Control equipment of C.D. installation at Osborne Head, N.S.
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NATIONAL RESEARCH COUNCIL OF CANADA

RADIO BRANCH

CONTROL EQUIPMENT OF C.D. INSTALLATION AT OSBORNE HEAD, N.S.

OTTAWA

JULY, 1942

CONTROL EQUIPMENT

of

C. D. INSTALLATION AT OSBORNE HEAD, N.S.

I N D E X

Page

DRAWINGS

- oOo -

CONTROL EQUIPMENT

of

C. D. INSTALLATION AT OSBORNE HEAD, N.S.

I ANTENNA ARRAY ROTATION CONTROL

The antenna array system used in the C.D. installation made by the National Research Council at Osborne Head, Nova Scotia, is supported on a rotatable steel structure about 30' x 18' x 6' in size, and weighing about 2500 pounds. In operation the array must be rotated at speeds varying over a wide range, and a speed, once set, should be maintained constant in spite of changes in wind loading and frictional torque. A top speed of 1/6th r.p.m., a range of speeds of the order of 300 to 1, and good regulation at all speeds were obtained by the system described in this report.

(a) Mechanical System - This consists of a 1600 to 1 reducing gear box ending in a large worm gear attached to the rotating structure. A belt and pulley system then allows a 900 r.p.m. motor to drive the array at 1/6 r.p.m.

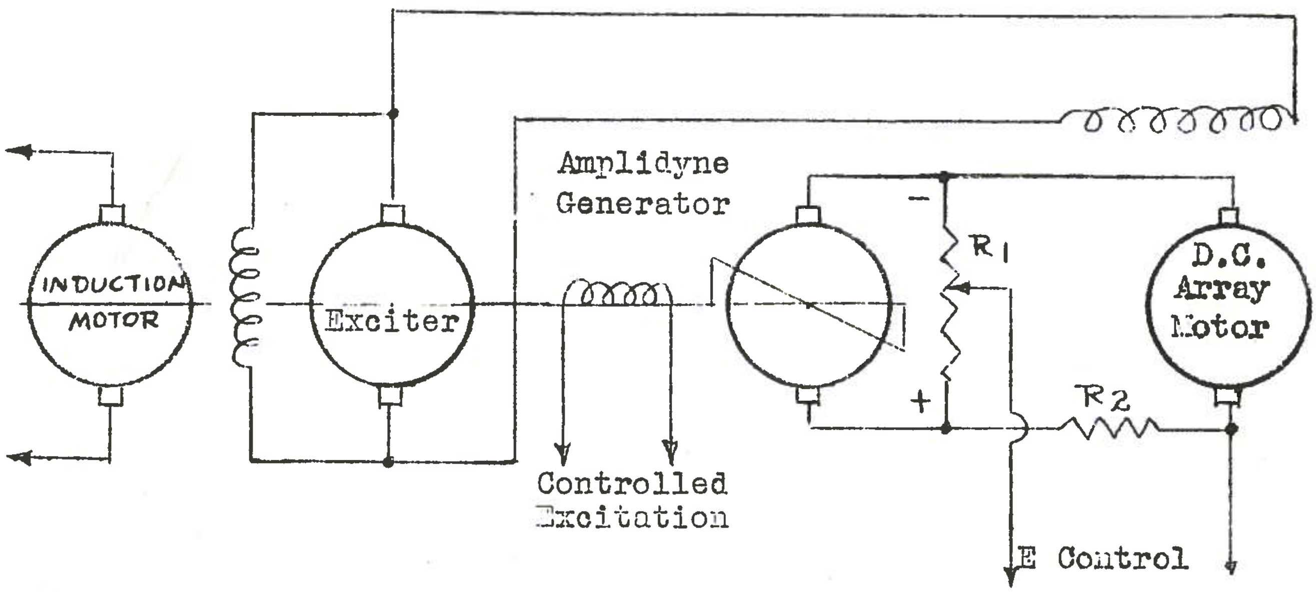
(b) Electrical Power System - A 1/2 h.p., D.C. motor is driven from a motor-generator set using an amplidyne type generator whose field is under external control.

(c) Electrical Control System - The antenna array controls are located on the control panel of the azimuth receiver (See drawing Ref. #300). The azimuth operator turns the rotation handwheel control to set the rate of change of azimuth required to follow the target (velocity tracking). This wheel controls direction by means of cams, micro-switches, and reversing relays, and controls speed by means of the Rotation Control Amplifier. This unit supplies the excitation required by the amplidyne generator and, by automatically compensating for any variation in the loading of the array structure, is responsible for the good speed regulation of the system. Two speed ranges are available on the control wheel, one providing a maximum speed one-eighth of the maximum on the other; this spreads out the range of lower speeds which are normally used the most. The desired speed range is selected by throwing the Rate Limiter switch. A dial has been attached to the control handwheel which is calibrated roughly in units of "knots per 10,000 yards"; this scale applies only to the low setting of the Azimuth Limiter switch. Two Azimuth Increment push-buttons are provided for inserting azimuth corrections without changing the rate already set. One gives full speed (on the speed range selected by the Rate Limiter switch) in the positive direction; the other, full speed in the negative direction. A STOP button is also provided by which the operator can stop the antenna instantly at any position. A limit-switch arrangement provides protection for the antenna feeders which restrict the available array rotation to approximately 320°.

The following drawings should be consulted in connection with the operation of the system:

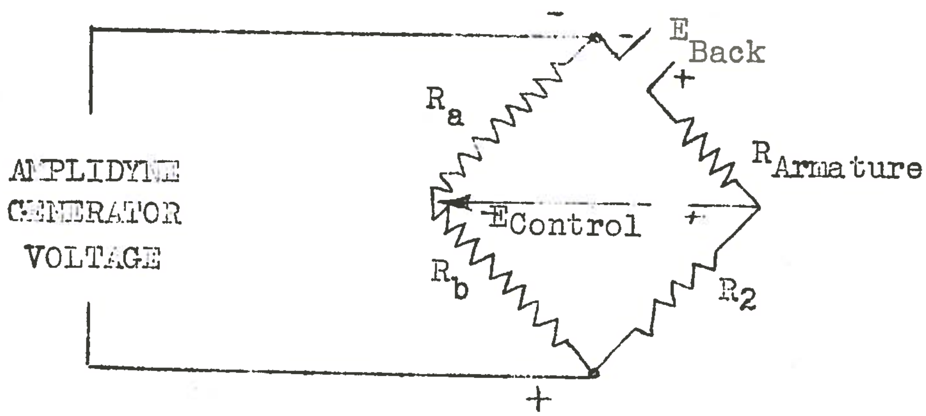
DRAWINGS:
- NRC-RE-192 - Electrical interconnections of complete system
- NRC-RE-193 - Schematic of complete system
- NRC-RE-144 - Schematic of Rotation Control Amplifier
- REF. #299 - Array Rotation Speed Characteristic
- REF. #300 - Azimuth Control Panel

(d) <u>Operation of Rotation Control System</u> - The essential circuit of the power units follows (See NRC-RE-193).



The three units, induction motor, exciter, and amplidyne generator are ganged on the same shaft. A resistance R_2 is inserted in one motor lead, and a 10,000 ohm potentiometer R_1 is placed across the generator output terminals. The resistance R_2 should be roughly the same as the resistance of the motor armature, but its value is not at all critical, and in this case is only about one-third the armature resistance.

The voltage marked E(control) is a feedback voltage used to compensate for changes in load by controlling the generator excitation. Since the driven motor operates with constant excitation, its back voltage is strictly proportional to its speed and the motor may be represented by its armature resistance in series with a voltage E(back) proportional to its speed. Part of the above circuit may then be redrawn as shown on the next page.



This is essentially a bridge circuit which may be "balanced" by making R_a/R_b = R(armature)/R_2. When this condition is fulfilled, E(control) is independent of the amplidyne generator voltage, but is directly proportional to E(back) and, thus, to the speed. E(control) has the very important characteristic that its value depends only on the speed of the motor, and it is not affected by the armature resistance drop, or by the armature current, or by the voltage necessary to produce that speed. Assuming that the bridge is balanced, the value of E(control) is given by the relation,

$$E(\text{control}) = E(\text{back}) \frac{R_2 + R_b}{R_a + R_b + R_2 + R(\text{armature})}$$

$$= E(\text{back}) \frac{R_2}{R_2 + R(\text{armature})}$$

Since R_2 is roughly one-third of R(armature), the value of E(control) is roughly E(back)/4. The use to which E(control) is put will now be discussed (refer to NRC-RE-193).

The excitation to the amplidyne generator is supplied by a pair of 6F6's, triode operated, as full-wave, grid-controlled rectifiers. The grid control for these tubes is secured from the load resistor of an 1852 pentode operating as a direct current amplifier. Attached to the array control wheel on the azimuth receiver panel is a potentiometer connected in a voltage-dividing circuit. A certain minimum voltage is set at the centre of the potentiometer and the voltage tapped off becomes more negative in either direction of rotation of the control wheel. This voltage is applied in series opposition with E(control) to the grid of the 1852. If the control is in the centre, the 1852 bias is low, the drop in its plate resistor is high, and the bias on the 6F6's is also high. The excitation to the amplidyne is very low (a minimum to be discussed later), and the output voltage is not sufficient to drive the motor. If, however, the control is moved, the bias on the 1852 is increased, its plate current is reduced or cut off, the bias on the 6F6's drops or is removed entirely, and the excitation supplied to the amplidyne is increased. The increased output voltage starts the motor and accelerates it rapidly, E(back) and E(control) increase, reducing the bias on the 1852, and the whole system settles down with a certain bias on the 1852 which allows just enough excitation to the amplidyne to give in turn a certain motor speed and value of E(control).

The load compensating action operates as follows. If the motor slows down due to an increased load (which the regulation of the generator alone cannot deal with) E(back) and E(control) tend to drop, the 1852 bias increases, the 6F6 bias decreases, more excitation is applied to the amplidyne, more torque is secured from the driving motor, and the system always tends to settle down in the conditions determined by the setting of the control potentiometer. Similar compensation takes place if the motor speeds up under reduced load. The action occurs extremely rapidly and, except with exceedingly high wind velocities, cannot be noticed.

Variable speed is obtained by moving the control wheel. The relation between voltage taken from the potentiometer (i.e. control wheel rotation) and speed of the array is shown in the accompanying drawing, (REF. #299). It is seen to be nearly linear. The units "knots per 10,000 yards" are used for speed since they are the most useful operationally. The highest speed available is 312 "knots per 10,000 yards" or 1 degree/sec., and the lowest usable speed is about 1 "knot per 10,000 yards".

(e) Amplidyne Unit - This consists of three rotating machines on one shaft. A 1 h.p., A.C. induction motor supplies power to the unit. The starting circuit of this motor has been deliberately designed so that it is necessary for the operator to be in the immediate vicinity of the unit when he presses the Start button, which actuates a hold-in relay. He may then, in the case of trouble, stop the unit at once by pressing the Stop button, which is located beside the Start button. An exciter driven by the induction motor supplies constant excitation to the D.C. array motor (122.5V D.C. and 1/5 amp.). The third machine is an amplidyne-type generator (250V D.C. and 2 amps.) which supplies armature voltage to the D.C. motor.

The special feature of the amplidyne generator is the low excitation required to produce full output voltage. Currents of the order of 20 ma. give full output from the generator, and the ratio of controlled to controlling power is about one hundred timeshigher than for conventional D.C. generators. The required excitation is easily secured from an electronic device, and at the same time a relatively large series resistance can be placed in the excitation circuit to reduce the delay in response to voltage changes, which is caused by the large inductance of the generator field.

(f) Reverse field of Amplidyne - Since the magnetic circuit of the amplidyne tends to retain some residual magnetism, and since this is rather more troublesome than in conventional generators, some current is passed through a second field at all times in the opposite sense to the controlling current. This current of 2 ma. is obtained from the exciter by means of a series resistance. Neglecting hysteresis, a fixed instead of a random flux is thus always present, and a certain current must be supplied from the rotation control amplifier to give a net zero flux and output voltage. This enables the minimum speed of the motor to be reached before the 6F6's are cut-off, i.e. at a point on the 6F6 characteristic where control is still possible. In this way speeds so slow that the motor brushes merely jerked from bar to bar of the commutator were obtained, and even a "dynamic state of rest", where the system resisted any effort to turn the motor shaft by hand in either direction, was possible. In operation, however, a minimum voltage on the control potentiometer is selected where the motor is able to turn smoothly.

(g) Bridge Circuit - "Regulation Control" - The 10,000 ohm potentiometer on the rotation control amplifier is used to adjust the bridge balance. The previous description of the operation of this system assumes a perfectly balanced bridge. If the bridge is unbalanced towards R_2, regulation is decreased. If moved in the opposite direction, "over-compensation" occurs, and the operation becomes rather unstable, even oscillatory. As it is not desirable to have perfect regulation since the mechanical system may develop a fault, the unit should be operated at a slightly "under-compensated" setting. This is done in practice by backing the potentiometer away from the position where unstable operation just becomes evident. In the Osborne Head unit, regulation increases with counter-clockwise rotation of the control.

(h) Rotation Control Amplifier - NRC-RE-144 and NRC-RE-193 - Two VR-150 regulated power supplies are incorporated in the unit. All terminals are brought out through a 10-terminal block of jacks which fits into a similar block of plugs in the case provided for the unit. A set of polarized test leads is provided in order to facilitate operation of the unit away from its mounting for test purposes. Metering of all important quantities in the circuit has been provided. The metering data shown on NRC-RE-144 are available on the cover of the unit along with the usual readings to be expected.

The following should be noted:--

1. Minimum and maximum speed controls (See later - Voltage Dividing Circuit).

2. The resistor-capacitor networks on the grid of the 1852 serve several purposes. R_6 and the 0.35 µfd condenser determine the time of response of the unit and, as chosen, allow the grid to respond sufficiently rapidly to any changes of E(control) and voltage from the control potentiometer. The 200,000 ohm resistance R_8, serves to ground the grid if the control potentiometer is disconnected, and, along with R_6 and the condenser, help keep any A.C. currents picked up by lead 46 off the 1852 grid.

3. R_7 - 6500 ohms. This series resistor in the excitation circuit is chosen to give exactly 20 ma. excitation current when the 1852 is cut-off (or removed from its socket). This is the maximum excitation which can be provided for the Amplidyne generator.

4. With only one 6F6 operating, no current flows in the excitation field on account of the very high inductance of the field, since only half-wave rectification is obtained in this case.

5. If the array motor stalls for any reason, full generator voltage is applied to it and a current of 5 amps. is taken from the amplidyne generator.

(i) Voltage Dividing Circuit - The -150 volt power supply is used for setting the speed-controlling bias on the 1852. A range of about 90 volts is normally used for this purpose. The maximum speed control, resistor R_5, is 7500 ohms and is left fixed at that value. The minimum speed control rheostat R_3 is adjusted as follows:

Stop the amplidyne unit and, with the control wheel on the azimuth receiver set in the centre of its rotation - relays open- and the rotation control amplifier meter reading amplidyne excitation, adjust the minimum speed control to give 2 ma. excitation. This is just enough to cancel the reverse excitation fed to the amplidyne from the exciter. Start the amplidyne and turn the control wheel sufficiently far to close the relays and to remain in the necessary position to do so. The minimum speed control should then be readjusted slightly to give definitely perceptible movement of the vernier azimuth selsyn. A speed of the order of 1/5° in one minute is easily seen and is sufficiently slow for velocity tracking. Slower speeds can be obtained, but the motor rotation tends to become jerky and in operation the setting of a slower rate than this is a long and difficult proceeding.

(j) Control Panel Receiver B - REF #300 -

1. Speed controls - The speed control is a 50,000 ohm, General Radio type 471A potentiometer, centre-tapped by the N.R.C. Shops. The voltage taken off this potentiometer increases negatively with rotation away from the centre and is linear with respect to rotation. The symmetrical arrangement about the centre tap is necessary in order that zero speed could be obtained in the centre of rotation and speed would increase as the wheel is turned in either direction from the centre.

A single-pole, double-throw toggle-switch serves as an Azimuth Rate Limiter. In the low range, 10,000 ohms is added in series with the potentiometer and 1300 ohms in parallel. Thus the lower tenth (9.3 volts or so) of normal high range of voltage is spread out over the whole potentiometer. In the high range, the 10,000 ohm resistor is shorted out and the 1300 ohm resistor opened, leaving the normal 90 volts or so across the potentiometer. Maximum speed on the high range is 312 knots/10,000 yards (1°/sec.) and on the low range is 37.5 knots/10,000 yards (0.12°/sec.). The scale provided on the control wheel is calibrated in "knots per 10,000 yards", and applies to the slow speed range only. It will usually be found accurate to within 2 "knots per 10,000 yards".

The Azimuth Increment push-buttons give the full speed available on whichever range is selected by the Rate Limiter. The lead normally going to the variable tap of the potentiometer is moved to the top of the potentiometer by one-half of the switch. The other half of the switch determines the direction of rotation as explained below.

2. Directional Controls - On the same shaft as the potentiometer are three cams operating micro-switches, only two of which are used in the present installation. One switch opens all relay circuits in the centre of rotation giving a definite OFF position. The other switch changes from one relay circuit to the other while the first switch is off, thus reversing the direction of rotation as the control wheel is turned through the centre OFF position. The Azimuth Increment buttons determine the direction of rotation by opening the circuit through the reversing micro-switch and energizing the proper relay direction. Thus the Positive Increment (red) button always produces positive rotation, regardless of the direction set by the handwheel, and similarly a negative rotation always results from pressing the minus (green) button. The Azimuth Stop (white) button opens the energizing circuit to both relays and operates exactly like the centre-off micro-switch. The operator may thus stop the array instantly at any position and regardless of the rate set.

(k) Relays and Limit Switches - Reversal of rotation of the array is secured by two relays ganged mechanically so that only one can close at one time. Both may, however, be open together, giving a definite OFF position. At this time the motor armature is shorted in order to minimize coasting of the array. Either relay circuit is selected by the micro-switch and increment buttons described in connection with the Control Panel, and with each relay circuit is associated another micro-switch in the array itself which serves as a limit switch. These limit switches are arranged to allow only 320° or so of rotation, thereby preventing damage to the concentric feeders. The motor is stopped by one relay opening as soon as the "blind sector" is reached, but it is only necessary to reverse the hand wheel control to get out of this region, as the other limit switch is still closed. In case either limit switch fails to operate, another single micro-switch opens both relay circuits if the blind sector is entered to the extent of 2°. If this occurs, a check should be made to determine why the normal limit switches failed to operate. All switch leads are available in the terminal box for testing and for shorting out if the array does get too far into the blind sector. In this connection it should be noted that, if the rotation control amplifier fails while the amplidyne and relays are operating, it is possible for the array to "back" into the blind sector, since a slow speed in the "wrong" direction can be secured from the reverse field of the amplidyne generator.

If the Safety Limit switch opens, great care should be used when getting away from the blind sector. Check all metered quantities in the rotation control amplifier as the control wheel setting is altered (relay circuit opened at fuse box). From the selsyns determine if array has entered the blind sector clockwise or counter-clockwise. If clockwise, rotate control wheel slightly counter-clockwise on low range, replace fuse and join terminals 15 and 16. The array should move counter-clockwise out of the blind sector. It may also be necessary to join 16 to 18 as all three switches open if the array is very far into the blind sector. After normal operation is resumed, remove all shorts. In the opposite case, i.e. array has entered counter-clockwise, rotate control wheel clockwise and repeat as above except that if all three switches have opened, join 16 and 17 in addition to 15 and 16.

II. ELECTRICAL WIRING AT OSBORNE HEAD

(a) A.C. Wiring - NRC-RE-191 - The A.C. Supply for the whole C.D. installation comes to one large panel located in the transmitter room. A switch near the building entrance is used to change from 220/110 volts, 60-cycle A.C. power lines to a 110-volt, 15 K.V.A. Diesel driven generator. Two 30 amp. switches are located on the main panel, one to control the oil heaters in the array rotation gear box, (temperature is kept above 45°F. by a thermostat located in the tower) and the other to supply lights and A.C. power in the array. The Oil Heater switch should be left ON at all times. A 60 amp. double-pole switch on the main panel controls the power supplied to the fuse box, and through it, to all the remaining equipment.

The voltage regulators feeding the electronic equipment can be adjusted for correct voltage, if the load is changed, by moving taps located at one end of each unit.

(b) Special Cables - NRC-RE-191 - All timing pulse and signal leads etc. between components of the Radio installation are shown in order to facilitate tracing and testing.

(c) Selsyn Connections - NRC-RE-97 - Azimuth readings from selsyns located in the tower, and range readings from Receiver A are fed to the terminal box by selsyn transmitters. Selsyn motors can be connected at the terminal box as needed. As installed selsyn azimuth readings are transferred to Receiver B for the use of the operator there.

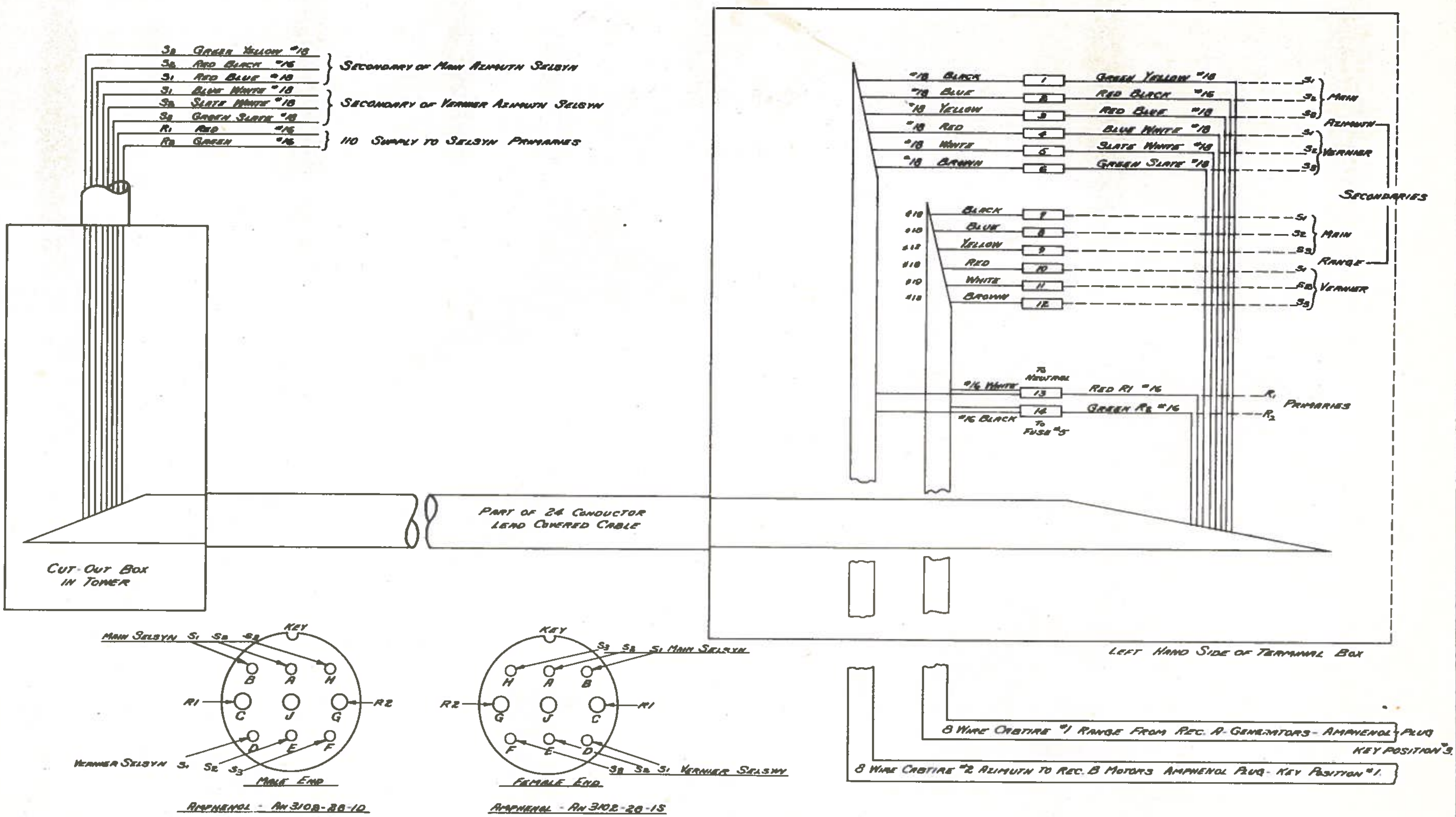
(d) Synchronous Motors and Telephones - NRC-RE-190 - A three-wire telephone circuit is available from Receiver B to the tower in case adjustments are needed in the array. The synchronous motors which are used in the beam-splitting method of determining azimuth are all connected to the one fuse. The R.F. wobble switch is not separately switched but the D.C. wobble switch and the colour disc can be phased properly in relation to it by switches on the control panel of Receiver B.

(e) Array Control Interconnections - NRC-RE-192; NRC-RE-193 - A functional drawing from which the principle of operation may be followed is provided in NRC-RE-193. The complete connections between the units described earlier in this report are indicated in NRC-RE-192.

HP

R. S. Rettie

H.H. Rugg



Back View of Plug & Socket
Key Position #1.

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
16	White	R1	C	110V. 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

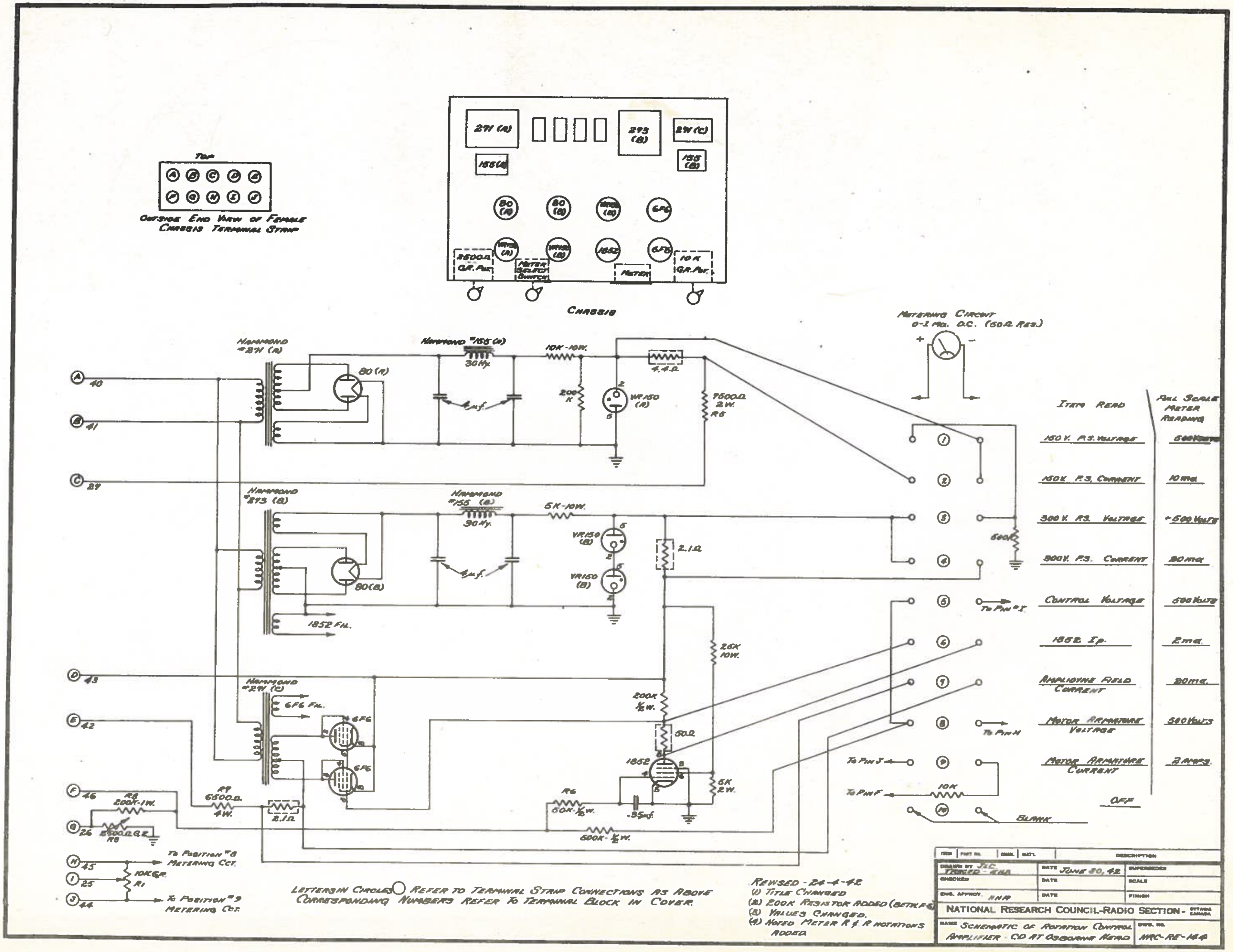
Item	Part No.	Quan.	Mat'l	Description

Drawn by WHR Traced - EHB	Date June 29-42	Supersedes
Checked	Date	Scale
Eng. Approv. R.S.R.	Date	Finish

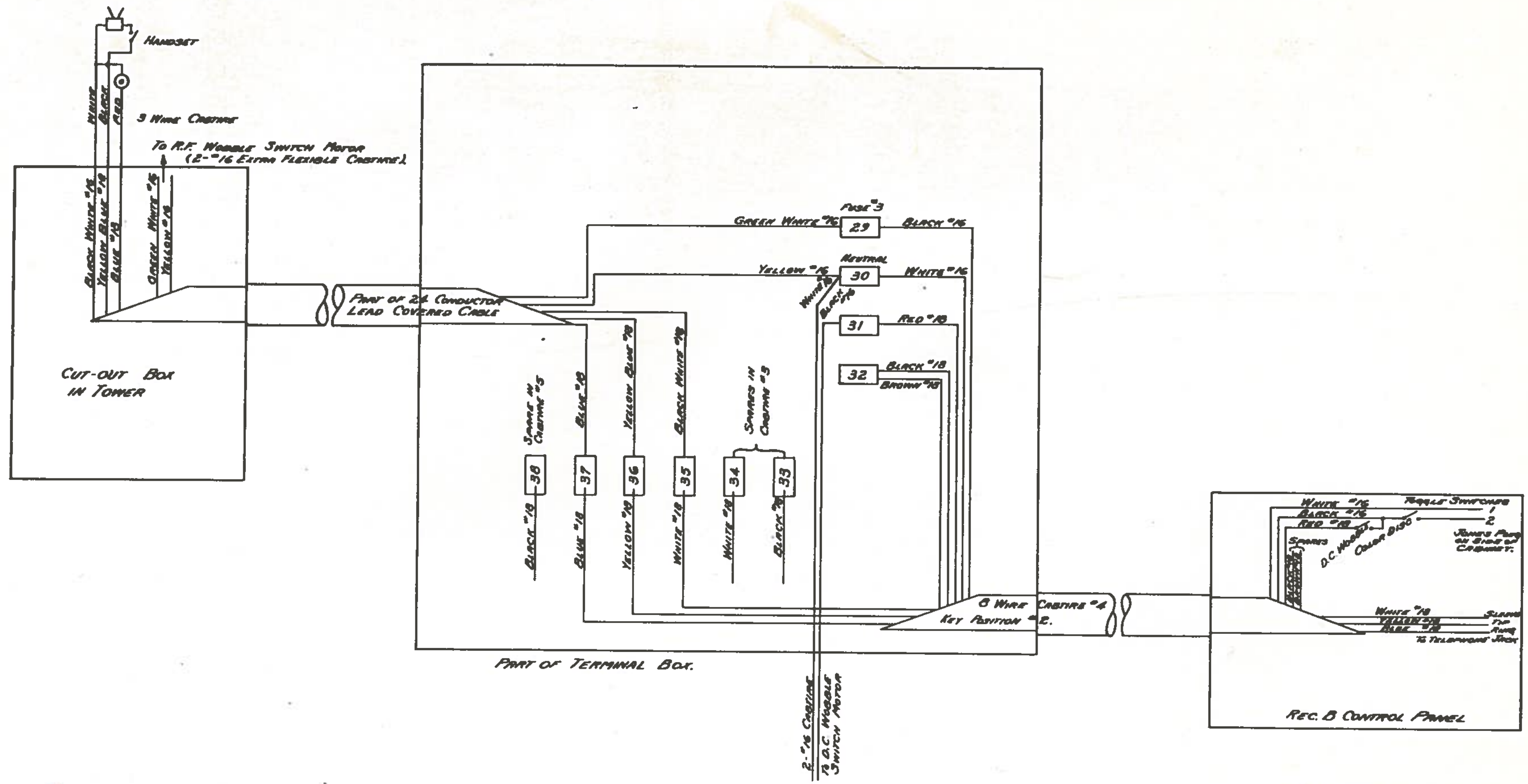
NATIONAL RESEARCH COUNCIL-RADIO SECTION - OTTAWA CANADA

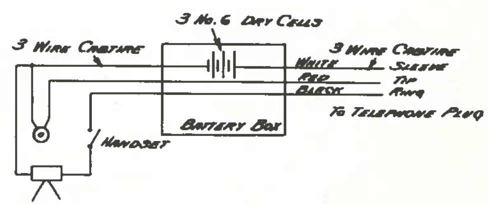
Name: C. D. at Osborne Head Selsyn Connectors

Dwg. No. NRC-RE-97



Top
Outside End View of Female Chassis Terminal Strip
291 (A)
293 (B)
291 (C)
155 (A)
155 (B)
80 (A)
80 (B)
VR150 (B)
6F6
VR150 (A)
VR150 (B)
1852
6F6
2500Ω G.R. Pot.
Meter Select Switch
Meter
10K G.R. Pot.
Chassis
Hammond #291 (A)
80 (A)
Hammond #155 (A)
30 Hy.
4 μf.
10K-10W.
200 K
VR150 (A)
4.4 Ω
7500 Ω 2W. R5
Hammond #293 (B)
Hammond #155 (B)
30 Hy.
5K-10W.
VR150 (B)
2.1 Ω
80 (B)
4 μf.
1852 Fil.
25K 10W.
Hammond #291 (C)
6F6 Fil.
6F6
6F6
200K ½W.
50 Ω
1852
5K 2W.
R8 200K-1W.
R7 6500 Ω 4W.
2.1 Ω
R6 50K-½W.
.25 μf.
600K-½W.
2500 Ω G.R. R8
To Position #8 Metering Cct.
10K G.R. R1
To Position #9 Metering Cct.
Metering Circuit 0-1 Ma. D.C. (50 Ω Res.)
Item Read
Full Scale Meter Reading
150 V. P.S. Voltage — 500 Volts
150 V. P.S. Current — 10 ma
300 V. P.S. Voltage — +500 Volts
300 V. P.S. Current — 80 ma
Control Voltage — 500 Volts
1852 Ip. — 2 ma
Amplidyne Field Current — 80 ma.
Motor Armature Voltage — 500 Volts
Motor Armature Current — 2 Amps.
Off
Blank
500K
To Pin #I
To Pin H
To Pin J
To Pin F
10K
Lettering in Circles ◯ Refer to Terminal Strip Connections as Above
Corresponding Numbers Refer to Terminal Block in Cover.
Revised - 24-4-42
(1) Title Changed
(2) 200K Resistor Added (Betw. F & G)
(3) Values Changed.
(4) Noted Meter R & R notations Added.
Drawn by J.C. Traced - ENB
Date June 30, 42
Eng. Approv. HNR
NATIONAL RESEARCH COUNCIL-RADIO SECTION - OTTAWA CANADA
Name Schematic of Rotation Control Amplifier - CD at Osborne Head
Dwg. No. NRC-RE-14A





24 Conductor Lead Covered Cable	Use	Terminal Box Number	8 Wire Cabtire	Original Plug Pin Number		2 Wire Cabtire
Black White #16	Telephone	35	White #18	D	Jack Sleeve	
Yellow Blue #18		36	Yellow #18	E	Jack Tip	
Blue #18		37	Blue #18	F	Jack Ring	
Green White #16	R.F. Wobble Switch	29	Black #16	H	Also Fuse #3	
Yellow #16		30	White #16	B	Also Neutral	White #16
	D.C. Wobble Switch	31	Red #18	G		Black #16
	Spares #4 Cabtire	32	Brown #18	A		
			Black #18	C		
	Spares #3 Cabtire	33	Black #18			
		34	White #18			
	Spares #5 Cabtire	38	Black #18			

No.	8 Wire Cabtire	Key Position No.
1	Range Selsyns Rec. A.	3
2	Azimuth Selsyns Rec. B	1
3	Array Motor Control Rec. B	3
4	Telephone, Synchronous Motors Rec. A	2
.5	Amplidyne, Rotation Control Amplifier	None

Revised 3/6/42 [initials]

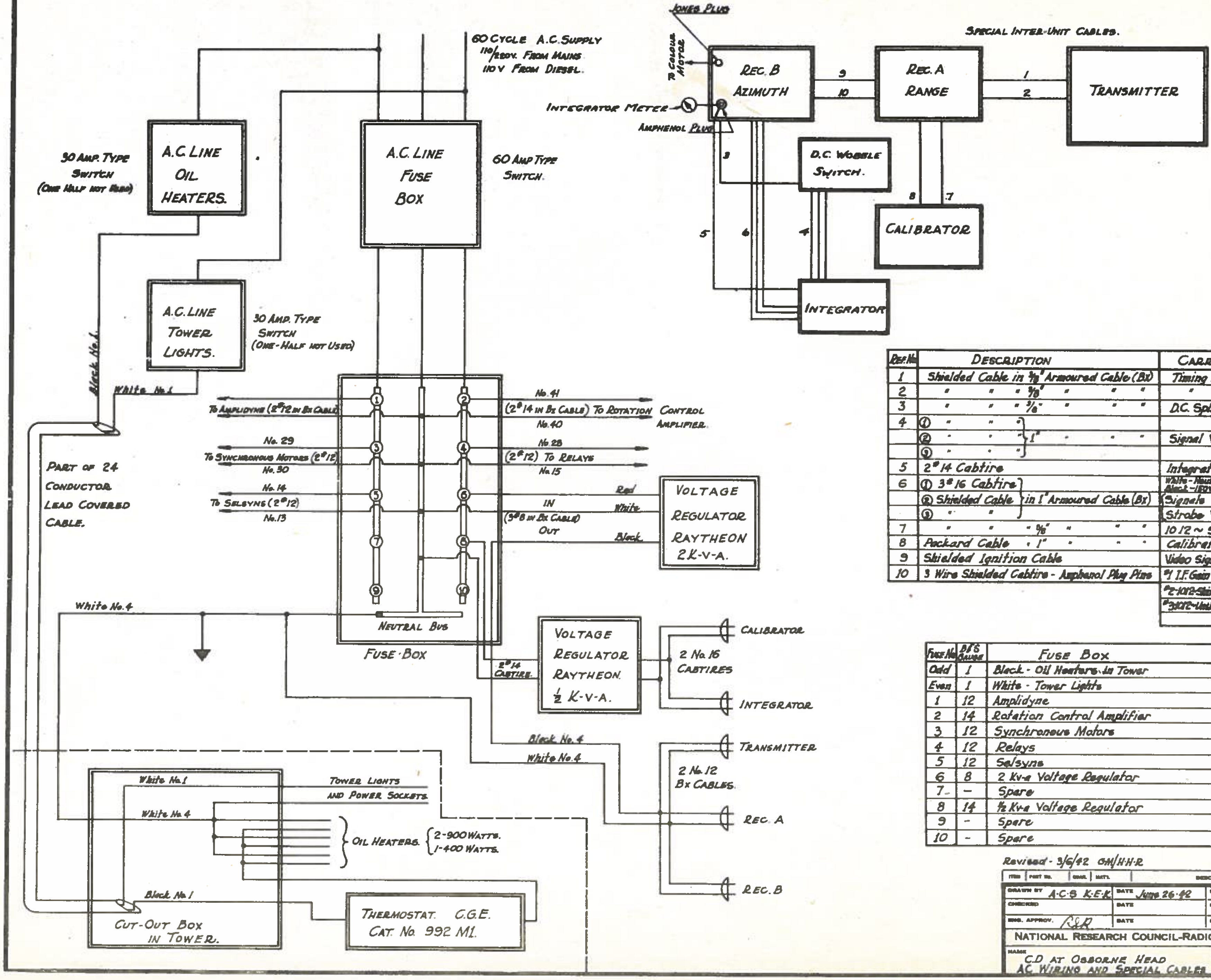
Item	Part No.	Quan.	Mat'l	Description

Drawn by R.C.S. Traced E.M.B.	Date April 24-42 June 27-42	Supersedes
Checked	Date	Scale
Eng. Approv. R.S.R.	Date	Finish

NATIONAL RESEARCH COUNCIL-RADIO SECTION - OTTAWA CANADA

Name: C.D. at Osborne Head. Synchronous Motors & Telephones

Dwg. No. NRC-RE-190



Ref. No.	Description	Carries
1	Shielded Cable in ⅜" Armoured Cable (Bx)	Timing Pulse
2	" " " ⅜" " " "	" "
3	" " " ⅜" " " "	D.C. Split Voltage
4	① " " " } 1" " " "	
	② " " "	Signal Voltages
	③ " " "	
5	2#14 Cabtire	Integrator Output
6	① 3#16 Cabtire } in 1" Armoured Cable (Bx)	White - Neutral Red +[illegible] Black - 180V D.C.
	② Shielded Cable	Signals
	③ " "	Strobe Voltage
7	" " " ⅜" " " "	10 12 ~ Sine Wave
8	Packard Cable " 1" " " "	Calibration Pips
9	Shielded Ignition Cable	Video Signal - Yellow J.P.
10	3 Wire Shielded Cabtire - Amphenol Plug Pins	#1 I.F. Gain - Green J.P.
		#2 - 1012 - Shifted Phase - [illegible] J.P.
		#3 - 1012 - Unshifted " - Red J.P.

Fuse No.	B&S Gauge	Fuse Box	Terminal No.	Neutral No.
Odd	1	Black - Oil Heaters in Tower		White #1
Even	1	White - Tower Lights		White #4
1	12	Amplidyne	Bx	Cable
2	14	Rotation Control Amplifier	41	40
3	12	Synchronous Motors	29	30
4	12	Relays	28	15
5	12	Selsyns	14	13
6	8	2 Kv-a Voltage Regulator	Bx	Cable
7	—	Spare		
8	14	½ Kv-a Voltage Regulator	Cab	tire
9	-	Spare		
10	-	Spare		

Revised - 3/6/42 GH/H.H.R

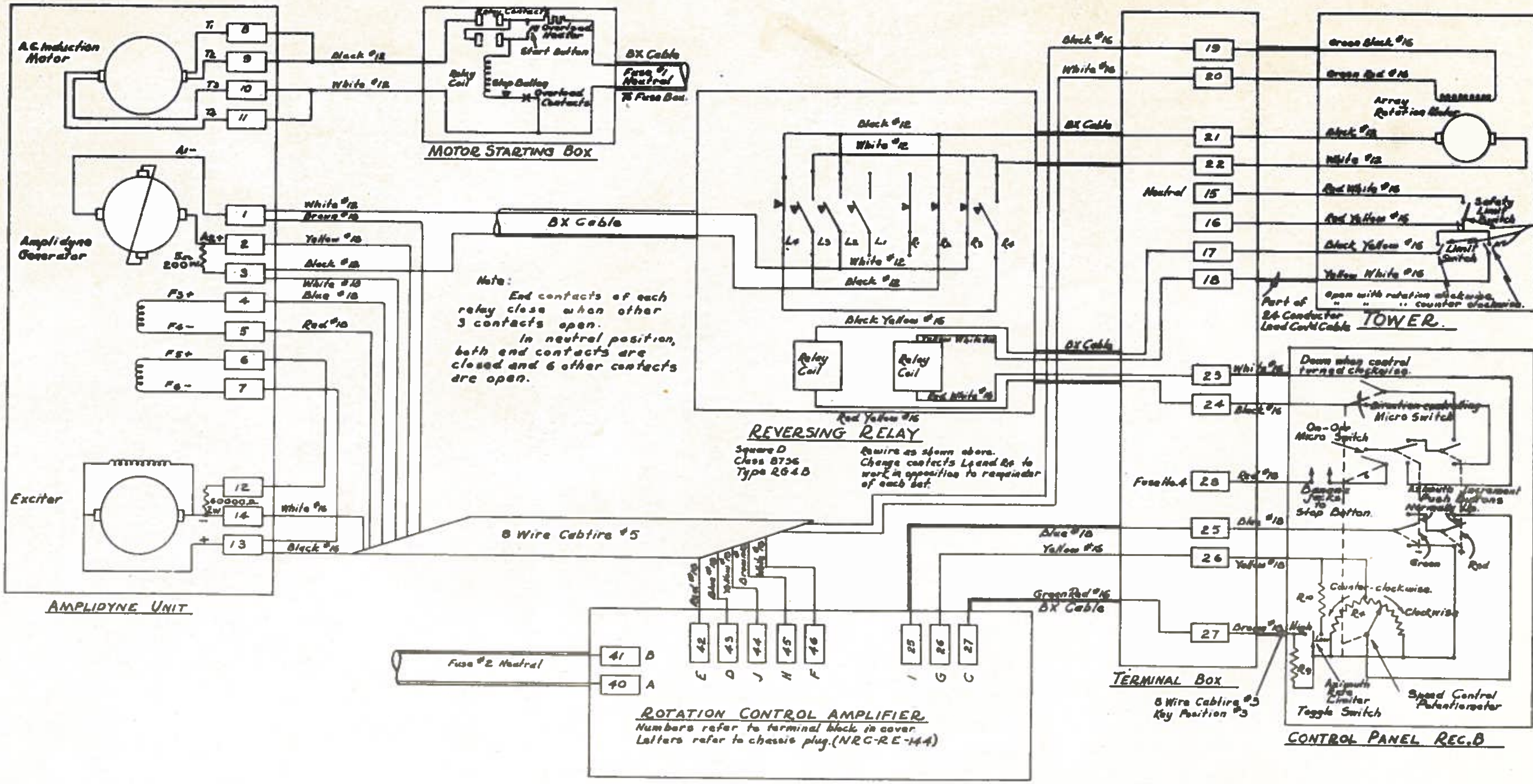
Item	Part No.	Chal.	Matl.	Description

Drawn by A.C.S K.E.K	Date June 26.42	Superseded
Checked	Date	Scale
Eng. Approv. R.S.R.	Date	Finish.

National Research Council - Radio Section - Ottawa Canada

Name: C.D at Osborne Head AC Wiring and Special Cables

Dwg. No. NRC-RE-191



Amplidyne Unit No.	8 Wire Cabtire and Others	To	From	Circuit No.
1(A1−)	White #12 Brown #10	Reversing Relay (R.C.A.)	Generator	21(22) 45
2(A2+)	Yellow #10	Via 5Ω to #3 (R.C.A.)	—	44
3	Black #12 White #10	Reversing Relay (R.C.A.)	Generator	22(21) 46
4(F3+)	Blue #10	(R.C.A.)	Field	43
5(F4−)	Red #10	(R.C.A.)		42
6(F5+)		Jumper to 12	Field	—
7(F6−)		Jumper to 13		—
8(T1)		Jumper to 9		—
9(T2)	Black #12	A.C. (Fuse #1)	Induction	—
10(T3)	White #12	A.C. (Neutral)	Motor	—
11(T4)		Jumper to 10		—
12		Via 60,000Ω to 14		—
13(+)	Black #16	Tower Motor	Exciter	19
14(−)	White #16			20

Circuit No.	To	From	24 Conductor Cable 8 Wire Cabtire #4	Amplidyne Plug Pin No.	Other Leads
15	Neutral	Safety Limit Switch	Red White #16	—	(White #12)
16	(Centre connection to Limit Switches)		Red Yellow #16	—	None
17	Relay Coil	Limit Switch	Black Yellow #16	—	Black Yellow #16
18	Relay Coil	Limit Switch	Yellow White #16	—	Yellow White #16
19	D.C. Motor Field	Exciter (+)	Green Black #16	—	Black #16 Cabtire)
20	D.C. Motor Field	Exciter (−)	Green Red #16	—	White #16 #5
21	D.C. Motor Armature	Reversing Relays	Black #12	—	Black #12
22	D.C. Motor Armature	Reversing Relays	White #12	—	White #12
23	Direction Controlling	Relay	White #16	F	Red White #16
24	Micro Switches	Coils	Black #16	D	Red Yellow #16
25	R.C.A.	Speed Control Unit	Blue #10	A	Blue #10
26	Speed Control Unit	R.C.A.	Yellow #10	H	Yellow #16
27	Speed Control Unit	R.C.A.	Brown #10	B	Green Red #16
28	Relay Circuit	Fuse #4	Red #10	J	(Black #12)

Revised BAR/HHR 27/6/42
Revised GM/HHR 3/6/42

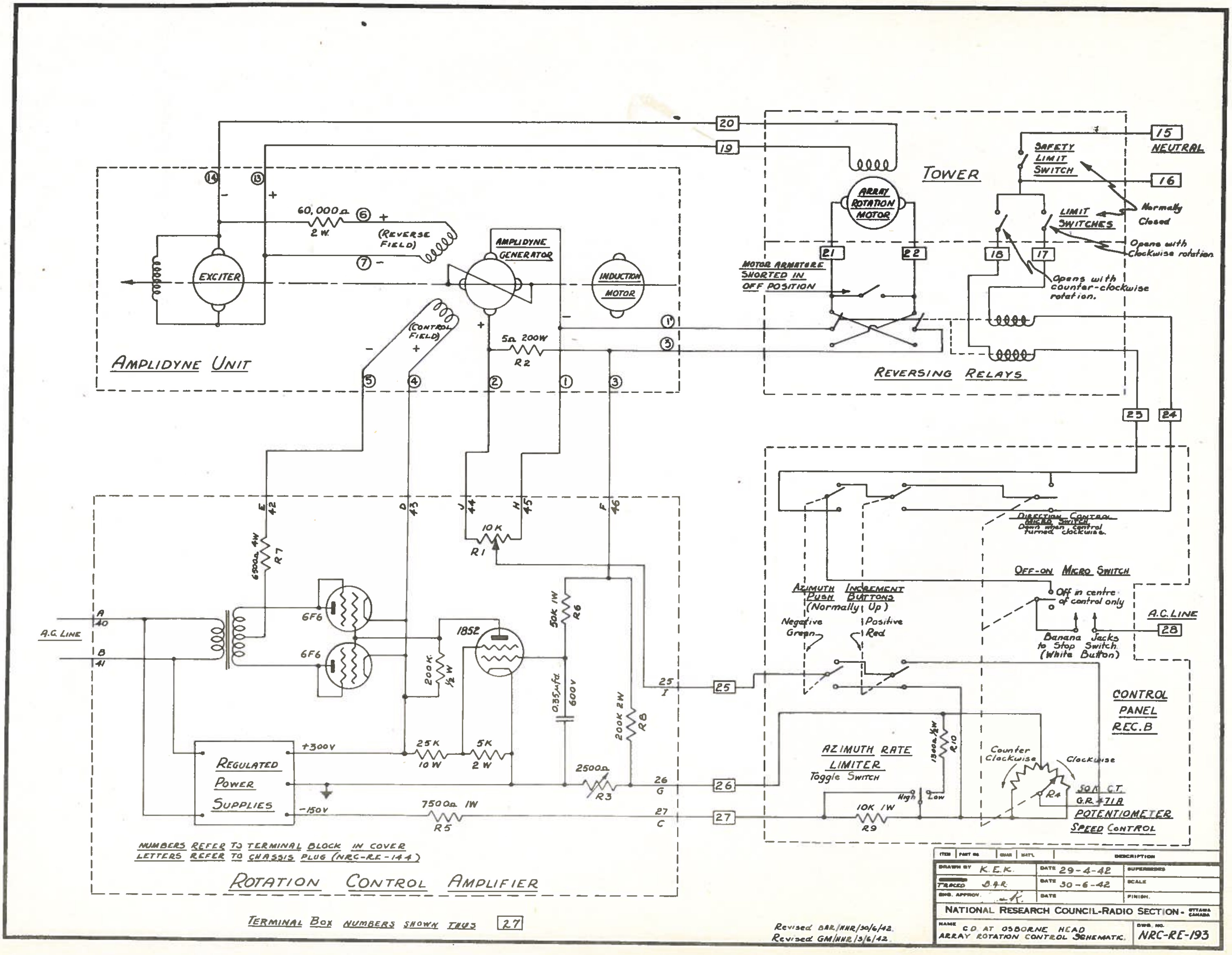
ITEM	PART No.	QUAL.	MATL.	DESCRIPTION

DRAWN BY A.C.S.	DATE April 28 '42	SUPERSEDED
TRACED B.A.R.	DATE June 27 '42	SCALE
ENG. APPROV. R.S.R.	DATE	POSITION

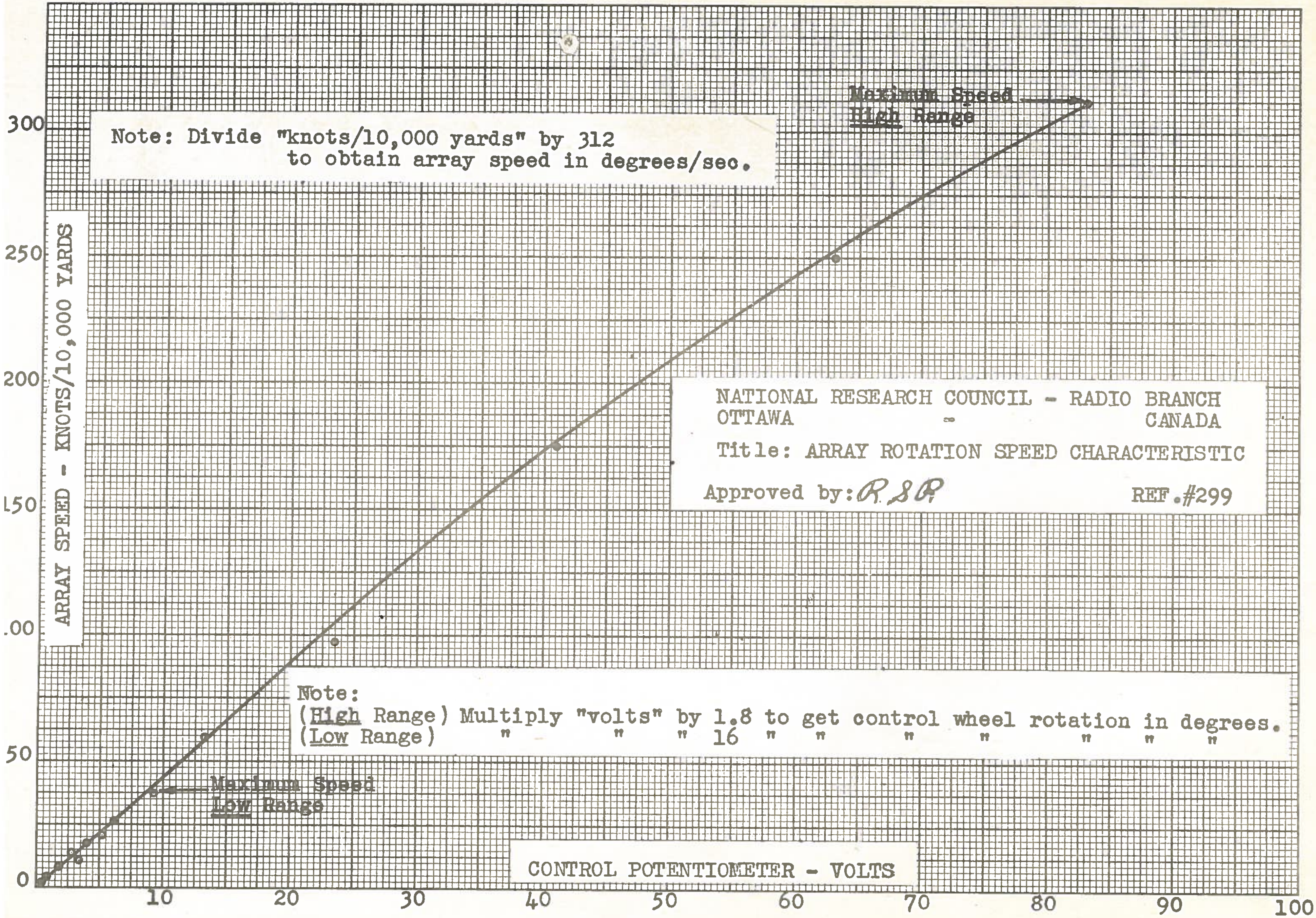
NATIONAL RESEARCH COUNCIL-RADIO SECTION- OTTAWA CANADA

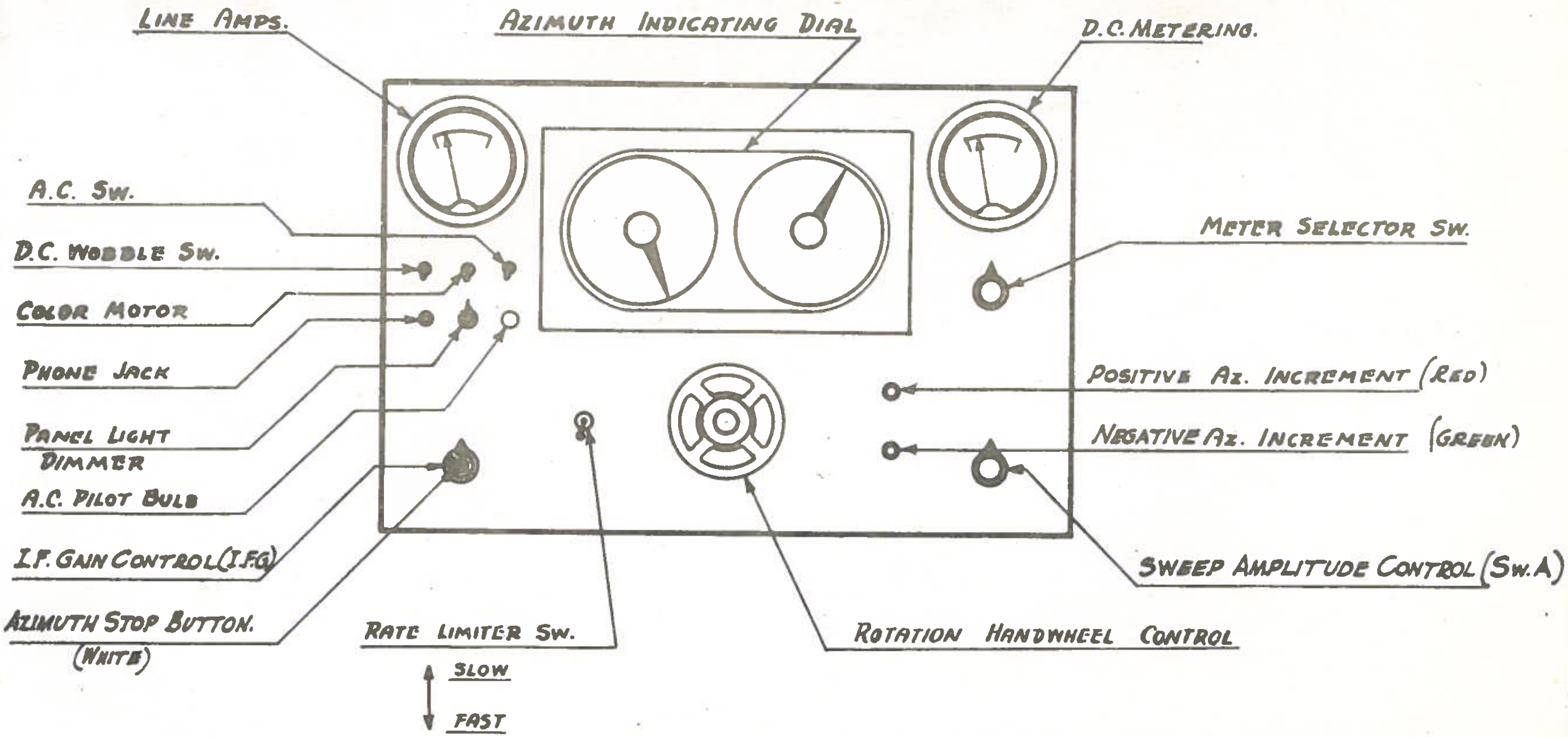
NAME: C.D. at OSBORNE HEAD - ARRAY ROTATION CONTROL CONNECTIONS

DWG. No. NRC-RE-192



20
19
15
NEUTRAL
16
TOWER
SAFETY LIMIT SWITCH
ARRAY ROTATION MOTOR
LIMIT SWITCHES
Normally Closed
Opens with Clockwise rotation
Opens with counter-clockwise rotation.
21
22
18
17
MOTOR ARMATURE SHORTED IN OFF POSITION
REVERSING RELAYS
AMPLIDYNE UNIT
60,000Ω
2 W.
(REVERSE FIELD)
EXCITER
AMPLIDYNE GENERATOR
INDUCTION MOTOR
(CONTROL FIELD)
5Ω 200W
R2
25
24
DIRECTION CONTROL MICRO SWITCH
Down when control turned clockwise.
OFF-ON MICRO SWITCH
Off in centre of control only
AZIMUTH INCREMENT PUSH BUTTONS (Normally Up)
Negative Green
Positive Red
Banana Jacks to Stop Switch (White Button)
A.C. LINE
28
CONTROL PANEL REC. B
AZIMUTH RATE LIMITER
Toggle Switch
High
Low
1300Ω ½W
R10
10K 1W
R9
Counter Clockwise
Clockwise
R4
50K C.T.
G.R. 471A
POTENTIOMETER
SPEED CONTROL
A.C. LINE
A 40
B 41
E 42
D 43
J 44
H 45
F 46
10K
R1
6500Ω 4W
R7
6F6
6F6
1852
200K ½W
50K 1W
R6
0.35μfd. 600V
200K 2W
R8
25 I
26 G
27 C
26
27
REGULATED POWER SUPPLIES
+300V
-150V
25K 10W
5K 2W
2500Ω
R3
7500Ω 1W
R5
NUMBERS REFER TO TERMINAL BLOCK IN COVER
LETTERS REFER TO CHASSIS PLUG (NRC-RE-144)
ROTATION CONTROL AMPLIFIER
TERMINAL BOX NUMBERS SHOWN THUS 27
Revised BAR/HHR/30/6/42.
Revised GM/HHR/3/6/42.
DRAWN BY K.E.K.
DATE 29-4-42
TRACED B.A.R.
DATE 30-6-42
NATIONAL RESEARCH COUNCIL-RADIO SECTION- OTTAWA CANADA
C.D. AT OSBORNE HEAD
ARRAY ROTATION CONTROL SCHEMATIC.
NRC-RE-193


Maximum Speed
High Range
Note: Divide "knots/10,000 yards" by 312
to obtain array speed in degrees/sec.
ARRAY SPEED - KNOTS/10,000 YARDS
300
250
200
150
100
50
0
NATIONAL RESEARCH COUNCIL - RADIO BRANCH
OTTAWA - CANADA
Title: ARRAY ROTATION SPEED CHARACTERISTIC
Approved by: R.S.R.
REF.#299
Note:
(High Range) Multiply "volts" by 1.8 to get control wheel rotation in degrees.
(Low Range) " " " 16 " " " " " " "
Maximum Speed
Low Range
CONTROL POTENTIOMETER - VOLTS
10
20
30
40
50
60
70
80
90
100



ITEM	PART NO.	QUAN.	MAT'L	DESCRIPTION

DRAWN BY K·E·K·	DATE 4-6-42	SUPERSEDES
CHECKED cca	DATE 2-7-42	SCALE
ENG. APPROV. RJR	DATE	FINISH.

NATIONAL RESEARCH COUNCIL-RADIO SECTION - OTTAWA CANADA

NAME	DWG. NO.
AZIMUTH CONTROL PANEL	REF. # 300