Osborne Head C.D. Displacement Convertor

National Research Council of Canada. Radio Branch

Publisher’s version / Version de l'éditeur:
https://doi.org/10.4224/21273957
PRA; no. PRA-54, 1942-10

SECRET

PRA-54

Copy No. 54

NATIONAL RESEARCH COUNCIL OF CANADA

RADIO BRANCH

OSBORNE HEAD C. D. DISPLACEMENT CONVERTOR

OTTAWA

OCTOBER, 1942

S E C R E T

PRA-54

OSBORNE HEAD C.D. DISPLACEMENT CONVERTOR

Contents

Page

I. Inttoduction 1

II. Description of Mechanical Features 2

III. Theory of Operation of Follow-up Unit. 5

IV. Notes on Mechanical Jamming of Convertor . . . 9

V. Notes on Electrical Wiring of Convertor. . . . 11

VI. Notes on Procedure for Mechanical Alignment. . 13

VII. Notes on Procedure for Electrical Alignment. . 16

VIII. List of Electrical Components. 17

IX. Illustrations:

Drawings - NRC-RE-97
NRC-RE-220
NRC-RE-221
LE-6-1-2
LE-6-1-3
LE-6-1-4

Photos - 1008 A, C, D, E, F, H, I, M.

- : - : - : -

OSBORNE HEAD C.D. DISPLACEMENT CONVERTOR

I. Introduction.

The Canadian 1½ meter C.D. installations give information accurate to within a few minutes of azimuth and possibly 25 yards in range. These installations have an antenna about 20 feet high by 40 feet broad, mounted some distance above the sea. As such an antenna is a landmark for miles, the Artillery usually prefers to locate the guns as far from the C.D. site as possible.

With the guns and the C.D. installation separated by several miles, some means of converting the range and bearing of a target given by the C.D. to a new range and bearing of the same target referred to the gun position, becomes necessary. This report is concerned with such a displacement convertor designed for use in conjunction with the C.D. equipment at Osborne Head, N.S. It has outside dimensions of approximately 6' 8" long, by 5' 3" high, by 2' 6" wide, and weighs approximately 1200 lbs.

The specifications supplied for this converter were for a maximum displacement of 20,000 yards with a C.D. range of 36,000 yards. The C.D. range information was to be supplied on 1,000 and 36,000 yard-per-turn Selsyns and the azimuth data on Selsyns with 10° and 360° per turn. Accuracies of 25 yards and 10' were called for. Subsequently the output information Selsyns were altered to conform with the 5,000 and 40,000 yard-per-turn dials used in certain C.D. fire control equipment. At this site, the convertor is operated with a displacement setting of roughly 3500 yards. Accuracies of better than 15 yards and 10' are obtained in normal operation.

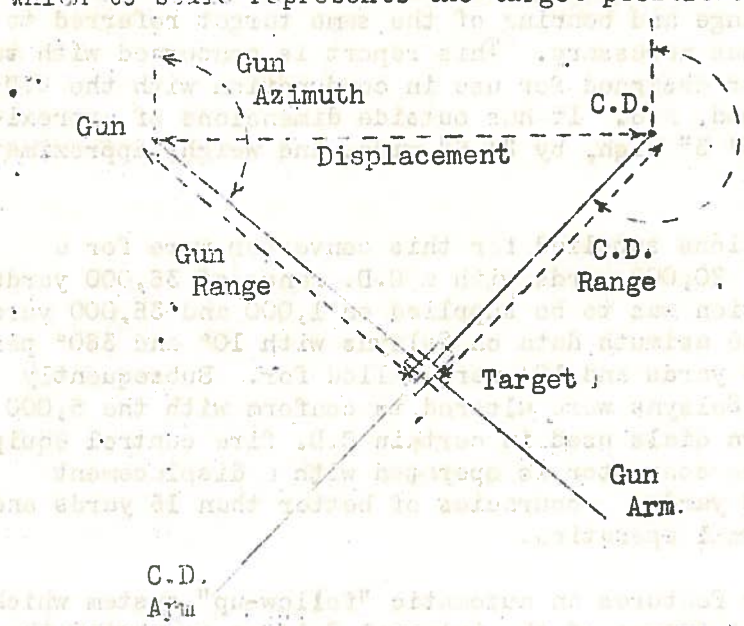
This converter features an automatic "follow-up" system which, in effect, amplifies the torque of the internal Selsyns receiving the C.D. data, and causes the entire unit to line itself up to correspond accurately with the C.D. data supplied. The accuracies specified above are readily obtained with this device which involves only a few vacuum tubes and driving motors. Its advantages in eliminating "follow-pointer" operators are obvious as this converter normally operates unattended.

The equipment is self-protecting against jamming in certain positions. It turns itself off if the target approaches too near the gun position.

II. Description of Mechanical Features.

A block diagram of all components of the convertor is provided in drawing NRC-RE-220. A general view of the equipment is shown in photo #1008 F.

This convertor comprises a mechanical scale model (at 2,000 yards per inch) of the triangle C.D.-Guns-Target. It includes two arms pivoted from the frame, one at the C.D. point, the other at the gun position point. The distance between these two points represents to scale the separation of the C.D. and the guns. A small carriage is provided on each of these arms, free to move along same. The C.D. arm carriage is driven by a lead-screw, and is directly below the gun-arm carriage. The centres of the two carriages are joined by a swivel joint, which to scale represents the target position.



It is apparent that as the C.D.-arm carriage is driven along to represent to scale the range of the target from the C.D., and as the C.D. arm is pivoted to a direction corresponding to the bearing of the target from the C.D., the gun-arm carriage will be drawn along its arm, and the gun arm itself will be turned. The distance of the gun-arm carriage from the gun-arm pivot represents the resulting range of the target from the guns, and the direction of the gun-arm corresponds to the bearing of the target from the guns. In operation the C.D. arm and carriage are moved to positions corresponding with the range and bearing information supplied from the C.D. The resulting positions of the gun arm and carriage are conveyed mechanically to Selsyns which electrically feed the information to the fire control site.

The pitch of the lead screw moving the C.D.-arm carriage is 20 threads per inch, 7/16" O.D. As it moves along its arm, the gun-arm carriage turns an Archimedian screw which has one thread per inch, and is 3/8" O.D. with 4 separate starts, giving a helix angle approaching 45°. Thus, one turn of the Archimedian screw represents 2,000 yards, and the rotation of this screw is used to supply the out-going range data.

The C.D. range information comes up through the hollow centre of the C.D. arm axis, by means of a shaft making one turn for 20 yards of range, so that rotation of the arm about its axis never introduces an error of more than 10 yards. In an actual installation covering 180° of azimuth, this error would only be 5 yards, an amount considered of negligible importance.

The mechanical arrangement of the convertor may be followed from the accompanying photographs. In photos #1008 D, E & F, the two carriages may be seen running on the C.D. (lower) arm and gun (upper) arm. Gearing is shown at the back of the gun arm by which the rotation of Archimedian screw at 2,000 yards per revolution is converted to suit the 5,000 yard/rev. and 40,000 yards/rev. Selsyns. The 8 Selsyn connections for outgoing range data are brought out through slip rings as shown in photos #1008 D and #1008 I. The gear arrangement for transmitting outgoing azimuth information corresponding to the rotation of the gun arm can be seen on #1008 I; these Selsyns do not require slip rings since they are mounted on the fixed framework. Prints #1008 D and #1008 N also indicate the mechanism for transferring C.D. range readings to the lead-screw. The small pinion at the centre of rotation of the C.D. arm is, as previously mentioned, supplied with C.D. range data at 20 yards per turn; the associated gear train converts this to 2,000 yards-per-revolution rotation of the lead screw. The mechanical drive which rotates the C.D. arm to the proper bearing can be seen from #1008 H.

The position of the pivot of the C.D. arm is fixed on the frame, but that of the gun-arm pivot is variable to allow for any desired gun-to-C.D. displacement not exceeding 20,000 yards. Print #1008 E shows the guide runners in which the gun-arm pivot assembly slides. This assembly is driven by a 20 thread-per-inch (100 yards-per-revolution) lead screw which cannot be seen in the photographs. This screw is also geared to 1 000 yard and 20,000 yard dials on the panel of the convertor which indicate the displacement setting. This adjustment is effected by a handwheel, shown in #1008 A, which is removed once the adjustment has been made.

On the front panel of the convertor are provided 5 sets of dials which indicate displacement, C.D. range and bearing, and gun range and bearing (see photo #1008 A). The displacement dials are, as mentioned above, driven mechanically from the displacement lead screw. Both pairs of C.D. data dials are mechanically driven from the gearing which rotates the C.D. arm and moves the C.D. carriage.

Transmission to the dials is, in these cases, by means of flexible shafts operating at 10° and 20 yards per turn, with gearing in the dials assemblies to provide the proper ratios between pointers. The gun-data pointers are mounted on regular receiving Selsyns which are electrically connected to the output transmitting Selsyns which also feed data to the gun site.

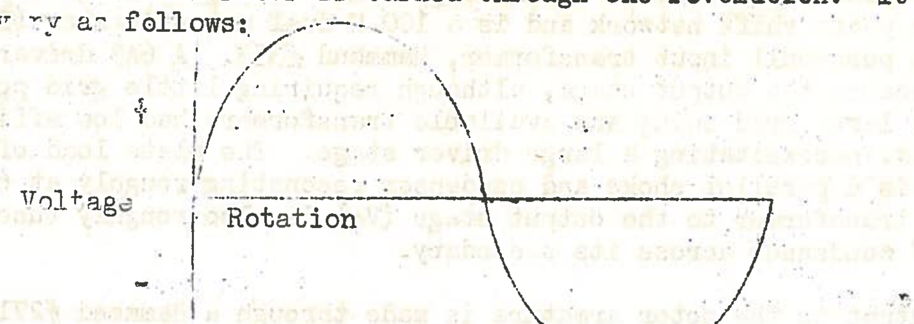
The "follow-up" system requires for each C.D. datum two Selsyn receivers (main and vernier) to be turned to correspond with the instantaneous setting of the convertor. With the exception of the vernier azimuth unit, these are driven from the C.D.-data-dial gearing mentioned above; they can be seen in Print #1008 M. The vernier azimuth Selsyn of this group is mounted elsewhere and can be seen in #1008 H.

III. Theory of Operation of Follow-up Unit.

In applications as in this convertor where it is wished to reproduce an angular displacement at some remote point, Selsyns or magslips offer the most convenient means. Unfortunately in the sizes normally used these devices are incapable of driving any appreciable load at the receiving end without seriously affecting the following accuracy. The follow-up mechanism to be described provides adequate torque for aligning this convertor to any position corresponding with the input data. It is a general purpose unit suitable for any similar application.

In the accompanying drawing LE-6-1-3 is shown the wiring diagram of the follow-up mechanism using a main and a vernier Selsyn as input, controlling a small A.C. motor. A block diagram of the unit is shown in NRC RF 221. This device has the advantage that the loading effect on the Selsyn transmitter is very slight due to the 500 ohm resistor in series with each input connection. Thus, the same transmitter may drive an ordinary Selsyn receiver in addition to one or more follow-up motor controls.

The principle of operation involves some Selsyn theory. Assume the field of a receiver Selsyn connected to an energised transmitting Selsyn in the normal manner. Now consider the voltage induced in the receiver rotor as this rotor is turned through one revolution. It is found to vary as follows:



Note that the relative phases of this voltage have only two possible values, 180° apart. The transition from one to the other is indicated by the reversal of sign on this graph. The nul position corresponds to the position of the transmitter rotor, and varies as this rotor is turned. This follow-up system operates by virtue of the existence of such an accurately located nul. It is of interest to note that the nul position is 90° removed from that in which the receiver Selsyn would normally align itself if free to rotate.

If such a Selsyn rotor is coupled mechanically to an A.C. motor, the field of which is powered by a constant voltage of fixed phase, and the armature of which is connected electrically through a suitable power amplifier to the Selsyn rotor, the motor will turn the Selsyn rotor to find the equilibrium nul. There are two voltage nuls but one is an unstable point due to the phase of the induced rotor voltage being such as to turn the motor away from this position. This is essentially the arrangement used in this system. However, in the follow-up device with which we are concerned, two Selsyn rotors are connected into the amplifier and both these rotors must be at a stable nul before the system will cease to hunt. Greater accuracy of following without fear of ambiguity is thus achieved by the use of a main and a vernier Selsyn transmitter with a gear ratio between the two which is in this case 36:1. Internal biasing in the unit permits only the main Selsyn to operate the follow-up as long as a large difference exists between the actual and the correct positions of the following Selsyns; the vernier Selsyn takes over when the main Selsyn follow-up has aligned the system roughly.

Detailed operation of the follow-up unit may be followed from drawing LE-6-1-3. The amplifier for the vernier Selsyn consists of an 1852 voltage amplifier (V_1) capacity coupled to a 6A3 driver (V_6) to a pair of 2A3's (V_7 & 8) as the output stage. Since the phase of the current in the motor field is not adjustable, a phase correction network is necessary in the amplifier in order that the motor armature current may be in the proper phase relation to the field current to give maximum motor torque. The .01 µF condenser in series with the 500 K variable resistor (R_2) across the push-pull input transformer constitutes the phase control of the amplifier. The gain control is before the phase shift network and is a 100 K dual potentiometer (R_1) across the push-pull input transformer, Hammond #353. A 6A3 driver is used because the output stage, although requiring little grid power, requires a large grid swing and available transformers had low efficiency at 60 c.p.s. necessitating a large driver stage. The plate load of the 1852 (V_1) is a parallel choke and condenser resonating roughly at 60 c.p.s. The input transformer to the output stage (V_7) is also roughly tuned by the .01 µF condenser across its secondary.

Output to the motor armature is made through a Hammond #271 small power transformer, connected backwards so that its normal 110 V. primary goes to the motor armature and the centre-tapped high voltage winding connects to the push-pull output stage. Output from the 2A3's is taken from their cathodes in order that the amplifier may present a very low output impedance to the motor armature, thus helping to prevent oscillation of the mechanical system in finding the nul.

The channel for the main Selsyn uses the identical driver and output stages (V_6, V_7, V_8). The input circuit and phase shifter controlling the first 1852 voltage amplifier (V_3) is similar to that in the vernier Selsyn channel. Since it is desirable to have only the vernier channel in control when following very closely to the correct position, a fixed bias is placed on the first 1852 (V_3) in the main Selsyn channel. This bias is somewhat greater than cut-off bias of the tube and hence, if the main Selsyn is following close to a proper nul, there is no A.C. voltage on the plate of this stage (V_3). When the following is in error by more than a few degrees, it is wished to have only the main Selsyn in control. Under such conditions, the input voltage to the 1852 (V_3)

in that channel becomes sufficient to cause an A.C. output voltage from the tube. This A.C. voltage is rectified by the 6H6 diode (V_2). The diode current flowing through the 250 K resistor in its plate lead produces a bias on the 1852 stage (V_1) of the vernier channel, inhibiting its action. The main Selsyn channel thus takes control.

The output from the first stage of the main Selsyn channel (V_3) is badly distorted due to operating the tube at below cut-off bias. A 60 c.p.s. resistance-capacity filter is inserted between the output of the first stage and the second main Selsyn stage (V_4) to restore good wave form. This second stage is also an 1852 (V_4) with its plate in parallel with that of the first stage in the vernier channel (V_1). The voltage from the two channels is here mixed.

Power supply for all but the output stage and all filaments is external. The 300 V. plate supply and -150 V. bias supply must be voltage regulated in order to ensure stable operation. The plate supply for the output 2A3's is built on the chassis. Very little filter is necessary because of the cathode-follower action of the output tubes. Drawing LE-6-1-4 should be consulted for power unit data.

Summing up, it can be seen that the input voltage to the 6A3 driver stage (V_6) is a 60-cycle voltage derived from one of two sources. If the following device is very close to being correctly aligned, this voltage is obtained from the vernier Selsyn only. However, if the alignment is considerably in error, the voltage is derived from the main Selsyn only. A narrow transition region exists in which both sources of voltage contribute.

The phase shifts through both channels must be adjusted separately so that the amplified voltage applied to the motor armature produces armature current which is in the proper phase with respect to the field current. The Selsyn power and follow-up unit power must obviously originate from the same source if these adjustments are to be permanent.

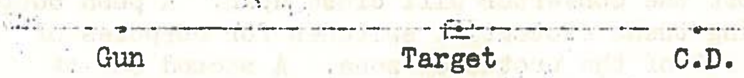
In this convertor, two complete follow-up units are required, one for each range and azimuth. The receiving Selsyns involved have been referred to previously in this report and are connected mechanically to the C.D. arm and carriage, so that their rotation corresponds to the present setting of the corrector at the C.D. point. The motors operated by the follow-up mechanism drive the C.D. arm and carriage. In this way the entire convertor is aligned in accordance with the input data. Moreover, checking the operation of the convertor is facilitated since the input data dials indicate not the actual input Selsyn data but the position to which the convertor has set itself.

Operating instructions for this unit are given later in this report.

One refinement has been contemplated for use in convertors where smooth rates are even more essential than in this case. It is proposed to provide information to the follow-up as to the rate at which the input data are changing. The follow-up motors would then be expected to operate normally at these fixed speeds, with the operation as outlined above being superimposed thereon. Investigations of the feasibility and necessity of this refinement have yet to be made.

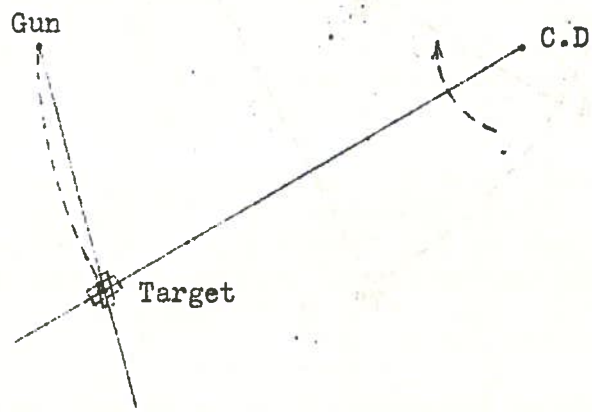
IV. Notes on Mechanical Jamming of Convertor.

When the carriages are run through certain critical positions, difficulties are encountered. Consider the case in which the target lies on the line between the C.D. and the gun. The corrector arms will be arranged as follows:



Now let the range of the target from the C.D. increase, with the azimuth remaining unaltered, until the target coincides with the gun position. Now if the range is increased slightly beyond this point, the gun bearing of the target should change rapidly through 180°. In practice, the convertor cannot perform the operation, and the carriage will eventually jam against the backstop on the gun arm which is at about - 4000 yards. Thus, serious errors would exist in the outgoing data under these conditions. A similar condition exists if the target is on this same bearing and the range is decreased from a large value in towards the gun position.

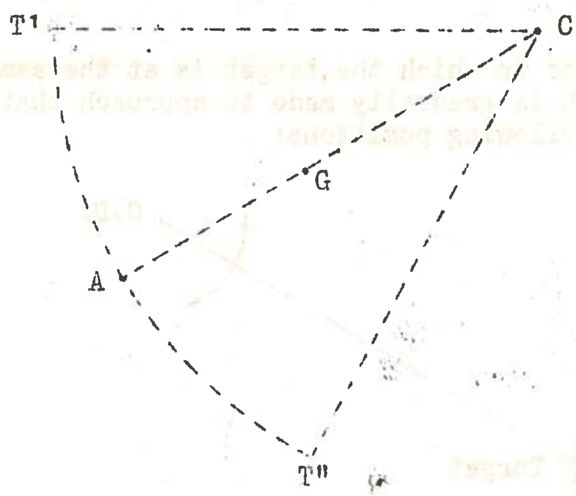
Another case arises in which the target is at the same range as the gun, and the azimuth is gradually made to approach that of the gun. The arms adopt the following positions:



It is apparent that the gun-arm carriage may jam in this position also.

It is, of course, desirable to prevent the carriage from jamming in this manner. A protective system was adopted for this convertor making use of the fact that the conditions which may result in jamming exist only when the target is in the immediate vicinity of the gun position. Consideration was at first given to providing a cam-operated switch which would trip whenever the target range from the guns dropped below 500 yards. This idea was discarded because of the difficulty of bringing out the connections from the rotating gun arm. The system finally adopted consists of two cam-operated switches, one of which opens whenever the target range from the C.D. is under 6500 yards, and the other whenever the target bearing from the C.D. is within 30° of the gun bearing. These two switches are connected mutually in parallel and in series with the control of the A.C. supply to the convertor. Thus, the target must be near the guns in both range and azimuth before the convertor will close down. A push button is provided for shorting these protective switches for purposes of backing the convertor out of the protected zone. A second set of switches has been incorporated covering a slightly smaller area. These operate if for any reason the first set fails.

As the C.D. to gun displacement is of the order of 3500 yards at Osborne Head, the target carriage never runs closer than 3000 yards to the gun pivot. The limitation which this protection imposes is that conversion is not possible in the sector C T' T" shown in sketch. At the Osborne Head site, however, this sector is not navigable, and hence the objection becomes academic.



These protective switches were added after the photographs were made, and hence do not appear therein. They are mounted on the C.D. data-dial gear boxes.

V. Notes on Electrical Wiring of Convertor.

The wiring data for this device are contained in the drawings LE-6-1-2, LE-6-1-3, LE-6-1-4 and NRC-RE-97. Power requirements are approximately 5 amperes at 115 V. 60 cycle A.C. Drawing #1008 C shows the panel at the rear of the corrector to which all the incoming and outgoing Selsyn information is brought and also the 110 V. 60 cycle input. The top pair of amphenol receptacles is for incoming range and azimuth information, the left hand one being range, right hand azimuth. The lower two amphenol receptacles are for outgoing gun range and azimuth. The centre two-prong receptacle is for the 110 V. 60 cycle supply. All the amphenol Selsyn plugs are wired according to Drawing NRC-RE-97. Azimuth plugs are in locking position #1, range in position #3, in accordance with the standard C.D. convention. Drawing #1008 A shows the front panel of the convertor.

The control switches mounted in the centre of the panel are, from top to bottom:-

Dial light on-off switch,
Selsyn-on-off switch,
Green indicator light for Selsyn-on-off switch,
110 V, 60 cycle A.C. 10 amp. fuze receptacle,
Limit switch cut-out and amber or red indicating lights.
(The above item replaces the lower fuze receptacle shown in Plate #2)
Inspection light on-off switch.

A.C. Wiring.

The 110 volt power supplied with the range Selsyn information is used to operate a relay so that in the event of the C.D. being shut down, the convertor also automatically shuts itself off. Due to the unconventional manner in which the Selsyns are used in this application, no 110 V. power is connected to the receiver rotors, and hence these wires and terminals are available for this other purpose. The A.C. power from the A.C. input plug is used to operate both follow-up units and their power supply, inspection lights, dial lights and a cooling fan. A 10-ampere fuze is suitable for use in this input circuit.

Cam-operated micro-switches shut off the convertor if the target carriages approach too close to the gun position. Yellow and red warning lights indicate opening of the first and second sets of switches respectively. Push buttons on the panel allow these switches to be short circuited for removing the convertor from the protected zone.

Selsyn Wiring.

The external Selsyn connections from the C.D. equipment can be followed from NRC-RE-97, the internal ones from LE-6-1-2. C.D. receiver Selsyns are wired to the input plugs via the resistor board. The rotor windings of these Selsyns feed into the follow-up units through one of the octal power plugs mounted on the chassis.

Output azimuth Selsyn connections are brought out through 6-prong plugs to terminal strips to which connections are made from the output data plugs and the output-data-dial Selsyns. The range output Selsyns feed through slip rings and a small 8-prong Jones plug to a similar terminal strip.

The output Selsyns are normally powered from the battery magslip network. However, a test plug has been provided which enables the output Selsyns to be energised from the local power source. In use this replaces the output-data plugs, and hence no data can be fed out under these conditions.

Follow-up Wiring.

The follow-up units comprise two motor-control chasses and one power supply chassis mounted in the convertor.

The power supply is in two portions, one giving + 300 V., the other - 150 V. Both portions are regulated and are similar to those used in G.L. equipment produced in these laboratories. Diagram LE-6-1-2 shows the wiring of the power supply.

Power distribution through these chasses and to the driving motors is by means of octal plugs. By means of this arrangement, the motor fields are placed in series.

VI. Notes on Procedure for Mechanical Alignment.

The following checks may be made on the convertor if its accuracy is suspected. They correspond with the methods originally used in making the installation, and should be performed only by responsible personnel.

To check the bearing of the C.D. from the gun, set the C.D. range to zero with 3,500 yards displacement. Swing the C.D. arm through about 180°. Change the C.D. range gradually until the smallest change in azimuth is observed. Then set the C.D. arm to the azimuth most frequently used and set the C.D. range pointers on zero. The gun azimuth bearing at this point should also read the grid bearing of the C.D. position from the gun. If not, the instructions given later on lining up gun magslips should be followed, making both sets of receivers read the proper bearing.

To check the C.D. azimuth readings, leave the displacement as above and set the C.D. azimuth dial to the gun azimuth reading of C.D. from gun, when the gun and C.D. arms should be approximately parallel. Then run the C.D. range out to 20,000 yards, observing the gun azimuth reading while doing this. It should not change. If it does change, move the C.D. arm in azimuth slightly until there is no change of gun azimuth. Then set the C.D. azimuth pointers to the bearing of the C.D. position from the guns.

To check the gun range zero setting, set the C.D. range to 10,000 yards, put the displacement to zero, swing the C.D. arm around through 180°, and the gun range should not change appreciably. If it does, try changing the displacement until the minimum change is observed. At that point, the C.D. range and gun range should read the same. If not, follow the instructions for alignment of gun magslips.

To check the displacement setting, set the C.D. range to some value beyond the dead zone, say 10,000 yards, and swing the C.D.azimuth through 180° from the bearing of the C.D. position from the guns, and the gun range should change by a value equal to twice the displacement. The displacement handwheel can be moved slightly until the desired result is obtained. Then the handwheel should be removed and the small snap cover put in place. The handwheel should be kept in a safe place by the officer in charge, as the corrector will feed out false results if the displacement is changed.

All the above checks can be made by rotating the antenna to change the C.D. azimuth and by changing C.D. range on the C.D. range gear box.

The C.D. arm should not be allowed at any time to go through more than 360°, otherwise an error of 20 yards is added for each 360° added. The limit switches on the C.D. antenna automatically prevent this value being exceeded.

The following procedure is to be followed if the convertor closes down due to the protective micro-switches opening.

1. Read the C.D. azimuth angle at the convertor.
2. Set the C.D. antenna azimuth to this convertor angle.
3. Set the C.D. range at the set to 10,000 yards.
4. Push the button located on centre of front panel of convertor. Corrector should then increase its C.D. range to 10,000 yards after time has elapsed to heat the tubes.
5. Release push button. Corrector should then continue operating.

To explain the reasons for this procedure, consult the diagram on page 10. If the corrector stopped due to the azimuth micro-switch opening, then the carriage has stopped either along CT' or CT". Hence, the convertor C.D. azimuth dial will read either CT" or CT' depending on which side it approached the dead zone from. If we place the C.D. antenna on line CT' (assuming corrector stopped on CT') and put the range at 10,000 yards, then the carriage will go out along line CT', and will not pass through "G". If the corrector stopped due to the range micro-switch opening, the carriage will be located along the arc T'AT". Assume it stopped at A. Then, the C.D. antenna will be placed on bearing CA. When the power comes on, with the C.D. range at 10,000 yards, the carriage will go on out from the point A to a range of 10,000 yards, and the convertor will continue to operate with the push-button switch released.

When the convertor has stopped for this reason, the above instructions should be followed rigorously, otherwise serious damage might result which would entail re-aligning the whole mechanism.

Should these instructions be disregarded, and the operator try to force the convertor still farther into the protected zone, the second set of micro-switches will open and the red panel light will come on. It will then be necessary for the operator to notify the officer-in-charge who must then remove a side panel. A shorting button will be found inside which must be pressed simultaneously with the panel button. Great care should then be taken that the convertor turns out of the protected zone without jamming.

Important.

When starting up the convertor, set the C.D. range and azimuth main dials to within 9,000 yards and 90° of the convertor dials. Should the dials be more than 180° apart, the convertor would try to fall into step 36,000 yards in error; in so attempting, the carriage would jam against a stop on one of the arms.

Notes on Lining Up Gun Magslips.

Set the convertor gun data vernier dials to some definite reading which should be recorded. Loosen the grub screws on the gears of the vernier transmitting Selsyns. Remove the caps from the rear of these Selsyns (over brushes) and rotate the Selsyn rotor until the vernier magslip pointers at the guns indicate the previously recorded setting. Tighten the gear grub screws and move the vernier output pointers on the convertor dial to their original settings. Repeat the above procedure for the main Selsyns.

VII. Notes on Procedure for Electrical Alignment.

Adjustments: The success of the follow-up mechanism to a large extent depends on the care taken in the initial adjustment. The vernier channel should be adjusted first. Turn the gain of the main channel to zero. Advance the gain of the vernier channel until some action becomes evident from the motor. Adjust the phase adjustment on the vernier channel. This adjustment may be done in two ways:

(a) With the input Selsyn turning at medium speed, adjust the phase control until following is most accurate, or
(b) With a few degrees displacement between the input Selsyn and the Selsyn driven by the motor, hold the motor shaft and adjust the phase control for maximum motor torque.

(b) is considered the better method. Advance the gain until the system oscillates or is on the verge of instability, then reduce the gain enough below this point to ensure stable following.

The main channel should then be adjusted. Note the gain setting of the vernier channel and turn the gain to zero. Set the threshold bias control on the input stage near zero bias and advance the gain until the motor shows action. Adjust the phase control the same as for the other channel. Adjust the gain by moving the input Selsyn approximately 90° from the driven Selsyn and then moving the gain control to the position giving maximum motor speed. This is done in order that the gain setting will not be too far advanced and overload the amplifier at large angles. Overloading the amplifier reduces motor speed and power. After adjusting the phase and gain controls the threshold bias control should be adjusted on the first stage. With the Selsyns in step, increase the bias on the first tube until a dead spot of about 5° appears over which the input Selsyn may be varied without producing any movement of the motor. Re-set the gain control on the fast channel to the value previously noted. The amplifier should now be in adjustment. Check the operation by making a sudden displacement of the input Selsyns and noting the action of the motor-driven Selsyns. They should be pulled into the proper nul without hesitation. If the system tries to settle down in the wrong nul on the vernier Selsyn, reduce slightly the threshold bias on the main channel until the pulling in action is without hitch.

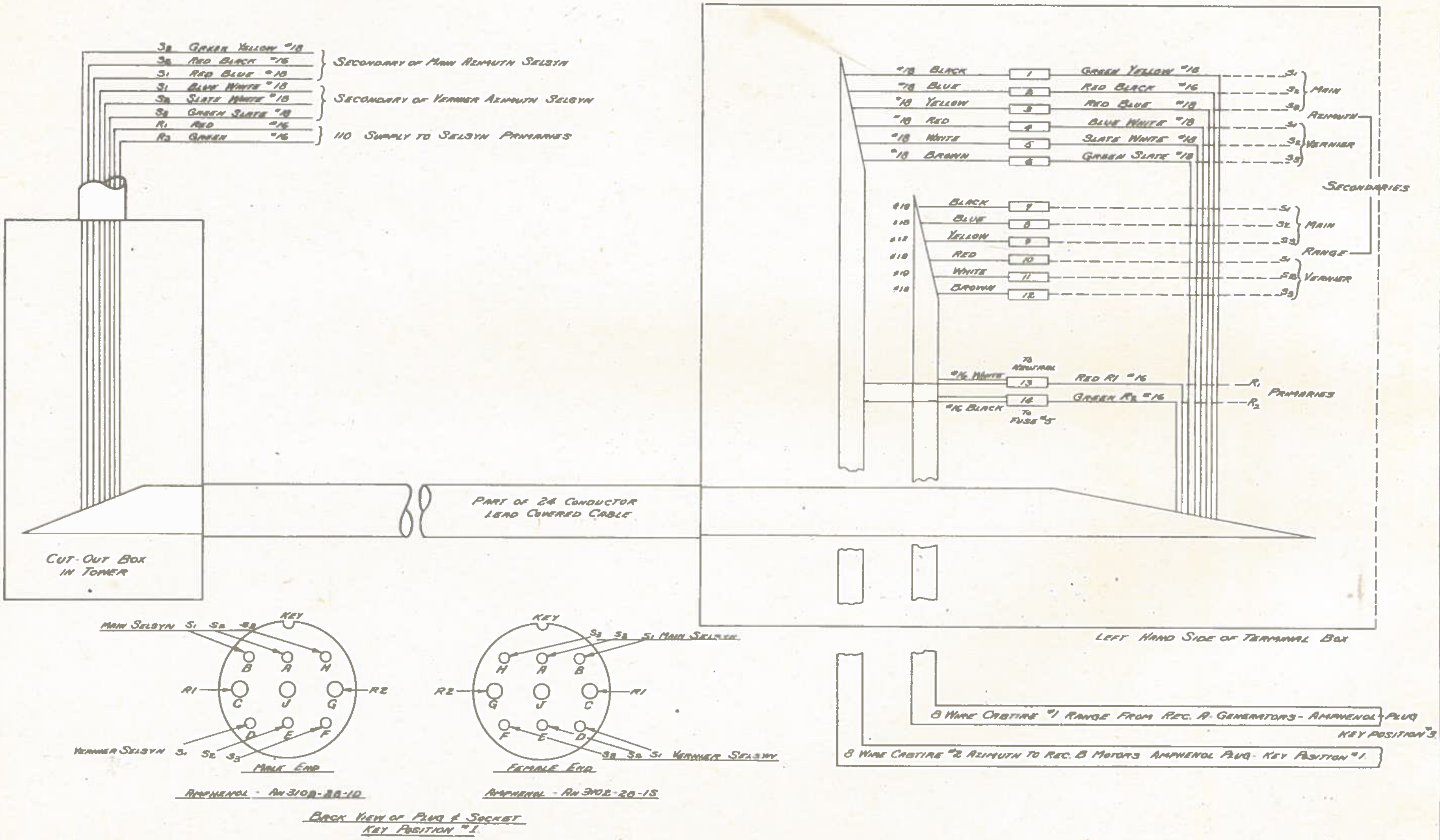
It may be necessary to rotate the Selsyns bodily in their mountings so as to make the main and the vernier nul points coincide. This can be checked by placing an A.C. voltmeter (0-50 volts) across the armature of the motor, and with the arm at the correct reading of the C.D. antenna (the displacement corrector C.D. reading can be taken and the C.D. antenna rotated until the C.D. azimuth dials on the C.D. set read the same) the body of the main Selsyn is rotated (with main gain control "on", vernier "off") until zero voltage is obtained across the armature.

VIII. <u>List of Electrical Components.</u>

Drive Motors - Bodine Type V-10, 1/80 H.P. 110 v. AC-DC

Input Selsyn Receivers - G.E. Selsyns Type 2 JD5A2 (Ring type mounting)
(all windings 110 v.)

Output Selsyn Transmitters and Receivers - G.E. Selsyns Type 2 JD55
(Foot mounting) (Rotors 110 v., stators 55 v.)



B & S Gauge	Colour		24 Conductor Lead Covered Cable	Main Panel No.
18	Green Yellow	S_3	Secondary of Main Azimuth Selsyn	1
16	Red Black	S_2	Leads Reversed As Shown to Insure	2
18	Red Blue	S_1	Proper Direction of Rotation.	3
18	Blue White	S_1		4
18	Slate White	S_2	Secondary of Vernier Azimuth Selsyn	5
18	Green Slate	S_3		6
16	Red	R_1	110 V. Supply to Selsyn Primaries	13
16	Green	R_2		14

8 Wire Cabtire Selsyn Cables and Connectors

All Selsyns to be Connected as Shown Unless Otherwise Stated

B & S Gauge	Color	Selsyn Lead No.	Amphenol Plug No.		Terminal Panel	Terminal Box Amphenol
16	White	R1	C	110 V. Supply Selsyn Primaries	13	13
16	Black	R2	G		14	14
18	Black	S1	B	Main Selsyn Secondary	7	1
18	Blue	S2	A		8	2
18	Yellow	S3	H		9	3
18	Red	S1	D	Vernier Selsyn Secondary	10	4
18	White	S2	E		11	5
18	Brown	S3	F		12	6

Revised 24-4-42

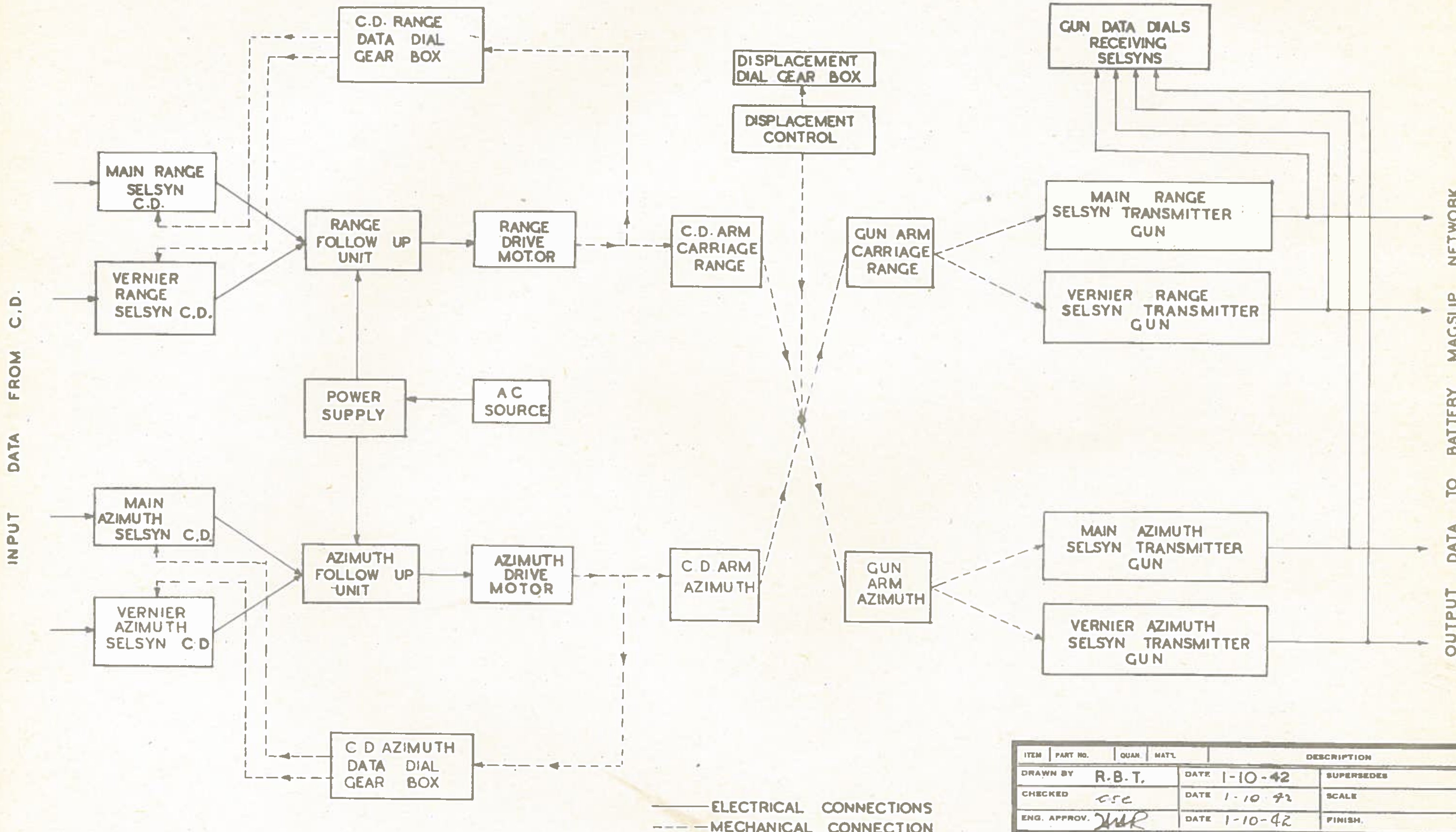
Item	Part No.	Quan	Mat'l	Description

Drawn by W.H.A. Traced - E.H.B.	Date June 29 '42	Supersedes
Checked	Date	Scale
Eng. Approv. R.S.R.	Date	Finish

NATIONAL RESEARCH COUNCIL-RADIO SECTION - OTTAWA CANADA

Name: C. D. at Osborne Head Selsyn Connectors

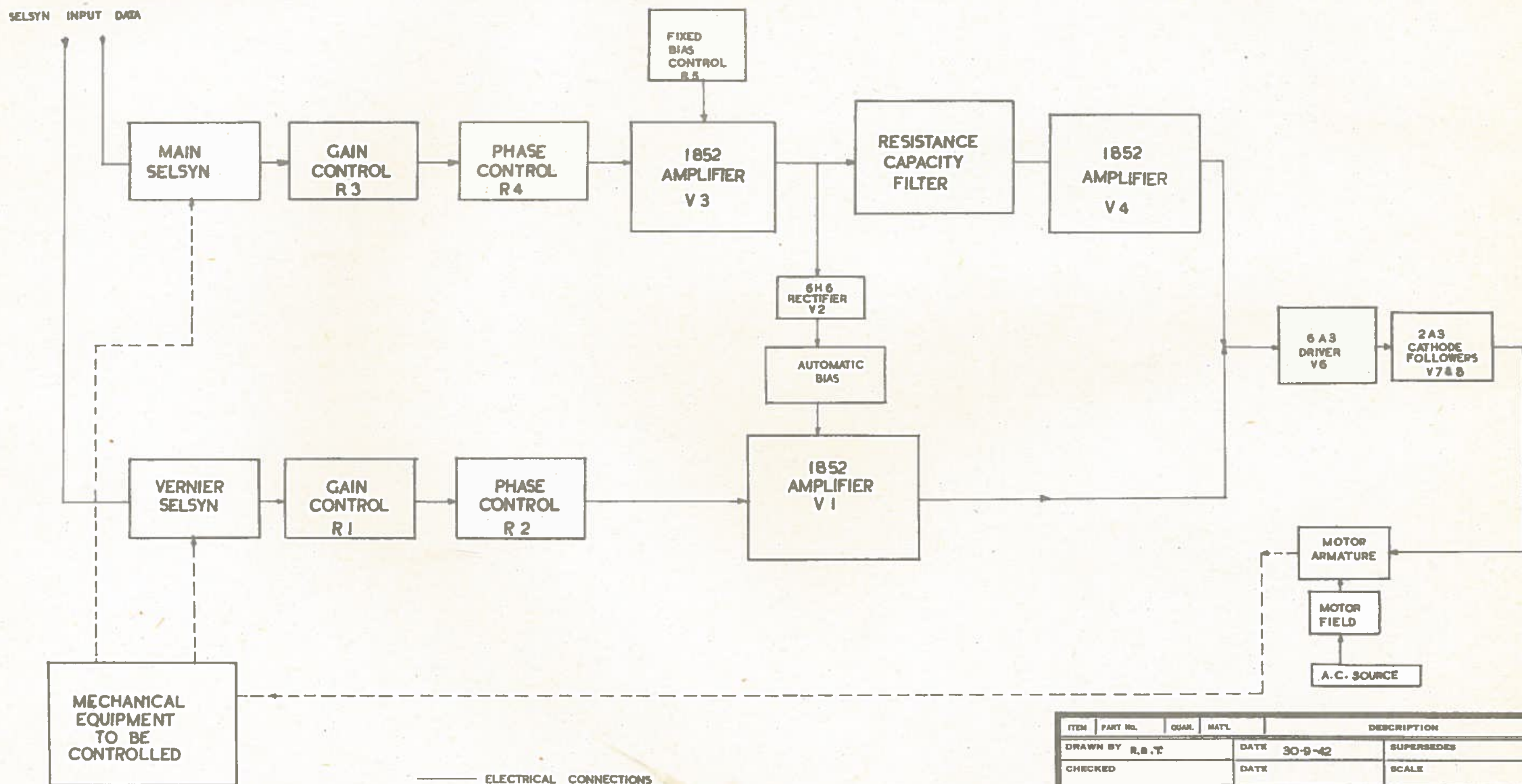
Dwg. No. NRC-RE-97



ITEM	PART NO.	QUAN	MAT'L	DESCRIPTION
DRAWN BY R.B.T.		DATE 1-10-42		SUPERSEDES
CHECKED CSC		DATE 1-10-42		SCALE
ENG. APPROV. HAR		DATE 1-10-42		FINISH

NATIONAL RESEARCH COUNCIL-RADIO SECTION - OTTAWA CANADA

NAME BLOCK DIAGRAM OSBORNE HEAD C D DISPLACEMENT CONVERTOR — DWG. NO. NRC RE - 220



——— ELECTRICAL CONNECTIONS
- - - - - MECHANICAL CONNECTIONS

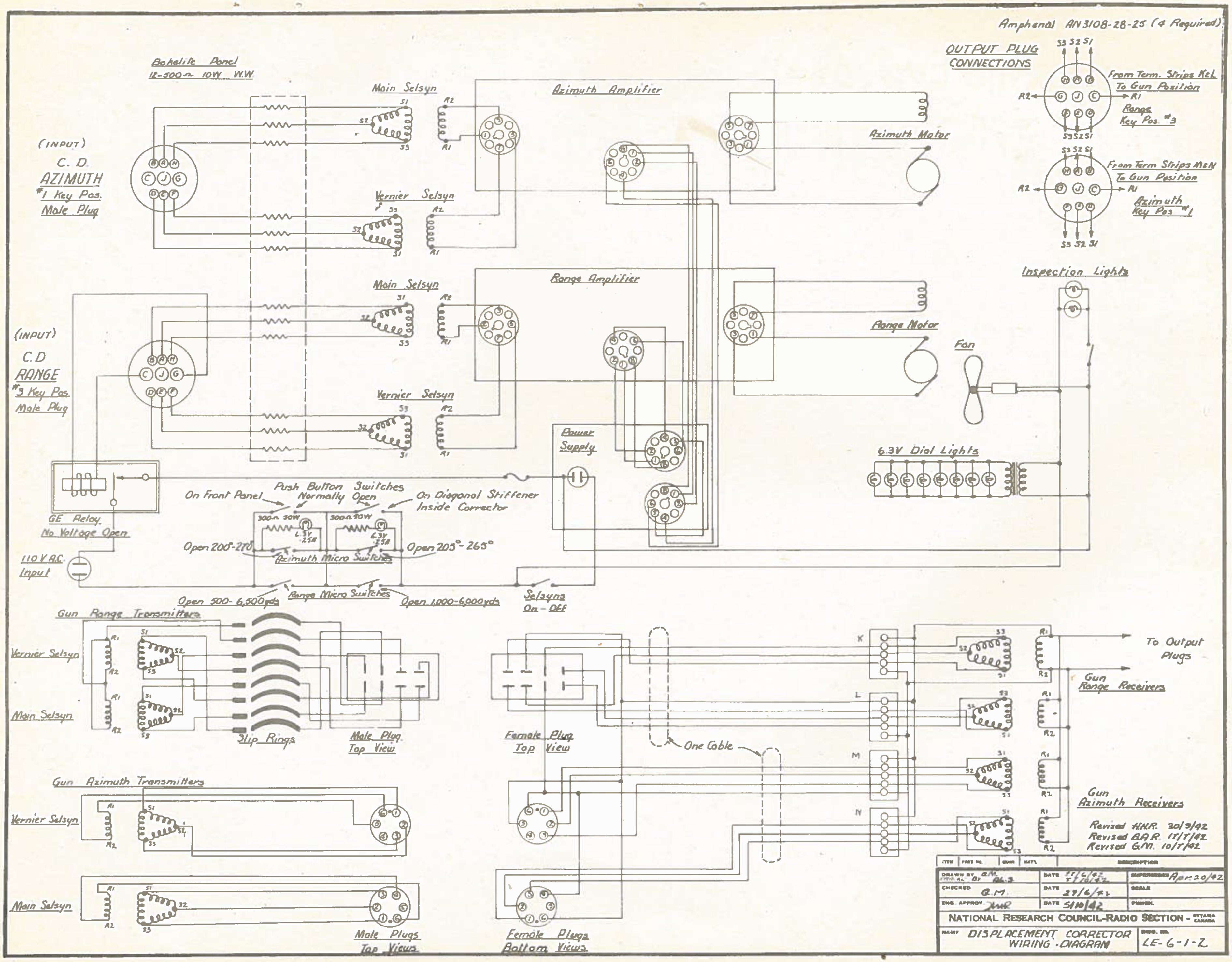
NOTE
TUBE AND RESISTOR DESIGNATIONS REFER TO N.R.C. DRAWING # LE. 6-1-3

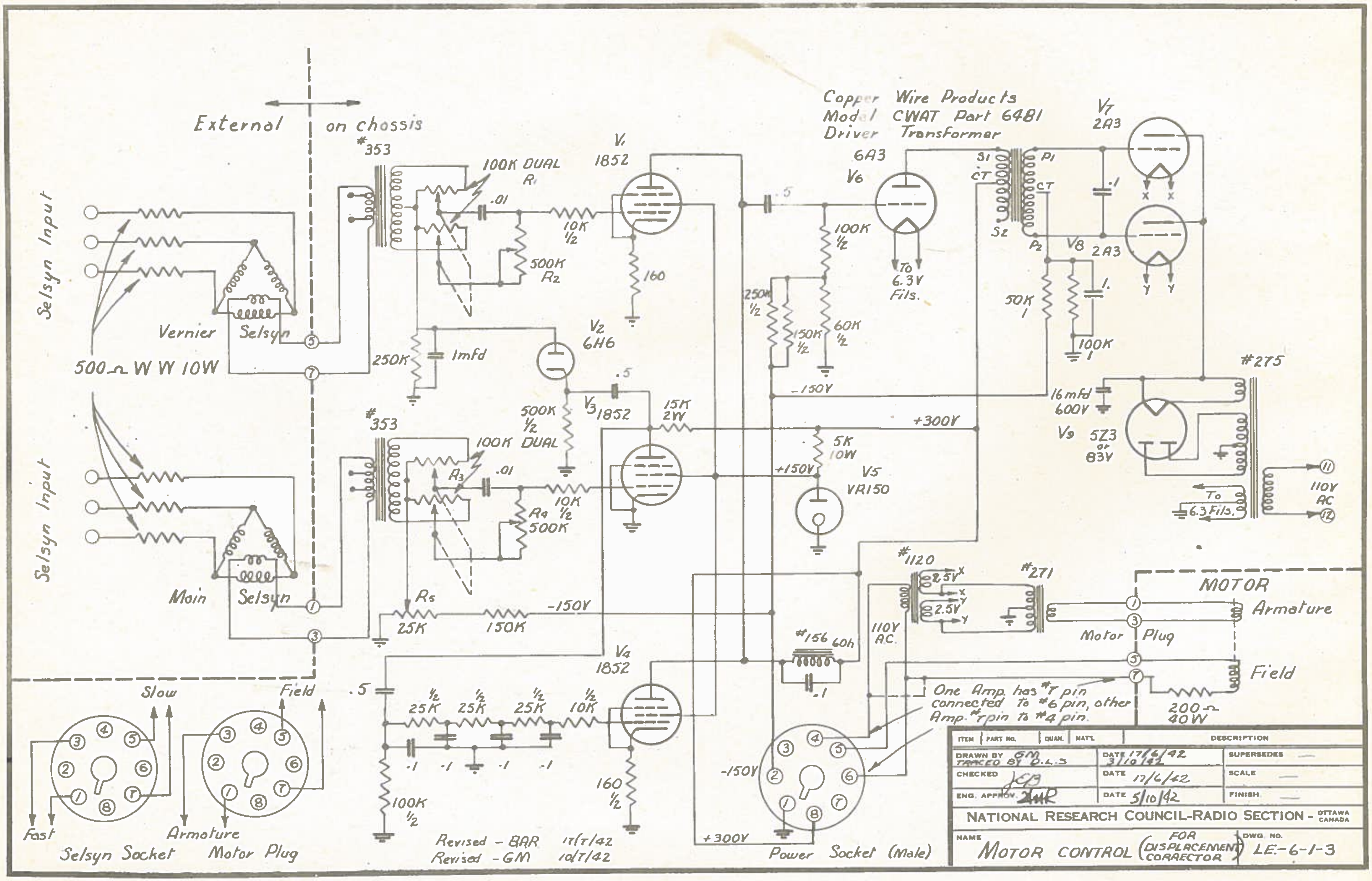
ITEM	PART NO.	QUAN.	MAT'L	DESCRIPTION
DRAWN BY R.B.T.	DATE 30-9-42	SUPERSEDES		
CHECKED	DATE	SCALE		
ENG. APPROV.	DATE	FINISH.		

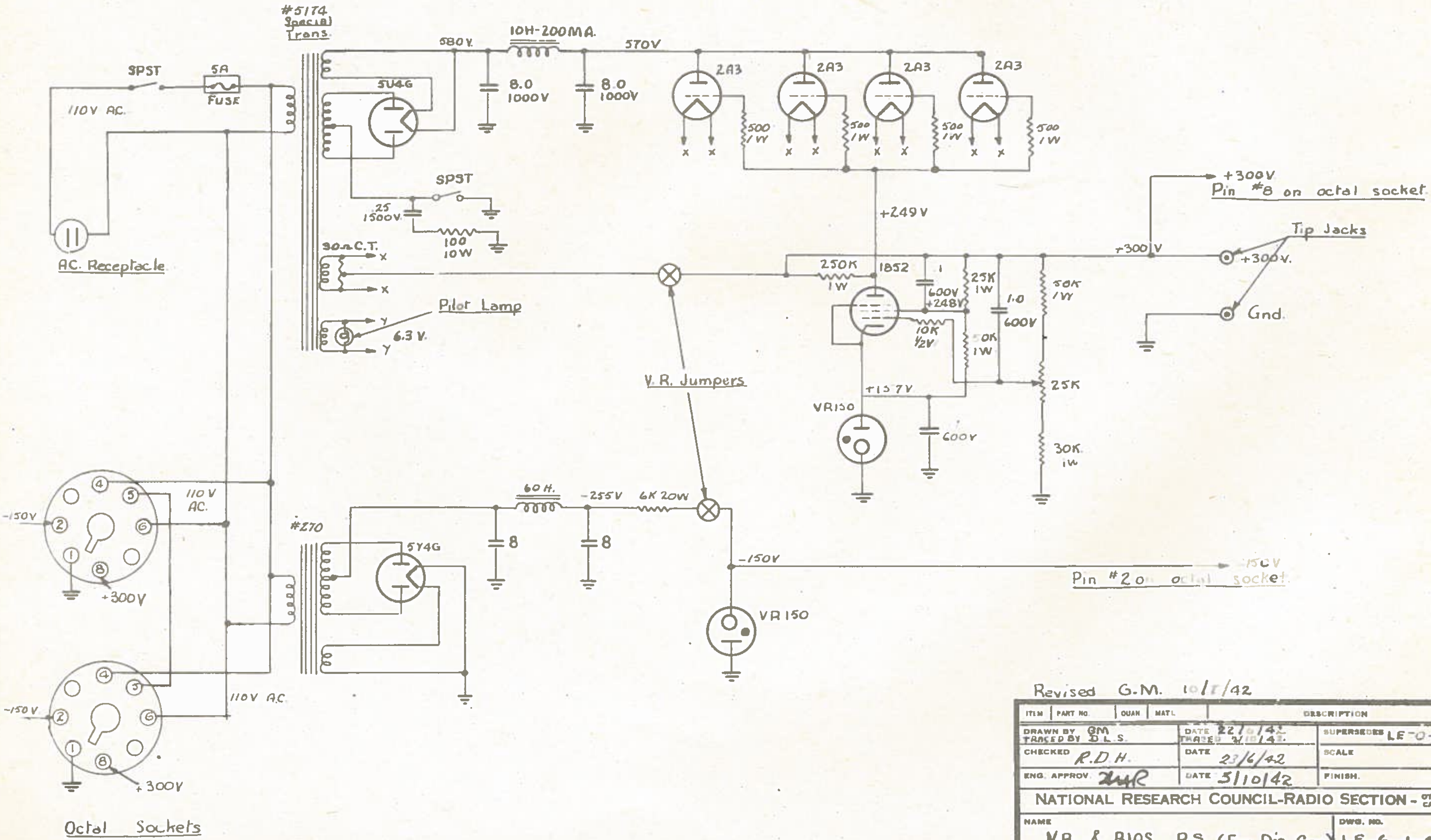
NATIONAL RESEARCH COUNCIL-RADIO SECTION - OTTAWA CANADA

NAME BLOCK DIAGRAM OF FOLLOW-UP FOR DISPLACEMENT CONVERTOR

DWG. NO. NRC-RE-221


Amphenal AN 3108-28-25 (4 Required)
OUTPUT PLUG CONNECTIONS
From Term. Strips K&L To Gun Position
Range Key Pos. #3
From Term Strips M&N To Gun Position
Azimuth Key Pos #1
Bakelite Panel 12-500Ω 10W W.W.
Main Selsyn
Azimuth Amplifier
Azimuth Motor
(INPUT) C. D. AZIMUTH #1 Key Pos. Male Plug
Vernier Selsyn
Range Amplifier
Range Motor
Inspection Lights
Fan
(INPUT) C.D RANGE #3 Key Pos. Male Plug
Power Supply
6.3V Dial Lights
Push Button Switches Normally Open
On Front Panel
On Diagonal Stiffener Inside Corrector
300Ω 50W
6.3V .25A
GE Relay No Voltage Open
Open 200°-270°
Azimuth Micro Switches
Open 205°-265°
110 V A.C. Input
Open 500-6,500 yds
Range Micro Switches
Open 1,000-6,000 yds
Selsyns On-Off
Gun Range Transmitters
Slip Rings
Male Plug Top View
Female Plug Top View
One Cable
To Output Plugs
Gun Range Receivers
Gun Azimuth Transmitters
Gun Azimuth Receivers
Revised H.H.R. 30/9/42
Revised B.A.R. 17/7/42
Revised G.M. 10/7/42
Male Plugs Top Views
Female Plugs Bottom Views
DRAWN BY G.M.
CHECKED G.M.
DATE 29/6/42
SUPERSEDES Apr. 20/42
NATIONAL RESEARCH COUNCIL-RADIO SECTION - OTTAWA CANADA
DISPLACEMENT CORRECTOR WIRING DIAGRAM
LE-6-1-2


External
on chassis
Selsyn Input
Selsyn Input
500 Ω W W 10W
Vernier
Selsyn
Main
Selsyn
#353
#353
100K DUAL
R1
500K
R2
100K DUAL
R3
R4
500K
.01
.01
10K
1/2
10K
1/2
V1
1852
160
V2
6H6
250K
1mfd
500K
1/2
.5
V3
1852
15K
2W
R5
25K
150K
-150V
V4
1852
.5
1/2
25K
1/2
25K
1/2
25K
1/2
10K
.1
.1
.1
.1
100K
1/2
160
1/2
Copper Wire Products
Model CWAT Part 6481
Driver Transformer
6A3
V6
To
6.3V
Fils.
100K
1/2
250K
1/2
150K
1/2
60K
1/2
-150V
+300V
5K
10W
+150V
V5
VR150
V7
2A3
V8
2A3
S1
CT
S2
P1
CT
P2
.1
50K
1
100K
1
16mfd
600V
#275
V9
5Z3
or
83V
To
6.3 Fils.
110V
AC
#1120
2.5V
2.5V
#271
110V
AC.
#156
60h
.1
MOTOR
Armature
Motor
Plug
Field
200 Ω
40W
One Amp. has #7 pin connected to #6 pin, other Amp. #7 pin to #4 pin.
-150V
+300V
Slow
Field
Fast
Selsyn Socket
Armature
Motor Plug
Power Socket (Male)
Revised - BAR 17/7/42
Revised - GM 10/7/42
ITEM
PART NO.
QUAN.
MAT'L
DESCRIPTION
DRAWN BY GM
TRACED BY D.L.S
DATE 17/6/42
3/10/42
SUPERSEDES
CHECKED
DATE 17/6/42
SCALE
ENG. APPROV.
DATE 5/10/42
FINISH
NATIONAL RESEARCH COUNCIL-RADIO SECTION - OTTAWA CANADA
NAME
MOTOR CONTROL (FOR DISPLACEMENT CORRECTOR)
DWG. NO.
LE-6-1-3



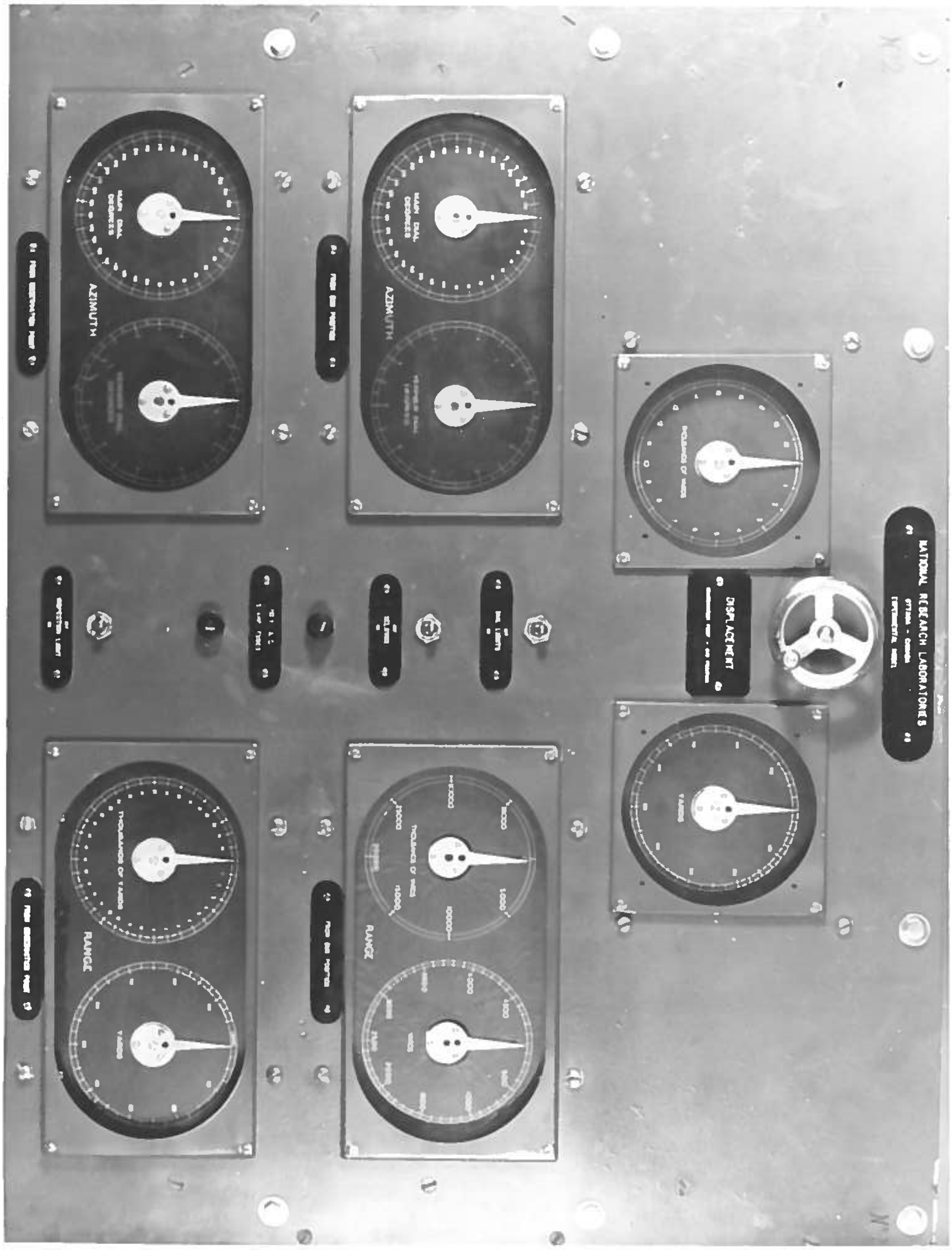
Revised G.M. 10/ /42

ITEM	PART NO.	QUAN.	MAT'L	DESCRIPTION

DRAWN BY GM TRACED BY D.L.S.	DATE 22/ /42 TRACED / /42	SUPERSEDES LE-0-53
CHECKED R.D.H.	DATE 23/6/42	SCALE
ENG. APPROV. WR	DATE 5/10/42	FINISH.

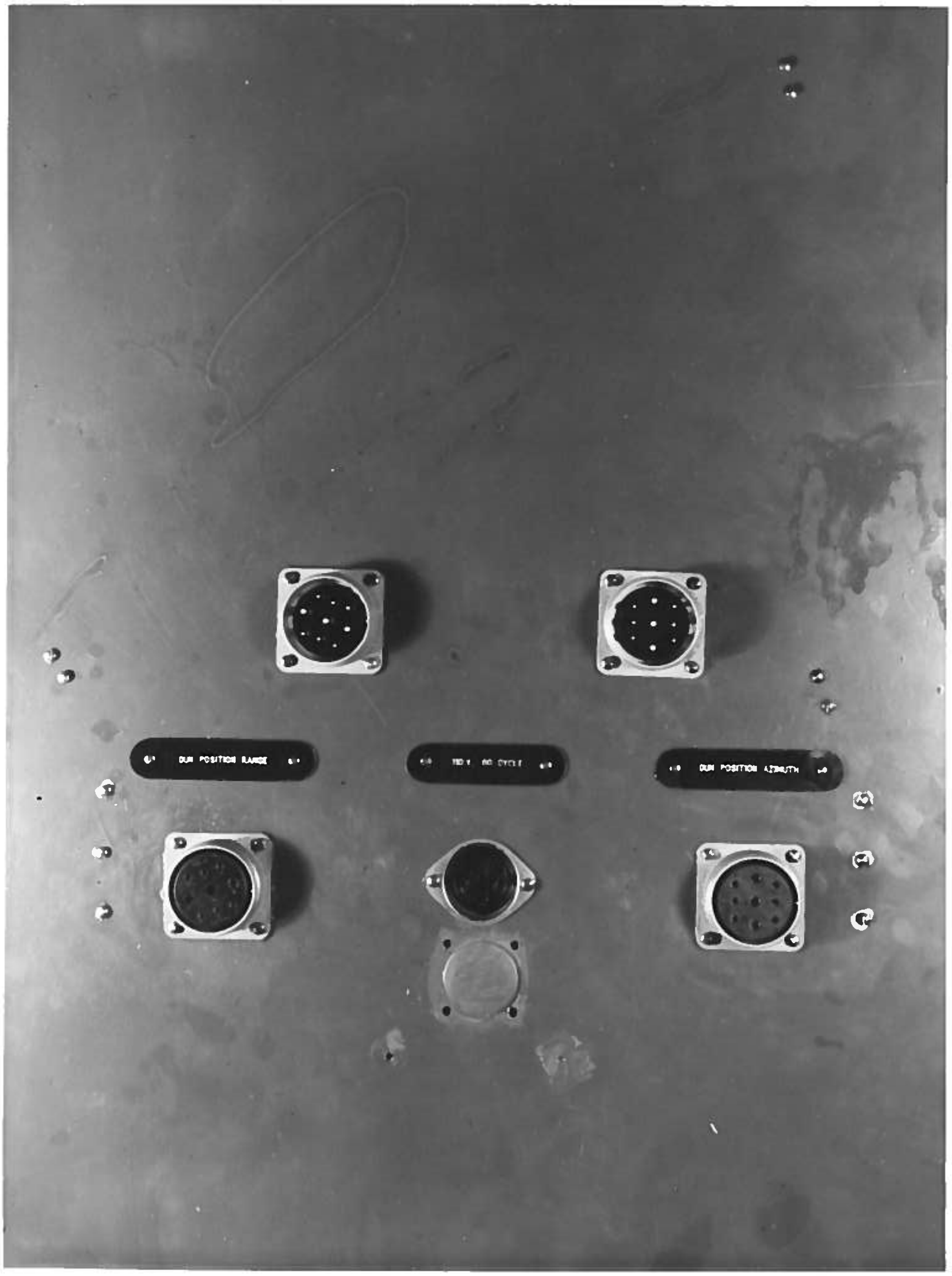
NATIONAL RESEARCH COUNCIL-RADIO SECTION - OTTAWA CANADA

NAME	DWG. NO.
V.R. & BIAS P.S. (For Dis. Corr.)	LE-6-1-4


AZIMUTH
AZIMUTH
DISPLACEMENT
NATIONAL RESEARCH LABORATORIES
RANGE
RANGE

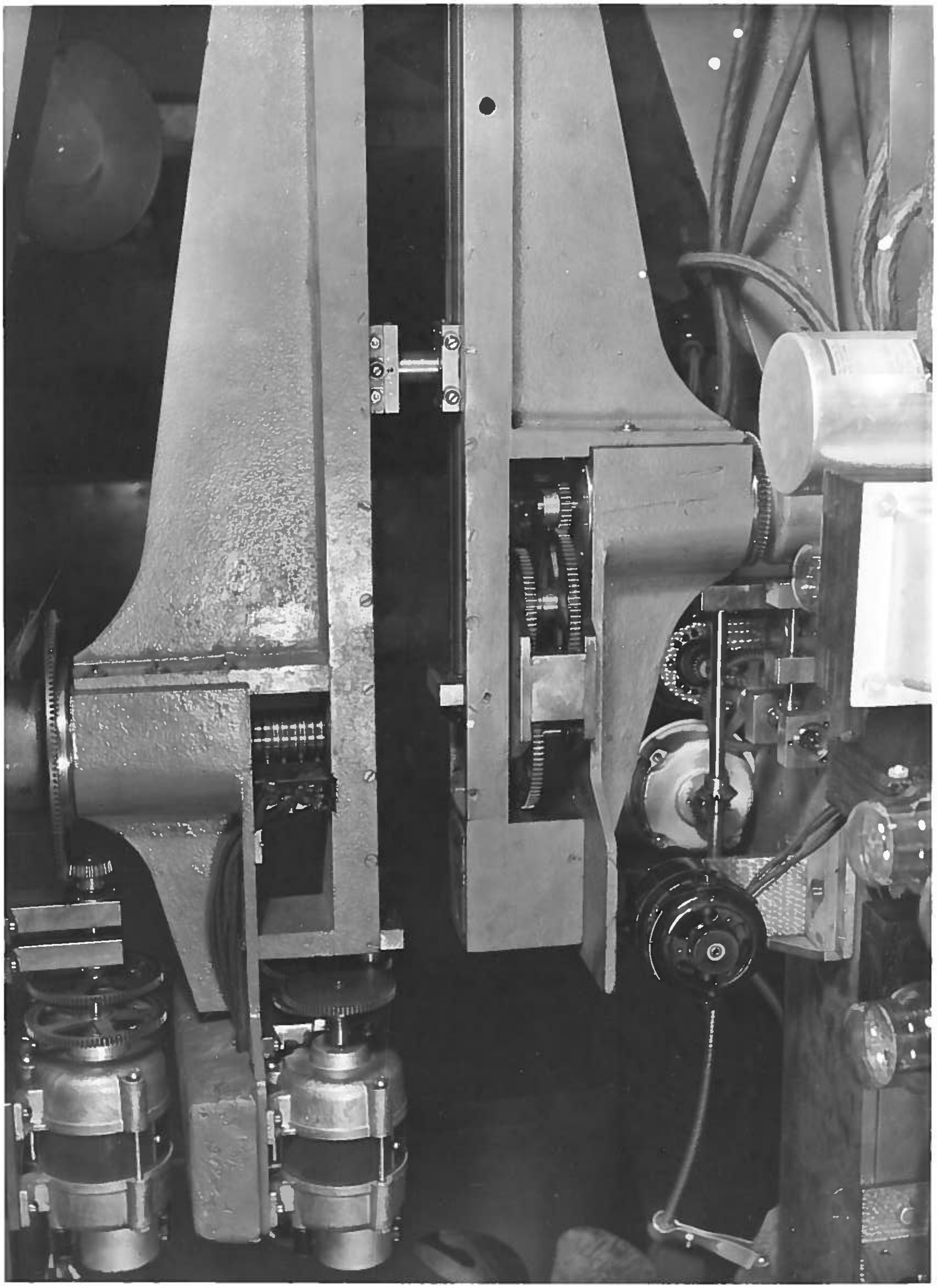
1008 A

PRA
54



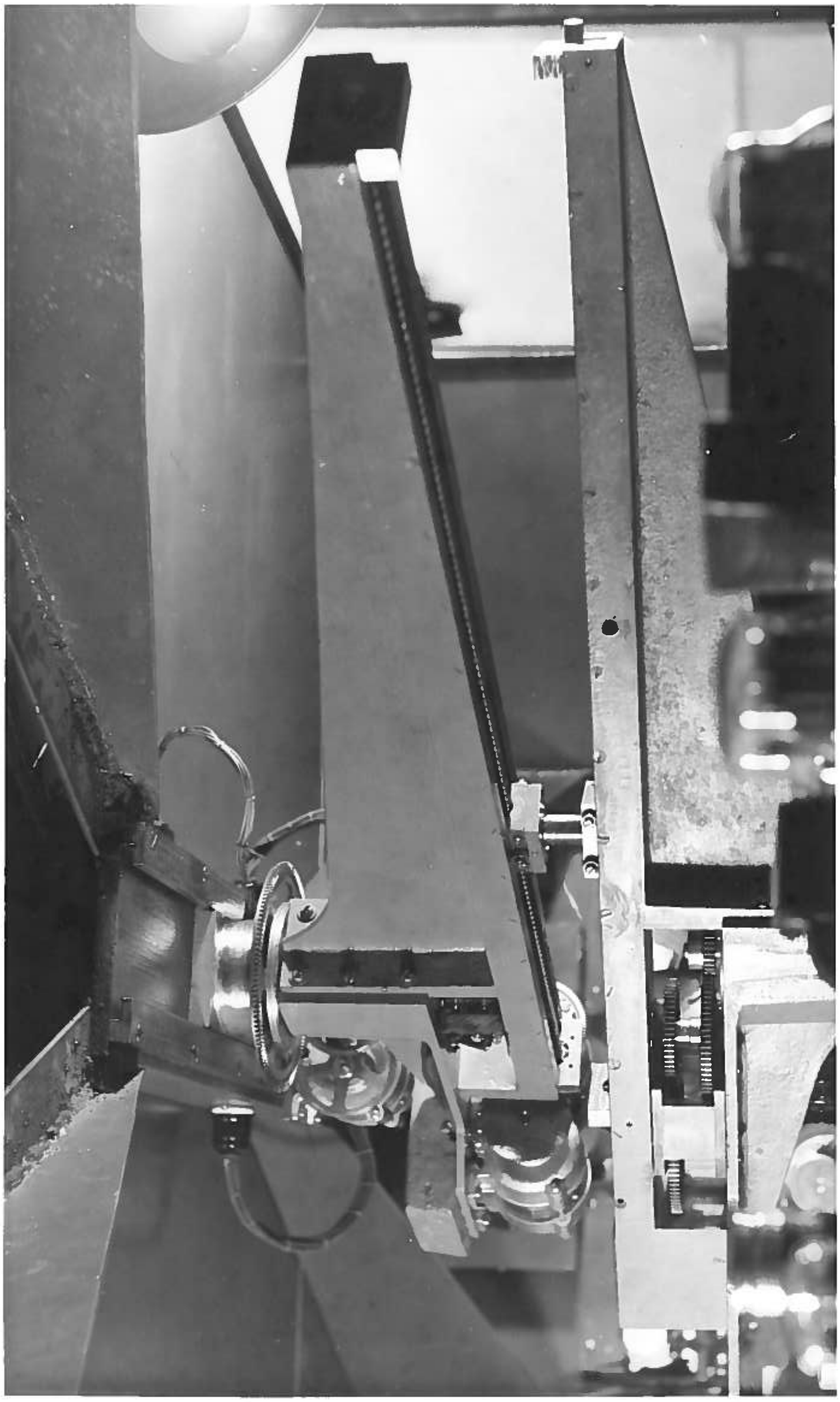
1008 C

PRA
54



PRA.54

1008-D.

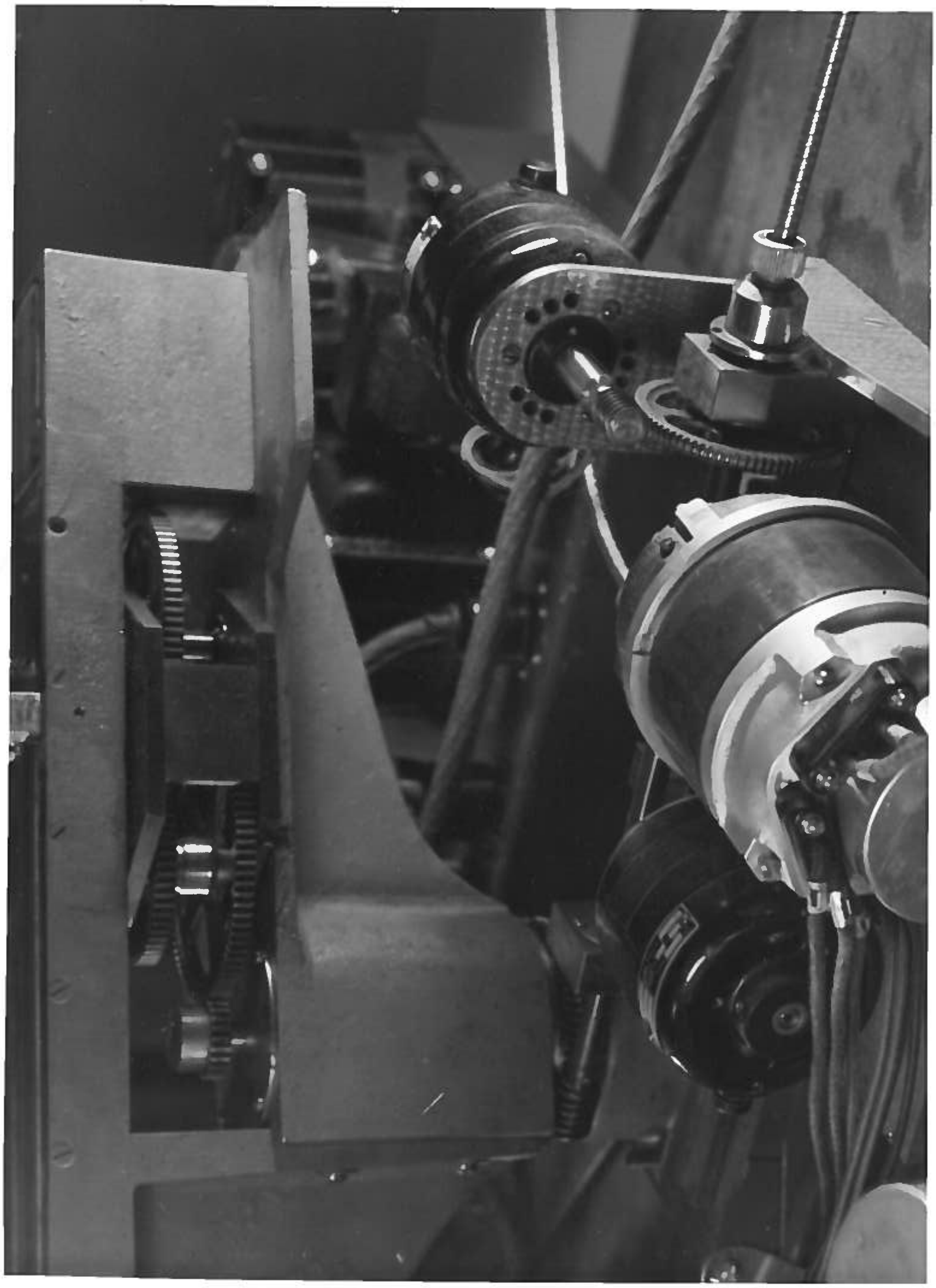


PRA.54

1008-E.

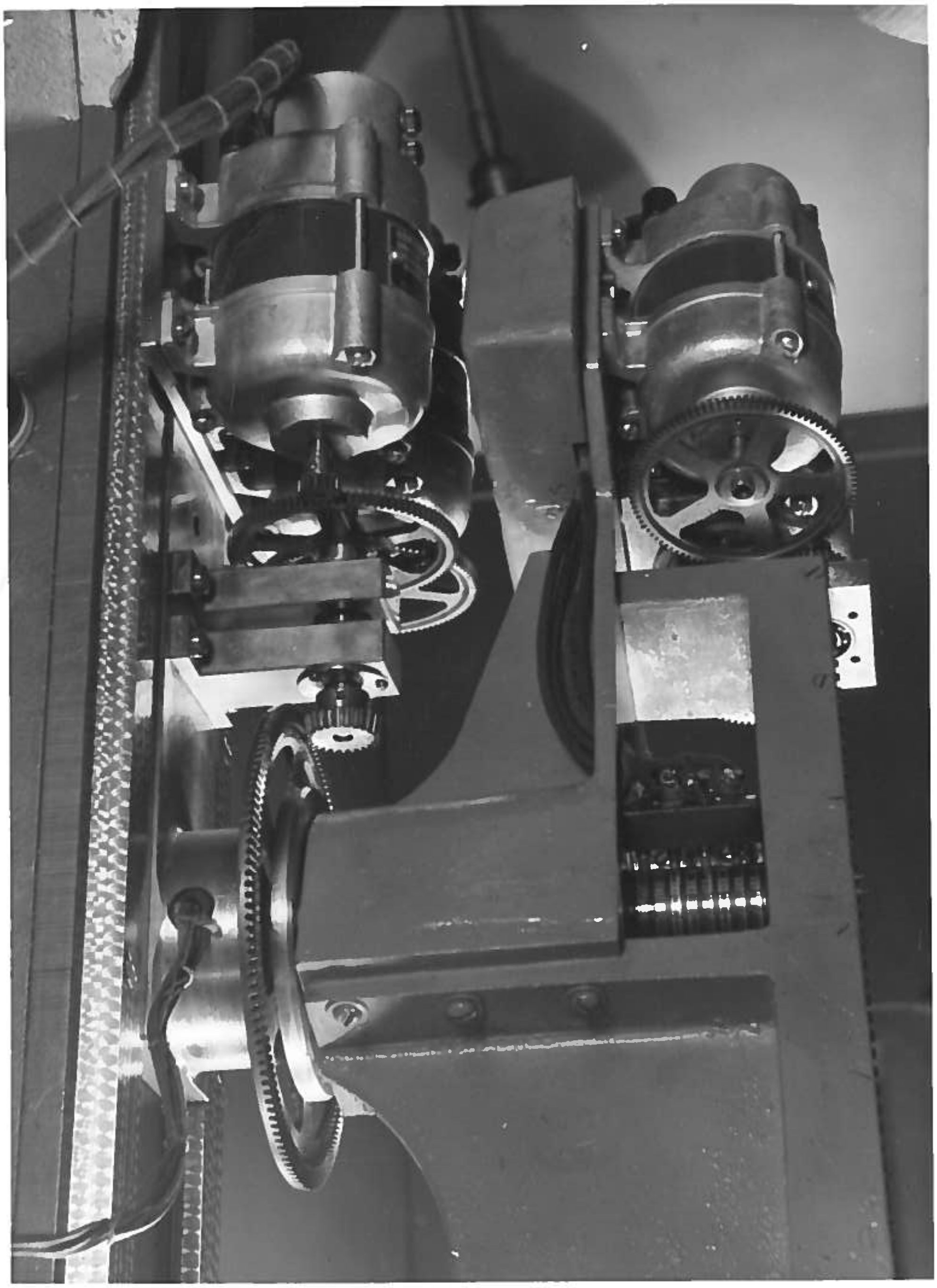
PRA.54

1008-F.



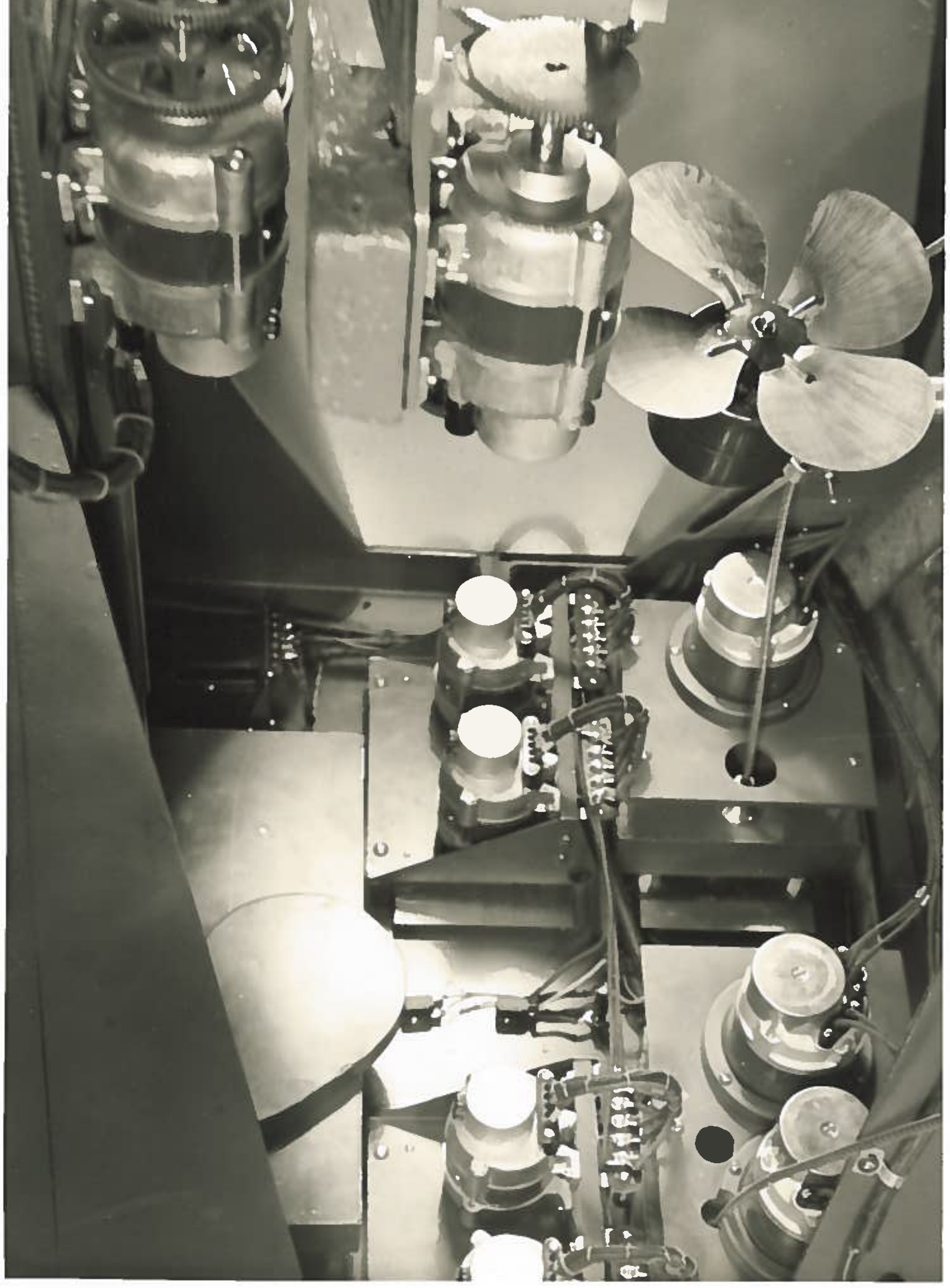
1008 H

PRA
54



1008 I

PRA
54



1008 M.

PRA.
54