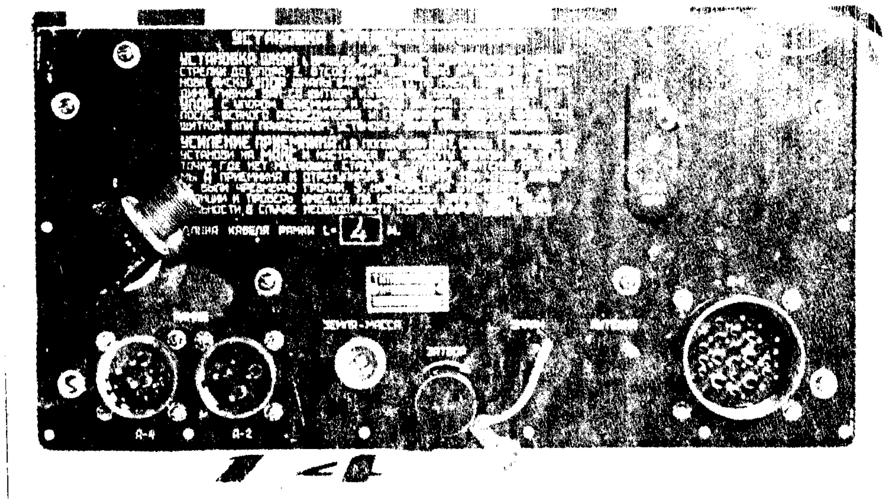

Fig. 5-11. Radio Compass Receiver.

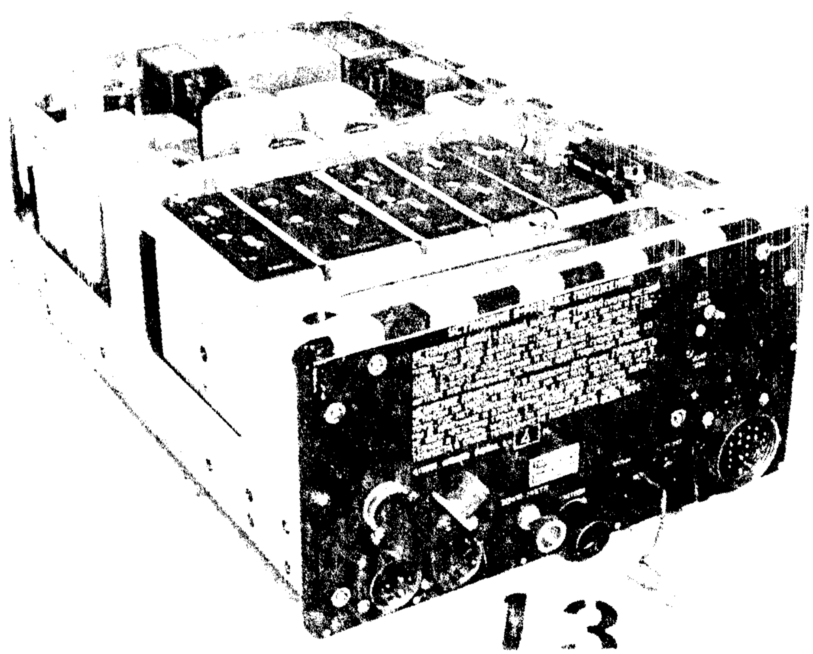

Fig. 5-12. Radio Compass Receiver.

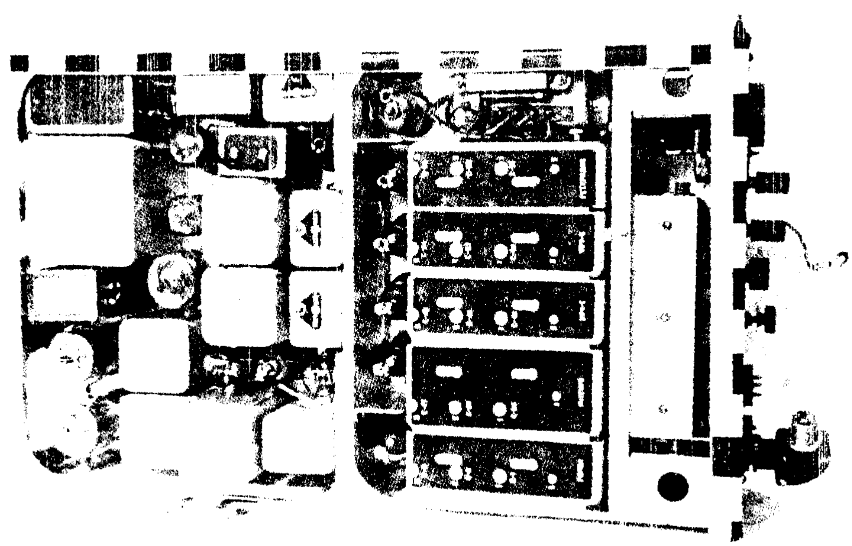

Fig. 5-13. Radio Compass Receiver.

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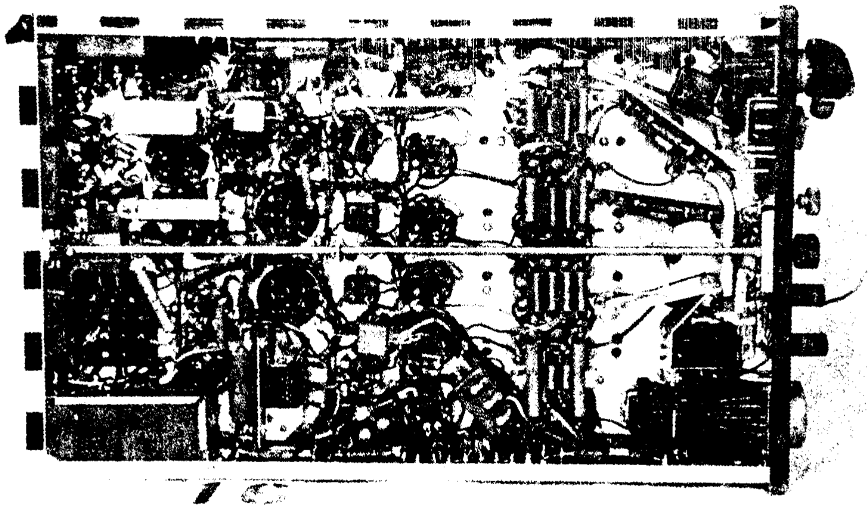


Fig. 5-14.
Radio Compass Receiver.

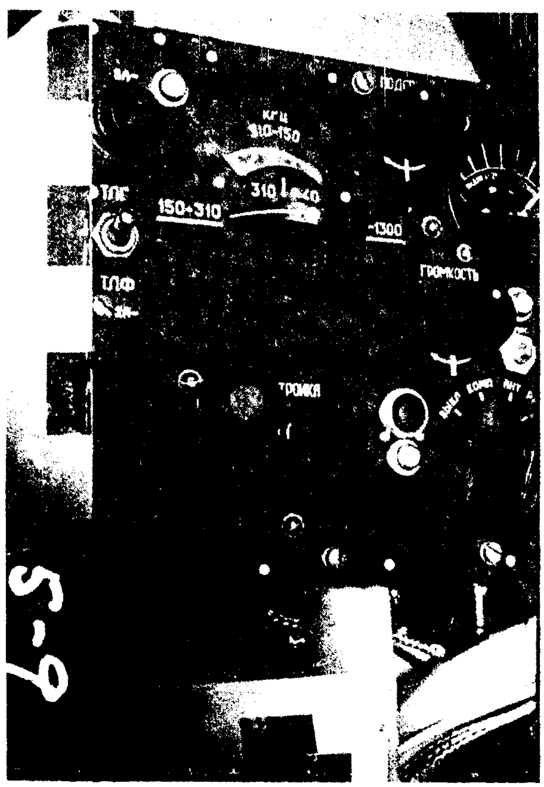
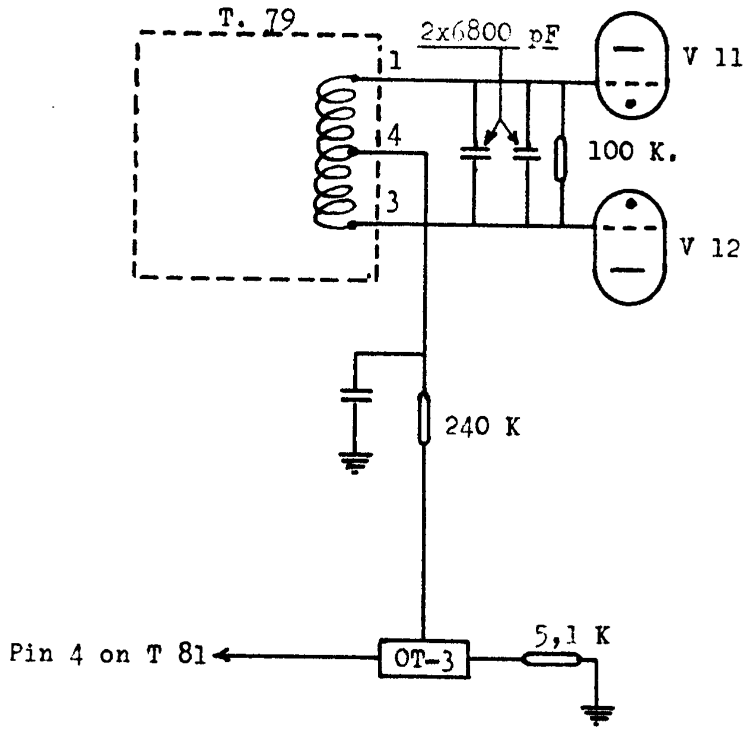
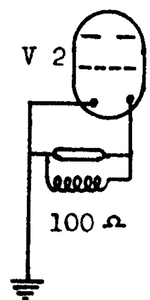


Fig. 5-15.
Radio Compass Control Box.





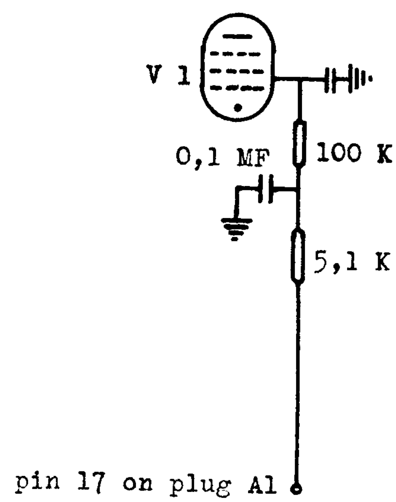


Fig. 5-16.

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SECTION VI

Marker Beacon Type MRP - 48 - P.

A. General description. The installation was identical with that exploited in 1953 except that it was manufactured in POLAND.

B. Technical Data.

Physical characteristics. Photographs of the POLISH manufactured marker beacon are shown below. Fig. 6-1 to 6-4.

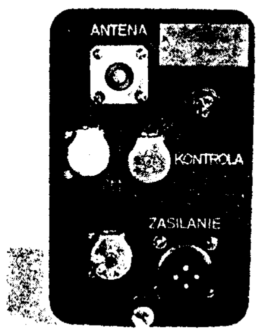

Fig. 6-1.

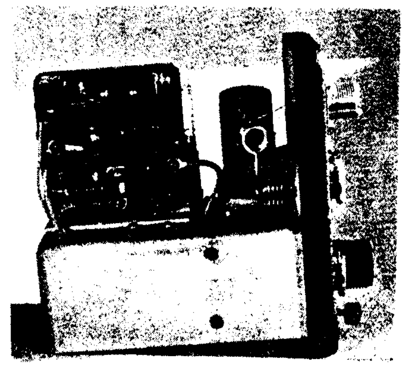

Fig. 6-2.

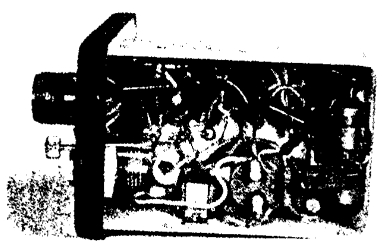

Fig. 6-3.

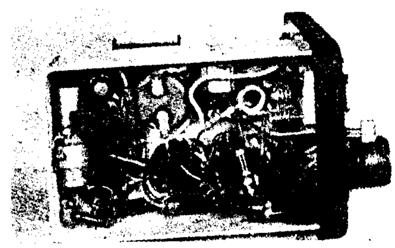

Fig. 6-4.

C. Circuitry - no change.

D. Operating procedures - no change.

E. Comments. The components in the receiver were of GERMAN, POLISH and RUSSIAN manufacture, but the manufacturing techniques were extremely good.

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SECTION VII

CABLING AND CONNECTORS

1. During the inspection of the equipment in the aircraft, it was apparent to electronic personnel that a different philosophy exists regarding the importance of bonding and screening from an interference point of view in the wiring examined. Although this aircraft did not carry radar gunsight equipment, it was clear that the wiring system found lends itself to internal interference and R/F sparking between adjacent cables.

2. Cable runs to different equipment in lengths of 10 feet or more were strapped together to make the cable form by plastic bands, and the screens of the different cables relied on the plug housing at the sockets for earthing.

3. No junction boxes or earthing cleats were found thoughout the electronic cabling.

4. Examples of the plastic bands and typical cable runs can be seen on Fig. Nos. 7-1, 7-2, 7-3.

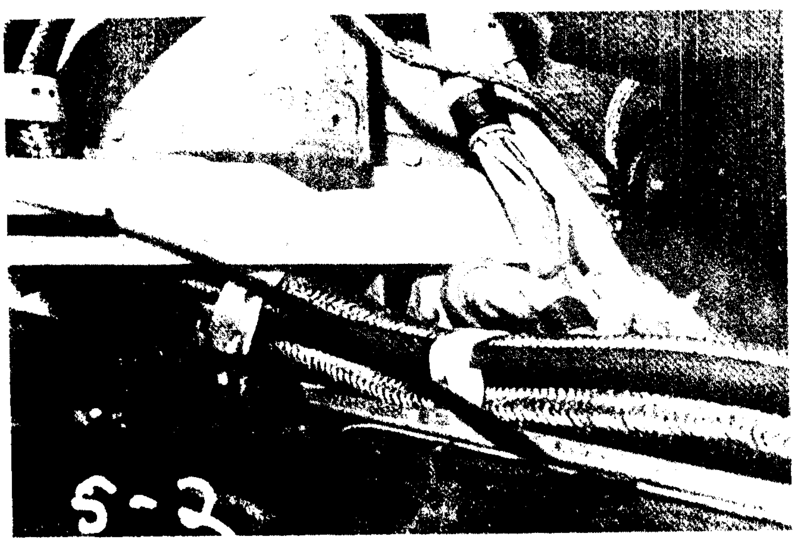

Fig. 7-1.

Fig. 7-3.

Fig. 7-2.

5. The aircraft electrical wiring as a whole was on a different principal to that of the West. Single wire negative feeds were run to all equipments and services with a negative feed from a point on the chassis via a plug and socket (Figs. 7-4 and 7-6). The lengths of these negative feeds were peculiar in that instead of taking the feed directly between the equipment or service and the plug socket on the airframe, as much as 3 feet of cable would be turned backwards and forwards on itself and cleated in position by a plastic studded strip. Heavy current carrying cables with metal sheathing, such as the main aircraft generator, would be run alongside other electronic sheathed cabling and loosely cleated together with plenty of independant movement during periods of vibration. A metal cleat with a quick action release was used in several places, but these merely held odd cables to the point on the airframe without effectively earthing, and no effect had been made to establish a definite connection electrically (Fig. 7-5).

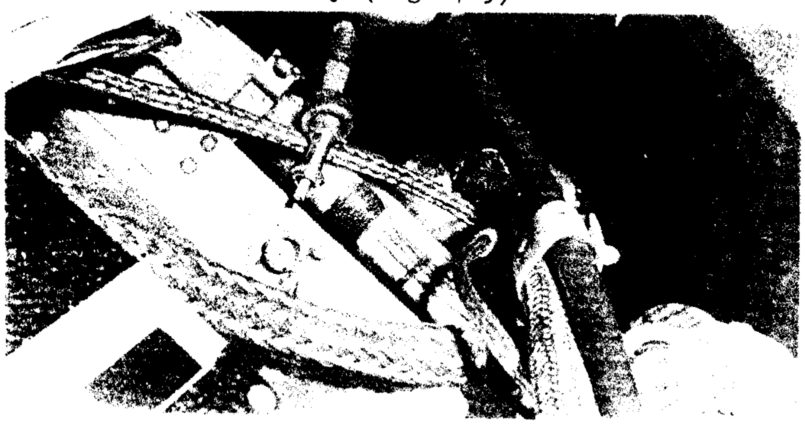

Fig. 7-4.

Fig. 7-5

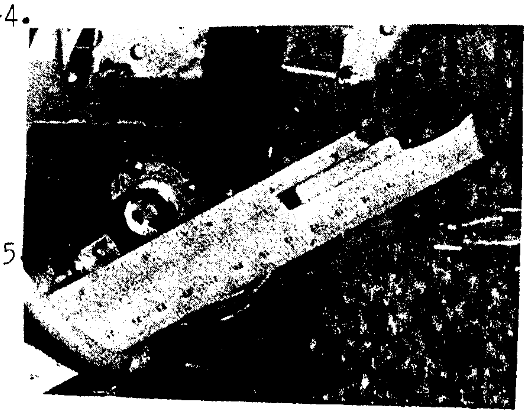

Fig. 7-6.

6. Navigation lights were fed for instance by a single wire from the main supply, and near the light was an earthing plug and socket to provide the other feed.

7. The one exception to this principal of electric wiring was the aircraft armament circuits, where two wire wiring was used directly from the aircraft main supply.

Plugs and Sockets.

8. At least five different types of plugs and sockets were examined, and the three variants, from Western W plug types, photographed in various stages of disassembly.

9. The most common type of multi-pin plug was found to contain spring loaded sockets to house each pin, the spring placed a pressure on the full length of the socket, and when a pin was pressed home, automatically maintained the good electrical contact between the two despite outside influences such as vibration. This is possibly similar to a German civilian manufactured plug and socket. (See Fig. 7-7 to 7-11).

Fig. 7-7.

Fig. 7-8.

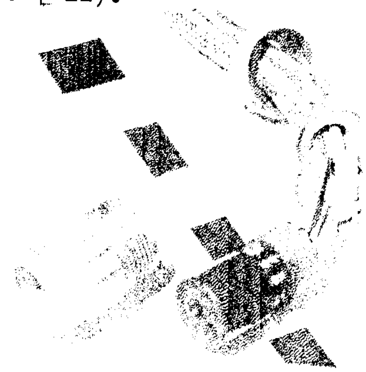

Fig. 7-9.

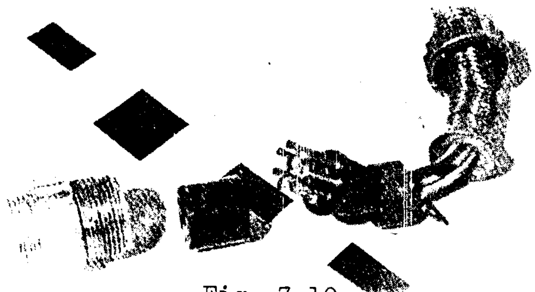

Fig. 7-10.

Fig. 7-11.

Despite this very fine electrical contact plug and socket the method of screwing the plug and socket together as a whole was cumbersome in the extreme, and considerable strain was placed on the cable ends, when plugs and sockets were separated or joined. All plugs and sockets were wire locked together after being tightened, and this wire locking is practiced on all plugs and sockets in the aircraft. (See Fig. Nos. 7-12 and 7-13).

Fig. 7-12

Fig. 7-13

10. A second type of plug (See Figs. 7-14 to 7-20) differed in that it did not have to be broken apart to remove it from a socket, a rotatable threaded outer case operated in a similar manner to "W" plugs (CANNON).

Fig. 7-14

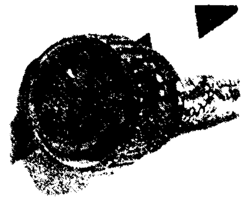

Fig. 7-15

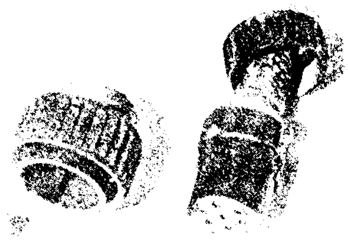

Fig. 7-16

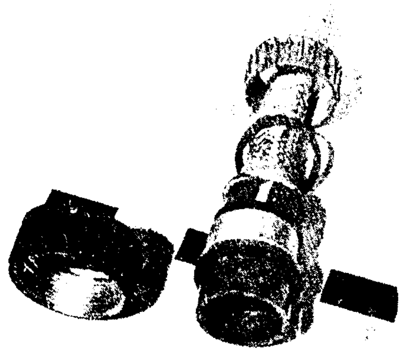

Fig. 7-17

Fig. 7-18

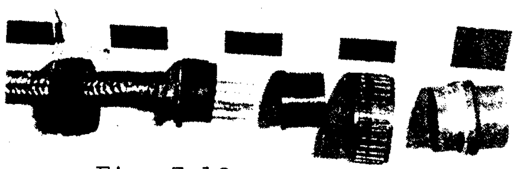

Fig. 7-19

Fig. 7-20

11. Household type 5 amp two pin bakelite plug and sockets were used in the cockpit and appeared to be available to supply 28VDC to test equipment in the cockpit.

12. General.

One further item noted as of interest, concerned the aircraft accumulator. It was housed in a completely enclosed box. A special amlet was provided for fume extraction consisting of a rubber tube connected to a metal pipe which ran into the nose wheel compartemnt and out under the fuselage just forward and starboard of the nose wheel door (See Figs. 7-21 and 7-22). The accumulator was rated at 24 volts 26 AH with maximum discharge current stated as 107A for 5 minutes

Fig. 7-21.
Accumulator Fume Outlet.

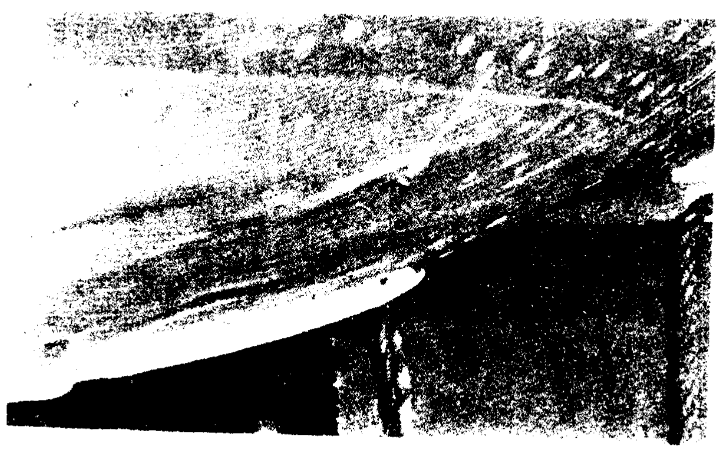

Fig. 7-22.
Accumulator Fume Outlet.

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SECTION VIII

AIRCRAFT-RADIO-SERVICING

A. General Description.

1. The inaccessability of all radio equipment with exception of the VHF, and the pilot's estimate that equipment was not usually touched if the performance was satisfactory and was expected to last the life of the aircraft, leads one to belive that radio servicing as is known in the West is not practiced behind the Iron Curtain. Further evidence of this was found in the factory seals being still in position on all equipment except the VHF. [redacted] if 25X1 an equipment became unserviceable the whole unit was replaced and the unserviceable item returned to the factory.

2. The other piece of equipment requiring adjustment internally for frequency changes, namely the VHF, careful designing of the receiver and transmitter had allowed for a simple test meter and selector switch to be plugged in to either set and retuning accomplished with a minimum of effort. This operation can be accomplished on all four channels in less than five minutes and this figure includes the time for removal of the nose panel.

3. It would hardly be coincidence that the only equipment requiring adjustment is easily accessible and the rest of the equipment, some of it more complex but not needing periodic adjustments, should be completely inaccessable and very difficult to remove and practically impossible to test in the area of stowage.

B. Servicing Problems.

1. If the findings of this investigation are common to other aircraft in the Polish Air Force, servicing problems are negligible and manpower required on airfields for these duties may be of a mechanic standard rather than a technician. All that is required is a manufacturing backing in manpower and spares. Though these latter may be small per airfield if the pilot's story of high serviceability is to be belived. Examination of the equipment certainly indicated a use of robust construction and first class components with a high standard of manufacture.
There was no attempt at miniaturization.

C. Comments.

1. It was noticed that metal sheathed cables used to interconnect the VHF set showed signs of wear and the Soviets had appreciated this by producing metal elbows for the cables to rest in and take the strain on the elbow rather than the cable housing. The cables showing wear were minus these elbows.

2. Tuning and Frequency changing of the VHF is so easy and accessable, that in other larger aircraft such as bombers or transport aircraft, crew members could easily be taught to change frequency in the air, and in that case this four channel set may provide far greater facilities than is usual for this type of set.

SECTION IX

SPACE UTILIZATION

1. The location and layout of the electronic equipment in this aircraft is the result of very careful planning and mastery of the technique of Space Utilization. Despite the use of equipment of weight and size corresponding to that in the West in 1946. This careful location planning has resulted in a unique layout by Western Standards. No thought has been given to the problem of ease of removal for servicing except in the one equipment which has to be frequently opened and internally adjusted for frequency changes namely the VHF. All other equipments were very inaccessable and not only were all external connectors wired for security, the actual cases of the equipment had bolts holding the inside equipment, sealed with wax, that in all equipments examined were intact prior to this inspection. The seal had the factory stamp imprinted on it and clearly indicated Soviet philosophy of leaving well alone and not carrying out periodic inspections internally in equipments.

2. One surprise in Space Utilization was the fitting of the VHF inverter, providing the power supplies, in the cockpit behind the instrument panel, and below all the pipes feeding the instruments. The instrument panel and all feeds had to be disconnected to remove this inverter, This most important of all power supplies was the only inverter in a pressurized compartment, other inverters of similar power and supplying other equipments were all in other non pressurized portions of the aircraft.

3. A careful examination of the aircraft for space to fit a gun ranging radar yielded the fact that a simple system could be installed using the area of the centre of the intake still available with all the present equipment in situation. The radar could not be a sophisticated system, but a simple fixed horn antenna with associated transmitter and receiver pre-amps in the nose, with the rest of the equipment located elsewhere in the aircraft.

25X1

SECTION X

[redacted]

A. Approach and Landing Aids.

1. The Radio Beacon Transmitting Station has a two letter identification.
   The altimeter is switched on when flying in very bad weather, also if the cloud formations are lower than 50 metres. The radio marker beacon is installed at the inner beacon which is located 1000 metres from the airfield. After flying over the inner beacon the pilot must be at 100 metres altitude and knows that he has flown over the inner beacon because the bell has rung. Then he bravely lets down because he knows the Radio Station was 1000 metres from the airfield and he had 1000 metres height, otherwise he could not land if the ceiling is below 50 metres. On the other beacon they do not have the marker beacon signal. The outer beacon is on 715 K/Cs. Call sign B.W. Near Beacon is on 289 K/Cs. Call sign B.

B. Ground Radars.

1. [redacted] that all regiments had radar of their own at their station and he had visited the one at his base. 25X1

2. The radar antenna was mounted on a mast 5 to 7 metres high and was on the right hand side of the station. The antenna rotated around the mast and was mounted between two x pieces either end of a horizontal bar. The radar station was in the centre of the station and had three operator positions as follows:

   (a) Radar display operator

   (b) Map operator

   (c) Communication operator

3. Six operators manned the station in two shifts of three operators. Some of the operators were drivers.

4. The communiaction operator passes information and plots to the Commanding Post known as S.D. This post S.D. is always on the airfield.

5. There was another antenna on the left hand side of the radar station 20 to 25 metres away.

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6. The radar display was stated to be a horizontal rectangle on the face of which was approximately a four cycle sine wave, and an aircraft appeared as a bright line some point along one of the cycles.

7. The map was in the center of the cabin and was circular in shape with a radius line drawn from the centre and appeared capable of rotation by the map operator.

8. The communication operator worked to the S.D. post by phone. [redacted] 25X1

C. Control Post S.D.

1. [redacted] Post S.D. co-operated with the pilot. There is a radar 25X1 on every airfield which locates target in the air. If he flies alone or with squadron they track him and find out if he is flying on prescribed course on his map. Radar operator is at S.D. and he makes a trace on the map where the radar shows him and he knows if I go right course.

2. The locator is also used to trace enemy. If target is shown on scope they call the readiness planes and they take off and try to get him. He has seen a ground radar station but he does not know how it operates. The sending impulses.

3. The station consists of the frame aerial which is rotated, if target is caught antenna stops. On the scope if the target is caught, the line gets brighter. They know on ground that if the line gets thicker they have a target on it. When they catch the target they put a grid with courses on top of it, then they calculate the position of the target. The radar station is mobile. The antenna is located on the ground but it is also mobile. If they move they take antenna with them and thinks they have a special trailer for it. The Soviets have better radars than this but do not know any details.

4. [redacted] with ground radars many times and [redacted] the ground radar gives [redacted] course and distance time and speed. 25X1

e.g.	H 100	V 6	100 kms	10 minutes
	(course)	(speed)	(distance)	(time)

5. [redacted] in emergency [redacted] personal number and [redacted] give it on R/T. Only the radar can intercept the signal, not the Flight Commander, [redacted] report such and such a situation. On the R/T. [redacted] not allowed to fly low below 500 metres but [redacted] sometimes flew at 5 metres to fool the radars. [redacted] never detected by the radars below 300 metres over the sea except by the G.P.N. Radar. 25X1

D. Serviceability of Radar Equipment. 25X1

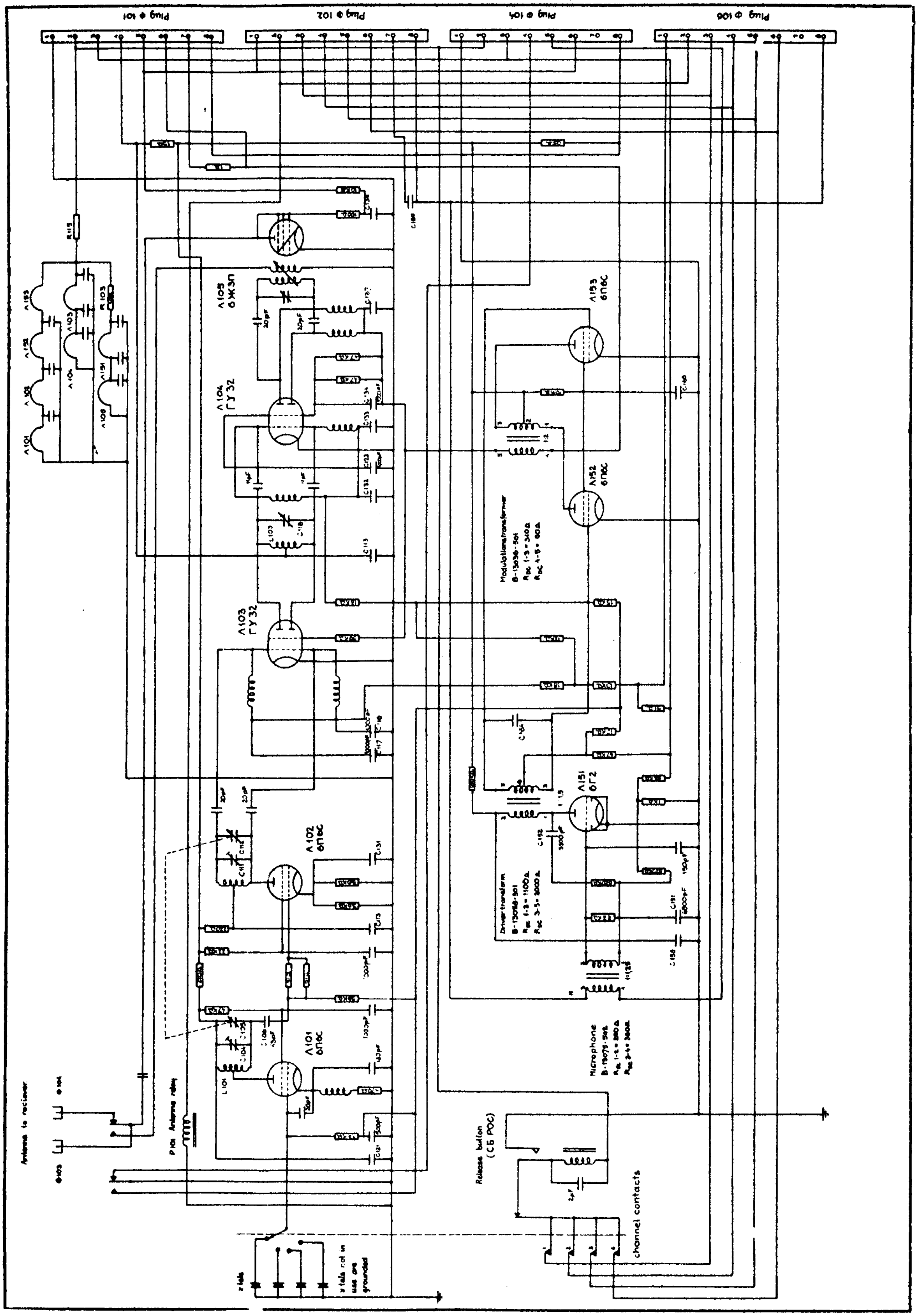
1. [redacted] did not have trouble with our equipments and ground equipments always worked".

E. General.

1. [redacted] the Russians have better aids in Russia but not in Poland. 25X1

VHF SET RSI-U-3M.

CIRCUIT DIAGRAM OF VHF TRANSMITTER.



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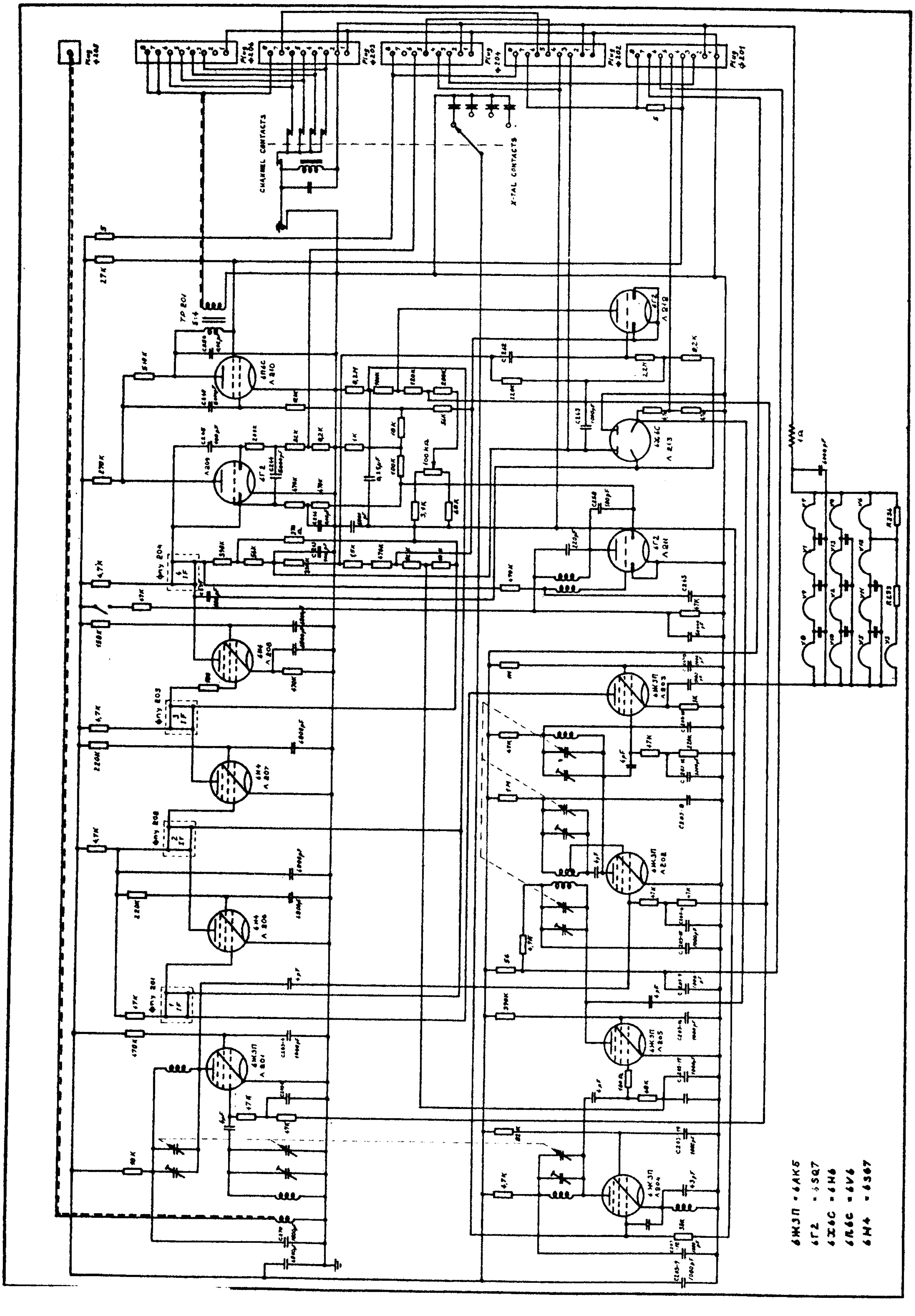
Dwg. no. 1.

VHF SET RSI-U-3M.

CIRCUIT DIAGRAM OF VHF RECEIVER.



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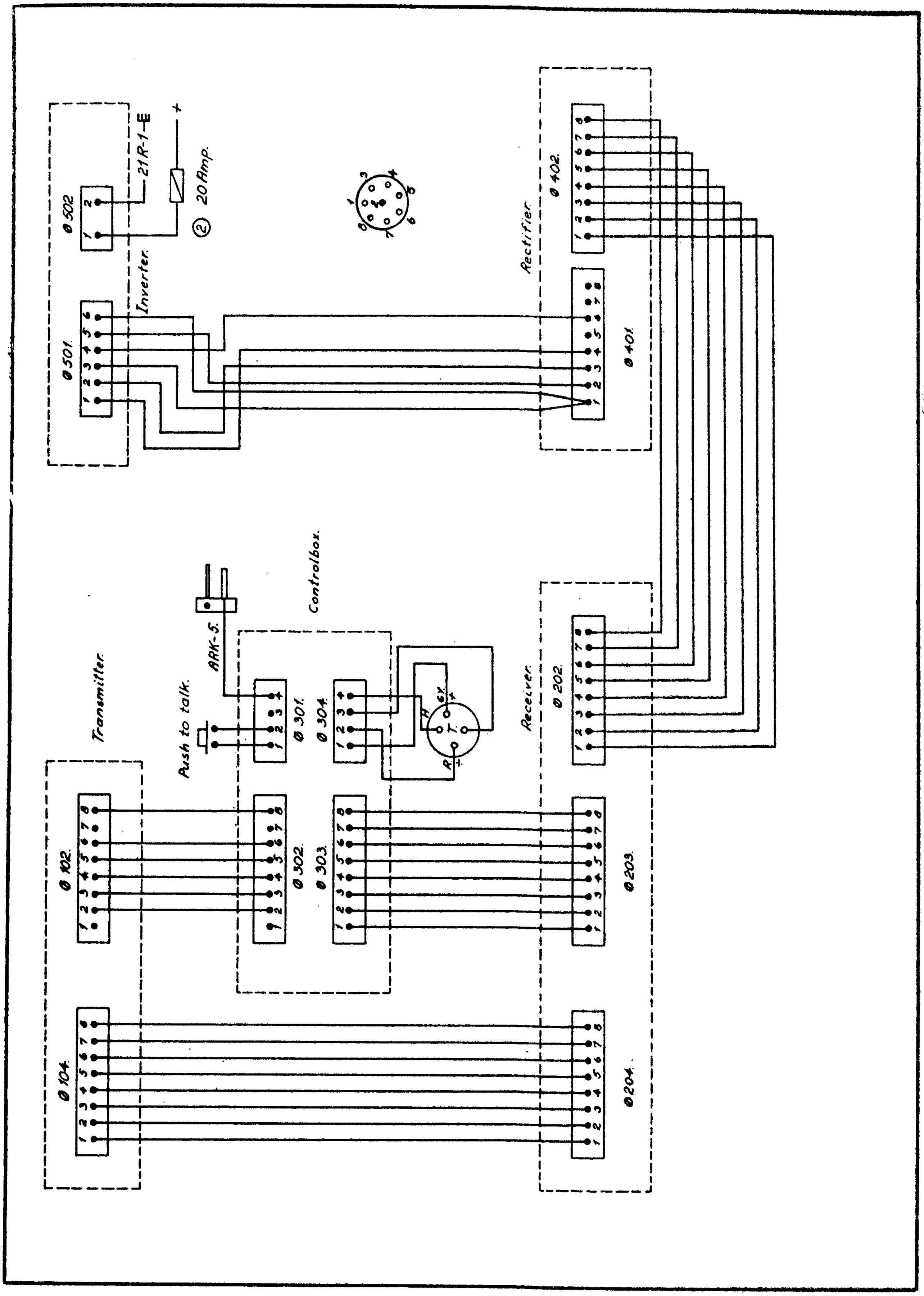
VHF SET RSI-U-3M.

INTERCONNECTION WIRING DIAGRAM.



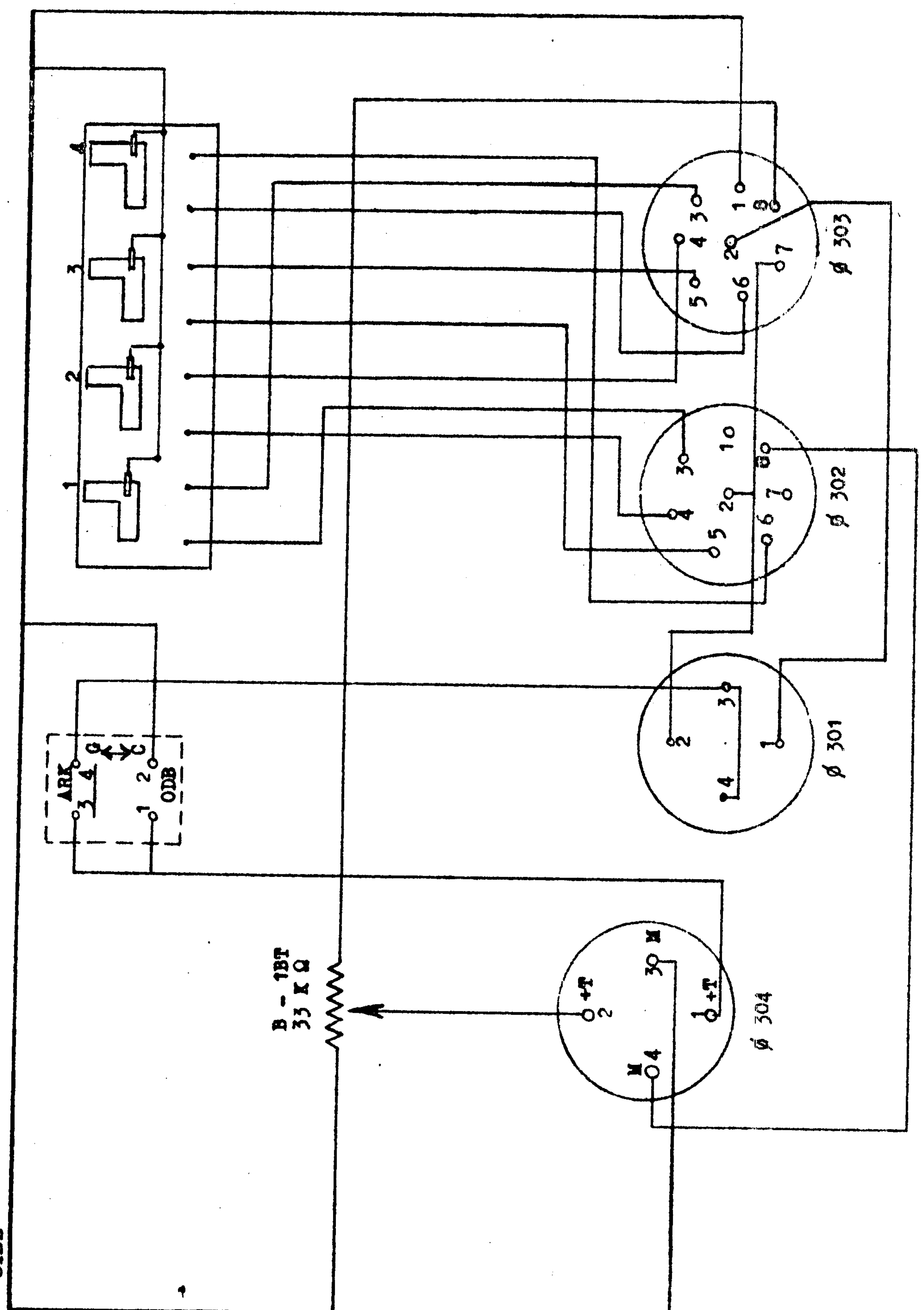
SECRET

Dwg. no. 3.

SECRET

VHF SET RSI-U-3M.

CIRCUIT DIAGRAM OF CONTROL BOX.

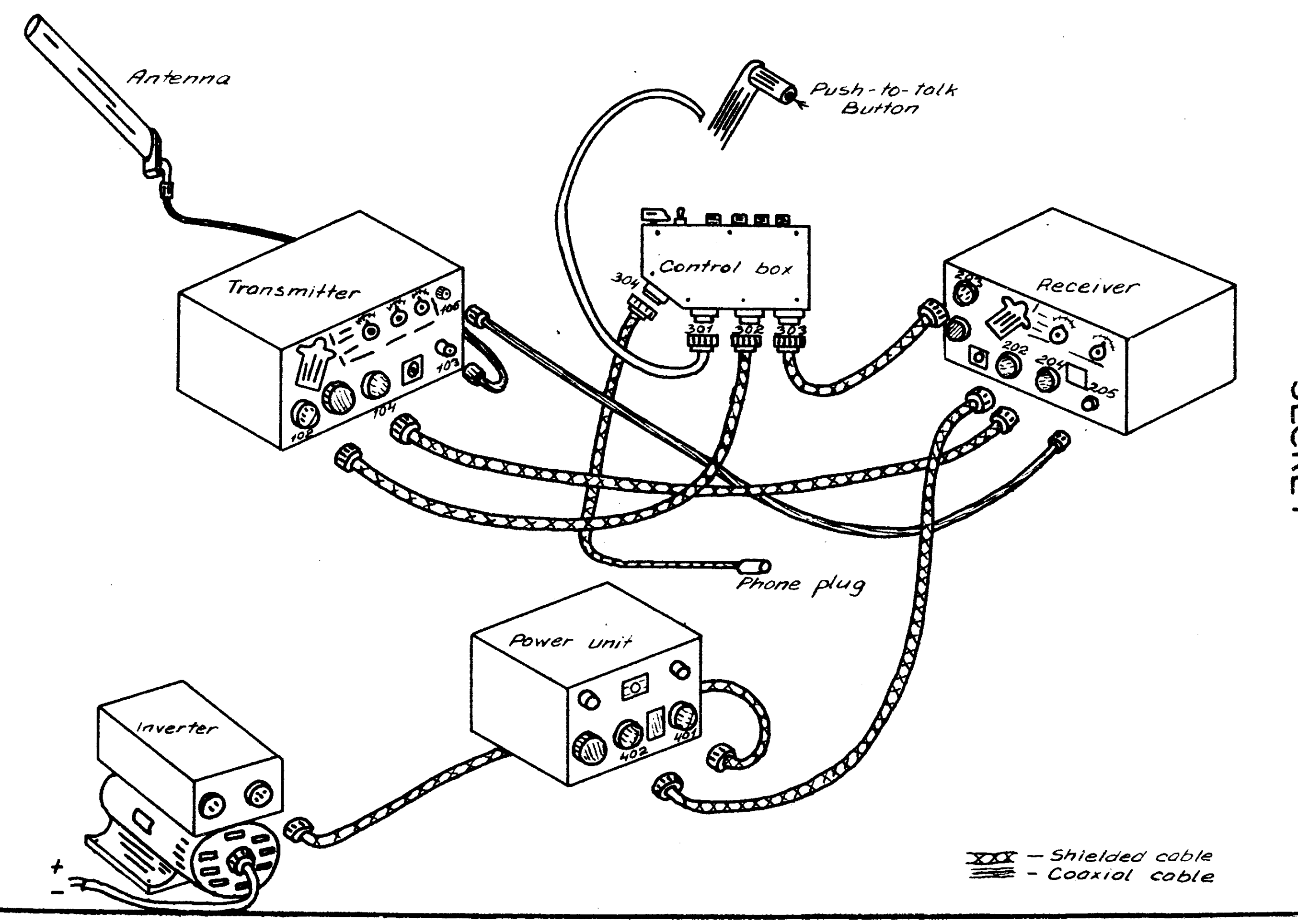


Dwg. no. 4.

SECRET

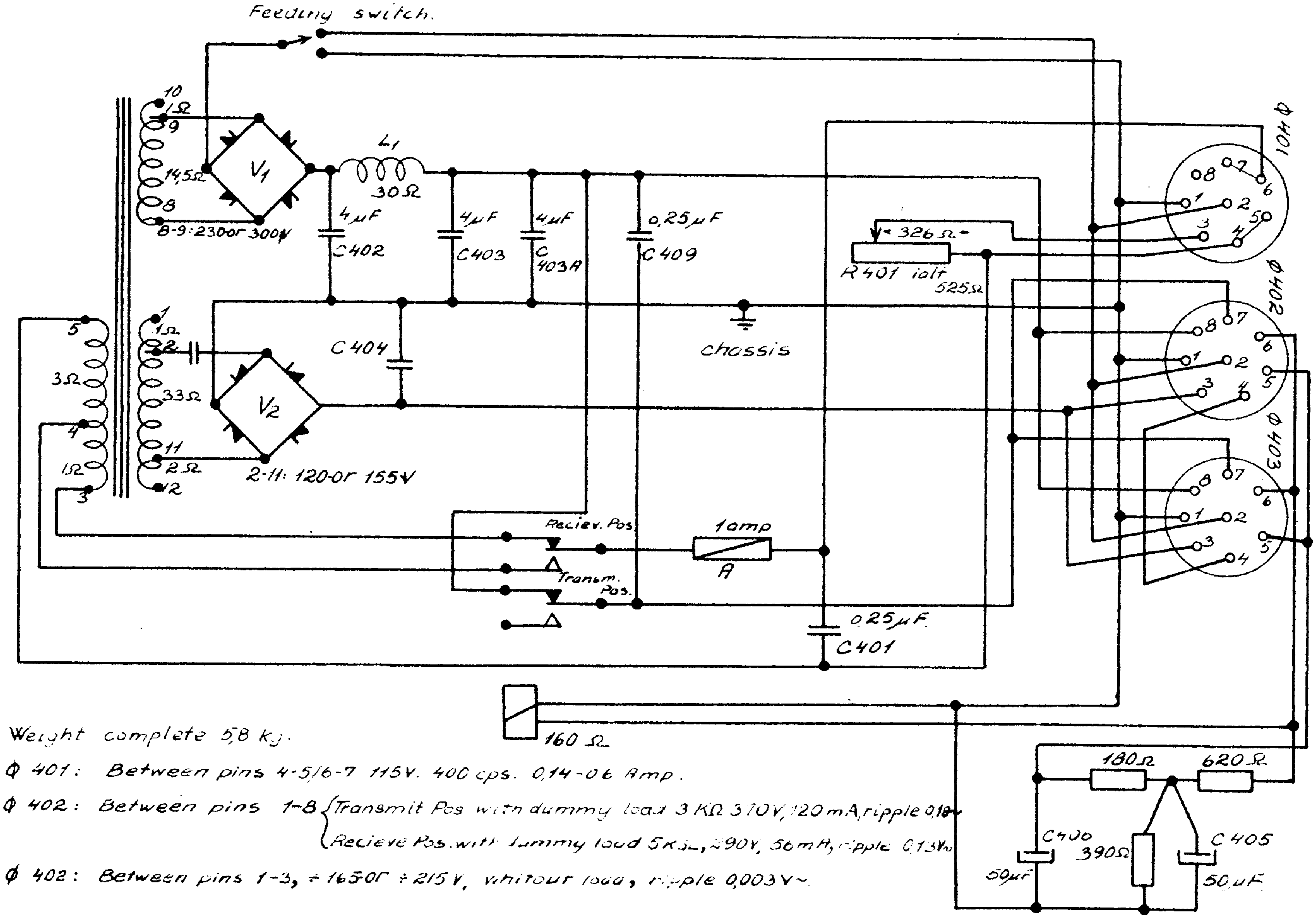
SECRET

VHF SET RSI-U-3M.
CABLE DIAGRAM.



Dwg. no. 5.

SECRET



VHF SET RSI-U-3M.

CIRCUIT DIAGRAM OF

VHF POWER SUPPLY. TYPE BM.

Dwg. no. 6.

SECRET

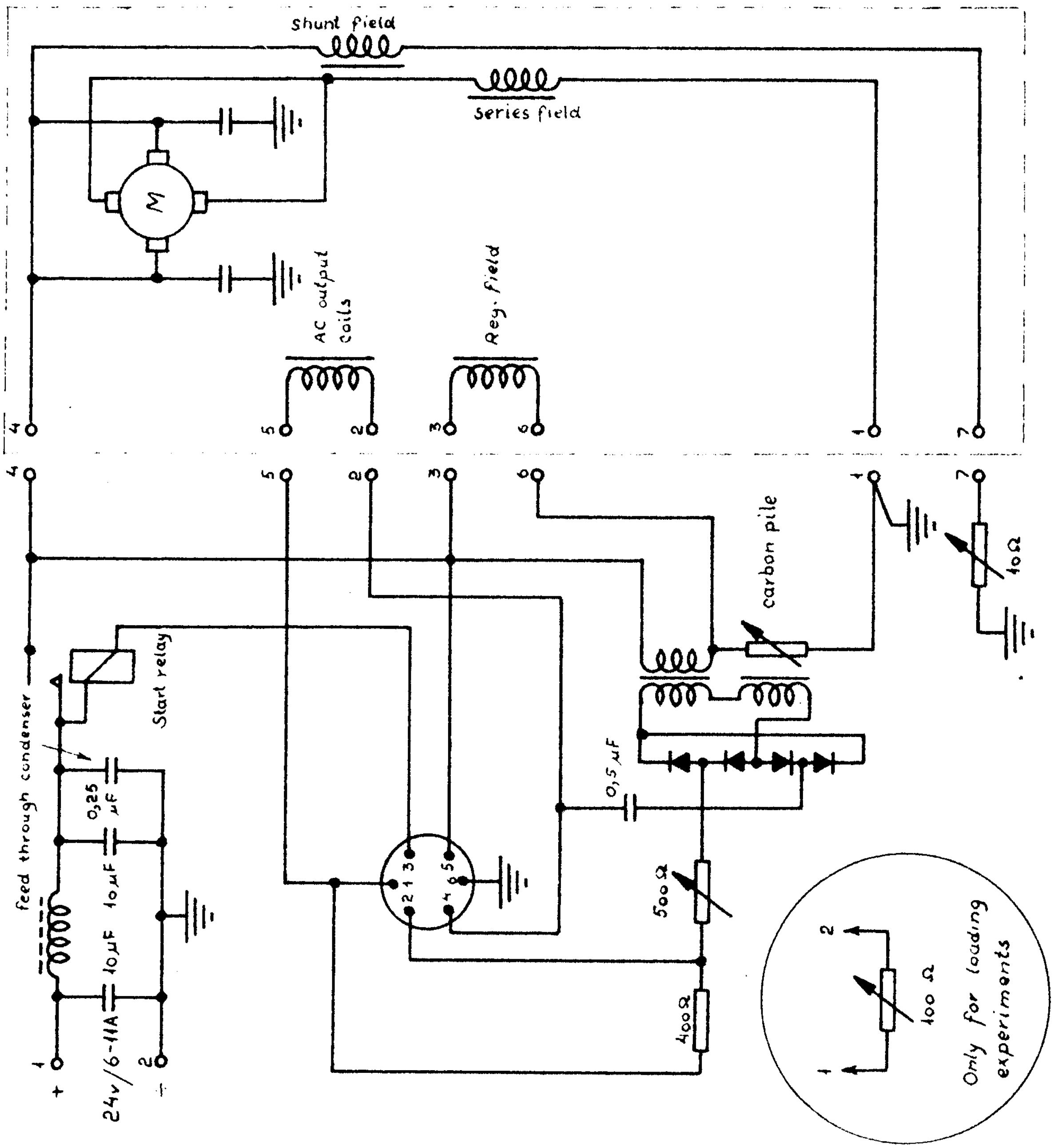
Loading experiments:

Output regulated to 115V/0 Amp, f=430 cps with 6% 3. harmonic and less than 1% other harmonics.

Output regulated to 115V/0,56 Amp, f=400 cps with 10% 3. harmonic and less than 1% other harmonics.

Output regulated to 115V/0,87 Amp, f=380 cps with 10% 3. harmonic and less than 1% other harmonics

Total weight 7,1 kg.

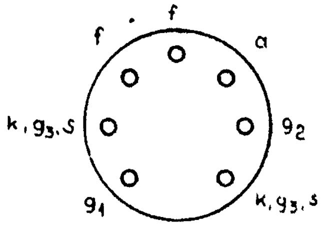


VHF SET RSI-U-3M.

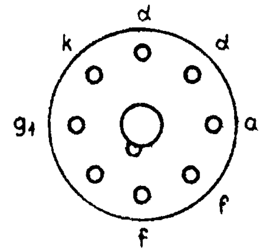
CIRCUIT DIAGRAM OF INVERTER UNIT TYPE MA-100M.

Dwg. no. 7.

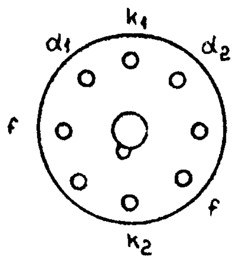
SECRET



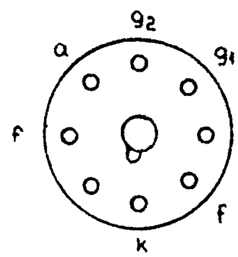
6 Ж 3 П
6AK5



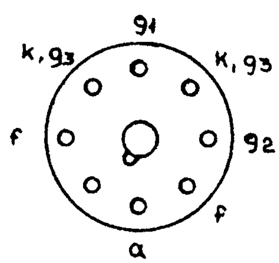
6 Г 2
6SQ7



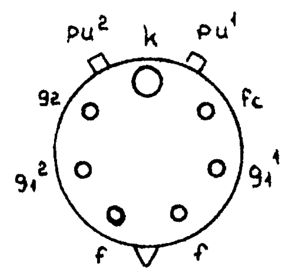
6 Ж 6С
6H6



6 П 6С
6V6



6H4
6SG7



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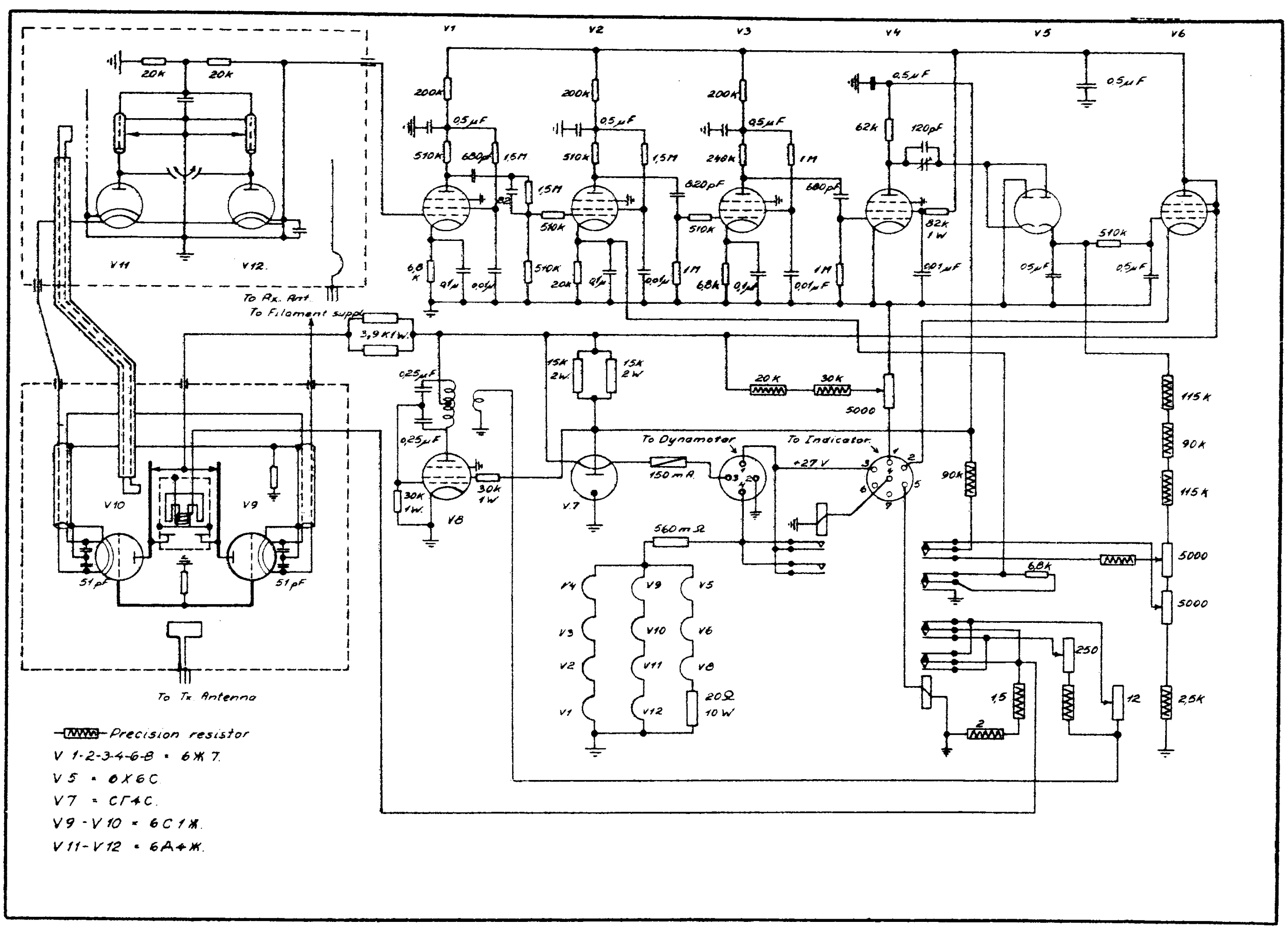
VHF SET RSI-U-3M.

TUBE BASE CONNECTIONS.

Dwg. no. 7A.

SECRET

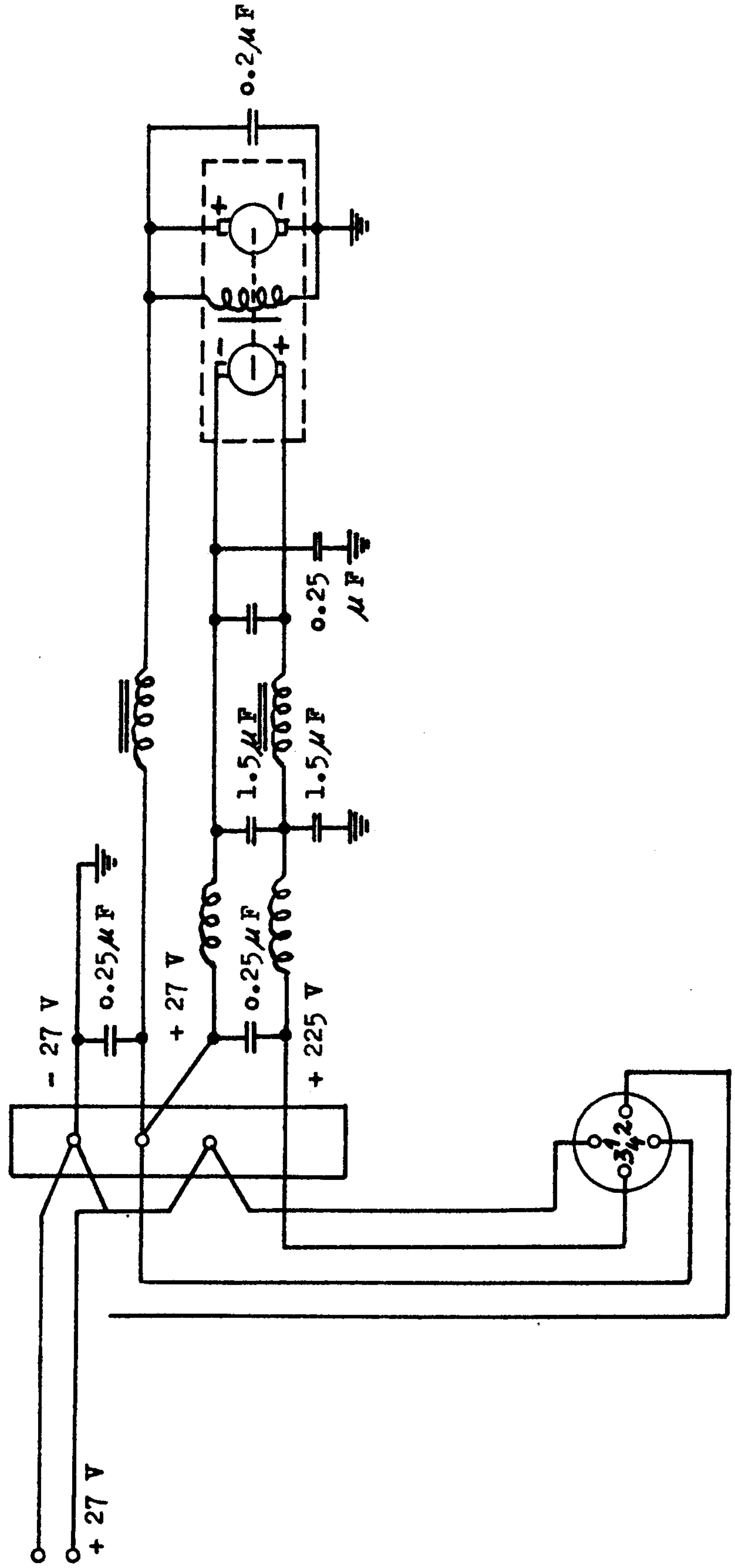
FM RADIO ALTIMETER RV-2.



Dwg. no. 8.

SECRET

FM RADIO ALTIMETER DYNAMOTOR DIAGRAM. TYPE PY-11 AM.

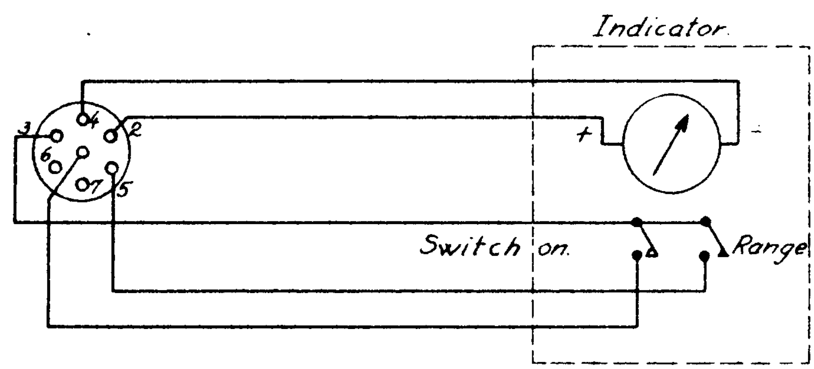


Dwg. no. 9.

FM RADIO ALTIMETER RV-2

ALTITUDE INDICATOR.

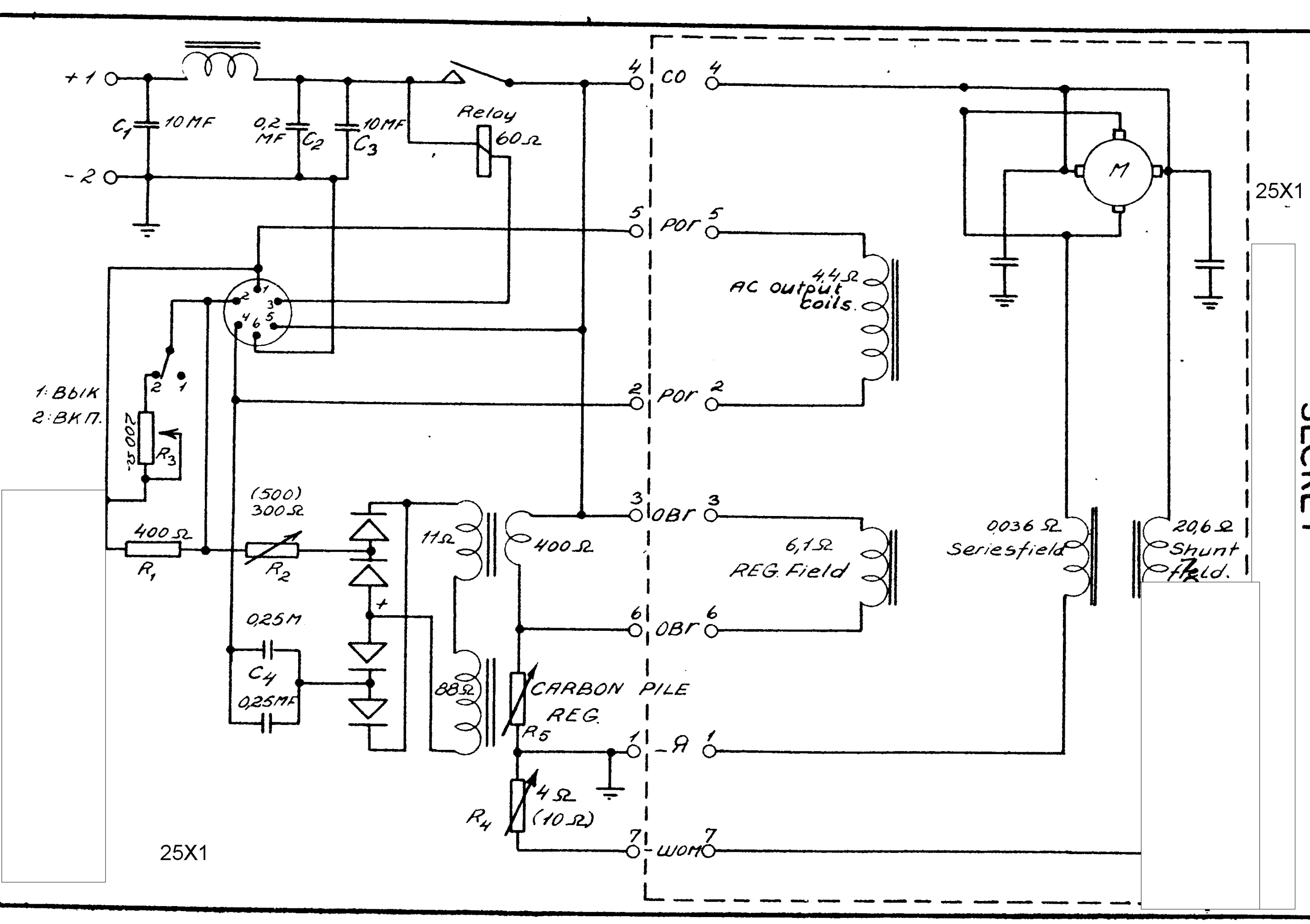
25X1



25X1

Dwg. no. 10.

RADIO COMPASS ARK-5.
INVERTER TYPE MA-250M.



25X1

25X1

Dwg. no. 11.

 25X1

[redacted]

APPENDIX TO PART III [redacted]

SUPPLEMENT [redacted]

Ground Radar.

The aerial [redacted] is a Kniferest type. 25X1

The Radar Indicator is oblong and has two modes of presentation

(i) A sinusoidal wave

(ii) An amplitude deflected horizontal time base.

The Plotting board was flat and displayed the local area round the airfield up to a radius of 100 miles.

The regimental radar [redacted] passed plots by land line to the Command Controller also located on [redacted] airfield. The Command Controller carried out interception by his Regiment on intruding or unidentified aircraft. 25X1

The Pilots carry a small photostatic copy of the radar plotting board map.

Details of an actual interception in 1956 of an Intruding Aircraft.

At the end of July or beginning of August 1956 six pairs of fighters were called to intercept an intruder, two pairs were called from [redacted] Regiment [redacted] 25X1

The interception took place in the morning and [redacted] was completed by 1200 hours.

[redacted] the Intruder was on course from KALININGRAD to SLUPSK and then turned out westwards into the Baltic.. 25X1

The Pilot was told to fly as high as possible and reached his ceiling at 15700 metres with overload tanks off.

The target was seen but was at 18000 metres and could not be reached by his aircraft. There were no Vapour trails because he said the weather was perfect and clear. He thought the aircraft was American.

The divisional radar at SLUPSK controlled the attenuated interception. Other regional high power radar at MALBORK and a SOVIET AIR FORCE MANNED AT KLUCZEWO. Command officers at divisional radar are of Lt. Col. rank. There are other divisional radars than the three mentioned in Poland but source does not know their location - name.

Divisional radars are not as high grade as "Main Radars" but higher than Regimental. [redacted]. Capt. ANTOSZ an ex-Pilot is in charge of the radar post at SWIDWIN. Controllers of Command Posts are trained at WROCLAW (BRESLAU) where a Division Headquarters is located. The course is under the C. in C. Polish Air Force. 25X1

BIALOGARD is an early warning Radar Station.

VHF

25X1

[redacted] no difference in power when working with the Regimental Radar Controller and then being taken over by the Divisional Radar Controller.

G.3775/DOP/1/57/30 [redacted] /The

25X1

SECRET

[redacted]

The VHF transmitter on the Station was of two types

(i) Mobile with telescopic mast and used by the Controller during exercises only.

(ii) Fixed installation with four channels in the Command Controllers cabin in the Air Traffic Control building, with a VHF aerial on a mast 50 metres from the building. Used by the Controller for interceptions.

The fixed VHF installation source had seen under the Controller's plotting table, it was only slightly larger than the aircraft equipment, had transmit and receive facilities and a normal 4 channel selector. Thought it could be an aircraft equipment running off a silent supply.

Polish airfields have remote H/F transmitters for use with transport aircraft.

Outside Flying hours no continuous watch is maintained on the airfield frequency, it can be on by request. The VHF Receiver is always on standby on the Divisional frequency - transmitting facilities have to be requested.

Control Capabilities and Details

The Controller can control [redacted] six pairs at a time. 25X1

[redacted] 3 Radar Operators with two interceptions each. 25X1

Radar Signals Officers

The Regiment's Signals Officer is a Captain STANISZ. He had Civil experience and qualifications before taking a three year course at the Officers Signals School.

Captain SZPOPER is the Regimental Radar Officer and he was trained at the same Signals School, but in a different section to Captain Stanisz. Specialist technical Officers work under the two Captains mentioned, one for Radio Beacons, another for Radio Locat, and one for Command Post. An NCO can be commissioned from the Ranks providing he has the necessary educational qualifications, and is under 28 years of age. He would be posted to the Radio School to take the Officers three year course.

Any qualified civilian up to the age of 21 can apply to take the Radio 3 year course and be commisioned at the end.

The Radio Radar School is at SIERADZ.

Operational Radar Ranges.

Regimental	Radar	(KNIFEREST)	250 K/M
Divisional	"	(TOKEN)	350 K/M
Main	"	(TOKEN)	350 and beyond

Aircraft Radars

MIG-17 have an "8" Radar tube an aircraft with this radar are based at KLUCZEWO, CHOJNA, KOLOBRZEG.

Source was sure that MIG-19 and 21 had Radar but he had not seen them.

He had been told all MIG later than 15 Series have some form of Radar.

Radio Beacon frequencies known to the pilot as follows

G.3775/DOP/1/57/30

SECRET

[redacted]

25X1

715 ZEGRZE BW
671 SWIDWIN CY
64 SLUPSK PK (?)
588 MALBORK (?) F (?)
660 KOLOBRZEG O (?)
33 BABIE DOLY

[redacted]

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