P.R.17. UNC[redacted]D 4th February, 1942.

~~MOST SECRET~~

AIR WARNING SET J.23.

CONTENTS.

Note: This information has been prepared in a hurried way and is of a preliminary nature only, to enable the equipment to be put into service. A more complete report is being prepared covering the installation.

[redacted] SET J.23

I. OPERATION AND TESTING DATA

A. GENERAL.

The equipment comprises a transmitter cubicle, receiver cubicle, T-R switch unit, and 36 element array. (See Block Schematic D.1608). The operating frequency is 200 Mc/s., pulse recurrence frequency is 50 c/s., and pulse length is 20 μsecs.

The following is a list of drawings relevant to the set.

B.1408	K61 General Assembly
D.1462	Aerial system
C.1594	Transmitter Cubicle Wiring
C.1595	Receiver
D.1596	Transmitter Unit Schematic
D.1597	Transmitter Power Supply, Schematic
D.1598	Modulator " " "
B.1599	Timing Osc., Time Base, C.R.O. and Pulse Shaper Schematic.
D.1600	Time Base and Receiver Power Supply Schematic
P.1602	C.R.O. Power Supply Schematic
C.1694	Temporary Receiver Schematic (U.556)
D.1695	Temporary Receiver Code (U.556)
D.1608	Block Schematic
P.1634	Wave Forms
P.1635	" "
P.1636	" "
P.1637	" "

B. CIRCUIT OPERATION.

1. Timing Oscillator Time-Base and C.R.O.

Referring to D.1608 and B.1599, V_4 and V_5 (6J7G's) form a multivibrator pair whose recurrence frequency is synchronised to the mains by injecting a 50 c/s. voltage via

67. The output at the plate of V5 is a distorted square wave, the negative half of which is used to initiate the sequence of events in the set.

The square wave is fed to the grid of V3 (6J7G), and appears at the grid of V2 (807) as a positive impulse. V2 is normally cut off and conducts only when this positive impulse arrives, producing a negative pulse of 20 μsecs. duration across the tuned circuit L4, C4. The diode V1 (6X5GT) serves to suppress the train of oscillations which would normally occur after the negative pulse. This negative pulse is then fed across to the modulator and triggers off the transmitter.

Simultaneously with the above the square wave is fed to a switching valve V6 (807), cutting off its plate current and allowing the condenser C14 to charge through R32. The potentials on C14 and the range potentiometer R35 are fed to the grids of a "long tail" push pull amplifier V7, V8 (807's) whose output is fed to the C.R.O. horizontal plates, producing a time base.

The components R32, C14, R34, R35 form a bridge circuit, and corresponding with any setting of R35, there is an instant of time such that the bridge is "balanced", i.e. amplifier grid potentials are equal, and the spot is passing through the electrical centre of the C.R.O.

R35 may hence be graduated directly in miles, and since C14 starts to charge at the beginning of the ground pulse the range is obtained by adjusting R35 so that the echo appears at the crosswire.

The switch SW1 contracts or expands the time base by changing the voltage on the bridge, the length of time base appearing on the screen being 120 miles or 30 miles respectively.

Zero adjustments R28 and R29 are set so that

the minimum potential on C14 (i.e. V6 conducting) is equal to the potential across R33.

The amplifier is balanced by closing SW3 and adjusting R45 so that the plate potentials of V7 and V8 are equal, i.e. the spot is at the electrical centre of the C.R.O.

The square wave from V5 is also fed to an amplifier tube V9 (6J7G) whose output is fed to the C.R.O. grid and serves to brighten up the working stroke of the time base.

(2) Modulator and Transmitter.

Referring to circuits D.1596 and D.1598, the negative pulse from the receiver cubicle is amplified by two 807's and the resulting positive 20 μsec. pulse is fed to 807 cathode followers, and then to the grids of the 833's. The 833's are connected in the cathode leads of the VT90 oscillator valves and are biassed so that the VT90 cannot normally oscillate. The positive pulse from the cathode followers drives the 833 grids into the positive region and allows them to pass the full oscillating current of the VT90's with a drop of 500 - 1000 volts.

(3) Transmitter Power Supply. (See D.1597).

This supply uses AV11 valves in a voltage doubler circuit, the H.T. transformer being tapped Low-Medium-High, corresponding with D.C. output voltages of 7, 9, and 11 K.V. respectively.

The "filaments" switch controls the mains supply to the modulator and the V.T.90 filament transformer, the latter being also interlocked with the blower.

A time delay relay allows the filaments to heat up before H.T. is applied, and a 50 ohm resistor in the H.T. transformer primary limits the switching on surge. This resistor is shorted out a fraction of a second later by a single pole contactor.

An overload relay set to trip at 10 mA. is connected in the H.T. return lead. This is of the automatic break-manual reset type.

C. OPERATING INSTRUCTIONS.

The transmitter frequency should be set by means of the knob on the front of the box so that the wavemeter neon bulb glows.

The aerial coupling condenser should be adjusted for maximum output as indicated by picking up signal on a test dipole placed near the array. The grid current reading on the monitoring meter should then be approximately .2 (full scale 1 mA.). It will be found that unstable operation may result if the grid current reads more than this value, and the overload trip may operate.

The "High" position on the H.T. switch should be used sparingly, as the increase in output is not great and valves are on the point of flashing over.

The receiver tuning should be checked at frequent intervals, oscillator tuning and the three trimmer adjustments being peaked on a suitable echo.

Time base adjustments are carried out as follows:-

The C.R.O. horizontal plates are shorted together with a piece of wire and the vertical crosswire is shifted across over the fluorescent spot. The shorting wire is then removed and the "Test" is operated to short the amplifier grids. The "Balance" potentiometer is then adjusted so that the spot appears at the crosswire. The switch is then returned to "Use", and with the range dial turned to zero the zero adjustments on both contracted and expanded scales are set so that the left hand end of the time base is on the crosswire.

D. VOLTAGE MEASUREMENTS AND WAVEFORMS.

Voltage measurements and waveforms at points t r throughout the units are attached.

E. D.C. VOLTAGES AT VARIOUS TEST POINTS ON TIME BASE AND C.R.O. UNIT UH54.

NOTES : (a) Readings taken on Avometer 1000 volt range (1000 ohms per volt meter.)

(b) Taps on rectifier supply transformers in 250 V. position.

1. Multivibrator Section. All voltages measured to chassis.

H.T. Supply voltage	290 V.
Plate Voltage of V5	80 V.
" " " V4	125 V.
" " " V3	175 V.
" " " V2	250 V.
Cathode " " V2	70 V.

2. Switching Valve V6. Voltages measured to negative of 900 V. supply. The voltages are given for both contracted and expanded time scales.

Cathode of V6	Contr.	275 V.
	Exp.	250 V.
Screen of V6	Contr.	325 V.
	Exp.	315 V.

3. Time base bridge network

Voltage across bridge	Contr.	165 V.
	Exp.	610 V.

4. Time Base Amplifier valves V7 and V8.

Cathode voltage to negative of 900 V. supply 340 V. in either contracted or expanded position.

Screen to cathode voltage.	Contr.	225 V.
	Exp.	165 V.

5. Blackout tube V9.

Plate voltage to earth	180 V.

6. H.T. Supply Voltage {Contr. 900 V.
{Exp. 870 V.

7. C.R.O. H.T. Supply Voltage 2700 V.

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F. N.556 - RECEIVER (MODIFIED TYPE A1-A1-U1).

General Specifications.

Sensitivity: 92 db. below 1/10 volt (signal equals noise)

Band Width: ± 0.14 Mc/s (3 db. down).

Tuning Range: 190 - 210 Mc/s.

Power Supply: 300 V. @ 60 mA (Max) H.T. Supply.
6.3 to 6.8 V. @ 4.5 A. Heater Supply.

I.F. Frequency: 30 Mc/s.

Osc. Frequency: 160 - 180 Mc/s.

Drawings.

C.1694 Circuit Diagram

D.1695 Circuit Code

Tube Complement.

2-954; 2-955; 4-6AC7; 2-6H6; 1-807.

Chassis Voltages. (Tolerance ± 10%)

N.B. These readings were taken under the following conditions:

(a) Meter Resistance 1000 Ohms/volt.

(b) Both Pre-Set and Main Gain Controls at "max" i.e. minimum cathode bias on controlled stages.

(c) High Tension Supply Volts - 300 V. D.C.

(d) Heater Supply - 6.4 V. A.C.

954 R.F.1.	Anode -	300 V.
	Screen -	80 V.
	Cathode -	1.5 V.
955 Osc.	Anode -	180 V.
	Grid Current	0.8 mA.

954 R.F.2.	Anode	-	300 V.
	Screen	-	80 V.
	Cathode	-	1.7 V.
955 Mixer.	Anode	-	300 V.
	Cathode	-	10 V.
6AC7's. I.F's 1, 2 & 3.	Anodes	-	300 V.
	Screens	-	150 V.
	Cathodes	-	2.5 V. (30 V. with both gain controls at Min.)
6AC7 I.F.4.	Anode	-	300 V.
	Screen	-	150 V.
	Cathode	-	2.5 V.
807 Video Amp.	Anode	-	180
	Screen	-	200
	Cathode	-	28 V.

Monitoring Meter Readings. (Both gain controls at Maximum).

Meter Switch Pos.	Anode	Reading
ANODES	RF1	0.22
	RF2	0.30
	MIX	0.40
	OSC.	0.60
	IF1	0.45
	IF2	0.40
	IF3	0.44
	IF4	0.54
	Video	0.74
	H.T.	0.5
OSC. GRID	———	0.8

Noise Reading.

(Meter on "Det" & Aerial Off)
(Gain Control at Max.) = 0.5

Miscellaneous Tests and General Testing Hints.

(For localising faulty stages etc.) The following 30 Mc/s input voltages required at the points specified to give a "DET" reading of 0.4 above noise:

IF4 Grid	-	1/10 v.
IF3 Grid	-	20 db. below 1/10 v.
IF2 Grid	-	41 db. below 1/10 v.
IF1 Grid	-	63 db. below 1/10 v.

These readings were taken with an A.W.A. 20 - 40 Mc/s. Signal Generator, with the output cable terminated in its characteristic resistance 80 ohms. Without this termination, the open circuit voltage will be twice that indicated on the attenuator as the internal impedance is 80 ohms.

In practice, it is more convenient to use the O.C. connection, in which case 6 db. must be added to the attenuator readings given above.

Since the I.F. circuits are aligned to 30 Mc/s, it is convenient to attach the central conductor of the generator cable directly to the "hot" side of the I.F. circuit in question and ground the sheath at the nearest available earth point.

It is important to realise that in testing over 2 or more stages erroneous readings may be obtained if the I.F. screens are removed (due to feedback). A remedial method is to remove the preceding 6AG7 from its socket and connect the generator output to the anode of the socket via a 1000 mmF mica condenser. (Failure to do this will result in the 80 ohm resistor in the attenuator being burned out).

It should also be borne in mind that some signal

generator attenuators give erroneous readings over the first 10 db. portion (below 1/10 v.) due to tight coupling to the oscillator tuned circuit.

The acorn sockets should be checked occasionally and the pins of these tubes cleaned.

The first and second acorns (954's) are more likely to fail than the others, especially if the pulse from the transmitter to the receiver exceeds 40 v. 20 v. is considered a perfectly safe limit.

HCM/JDS.

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II - ADJUSTMENT OF 36 ELEMENT ARRAY FOR A.W.

A. ADJUSTMENT OF IMPEDANCE GEAR.

(1) Set oscillator to required frequency.

(2) Vary the inductance tuning adjustment until maximum and minimum readings are $\frac{\lambda}{4}$ apart (37.5 cm. at 200 Mc/s.).

(3) Adjust the shorted quarter wavelength of the gear until the minima or maxima for shorted and open circuited terminals are $\frac{\lambda}{4}$ apart.

B. AERIAL ADJUSTMENTS.

(1) Determine length of feeder required between points P and Q for aerial section with the longest feeder. Allow for the variation of the dimension A over the range provided. Cut all three feeders to this length.

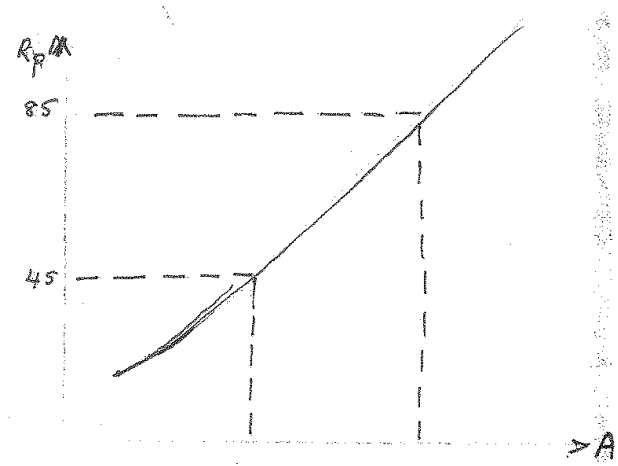
(2) With the feeders and matching sections in position connect one feeder to the impedance gear (by means of an extension feeder to the ground if necessary). Since the feeder has the same impedance as the gear (85 ohms), it is permissible to set up the scale as follows. Short circuit P and tune gear for a minimum. Mark scale S.C. and $\frac{\lambda}{4}$ away mark scale O.C., (this is position to which the gear would tune for an open circuit at P). These are the two resonance positions to which the gear tunes when the impedance at P is a pure resistance: it tunes to O.C. if resistance at P > 85 ohms, and to S.C. if resistance at P < 85 ohms. Shorten the feeder if these points are not in a convenient range on the gear.

(3) Remove the short circuit and tune for a minimum. Vary the shorting bar position (dimension B) until the gear tunes at O.C. or S.C. and note the ratio $\frac{V_{min}}{V_{max}}$. Then the resistance at P terminating the feeder is:-

$$R_p = 85\sqrt{\frac{V_{min}}{V_{max}}} \quad \text{for min. at S.C.}$$

$$\text{or } R_p = 85 / \sqrt{\frac{V_{min}}{V_{max}}} \quad \text{for min. at O.C.}$$

The match is incorrect unless $\frac{V_{min}}{V_{max}} = 1$, i.e. zero rise and fall of meter reading as the impedance gear is varied. The variation of parallel resistance R_p at P with the dimension A is as follows:-



Hence if $R_p < 85$ (i.e. minimum occurs at S.C.), increase A and vice versa. Having altered A to a new position, vary B until the gear again tunes at a resonance point. If $\frac{V_{min}}{V_{max}}$ is closer to 1, the variation of A was in the right direction. Repeat this procedure until the variation of voltage is less than about 2%. Use the linear scale on the receiver as a match is approached by setting the meter to 100 by means of the attenuator control, with the gear tuned to V_{max}. Then $\frac{V_{min}}{V_{max}}$ as a percentage is given by the meter reading for V_{min}.

The dimension A is normally about 5" and $(B-A) > \frac{\lambda}{4}$. The dimensions for the centre section will differ from those of the outer section.

(4) Repeat with sections 2 and 3. With the ends P shorted, these two feeders should be cut until they tune at S.C. When cutting these two feeders before fitting them to the matching sections, it is a good plan to leave them slightly longer than No. 1, by a known length. This

avoids the necessity of cutting 1 after adjustment, if either 2 or 3 should prove shorter. If a feeder is longer than No. 1 it will tune for a minimum on the side of S.C. nearer the oscillator (provided the distance from S.C. $\not> \frac{\lambda}{4}$).

C. ADJUSTMENT OF JUNCTION BOX MATCHING UNIT.

The theoretical values of C and D are:-

$$C = 3\tfrac{1}{2}''$$

$$D = 5\tfrac{3}{4}''$$

(1) Fit unit with lengths slightly longer than these. Since platform space is limited, measurements will probably have to be done from the ground through the main feeder (or a suitable extension feeder connected to E in its place).

(2) Short circuit E and find positions S.C. and O.C. as before.

(3) Cut D until tuning is at S.C. and O.C. and note resistance. If not correct alter C, (reducing C lowers the resistance and vice versa).

The steps of this adjustment are exactly similar to those of the aerial matching; however, a mismatch of 10% is not serious here.

Make sure that the open end of the stub D and the joints at C and E cannot spark to earth.

A.W. AERIAL MATCHING

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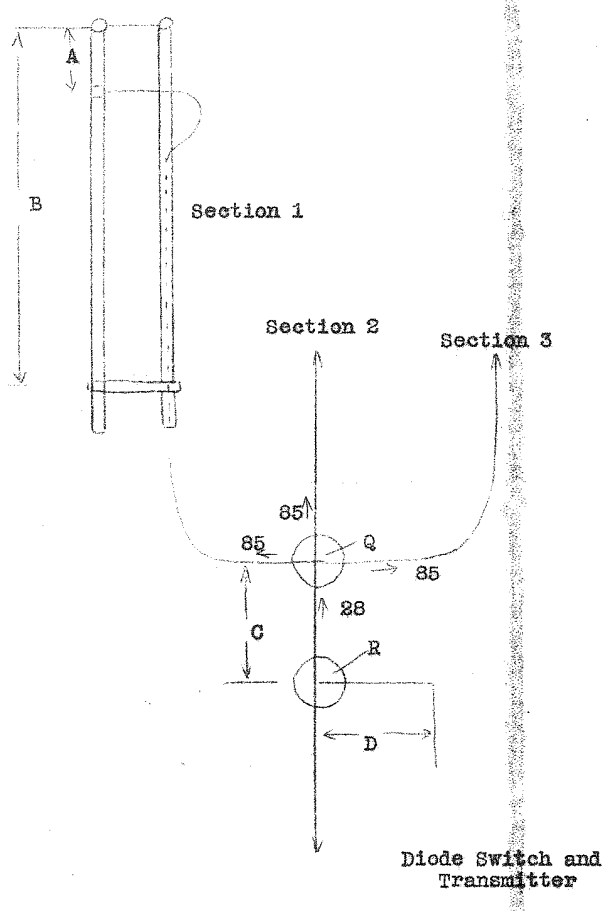
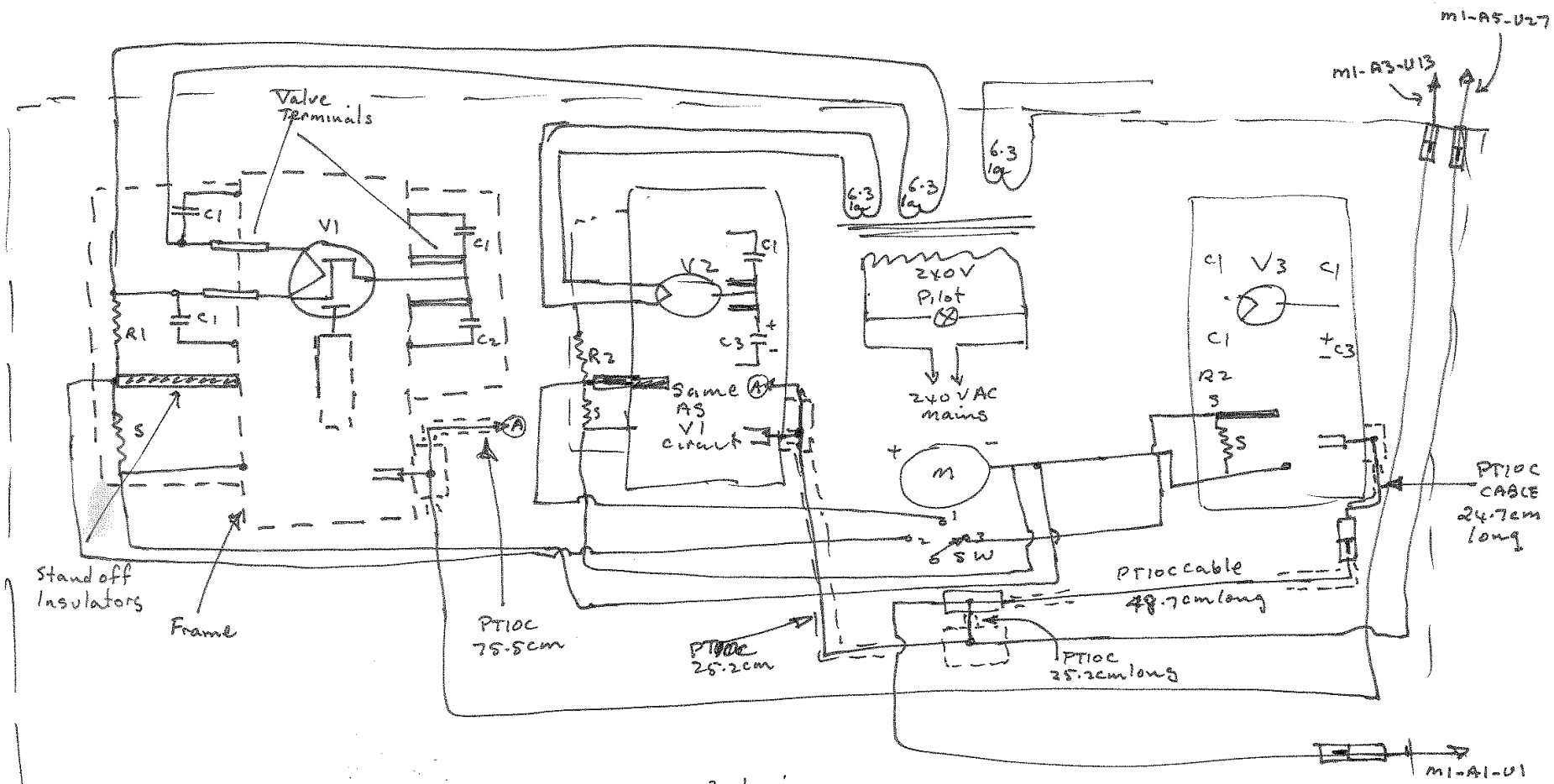


All feeder is PT.12.R Z_o = 85 ohms

LIM: 8A.



Circuit diagram
Viewed ~~from Front~~

C1 – 100 μμF 2000V W.
C2 – 0.2 μF Paper 400V
C3 – 10 μFd electro 135V Peak
R1 – 50 KΩ
R2 – 5 KΩ
S = External shunt for M
SW = Yaxley Switch

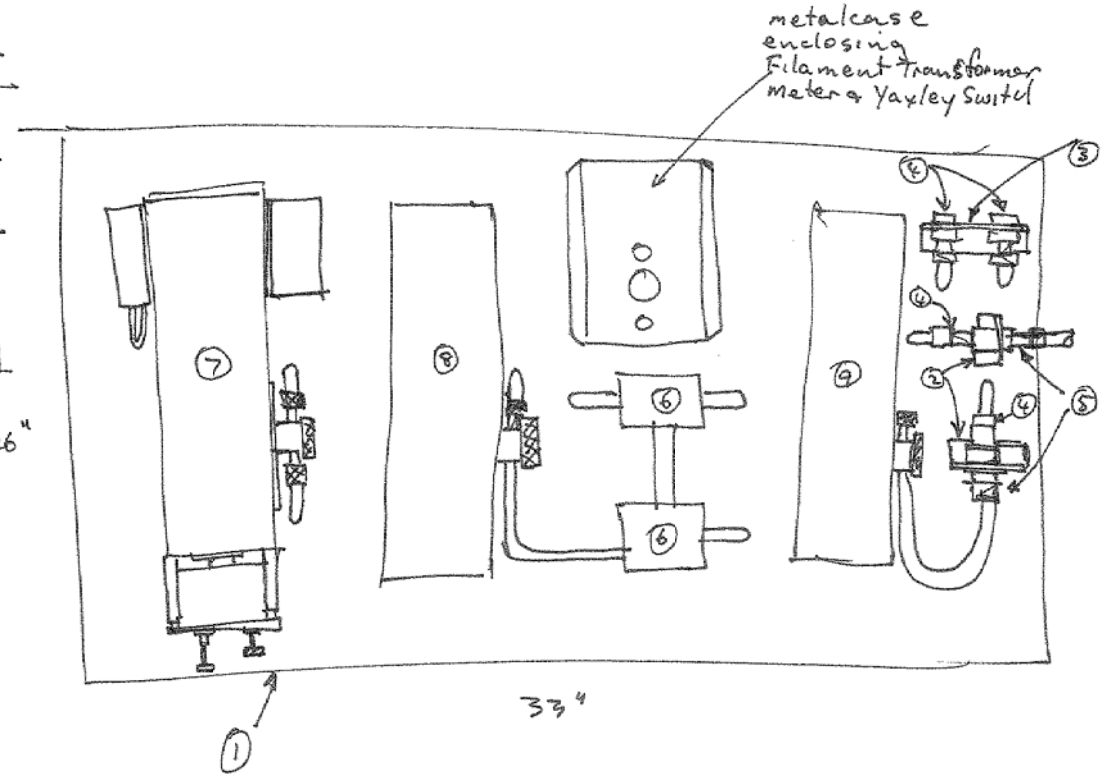
V1, V2, V3 } RPV1
M = Meter 0–10ma Palec type 216 – External shunt

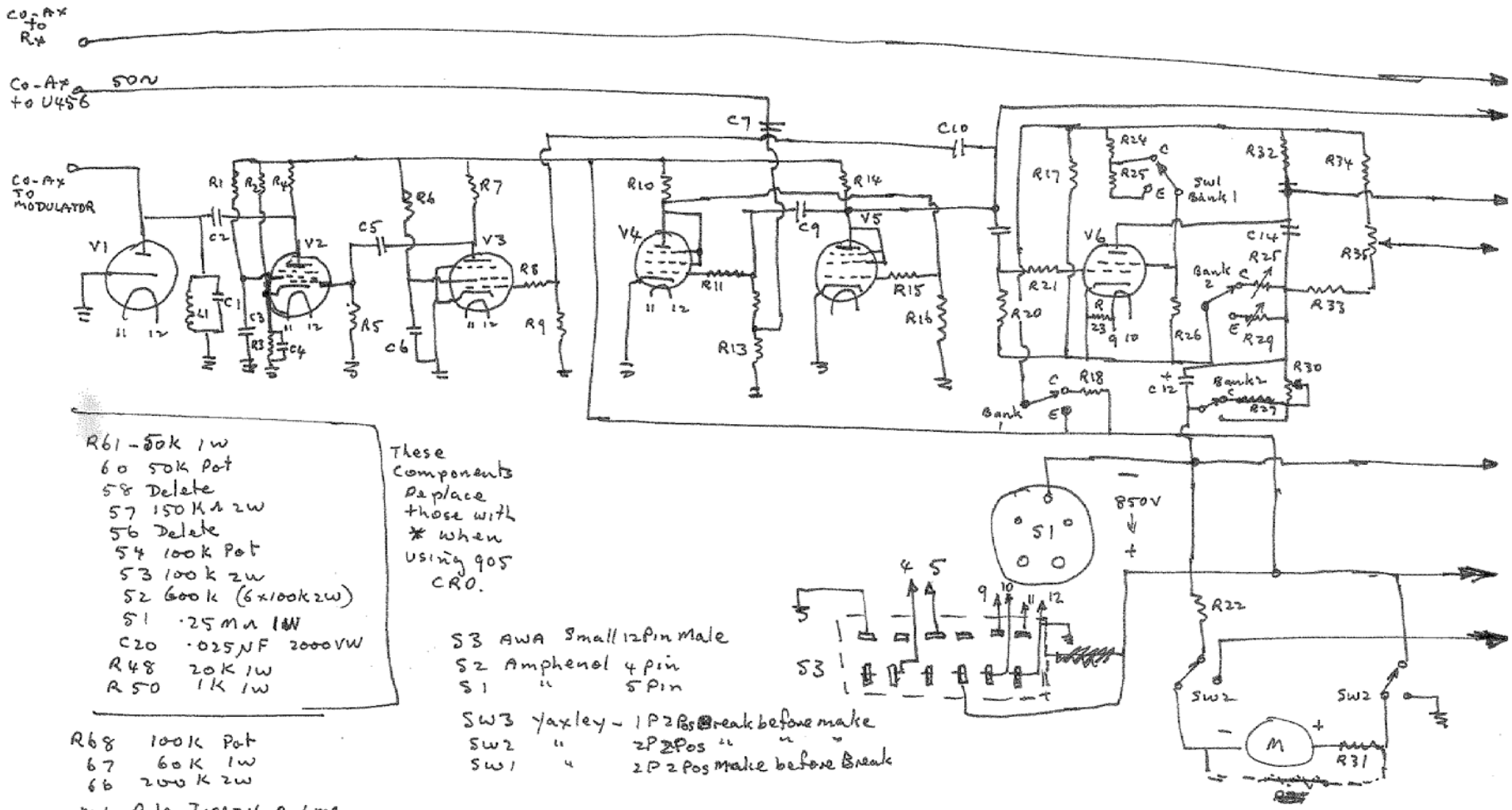
K61
General Assy
B1408

16-12-41

Item	Description	Dwg No	Req	Material
8	U 393	B927	1	-
9	U 392	"	1	-
7	U 391	"	1	-
6	Detail	D 1364	1	Brass
5	93-m- Cable Connector	-	4	-
4	93-CL " "	-	4	-
3	Detail	P1410	1	m.s.
2	"	P1411	2	m.s.
1	Detail	C1409	1	Wood

B1408 Cont.





R61 - 50K 1W
60 50K Pot
58 Delete
57 150KΩ 2W
56 Delete
54 100K Pot
53 100K 2W
52 600K (6x100K 2W)
51 ·25MΩ 1W
C20 ·025μF 2000VW
R48 20K 1W
R50 1K 1W

These Components Replace those with * when using 905 CRO.

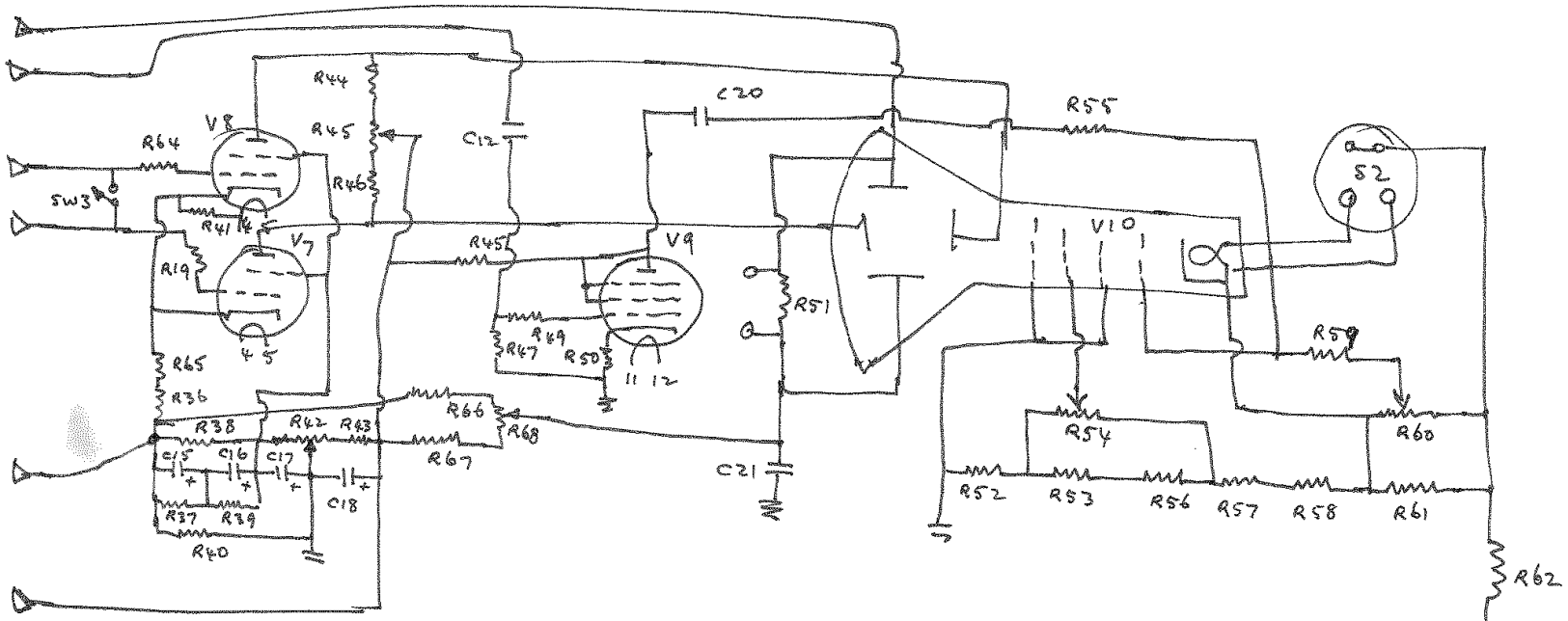
R68 100K Pot
67 60K 1W
66 200K 2W

M1 Palec Type 216 0-1ma
L1 AWA Magnetite Core 550T. x 31SWG

*V10 3222 CRO (OR 905)
V9 6J7-G
V6 → V8 807
V3 - V5 6J7-G
V2 807
V1 6x5-GT

S3 AWA Small 12Pin Male
S2 Amphenol 4 pin
S1 " 5 Pin

SW3 Yaxley - 1P 2Pos Break before make
SW2 " 2P 2Pos " " "
SW1 " 2P 2Pos Make before Break



C21	.5 μF	400 V W
* C20	.025 μF	3000 V W
19	.02 μF	400 V
18	14 "	600 V
17	"	"
16	"	"
15	"	"
14	.015	2000 V
12	14	600 V
11	.01	1500 V
10	.01	400 V
9	.1	400 V
8	.1	"
7	.1	"
6	.5	"
5	.005	"
4	.1	

C3	.5 μF 400 V
2	.01
1	.001
R65	2500 Ω IRC Type AB
64	20 K ½ W
3	10 K 1 W
2	5 mΩ (10 x 0.5 m 1 W)
* 61	150 K 2 W
* 60	25 K Pot. W.W.
59	150 K 1 W
* 58	70 K 2 W
* 7	150 K 2 W
* 6	100 K 2 W
55	1 meg 1 W
* 4	.5 meg
* 3	100 K 2 W
* 2	1.05 meg (7 x 150 K 2 W)
* 1	1 m 1 W
* 50	5 K 1 W

49	10 K ½ W
* 48	50 K 1 W
7	.5 meg ½ W
6	20 K Ω 50 W Type EP
5	5 K Pot W.W.
4	20 K 50 W Type EP
3	30 K 3 W
2	7.5 K Type DJ (Adj)
1	200 K ½ W
40	50 K Type EP IRC WW
39	250 K 1 W
8	50 K EP IRC WW
7	250 K 1 W
6	10 K EP
5	3880 Ω POT IRC WW
4	30 K 2 x 15 K E.S.
3	150 Ω 3 W WW IRC
2	1 meg (4 x 250 K) HO WW1 or WW4
1	100 Ω
30	10 K EP

29	500
8	500
7	20 K 3 W
6	25 K 2 W
5	100 K 2 W
4	25 K 2 W
3	250 K ½ W
2	1 meg (2 x .5 meg 1 W)
1	100 K 1 W
20	1 meg 1 W
9	20 K ½ W
8	50 K EP
7	.5 meg 2 W
6	50 K 1 W
5	10 K ½ W
4	50 K 2 W
3	15 K 1 W
2	50 K 1 W
1	10 K ½ W
10	50 K 2 W

9	.5 meg ½ W
8	10 K ½ W
7	30 K 1 W
6	100 K 1 W
5	.5 meg ½ W
4	50 K 1 W
3	15 K 1 W
2	50 K 2 W
1	50 K 1 W

24-3-42

1U453 Schematic

B2212