WIRELESS SET (CDN.) No. 19 Mk. III

Instruction No. 1

TECHNICAL DESCRIPTION

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ABBREVIATIONS

A	"A" set
A.C.	alternating current
AE.	aerial
A.F.	audio frequency
Amp.	amplifier
A.V.C.	automatic volume control
B	"B" set
B.F.O.	beat frequency oscillator
Bty.	battery
C.P.S.	cycles per second
C.R.O.	cathode ray oscilloscope
C.W.	continuous wave
Db.	decibel
D.C.	direct current
Det.	detector
D.F.	direction finding
H.	henry
H.F.	high frequency
H.T.	high tension
I.C.	intercommunication amplifier
I.F.	intermediate frequency
Kc/s.	kilocycles per second
L.T.	low tension
M.	meters (metric measurement)
Ma.	milliampere
Mc/s.	megacycles per second
M.C.W.	modulated continuous wave
MIC.	microphone
MFD.	microfarad
MMFD.	micromicrofarad
Mod.	modulator
MW.	milliwatts
OSC.	oscillator
P.A.	power amplifier
R.F.	radio frequency
R/T.	radio telephony (Speech)
Sig. Gen.	signal generator
S/R	sender/receiver
uA	microamperes
uV	Microvolts
U.H.F.	ultra high frequency (300–3000 Mc/s.)
V.	volts
V.H.F.	very high frequency (30–300 Mc/s.)
W.	watts

WIRELESS SET CDN. No. 19 Mk. III

Instruction No. 1

GENERAL

1. Wireless Set (Cdn.) No. 19, Mk. III consists of the "A" set, a medium power, high frequency transmitter and receiver; the "B" set, a low power, very high frequency transmitter and receiver; and the I.C. Amplifier, an audio amplifier for intercrew communication.

TABLE 1—FREQUENCY RANGE

Set	Frequency Range	
	In Mc/s.	In Meters
"A"	2–8 (covered in two bands)	150 - 37.5
	High Band: 2.0 - 4.5	150 - 66.6
	Low Band: 4.5 - 8.0	66.6 - 37.5
"B"	230–240	1.30 - 1.25

TABLE 2—TYPES OF OPERATION

"A" Set	R/T M.C.W. C.W.
"B" Set	R/T

2. The approximate range between vehicles in motion using an 8′ rod type aerial is shown in Table 3. All "A" set working ranges may be increased by using:

(a) longer aerials.

(b) stationary vehicles,

(c) elevated horizontal aerials.

TABLE 3—APPROXIMATE WORKING RANGE

Set	Approximate Working Range		
	R/T	M.C.W.	C.W.
"A"	10 miles	15 miles	20 miles
"B"	1000 yards—line of sight between vehicles in motion using half wave AE.		

TABLE 4—CURRENT DRAIN

Conditions (Two-wire, 12V. operation)	Current Drain in Amperes	
	Vibrator	Dynamotor
Receive "A"	4	8
" "A" & "B"	5.5	9.5
" "A" & I.C.	5.5	9.5
" "B" & I.C.	3.5	7
" "A", "B", & I.C.		10
Send "A" (R/T)		9
" "A" & "B" (R/T)		11
" "A" (C.W.)		10

TABLE 5—WEIGHTS AND DIMENSIONS

Unit	Weight in Lbs.	Dimensions in Inches		
		Length	Depth	Width
Sender/Receiver	40½	17½	8¼	12¼
Supply Unit No. 2	30½	6	8¼	12¼
Carrier No. 1	14¾			
Sender/Receiver, Supply Unit, and Carrier combined.	88¼	27	10	13¼

3. The Wireless Set (Cdn.) No. 19, Mk. III was designed to be used in armoured fighting vehicles, various wireless trucks, or as a ground station.

4. The set combines the following facilities:

(a) Communication between troop and base ("A" set).

(b) Communication between vehicles or tanks in a troop ("B" set).

(c) Intercommunication between members of the vehicle or tank crew (I.C.).

5. As certain portions of the receiver circuit are also common to the sender, tuning the receiver controls will automatically tune the sender to the same frequency, simplifying netting.

6. Although mechanically and electrically interchangeable in the major components with the British Wireless Set No. 19, Mk. III, a number of further modifications were considered essential and were incorporated prior to manufacture in Canada. From the viewpoint of the operator, however, there should be no great difference between the British and Canadian set. The Canadian set is also fully interchangeable in all its applications with Wireless Set No. 19, Mk. II of British, Canadian, and U.S. manufacture.

BRIEF ELECTRICAL DESCRIPTION

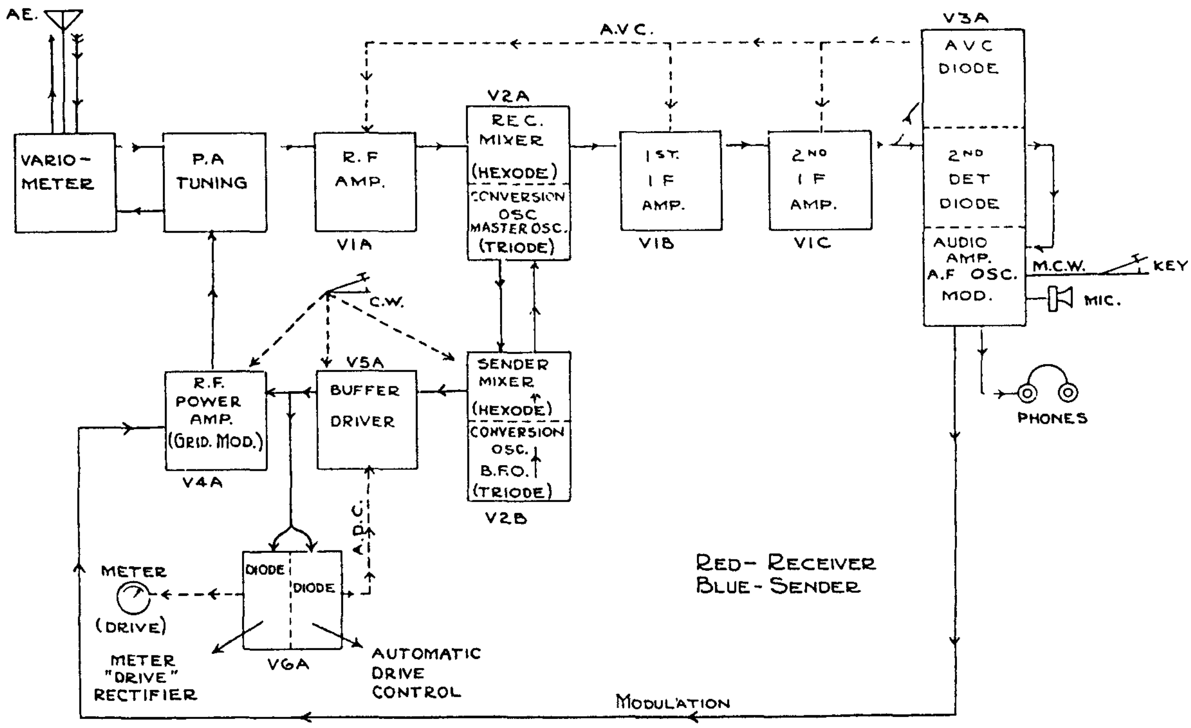


FIG. 1—"A" SENDER/RECEIVER

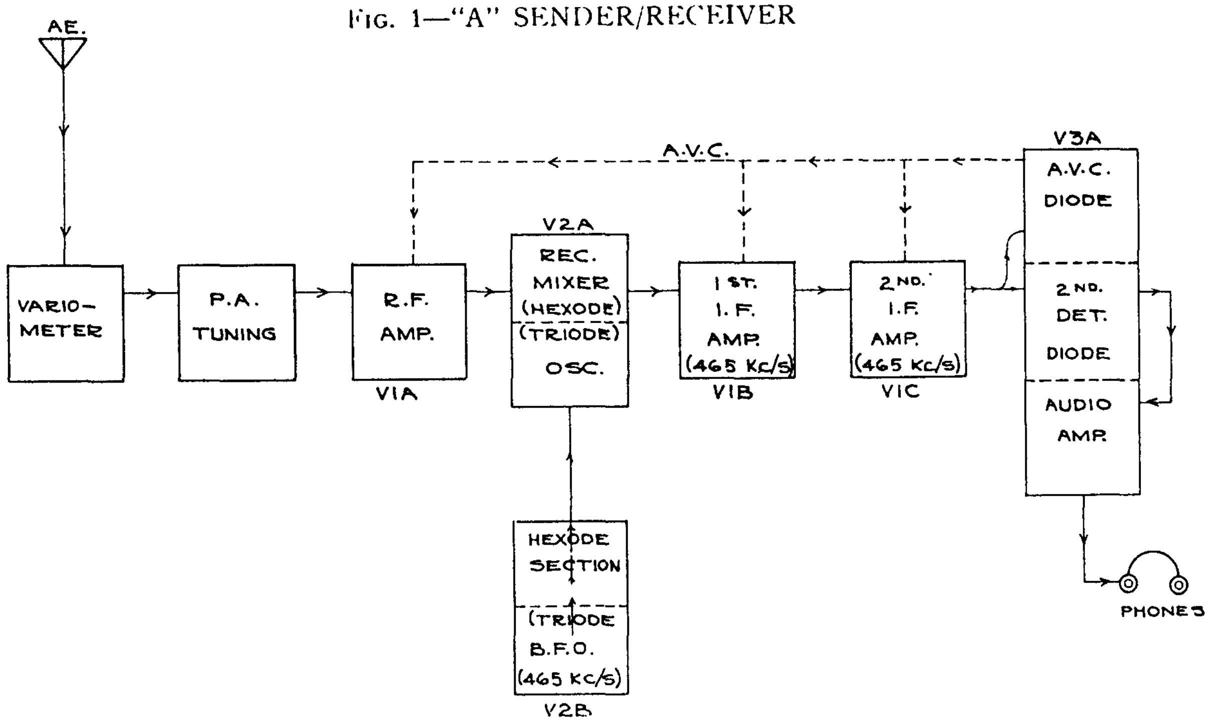


FIG. 2 "A" RECEIVER

7. The "A" receiver is a conventional superheterodyne comprised of one stage of R.F. amplification, a frequency converter, two stages of I.F. amplification and a detector-audio amplifier. A beat frequency oscillator is incorporated for C.W. reception. An A.V.C. circuit is also employed.

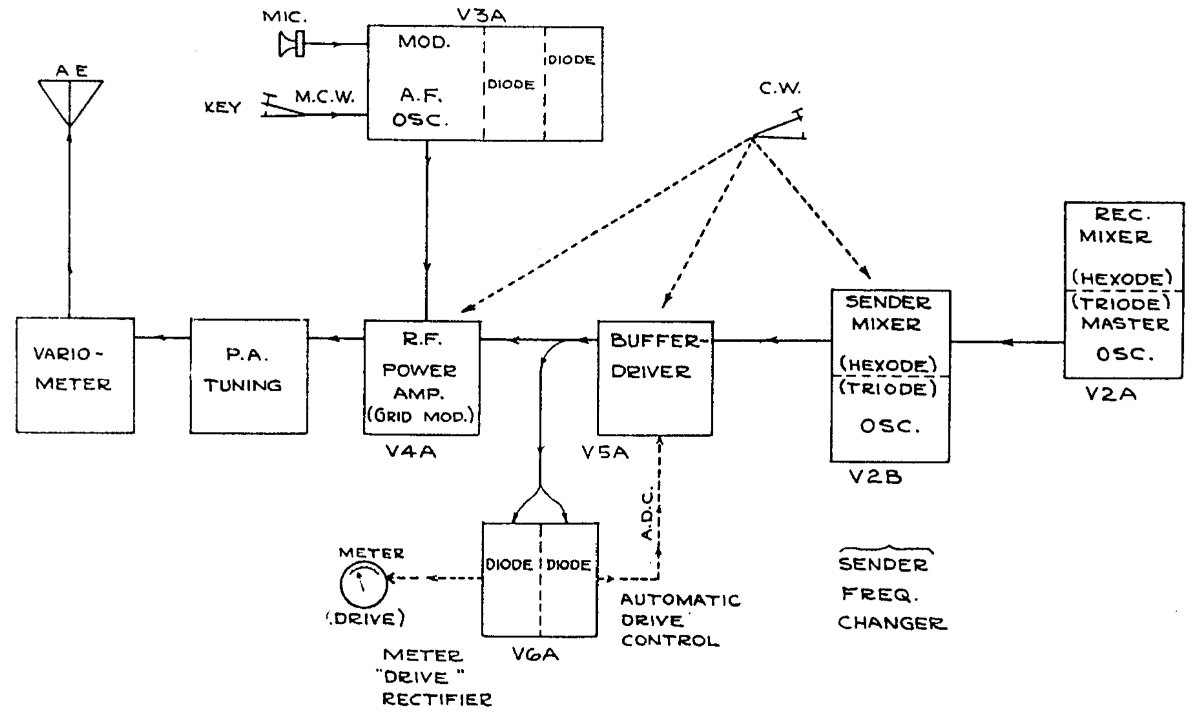


FIG. 3—"A" SENDER

8. The "A" Sender consists of a master oscillator, sender frequency changer, driver-buffer and power amplifier. Automatic drive control is employed between the power amplifier and the driver-buffer to stabilize the output of the latter. A modulator valve is used to grid modulate the power amplifier on R/T and M.C.W.

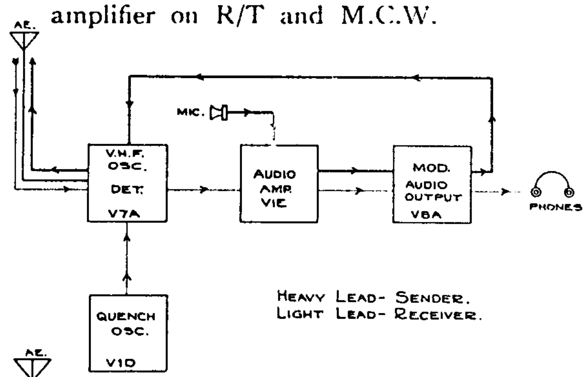


FIG. 4—"B" SENDER/RECEIVER

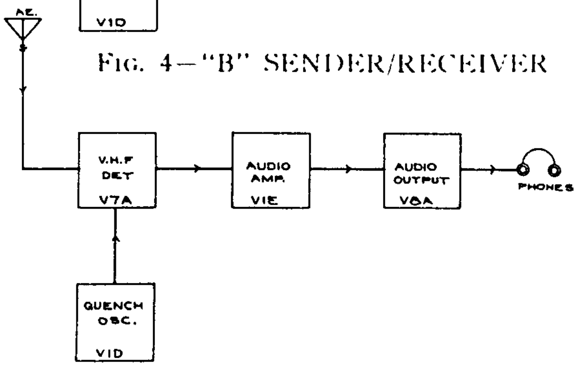


FIG. 5—"B" RECEIVER

9. The "B" receiver is composed of a superregenerative detector, a quench oscillator, and 2 stages of audio amplification.

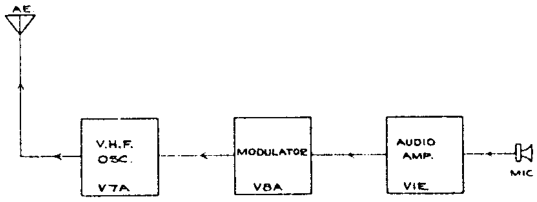


FIG. 6—"B" SENDER

10. The "B" set sender is composed of a self-excited Colpitts' oscillator, a microphone amplifier and a modulator.

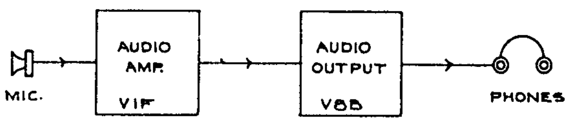


FIG. 7—I.C. AMPLIFIER

11. The I.C. Amplifier is a conventional two-stage audio amplifier employing degeneration.

12. Power is supplied to the set by Supply Unit No. 2 which incorporates a vibrator as well as a dynamotor. Necessary low tension voltage is supplied by accumulators. It is possible to operate the set solely from the dynamotor, or from the combination of the dynamotor and vibrator, which is a more economical type of operation.

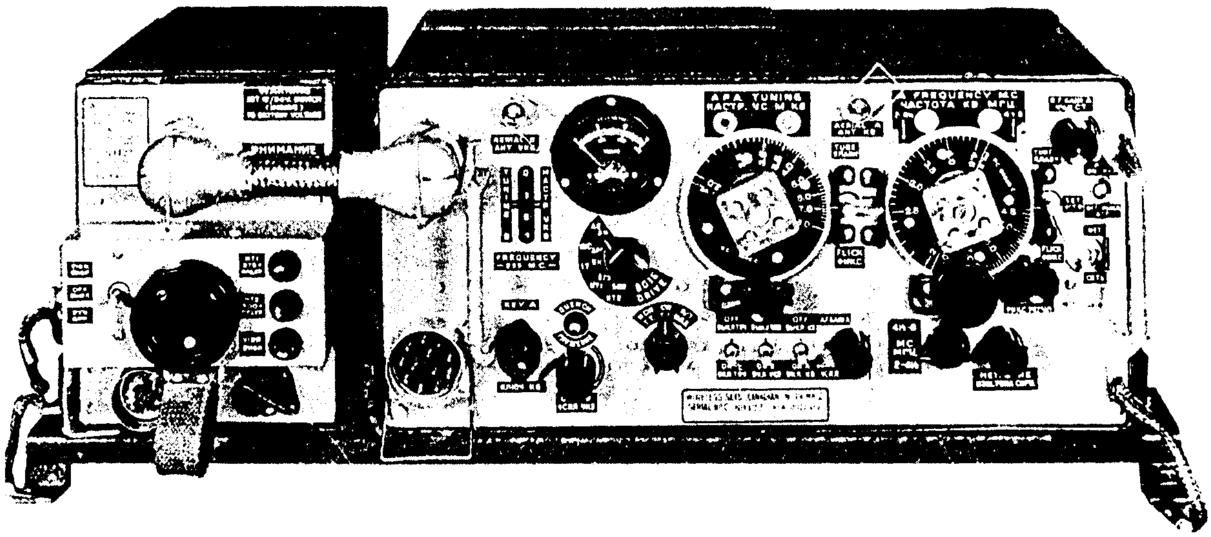


PLATE 1—FRONT VIEW OF SENDER/RECEIVER AND SUPPLY UNIT No. 2

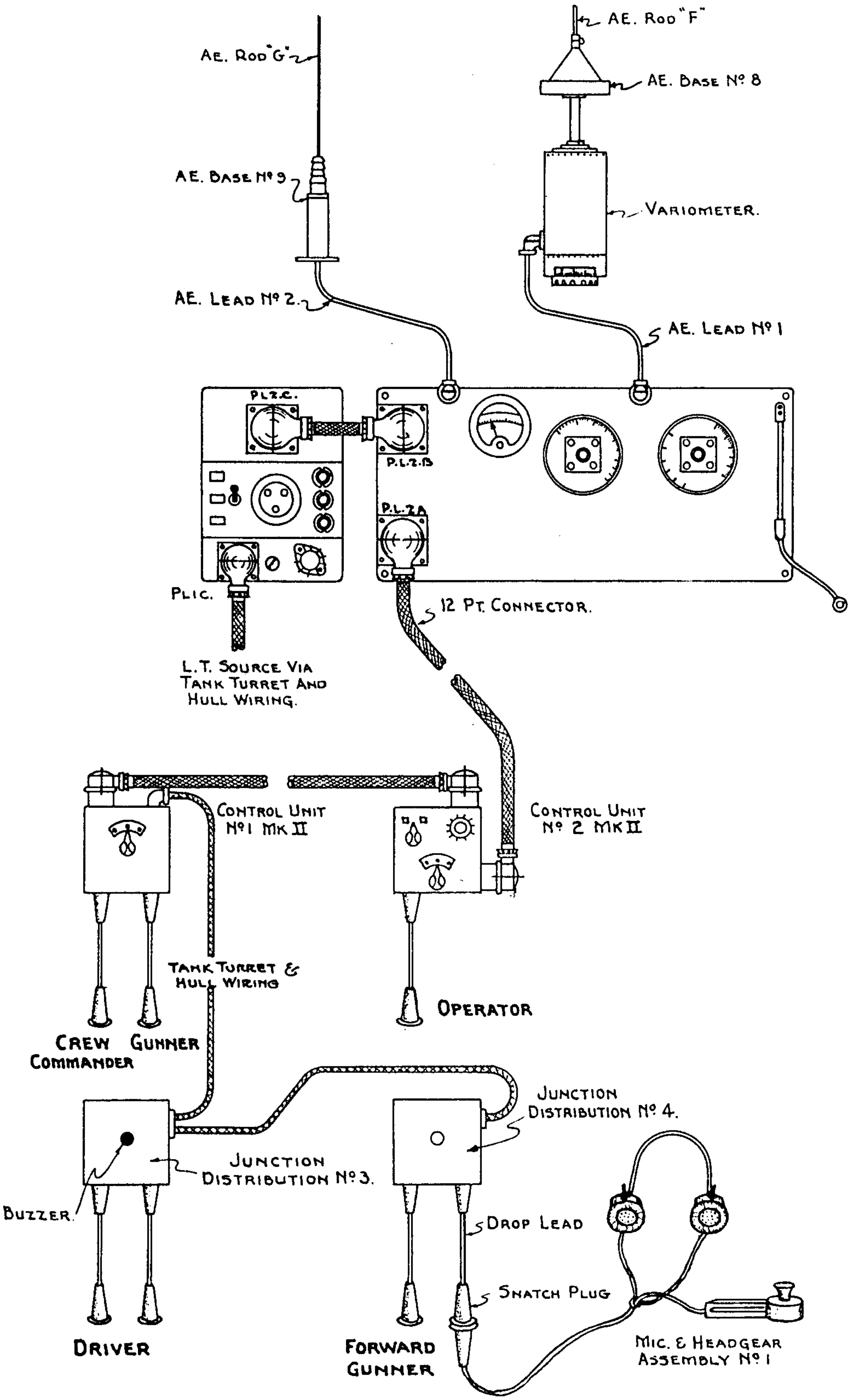


FIG. 8—WIRELESS SET (CDN.) No. 19 Mk. III CONNECTED AS A COMPLETE STATION (TANK INSTALLATION)

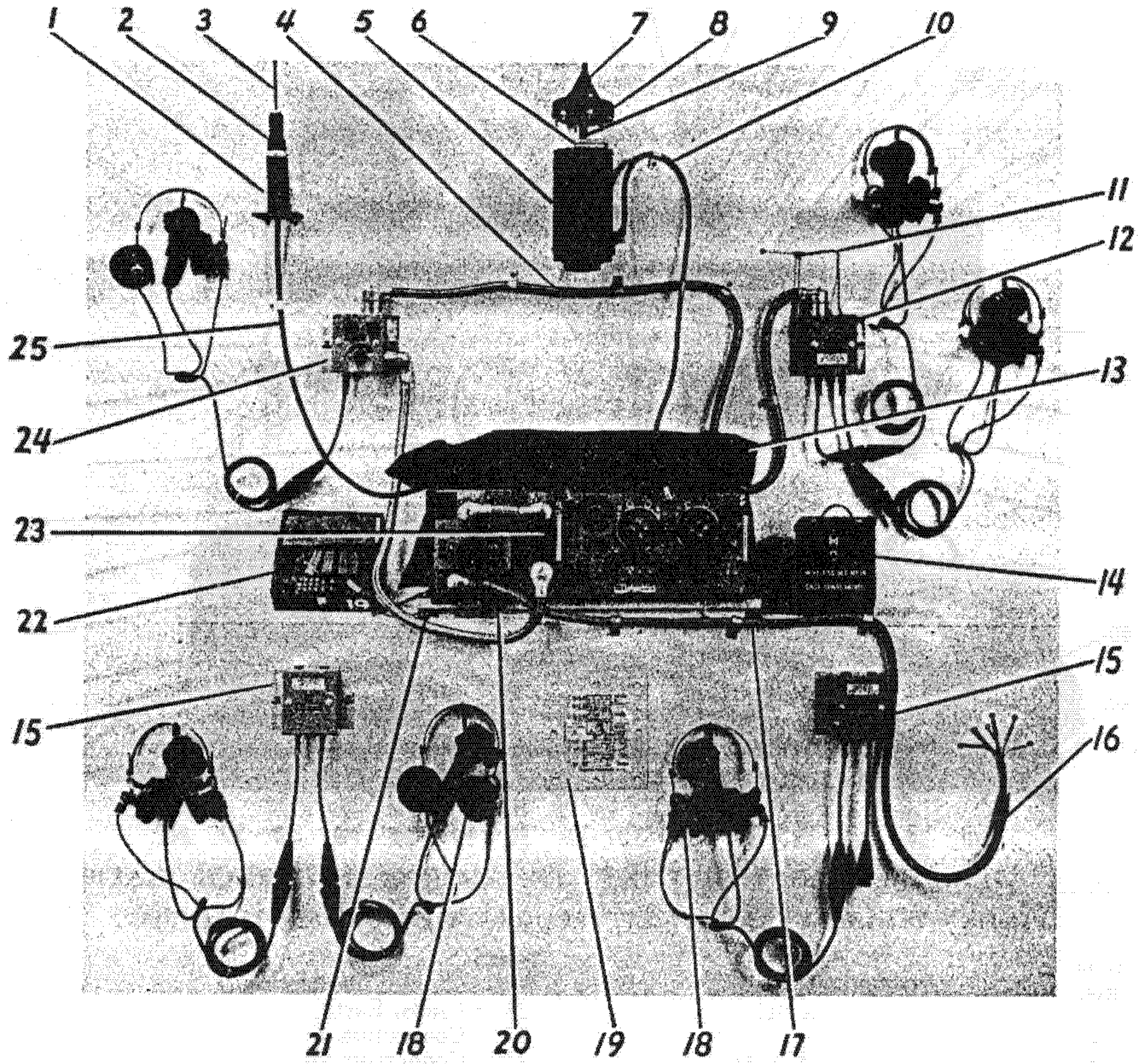


PLATE 2—INSTALLATION EQUIPMENT FOR RAM II.

INDEX TO INSTALLATION KIT CRUISER TANK RAM I AND II

Item Ref.	Description	Item Ref.	Description
1	Aerial Base No. 9 Mtg. No. 1	13	Cover, Waterproof, No. 1
2	Aerial Base No. 9	14	Case, Spare Valves
3	Aerial Rod "G"	15	Junction Distribution No. 3
4	Connector 12 Pt. No. 4 C	16	Connector 6 Pt. No. 12A
5	Aerial Variometer Mk. II	17	Carrier, No. 1
6	Plates Packing No. 1	18	Microphone and Receiver Headgear
7	Aerial Base No. 8	19	Wiring Diagram Plate No. 191
8	Aerial Base No. 8 Mtg. No. 3	20	Supply Unit No. 2
9	Aerial Feeder Assembly No. 5	21	Connector 12 Pt. No. 3 B
10	Leads, Aerial No. 1	22	Case, Spare Parts No. 5C
11	Connector, Single No. 193	23	Sender Receiver (Canadian) Mk. III
12	Control Unit No. 1 Mk. II	24	Control Unit No. 2 Mk. II
		25	Leads, Aerial No. 2

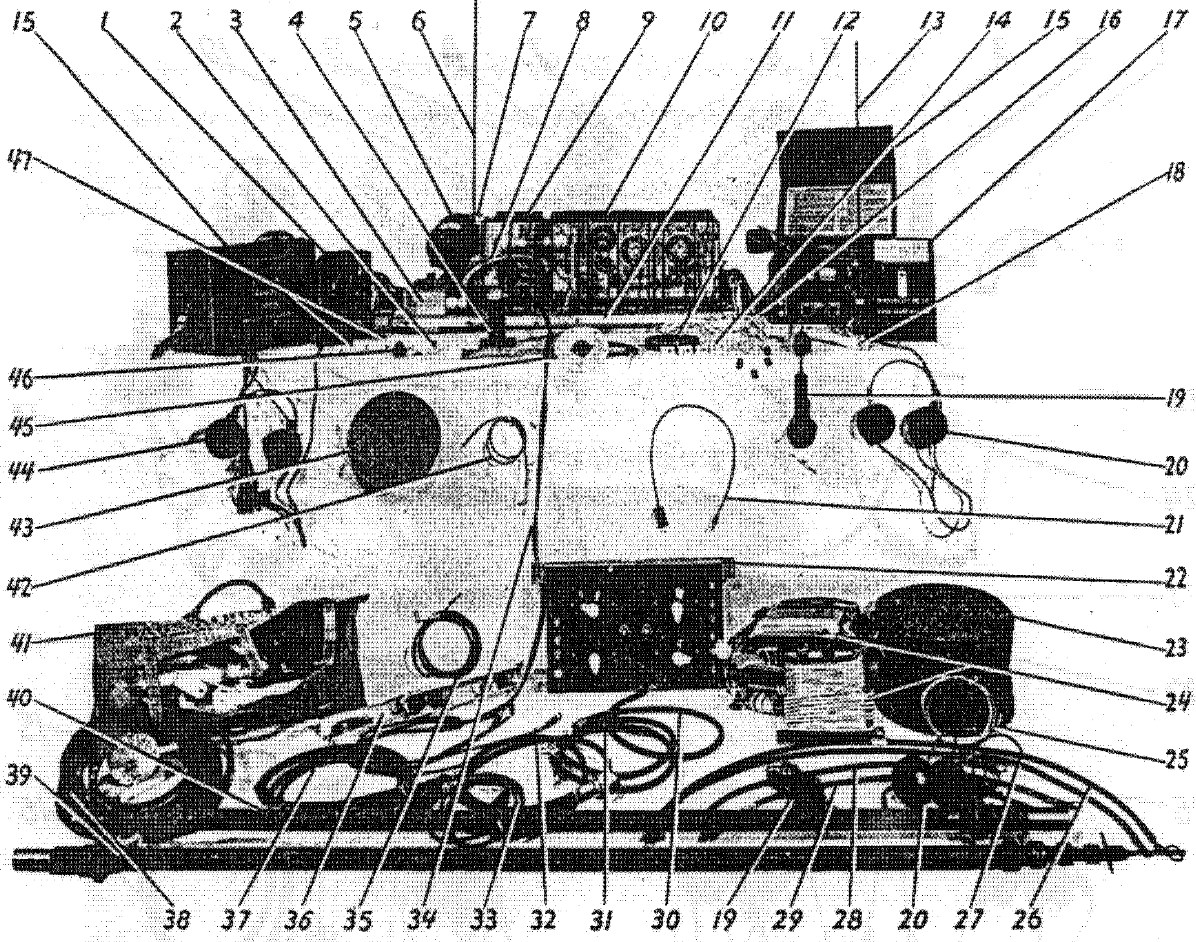


PLATE 3—INSTALLATION EQUIPMENT FOR GROUND AND TRUCK STATION

INDEX TO INSTALLATION KIT TRUCKS, GROUND AND TRAINING

Item Ref.	Description
1	Case, Spare Parts, No. 5C
2	Kits, Hardware
3	Control Unit No. 3B Mk. II
4	Aerial Base No. 9 Mtg. No. 1
5	Aerial Variometer Mk. II
6	Aerial Rod "F" Section
7	Plates, Seating No. 4
8	Connector 12 Pt. No. 1E
9	Supply Units No. 2
10	Sender Receiver (Canadian) Mk. III
11	Carriers, No. 3
12	Aerial Base No. 8 Mtg. No. 3
13	Aerial Rod "G"
14	Set of Clips
15	Wireless Remote Control Units No. 1 (Canadian)
16	Leads, Counterpoise, No. 2 Mk. II
17	Case Spare Valves
18	Aerial Base No. 9A
19	Microphones Hand No. 3
20	Receivers Headgear M.C. (Canadian)
21	Lamps Operator No. 6 (Canadian)
22	Switchboards Charging No. C5 (Canadian)
23	1/6 Mile Cable, Electric D3 Twisted
24	Aerials, 250 ft. No. 1, 185 ft. No. 1, 150 ft. No. 2, 110 ft. No. 1, 90 ft. No. 1, and 70 ft. No. 1 Leads.
25	Leads, Earth, No. 2
26	Connectors, Single No. 24B
27	Connectors, Single No. 24C
28	Connectors, Single No. 24A
29	Connectors, Single No. 24
30	Connectors, Single No. 23A
31	Connectors, Single No. 23
32	Connectors, Twin No. 77
33	Leads, Jumper No. 1
34	Connectors, 4 Pt. No. 33
35	Leads, Aerial No. 5
36	Carriers Mtg. No. 1
37	Leads, Aerial No. 3
38	Connectors, Twin No. 53
39	Aerial Vertical, 34 C4. Steel (Can. Telescopic)
40	Masts, Vertical, 20 ft. Steel (Can. Telescopic)
41	Bags, Aerial Gear
42	Leads, Earth No. 3
43	Reels, Cable No. 2 Mk. II
44	Micro. and Rec. Headgear No. 1
45	Aerial Feeder Assembly No. 9
46	Grommets, Rubber No. 23
47	Plates, Packing No. 2

BRIEF MECHANICAL DESCRIPTION

13. The "A", "B", and "I.C." sets are mounted on the same chassis and are contained in one case, known as the Sender/Receiver unit. The supply unit is contained in a separate case, but is mounted on the same carrier as the Sender/Receiver unit.

14. The complete station is packed in two kits:

(a) The Set and Standard Kit containing the following:
    Sender/Receiver Unit
    Supply Unit No. 2
    Carrier No. 1
    Variometer
    All other parts common to all installations.

(b) The Installation Kit containing all the additional necessary parts for every different type of vehicle or installation in which this set is used. Full installation instructions and diagrams accompany each kit. These kits are provided for the following:
    Infantry Tank Mk. III
    Armoured Car
    Scout Car
    Reconnaissance Car
    Cdn. Cruiser Tank
    Heavy Utility Vehicle
    15 cwt. House type
    Wireless Vehicle
    Universal Carrier
    Ford Special Vehicle
    Truck, ground and training
    Installation Kit (Lend-Lease)
    Installation Kit (Canadian)
    Etc.

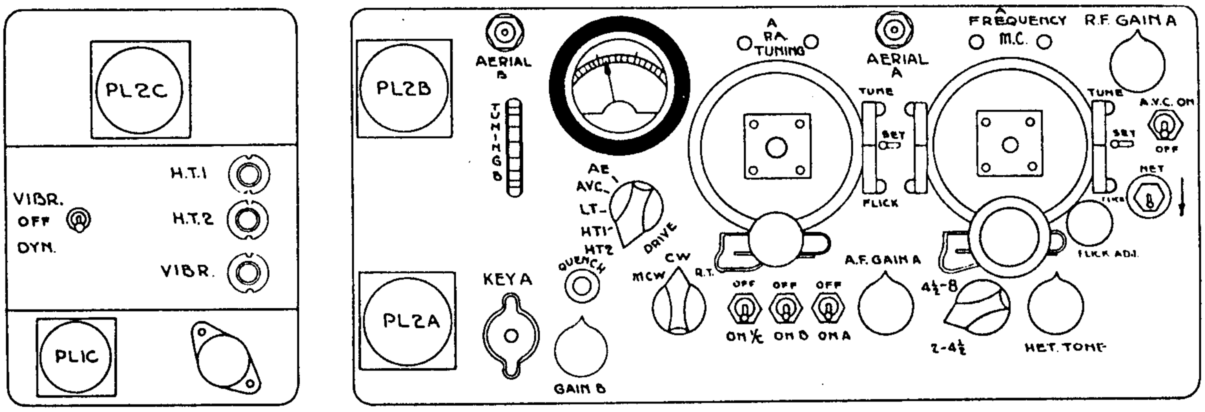


FIG. 9—FRONT PANEL SKETCH

Controls

15. The following controls are located on the front panel of the No. 19 set:

(a) A FREQUENCY MC—

This master frequency control tunes the sender and receiver simultaneously. It operates a 4-gang variable condenser which tunes all the R.F. tuned circuits in the "A" set except the aerial and power amplifier anode circuits. It is fitted with a slow motion drive. For coarse tuning the large knob should be used and, for fine tuning, the smaller one. It is also fitted with a flick mechanism which permits rapid change-over from one pre-set frequency to another. When the flick lever is at TUNE the flick indicators are disengaged and the slow motion drive is engaged. In the SET position both the indicators and the slow motion drive are engaged. In the FLICK position, the slow motion drive is disengaged and the indicators are engaged. The flick locking screws must never be loosened more than half a turn.

(b) A PA TUNING—

This control operates the single variable condenser which tunes the anode circuit of the power amplifier on Send and the grid of the R.F. amplifier on Receive. It is used with the variometer to tune for maximum output, and is fitted with a flick mechanism.

(c) FLICK ADJ—

This is a permeability-tuned adjustment to the master frequency control, which will change the frequency about 1 Kc/s. on either side of the master setting at 2 Mc/s. and about 4 Kc/s. on either side at 8 Mc/s. Neutral position of this adjustment is indicated by a click. For various reasons, such as changes in temperature or the state of the batteries, the set will vary slightly or drift in frequency. Drifting is indicated by a rise in pitch of incoming R/T signals and background rustle, and by a slight distortion of signals. By means of this control the operator can correct drift without altering his flick setting, by turning the NET switch on and pulling out or pushing in the FLICK ADJ. If the knob is turned as it is pulled, a finer setting will be possible.

(d) 4½–8 Mc/s. 2–4½ Mc/s:—

This is the band switch. It is a 12-pole, 2-position switch that selects the required frequency band by connecting in one set of coils while short circuiting the other.

(e) R.F. GAIN A—

This control operates a potentiometer which changes the bias on the R.F. and 1st I.F. stages and thus changes the strength of the signal received. It is used in conjunction with the A.F. GAIN A to produce a maximum signal output with minimum interference. When the A.V.C. circuit is turned off, this control is used to adjust the strength of the signal.

(f) A.F. GAIN A—

This control regulates the volume of sound heard in the headphones by adjusting a potentiometer on the input to the A.F. amplifier.

(g) MCW, CW, R/T—

This transmission selector switch selects the type of communication to be used, e.g. – R/T (Radio Telephony), C.W. (Continuous Wave), or M.C.W. (Modulated Continuous Wave).

(h) HET TONE—

This control adjusts the frequency of the B.F.O. over a range of from 700 cycles to 1800 cycles and consequently changes the pitch of the C.W. note received. It is used only on C.W. reception.

(i) NET—

The NET switch provided a means of "netting" the "A" Sender/Receiver to an incoming signal. When the switch is down it operates a 465 Kc/s. oscillator which beats against the signal produced in the I.F. channel by the incoming carrier. At zero beat, this I.F. signal is also 465 Kc/s. and the set is netted.

(j) AVC ON–OFF—

On C.W. it is found that better results may be obtained if the automatic volume control circuit is not used. This switch cuts the A.V.C. in or out of the circuit. A.V.C. should be ON whenever the vehicle is on the move or when the set is working on R/T.

(k) A ON–OFF—

This toggle switch connects the power to the "A" set only.

(l) B ON–OFF—

This toggle switch connects +H.T.1 to the "B" set and +L.T. to the "B" and I.C. heater network.

(m) I.C. ON–OFF—

This toggle switch connects +H.T.1 to the I.C. amplifier and +L.T. to the "B" and I.C. heater network.

(n) KEY A—

Pushing the key assembly plug fully into this jack puts the set on Send. When the plug is half way out the set is on Receive. This is the only means of Send/Receive switching on C.W. and M.C.W.

(o) AE, AVC, LT, HT1, HT2, DRIVE—

This switch enables the test meter to be used for the purposes outlined in Table 6.

Position of Meter Switch	Indication
AE	Measures aerial current feedback from the variometer. Maximum reading indicates that the sender is operating properly and that the aerial circuit is tuned.
AVC	Maximum dip on the meter indicates that the receiver is properly tuned to the incoming signal.
LT	Checks the low tension voltage applied to the heaters, relays, etc.
HT1	Measures the high tension applied to the receiver (265 V.)
HT2	Measures the high tension applied to the sender (540 V.) This reading can only be taken when the power unit is on DYN.
DRIVE	Measures the input to the power amplifier. This reading indicates that the sender is working properly up to the P.A. circuit. The set must be on transmit.

TABLE 6—FRONT PANEL METER INDICATIONS

(p) TUNING B—
This dial tunes the "B" set over a range of from 230 to 240 Mc/s., by means of a split stator variable condenser. The dial is calibrated in 10 equal divisions, not by frequency, to enable the operator to preset the "B" set more easily.

(q) GAIN B—
This control regulates the volume of sound heard in the "B" set headphones, by means of a potentiometer on the output of the A.F. amplifier.

(r) QUENCH—
This is a permeability-tuned adjustment of the frequency of the quench oscillator in the "B" set receiver. It is used to eliminate interference between various 19 sets in the immediate neighborhood caused by the beating of quench frequencies or their harmonics.

(s) VIBR-OFF-DYN—
This toggle switch (on the supply unit) selects the power unit which will be used to operate the set.

(t) VARIOMETER—
The variometer, together with the A PA TUNING dial is used to tune the aerial to resonance at the frequency begin used. The variometer must be adjusted whenever the frequency or the type of aerial is changed. It must also be adjusted whenever the set is switched from C.W. to R/T or vice versa. There are two scales on the variometer:— 0–100 and 200–100. The lower frequencies will have a setting on the 0–100 scale, the lowest frequency near 10; and the higher frequencies will have a setting on the 200–100 scale, the highest near 110. Red bands on the variometer dial indicate the change-over from one scale to the other. Never use a setting covered by either red band. See if better results may be obtained at the top of the other range.

Associated Equipment

16. Wireless Remote Control Unit (Cdn.) No. 1 may be used with the Wireless Set (Cdn.) No. 19 Mk. III. These units permit operation by remote control or connection into a field exchange.

17. A Crystal Calibrator NT-11 for the No. 19 Set allows the operator to tune the set accurately to frequencies within the range of

the set, despite any dial calibration errors. The crystal calibrator may also be used to determine accurately the frequency of signals received on the "A" receiver. When in use it is mounted on the top or side of Supply Unit No. 2.

18. The Wireless Set No. 19 Power Amplifier is a linear R.F. amplifier used in conjunction with any Wireless Set No. 19 where considerable R.F. power output is desired for long range communication. It amplifies the carrier output of the No. 19 set before feeding it to the aerial.

19. Complete details of operation are contained in pamphlets supplied with each of the units described in Paras. 16, 17 and 18. Full technical and maintenance instructions are contained under a separate E.M.E.R. title.

Special Features of Wireless Set (Cdn.) No. 19 Mk. III versus Mk. II.

20. Supply Unit No. 2 is a dynamotor-vibrator combination unit which will operate at a much greater efficiency than previous types, resulting in a much lower current drain from the L.T. source. The Canadian Supply Unit No. 2 is interchangeable with the British Supply Unit Mk. III. It is also interchangeable with the British, Canadian and U.S. Supply Unit No. 1, with only minor adaptation.

21. The Mk. III set is fitted with a slow motion drive attached to the A FREQUENCY MC dial. This drive consists of a large and small knob; the large knob being used for coarse tuning and the small knob for fine, accurate tuning.

22. The push button marked NET on the Mk. II set has been replaced by a toggle switch, so the operator may have both hands free for tuning the set.

23. By means of a flick adjustment the frequency of the receiver on NET may be very slightly adjusted after the flicks are locked. The FLICK ADJ is used to correct for small frequency drifts of the receiver conversion oscillator caused by changes of temperature, vibration, etc.

24. The flick locking screws on the P.A. and M.C. dials of the Mk. II set have the coin slots replaced, on the Mk. III set, by a coin-like appendage which enables the operator to lock or unlock the flicks by hand without using a coin or other tool.

25. Separate ON-OFF switches are provided for "A", "B", or "I.C." which allow selection of only the specific set or sets desired with a corresponding decrease in power consumption.

26. An AVC ON-OFF switch allows the A.V.C. circuit to be switched off during C.W. reception, resulting in improved reception of this type of signal.

27. An R.F. GAIN control has been added to the Mk. III set. This control is necessary when the A.V.C. is switched off to prevent overload distortion in the valves normally supplied with A.V.C. bias when a powerful signal is being received.

Canadian Versus British W.S. No. 19 Mk. III

28. Canadian and British Wireless Sets No. 19 Mk. III are interchangeable in all their applications and installations. All accessories and essential spares, such as microphones, headphones, control boxes, variometer, aerial, etc. are individually and mutually interchangeable. Most of the components used in the Canadian Mk. III set are the same as those used in the British version. Not all of them, however, are fully interchangeable. The most important differences between the two sets are listed below:

(a) The Canadian set includes a frequency adjuster control not found on the British set. The presence of this control makes the main tuning condenser assembly non-interchangeable with the British condenser gang.

(b) The Canadian set includes an A.V.C. ON-OFF switch. This is not used on the British set, and its panel has no provision for this control.

(c) The British set uses a new B.F.O. circuit, while the Canadian set still uses the same circuit employed in the Mk. II set. Thus the B.F.O. coils are not interchangeable.

(d) The British set uses a new circuit in the sender mixer and driver coils, while the Canadian set still uses the same circuit as that employed in the Mk. II set. Hence these above-mentioned coils are not interchangeable.

(e) The British set uses a new type of circuit on the sender automatic drive control circuit, while the Canadian set employs the same circuit as that in the Mk. II set.

(f) The British variometer uses a new AE. current transformer and rectifier circuit, while the Canadian set uses the same circuit as on the Mk. II.

(g) The British set employs a resistance-capacitance network as a tone filter on Receive C.W. This is not used on the Canadian set.

(h) The Canadian Supply Unit No. 2 is considerably different from the British equivalent, and very few component parts are interchangeable. However, the supply units are fully interchangeable as a whole.

(i) It must be noted that the arrangement of component parts on the chassis often differs considerably. Canadian maintenance spares cannot be used in the British model without careful consideration, and vice versa.

DETAILED ELECTRICAL DESCRIPTION

29. Nine types of valves are employed in Wireless Set (Cdn.) No. 19 Mk. III. (See Table 7). Many of these valves serve a dual purpose, being used on both Send and Receive.

TABLE 7—TYPES OF VALVES EMPLOYED IN Mk. III SET

Quantity	Type	Description
6	6K7G	R.F. Pentode (variable mu)
2	6K8G	Triode-hexode frequency converter
2	6V6G	Beam Power Amplifier
1	6B8G	Double-diode pentode
1	6H6	Double-diode
1	EF50	R.F. Pentode (steep slope)
1	807	Beam Power R.F. Amplifier
1	E–1148	V.H.F. Triode (low capacity)
1	OZ4A	Cold cathode, Full Wave Rectifier (gas filled) used in Supply Unit No. 2

TABLE 8—FUNCTION OF VALVES IN I.C. AMPLIFIER

Circuit Reference	Type	Function
V1F	6K7G	1st A.F. Amplifier
V8B	6V6G	Output A.F. Amplifier

TABLE 9—FUNCTION OF VALVES IN "B" SET

Circuit Reference	Type	Function	
		Sender	Receiver
V7A	E-1148	V.H.F. Osc.	Superregenerative Detector
V1D	6K7G		Quench Osc. 165-220 Kc/s.
V1E	6K7G	Modulation Preamplifier	1st A.F. Amplifier
V8A	6V6G	Modulator	Output A.F. Amplifier

TABLE 10—FUNCTION OF VALVES IN "A" SET

Circuit Reference	Type	Portion of valve	Function	
			Sender	Receiver
V1A	6K7G			R.F. amplifier
V2A	6K8G	Entire Valve		Rec. frequency converter
		triode	Master Oscillator	Rec. conversion Osc.
		hexode		Receiver mixer
V1B	6K7G			1st I.F. amplifier
V1C	6K7G			2nd I.F. amplifier
V3A	6B8G	pentode	R/T Modulator, M.C.W.—A.F. Osc. and Modulator	A.F. Amplifier
		1st diode		2nd detector
		2nd diode		A.V.C. rectifier
V2B	6K8G	Entire Valve	Sender frequency—changer	
		triode	Sender conversion Osc.	B.F.O. (465 Kc/s.) and Netting Oscillator
		hexode	Sender mixer	
V5A	EF50		R.F. Buffer-driver	
V6A	6H6	1st diode	Automatic drive control	
		2nd diode	Meter drive rectifier	
V4A	807		R.F. Power Amplifier (grid modulated)	

I.C. Amplifier

30. The I.C. set is a two-stage A.F. amplifier, employing degeneration.

31. Switch S10C (I.C. ON–OFF) completes the I.C. and "B" set heater circuit from pin 3 of PL-2B (+12 V. heaters) through the series-parallel heater network to ground and back to pin 1 of PL-2B, (–12 V. heaters). S10C also completes the positive H.T. circuit to the I.C. amplifier only, supplying +265 V. from pin 6 of PL-2B to the screen and plate circuits. –265 V. is grounded through pin 1 of PL-2B. S10B ("B" ON–OFF switch) also controls this heater circuit. Condensers C15K and C15L are used with the "B" set.

32. The valves of the I.C. and "B" set have their 6 V. heaters series-connected in pairs across the 12 V. supply, a pair being composed of valves having equal current drain. As V7A draws less current than V1D, R38A (56 ohms) is connected in parallel with V7A to carry the extra current required by V1D. The centre points of these series pairs are connected together by an equalizer bus, to compensate for slight differences in the valve current drains.

33. With the control unit switch in the I.C. position, pin 3 of PL-2A is connected through a dynamic microphone to ground. This microphone then completes its circuit through pin 3 of PL-2A and through the primary of the microphone input transformer, T4B, to ground. Any voice frequencies from the microphone will then appear across the primary of T4B. Resistor R2D (220 ohms) is shunted across the primary of T4B, loading it, so that if two or more microphones are paralleled across the primary, the net change in load will be greatly minimized, and the voltages developed across the primary will not be affected greatly. R2D also has the effect of applying a load (reflected through the secondary) to the control grid of V1F, eliminating open circuit hum or howl so often encountered in A.F. amplifiers. A grounded electrostatic shield is placed between the primary and the secondary of T4B to prevent transference of "hash" by capacity. The secondary of T4B which has a 50:1 step-up ratio, will have induced in it a voltage identical in character to that in the primary but increased in value fifty times. This voltage is applied to the control grid of V1F through R23D. C14B (.0001 mfd.) is placed across the secondary to by-pass the higher frequencies to ground, but it offers considerable impedance to normal voice frequencies.

34. V1F (6K7G), the 1st A.F. amplifier, operates Class A.

(a) R23D (22,000 ohms) tends to prevent overload distortion in V1F by limiting any grid currents which might flow if the applied grid voltage were to exceed the cathode bias on the valve. (Class A amplifiers cannot allow grid currents to flow or distortion results. Therefore, the grid must never be driven more positively than the cathode, or it will attract electrons to itself, resulting in grid current).

(b) The suppressor grid of V1F is connected to ground, and so has a negative bias voltage placed on it by virtue of cathode bias as described in (f) below.

(c) R23E (22,000 ohms) is the filter resistor through which +265 V. is supplied to the plate of V1F. C31C (2. mfd. electrolytic) completes the filter circuit by acting as a by-pass to ground. This filter prevents any surge or signal from the +265 V. line from appearing on the plate of V1F. It also prevents any signal that appears on the plate of V1F from escaping to the +265 V. line. This circuit is often known as a "decoupling circuit," and the components are known as the decoupling resistor and decoupling condenser.

(d) R7K (100,000 ohms) is the plate load resistor of V1F. The signal voltage applied between grid and cathode of V1F produces strong plate currents, varying in amplitude with the same characteristics as the applied signal. This varying plate current, passing through R7K causes varying voltage drops across it, proportional to the instantaneous current. Thus, amplified signal voltages are developed across R7K.

(e) R1F (470,000 ohms) is the resistor through which +265 V. is applied to the screen grid of V1F. Screen currents flowing through R1F will also produce a voltage drop, so it acts as a voltage dropping resistor to govern screen voltages. C4X (.1 mfd.) is the filter condenser from the screen of V1F to ground, acting in conjunction with R1F.

(f) R9C (1,000 ohms) connects from ground to cathode of V1F and carries all the plate and screen current from -265 V. to cathode. When there is no signal on the control grid of V1F, this plate and screen current is constant. The control grid will be at ground potential (being connected to ground through R23D and the secondary of T4B) and the current flowing across R9C will produce a voltage drop, making the cathode of V1F positive with respect to ground. This means, conversely, that ground is negative with respect to cathode as is the grid which is at ground potential. In this manner there is a negative bias voltage placed on the grid of V1C equal to the voltage drop across R9C, giving V1C "cathode bias." (Cathode, not ground, is the zero reference point of any valve when considering bias voltage.)

(g) C29C (.01 mfd.) is the coupling condenser through which the amplified A.F. signal voltages developed across load resistor R7K are applied to the control grid of V8B.

35. Degeneration consists of feeding some of the amplified voltage from the plate circuit of a valve, back to any preceding input control grid, so that it is 180° out of phase and "bucks" the applied signal voltage. It is accomplished in V1F by omitting the conventional by-pass condenser usually found in parallel with a cathode resistor such as at R9C. The negative bias on control grid V1A depends on the voltage drop across R9C, i.e., — the instantaneous current flowing through R9C. If a signal is applied to the control grid of V1F, making it less negative (on the positive half cycle of the signal), the control grid will allow more electrons to flow from cathode to plate, increasing the plate current, and likewise the current across R9C. The increased current causes increased voltage drop across R9C, and increased negative bias on control grid of V1F, thus "bucking" the applied signal. A similar but converse action takes place on the negative half cycle of the applied signal.

36. V8B (6V6G), the output A.F. amplifier, also operates Class A.

(a) R8F (1 meg.) is the grid and load resistor across which signal voltages (applied to the control grid) are developed.

(b) The screen grid of V8B is fed directly from the +265 V. supply, with no decoupling other than the large capacity filter condenser on the +H.T.1 line at the power supply unit. Plate voltage is fed through the primary of the output transformer, T6A, from the +265 V. line.

(c) R39A (820 ohms) is the cathode resistor, used for "cathode biasing" of V8B. As this resistor is not by-passed, there is also some degeneration in this circuit, as described in Para. 35.

37. The signal applied to the control grid of V8B is amplified by the valve, and appears across the primary of the output transformer, T6A. The secondary of T6A has one end grounded, and the other end is fed to pin 6 of PL-2A, and from there through the dynamic headphones to ground, completing the circuit, when the control units are switched to the I.C. position. Pin 6 of PL-2A is connected to pin 2 of PL-2B, which in turn is connected to pin 2 of PL-2C on the power supply unit. Pin 2 of PL-2C is connected to pin 2 of PL-1C (power supply input) and from there to various Junctions Distribution and headphones throughout the vehicle so the driver, etc. may listen in on the I.C. channel. R2E (220 ohms) across the secondary of T6A, loads down the output so that connecting additional headphones in parallel will not materially reduce the output level. R21B (27,000 ohms) connects from the "hot" end of T6A secondary back to T4B primary so that a portion of the amplified signal in the I.C. channel is fed back into the channel 180° out of phase, producing degeneration.

38. Degeneration in the I.C. channel, therefore, is accomplished by two degenerative cathode resistors and by actual negative feedback. It provides a channel which will not overload or distort. It cures distortion caused by accidental regeneration due to stray coupling in parallel leads, etc. It limits the gain of the channel to the required level. It provides automatic gain control as low input levels give a response very little less than very high input levels. Thus greater intelligibility is achieved.

The "B" Set

39. The "B" set is a V.H.F. (235 Mc/s.) sender and receiver employing 4 valves. The A.F. portion, V1E and V8A, is common to both sender and receiver and is very similar to the I.C. set. The "B" set is known as a "transceiver" because the R.F. valve, V7A, and its tuned circuit, is common to both Sender and Receiver. It is the plate-modulated oscillator, coupled directly to the aerial, on Send; and the superregenerative detector on Receive. Thus the set sends and receives on the same frequency. V1D is a "quench" oscillator (165–220 Kc/s.) used to produce superregeneration in V7A.

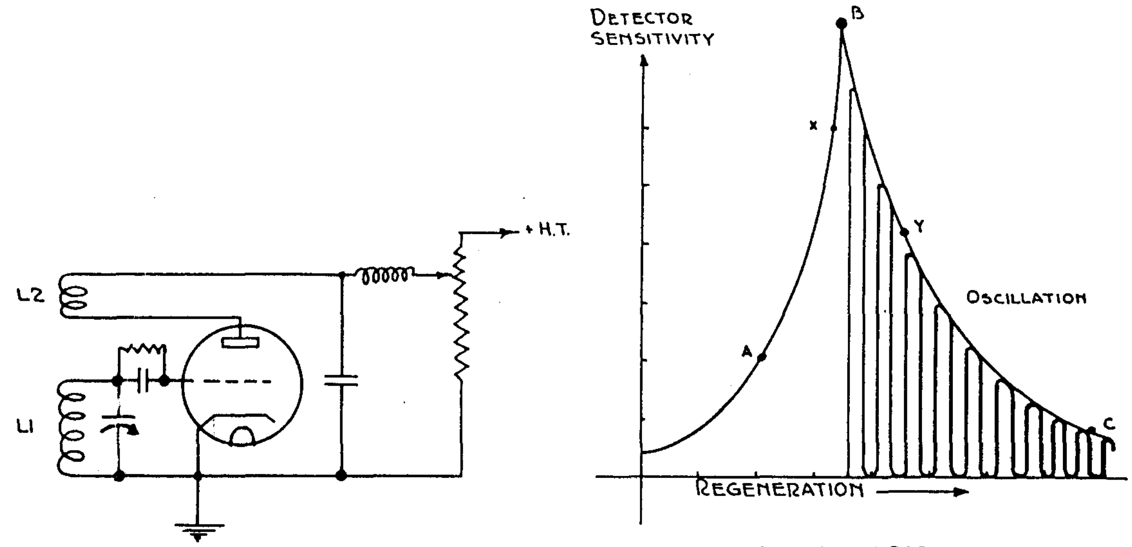


FIG. 10—PRINCIPLES OF SUPERREGENERATION

40. Modulated oscillators are subject to considerable frequency modulation, but this is compensated for because of the fact that the associated superregenerative type of receiver used with this set, while extremely sensitive, is very unselective. Thus a sender can shift in frequency considerably before any difference is noted at the receiver end.

41. The heater circuit is fundamentally identical with that of the I.C. amplifier, described in Paras. 31 and 32; the "B" and I.C. amplifier heaters being combined into the one multiple network. S10B (B ON–OFF) controls this heater circuit, as does also switch S10C (I.C. ON–OFF). S10B also supplies +265 V. from pin 6 of PL-2B to the plates and screen grids of the "B" set. −265 V. is grounded through pin 1 of PL-2B.

42. In parallel with the heater network is the "B" set send-receive relay coil, L19B, which is connected to pin 8 of PL-2A. When operating the "B" set, pressing the pressel switch on the microphone grounds this pin, completing the circuit so that relay coil becomes energized and by magnetic attraction throws all the send-receive switches (S5B) to the Send position. Releasing the pressel switch on the microphone breaks the circuit, and a spring returns the S5B switches to the Receive position.

43. Condensers C15K and C15L (.0005 mfd.) are used to by-pass the "hot" side of the V7A heater to ground in order to keep R.F. out of the heater circuit. It was found that at this extremely high frequency it was necessary to by-pass to two separate points on the chassis.

44. For simplicity, the circuit shown in Fig. 10 is that of a tickler-feedback regenerative detector. The sensitivity of the detector varies directly with the amount of "feedback" used. Increasing the plate voltage increases the current through L2 and consequently increases the feedback and sensitivity. Decreasing the plate voltage likewise decreases the feedback and sensitivity. The most sensitive condition would appear to be that where maximum regeneration (maximum plate voltage) was used. However, that is not necessarily so, because referring to the graph above, it can be seen that regeneration can only be carried successfully as far as point A. If more regeneration is used the circuit becomes very unstable. It will suddenly shoot up to

point B, maximum sensitivity, and then break into uncontrolled oscillations which cause distortion and reduce the sensitivity to about C. Superregeneration offers a means of operating the circuit quite stably near point B.

45. In the "B" set it is accomplished by using a quench oscillator, working at any frequency from 165 to 220 Kc/s. This oscillator is coupled into the plate circuit of the detector so that the voltages of the quench oscillator plate circuit alternately aid and then "buck" the +H.T.1 potential being fed to the detector plate. It actually varies the dectector plate voltage over a range of approximately 70 volts, at a frequency of roughly 190 Kc/s. Referring again to Fig. 10, on the positive quench peaks, the detector sensitivity rises from point A to point B and then starts to oscillate. However, it never gets a chance to oscillate strongly enough to distort before the quench cycle reverses and the feedback decreases, due to lower plate voltage dropping the sensitivity of the detector and causing oscillations to cease. No sooner does this happen than the quench oscillator cycle reverses again and the detector sensitivity cycle commences again. Thus the sensitivity varies constantly from below A to approximately Y, at the quench frequency rate, which means that the sensitivity varies rapidly around an average of approximately point X. The actual detecting action is that of a normal grid leak detector.

46. Superregeneration is many times more sensitive than any other known type of detector, and the characteristic loud hissing noise heard is due to thermal agitation and shot effect noises in the circuit, made audible by means of the extremely high sensitivity. An incoming signal reduces the sensitivity so that the hiss weakens or disappears. This also acts as an A.V.C. and helps to suppress such static noises as ignition, etc. (There is very little interference on 235 Mc/s. anyway). Superregeneration may be used at any frequency, but it is most successful on V.H.F. circuits. The quench may be any low frequency so long as it is above the audible range. The frequency of the "B" set quench was chosen in order to prevent interference with the "A" set. One disagreeable factor is that the powerful quench frequency is being radiated from the aerial to which the detector is coupled, and other sets nearby must use a slightly different quench frequency to avoid heretodyne interference.

The "B" Receiver

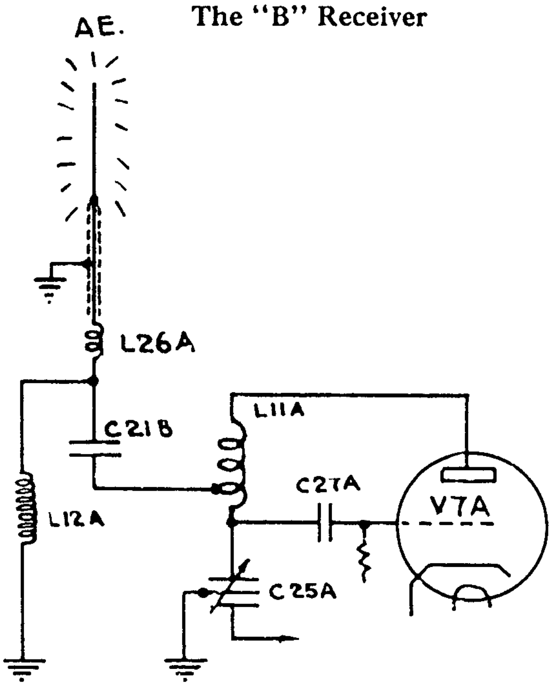


FIG. 11—"B" SET AERIAL CIRCUIT

47. The 20″ half-wave aerial rod used is broadly resonant from 230–240 Mc/s. (235 Mc/s. ± 2%). The coaxial feeder is an odd number of half-waves in length; Aerial Lead No. 2 being 1½ wavelengths (4′2″) and Aerial Lead No. 3 being 2½ wavelengths (7′).

48. L26A, C21B (.000007 mfd.), and a portion of L11A and C25A to ground form a quarter wave, giving the aerial system an end-fed ¼ wave input impedance. Therefore, this L26A circuit acts similarly to the variometer of the "A" set, only it is tuned automatically when tuning the main "B" gang, C25A, which is common to both aerial and tank circuits. L12A is an R.F. choke. It provides a D.C. path to ground so that static charges cannot accumulate on the aerial rod, but prevents the escape of 235 Mc/s. R.F. It does not act as a choke to the lower quench frequencies, and tends to short circuit them to ground at this point, minimizing their radiation. L12A is also a portion of the antenna impedance matching network.

49. The incoming signal which is induced in the aerial rod is fed through the coaxial feeders to "B" set aerial socket, S05A, through L26A and coupling condenser C21B to "B" set tank circuit and the grid of V7A.

50. V7A (E-1148) is used as the superregenerative detector. It is a V.H.F. triode with low interelectrode capacities. L11A, tuned by C25A (2.5 – 6.5 mmfd. per section), the split stator tuning gang, forms a modified Colpitts' circuit using capacitive feed-back. The grounded rotor, plus the fact that the "B" set dial is "edge-tuned" helps eliminate hand capacity effect when tuning. This Colpitts' circuit tunes from approximately 230 to 240 Mc/s. C27A (.00002 mfd.) grid coupling condenser is a temperature compensated ceramic capacitor. It compensates for any tendency towards frequency drift in the circuit, due to temperature changes.

51. +H.T.1 is fed from pin 6 of PL-2B and S10B to the +265 V. line and through the relay switch and R11B, parallel resistors R33A and R33.1A, the relay switch, L15A and R31A to the tap near the centre of L11A to the plate of V7A. As the voltages on the plate and grid of a valve are 180° out of phase, a neutral point occurs on L11A half way between the two which will be at ground potential. If +H.T.1 is fed at this point, an R.F. choke will be unnecessary. R31A (2,200 ohms) taps in at this point, to feed +H.T.1 and it also acts as an R.F. filter in case the tap on L11A becomes slightly unbalanced. C37A acts as a filter by-pass to ground, in conjunction with R31A. R32A (15,000 ohms) and R18C (270,000 ohms) form a grid leak to ground.

52. L13A is a V.H.F. choke connecting the cathode of V7A to ground. It would be degenerative at normal frequencies but due to the relatively great length of the electron transit time in the circuit as compared with the rapidity of the operational cycle at these very high frequencies, it tends to have a regenerative effect, aiding feedback on both receive and send. Phase shift of current versus voltage across this choke also aids in obtaining this regenerative effect.

53. V1D (6K7G) is the quench oscillator. The suppressor grid and cathode are grounded. L14A with C28A (.0007 mfd.) and C37A (.0005 mfd.) form a Colpitts oscillatory circuit. L14A is permeability-tuned from approximately 165–220 Kc/s. by an adjustable polyiron core using the QUENCH control on the front panel. C15G (.0005 mfd.) is the grid coupling condenser. R6G (47,000 ohms) provides Class C grid leak bias. +H.T.1 is supplied from the +265 V. line through R11B (3,300 ohms), R33A (27,000 ohms) and R33.1A (47,000 ohms) through L15A to the plate of V1D. R11B and C31A (2.0 mfd. electrolytic) form a decoupling network to prevent quench or V.H.F. from escaping to the +265 V. line. C15H (.0005 mfd.) serves to by-pass the +H.T.1 line to ground on both Send and Receive and decouples R.F. from this line. R34A (47,000 ohms) acts as a voltage dropping resistor to supply +H.T.1 from the decoupling network, R11B, to the screen of V1D. C4V (.1 mfd.) together with R34A form a screen decoupling network. R33A and R33.1A in parallel serve as a voltage dropping resistance feeding V1D and V7A. R33.1A was added to allow the use of the E-1148 valve (low mutual conductance.) If the British CV6 valve is used, R33.1A must be removed. L15A serves as a quench frequency choke to confine the quench voltages to the V1D — V7A circuit in order to plate modulate +H.T.1 voltage supply to V7A, producing superregeneration. C29A (.01 mfd.) with R33A and R33.1A form an A.F. decoupling network forcing the detected A.F. output of V7A through C29A, R6H (47,000 ohms), and "B" control potentiometer, R35A (100,000 ohms) to ground. R33A and R33.1A are the audio load resistors across which this detected audio output voltage of V7A is developed. R6H together with C30A and C30B (.001 mfd.) form a decoupling network to further separate undesired "quench" from the audio signal. Audio voltages are picked off R35A and fed through a shielded cable through R23B to the control grid of the 1st A.F. amplifier V1E.

54. V1E (6K7G), the 1st A.F. amplifier, operates Class A. R9B (1,000 ohms) provides cathode bias. Not being by-passed it has a degenerative effect. (See Para. 35). R23B (22,000 ohms) in series with the grid lead tends to reduce grid currents (and consequent distortion) should they exist due to overexcitation. (See Para. 34). R1A (470,000

ohms) is a decoupling and voltage dropping resistor through which +H.T.1 is fed from the +265 V. line to the screen grid of V1E. C4W (.1 mfd.) is a screen condenser, by-passing the screen grid to ground. Plate voltage is fed from the +265 V. line to V1E through R23C (22,000 ohms) and R7J (100,000 ohms). R23C acts as a voltage dropping resistor, and a decoupling resistor in conjunction with C31B (2.0 mfd. electrolytic).

55. Audio voltages applied to the grid of V1E are amplified and these amplified voltages appear across R7J, the plate load resistor. (See Para. 34 (d)). C29B (.01 mfd.) is the coupling condenser which applies these voltages to the control grid of V8A. The other end of R7J is coupled to ground for A.F. by C31B and from there to the cathode of V8A through C16B. C15J (.0005 mfd.) is a decoupling condenser, removing any quench or V.H.F. which may appear at this point.

56. V8A (6V6G), the output A.F. amplifier, operates Class A. R37A (390 ohms) and R9D (1000 ohms), connecting the cathode to ground, provide cathode bias for V8A. C16B (12. mfd. electrolytic) acts as a by-pass from cathode to ground to eliminate degeneration. (It prevents varying voltage drops across cathode resistors on each grid cycle by by-passing these A.F. fluctuations, thus giving V8A a steady bias). R8D (1. meg.) connects the control grid of V8A to ground for biasing purposes. It also acts as a load resistor across which appear the A.F. voltages delivered from V1E by C29B. +265V is delivered from the +H.T. 1 line directly to the screen and through the primary of the output transformer, T5A, to the plate.

57. T5A has two secondary windings, one of which is not used on Receive. A.F. voltages applied to the control grid of V8A are amplified and appear across the primary from which they are induced into the secondaries. One end of the lower secondary is grounded, and the other end goes to pin 5 of PL–2A. From there it connects to the control units, and in the "B" position of the control unit switches, across the headphones to ground, completing the output circuit. R2C (220 ohms) acts as a load across the secondary so that adding two or more additional headphones will not materially change the output level. Another load also appears across the secondary via R36C and the primary of T4A to ground, but its effect is negligible, and its real use is on Send.

The "B" Sender

58. The circuit changes that take place when switching from Receive to Send are as follows:—

(a) The quench oscillator valve, V1D, is no longer used. It is made inoperative by removing +H.T.1 potential from the screen.

(b) Higher +H.T.1 voltage is delivered to V7A on Send than on Receive for strong oscillation. +H.T.1 is now delivered from the +265 V. line, through the Sender secondary of T5A through the relay switch, L15A, R31A and L11A to the plate of V7A. It is also applied to the plate of V1D, but this valve is inoperative as the screen voltage is removed. L15A now serves no useful purpose.

(c) The grid circuit of the 1st audio valve, V1E, is switched from the receiver gain control to the secondary of the microphone transformer, T4A, by the "B" Send-Receive relay.

(d) The cathode resistor of V8A, R9D (100 ohms), is shorted, so that R37A (390 ohms) is now the only cathode bias resistor. This results in decreased bias on V8A with a consequent increase in output for modulation purposes.

(e) At V7A the grid leak resistor, R18C (270,000 ohms) is shorted, leaving only R32A (15,000 ohms) as a grid leak to ground. This results in strong oscillation of V7A, aided by the increased plate voltage. The same tank circuit being used, these oscillations will be at the receive frequency.

59. T4A is a microphone input transformer identical to that of the I.C. channel (See Para. 33). It has a 50–1 step up voltage ratio from primary to secondary and there is an electrostatic shield between the primary and secondary to prevent capacitive "hash" transference. One end of the primary is grounded and the other end connects to pin 2 of PL-2A. From there it connects through to the control unit, and, in the "B" position, through a dynamic microphone to

ground, completing the circuit. One end of the secondary of T4A is grounded, and the other end connects through the relay switch and R23B to the control grid of V1E. R7H (100,000 ohms) across the secondary of T4A prevents open circuit hum or howl.

60. Degenerative feedback, similar to that of the I.C. channel (See Para. 38) is employed. From the "hot" end of the receive secondary of T5A, R36A (39,000 ohms) connects back, through the primary of T4A to ground, giving degenerative feedback.

61. Apart from the preceding circuit changes, the audio channel now acts exactly as it did on Receive, except that the exciting source is now a microphone.

62. The receiver secondary winding on the output transformer, T5A, is still connected through to the headphones, with the control unit in "B" position, providing Sidetone. Thus the operator is able to monitor his own transmission and other personnel connected in on the "B" channel can also hear the speaker on Send, as well as the incoming signals on Receive.

63. The sender secondary winding of T5A has impressed across it the amplified A.F. microphone voltages. As this winding also carries +the H.T.1 supply to V7A, the A.F. voltages will alternately aid and oppose this D.C. voltage, so that V7A has a constantly changing voltage applied to its plate circuit, varying at the A.F. rate. (Plate modulation.) This varies the amplitude of the R.F. output of V7A, or amplitude modulates it.

64. The aerial circuit of the "B" set sender is the same as on Receive.

The "A" Set

65. The "A" set consists of a sender-receiver, covering a frequency range of 2 – 8 Mc/s. By means of band switch S11A, this range is covered in two bands for the purpose of obtaining better band-spread and better tracking of tuned circuits. Function switch S7A allows the sender-receiver to be operated on R/T, C.W., or M.C.W. as required. Operating two or more stations on a common frequency or net is greatly simplified as the frequency selector dial (M.C. gang) is common to both sender and receiver, i.e., — the "A" set automatically sends on its receiver frequency.

66. The "A" set contains 9 valves; 5 of which are used on Receive R/T or M.C.W.; 6 on Receive C.W.; 5 on Send C.W.; and 6 on Send R/T or M.C.W. Some valves are common to both sender and receiver. (See Table 10.)

67. The front panel meter, controlled by switch S8A, will give the following readings in the indicated positions:

AE. — Aerial current on Send.
A.V.C. — an indication of A.V.C. action.
L.T. — +12 V. heaters.
H.T.1 — +265 V.
H.T.2 — +540 V.
DRIVE — amount of R.F. drive, or excitation.

68. The heater circuit is a series-parallel network. R30A (30 ohms) is shunted across one of the parallel branches to compensate for uneven current drain, as V4A on the other branch draws a considerably greater current than the other valves. This resistor, along with the equalizer, ensures a 6 V. drop across each branch. The "A" ON-OFF switch, S/C104A, when closed, completes the heater circuit from pin 3 of PL-2B (+12 V. heaters) through the heater network to ground (–12 V. heaters). S/C104A also completes the +265 V. circuit from pin 6 of PL-2B to the "A" set wherever required.

69. +12 V. is fed directly from pin 3 of PL-2B, through the "A" set send-receive relay coil, L19A, to pin 7 of PL-2A and also to key jack, J1A. Grounding this lead by pressing the microphone pressel switch or inserting the key plug in J1A completes the relay circuit, throwing all the S5A relay switches from Receive to Send. When this circuit is broken, a relay spring returns all the S5A switches to the receive position.

70. +12 V. is also fed directly from pin 3 of PL-2B through the meter multiplier series resistor, R26A (29,000 ohms) and through the meter, when in the L.T. position, to ground.

71. +265 V. is fed directly from pin 6 of PL-2B through the meter multiplier, R24A (1.2 meg.)

and through the meter, when in H.T.1 position, to ground, completing the circuit.

72. +540 V. is fed directly from pin 4 of PL-2B, through the meter multiplier R25A (1.2 meg.) and through the meter, when in the H.T.2 position, to ground. -540 V. is grounded in C.W. position of S7A, so the meter will read 540 V.; but in R/T or M.C.W. -540 V. is grounded through R/C104A (1,500 ohms). This will affect the meter reading very little on Receive, but on Send it may read approximately 40 V. lower.

73. PL-2B is connected by means of shielded cable to PL-2C on Supply Unit No. 2. PL-2A connects to control units and headgear, etc.

W.S. (Cdn.) No. 19 Mk. III Versus Mk. II

74. Following is a list of differences between the Wireless Set (Cdn.) No. 19 Mk. III and the Mk. II set:

(a) The Mk. III set was designed to be used with the Supply Unit No. 2 which allows operation from (i) 2-wire 12 V. systems, (ii) 2-wire, 24 V. systems, and (iii) 3-wire, 24 V. systems with a 12 V. tap. On (i) and (iii) above an optional vibrator supply may provide H.T.1, with increased economy, for Receive; and an automatic relay changes over to dynamotor on Send. H.T.1 is now 265 V. and H.T.2 is 540 V. instead of 275 V. and 500 V. as on Supply Unit No. 1.

(b) The 6-point battery plug, PL-1A, on the front panel has been replaced by a 12-point plug, PL-2B, to accommodate the extra facilities of Supply Unit No. 2. There is no change in connections on pins No. 1 to 6; however, pin 7 of PL-2B is the 540 V. return, supplying bias to V4A (807) on Send R/T and M.C.W.; and pin 8 of PL-2B is connected to pin 7 of PL-2A and places the supply unit relay (vibrator-dynamotor) in parallel with the "A" receive-send relay so that the pressel switch on the microphone will throw both relays on Send. This is also controlled by the key jack.

(c) S/C-104A (A ON-OFF), a double pole, single throw toggle switch, has been added to the Mk. III set. It controls the "A" valve heaters, and all the +265 V. circuits to the "A" set.

(d) S10B (B ON-OFF), a double pole, single throw toggle switch, controlling "B" and "I.C." heaters, and all +265 V circuits to the "B" set, replaces S9A, the B ON-OFF switch of the Mk. II set.

(e) S10C (I.C. ON-OFF), a double pole, single throw toggle switch, controls "B" and "I.C." heaters, and all +265 V. circuits to the I.C. amplifier, and replaces S10A, the A ONLY-ALL switch of the Mk. II set.

(f) Netting switch, S/C-105B, a single pole, single throw toggle switch replaces the netting button so both hands may be free for netting adjustments.

(g) S/C-105A, the AVC ON-OFF switch, removes A.V.C. action when at the OFF position for C.W. reception.

(h) R/C-103A (1. meg.), in series between the A.V.C. line and S/C-105A, prevents choke L10A from being directly grounded when S/C-105A is OFF. That condition would result in large losses across L10A when on Send. The Receive R.F. valve, V1A, has its control grid connected through C2A to the Sender P.A. tank circuit of V4A. Although V1A is rendered inoperative on Send due to its screen voltage being removed, large sender R.F. voltages appearing at V1A grid will be rectified between grid and cathode, placing a D.C. potential of approx.—100 V. through L10A to the A.V.C. line. If this A.V.C. line were directly grounded by the A.V.C. ON-OFF switch, the amount of rectification at V1A would be tremendous, resulting in large R.F. losses, and heavy D.C. flow through L10A, to say nothing of damage to V1A. Hence, the extra 1. meg. resistor R/C-103A, to minimize the flow of these rectified currents when the A.V.C. is switched OFF.

(i) S8A, the meter switch, reads A.V.C. directly across R9A (1,000 ohms) instead of to ground. One end of R9A is not directly grounded, as in the Mk. II set.

(j) R/C-105A (10,000 ohms variable), the R.F. GAIN control is necessary when

A.V.C. is switched off. The screen grid bleeder, R4A at V2A is not directly grounded now, but connects through R/C-105A to ground. The junction of R4A and R/C-105A is now a point on a voltage divider network between +265 V. and ground. This junction may be made any value between 0 and +30 V. with respect to ground by varying R/C-105A. The cathode resistors V1A and V1B connect to this junction point so that R/C-105A may vary the total cathode bias on these valves and thus control the gain.

(k) V6A (6H6) no longer supplied bias to V4A (807) on Send R/T and M.C.W. It is isolated from the V4A grid circuit, and only serves as an automatic drive control and a drive rectifier for DRIVE reading on the meter.

(l) On R/T and M.C.W., R/C-104A (1,500 ohms) is in series between -540 V. and ground. The control grid of V4A connects to the -540 V. line through R7D. This junction is by-passed to ground by C/C-107A (12 mfd. electrolytic). The voltage drop across R/C-104A places approximately 40 V. cathode bias on V4A. Grid leak bias is still used on C.W. The H.T. 2 meter reading on Send will be 500 V. on R/T and M.C.W., and 540 V. on C.W. as -540 V. is then grounded by section 5 of S7A.

(m) L/C-103A (FLICK ADJ) is a "slug-tuned" coil in the receive conversion oscillator circuit, for correcting any netting error after the flicks are locked. It tunes ± 1 Kc/s. This control is located to the right of the M.C. dial on the front panel.

(n) A slow motion drive (extra fine vernier) has been added, to the M.C. dial only, for extremely accurate setting.

The "A" Receiver

75. The "A" receiver is a conventional super-heterodyne, with an I.F. frequency of 465 Kc/s. It has an R.F. stage before the receiver mixer, and the receive conversion oscillator operates at a frequency 465 Kc/s. higher than the incoming signal to provide a "difference beat note" of 465 Kc/s. which is fed by the mixer into the I.F. channel. There are two stages of I.F. amplification, followed by a double-diode pentode valve. One diode acts as a 2nd detector; the pentode section is the A.F. output amplifier, and the other diode functions in a delayed A.V.C. circuit. For C.W. reception a switch, S/C-105A, makes the A.V.C. inoperative, and an R.F. GAIN control must then be manipulated to prevent overload distortion. This control is normally left at maximum when the A.V.C. is ON.

76. A B.F.O. (triode section of V2B), feeding into the I.F. channel operates at exactly 465 Kc/s., the centre of the I.F. channel. Netting switch S/C-105B supplies +H.T.1 voltage to the plate circuit of the B.F.O. When tuning in a signal on the "A" receiver with the M.C. gang, it must be tuned so that the heterodyning whistle of the incoming I.F. signal and the B.F.O. is exactly at zero beat. The netting switch is then switched off. The receive frequency converter, V2A, has now converted the incoming signal to exactly 465 Kc/s., the centre of the I.F. channel. A variable polyiron core in coil L/C-103A allows slight adjustments of the receive conversion oscillator (V2A) frequency for minor netting correction after the M.C. dial is locked in a "flick" position.

77. On Receive C.W., the B.F.O. is supplied with +H.T.1 voltage, and the HET TONE control is brought into the circuit, allowing the B.F.O. frequency to be shifted approximately 1½ Kc/s. to form an audible beat note with the incoming I.F. signal for C.W. reception.

78. The P.A. tuning and the variometer-aerial circuits are common to both sender and receiver. The P.A. circuit, on Receive, acts to make V1A a tuned R.F. stage.

79. The changes in the "A" receiver circuit (when A relay, S5A, is switched to Send) are as follows:

(a) Screen voltage is removed from V1A, V1B and V1C making them inoperative. Section 2, S5A).

(q) +H.T.1 voltage is applied to the B.F.O. V2B plate circuit, causing it to oscillate Section 3, S5A).

(c) The HET TONE control (R14A) circuit is opened so that the B.F.O. operates at exactly 465 Kc/s. Section 1, S5A).

(d) Plate and screen voltage is removed from V3A (Section 3, S5A) except as in (e) below.

(e) Plate and screen voltage is re-applied to V3A on R/T. Section 9, S7A); and on M.C.W. with the key depressed (through sections 9 and 2, of S7A, the key jack, J1A; the depressed key, and through section 3 of S7A to +265 V. line).

(f) The control grid of V3A is disconnected from A.F. GAIN A control, R13A (Section 4, S5A), and connects through sections 8 of S7A to the secondary of microphone transformer T3A on R/T and on M.C.W. through C22A to the secondary of T2A, making T2A into an audio oscillator circuit.

80. The variometer serves to tune the aerial rods to resonance with the incoming signal frequency by adding inductance in series to artificially load it to ¼ wavelength. The incoming signal is fed through T1A, L1A, and C24A of the variometer to S04A (AERIAL A socket on the front panel) by means of a coaxial feeder. From S04A, the signal is applied through coupling condenser C1A (.004 mfd.) to the P.A. tuning tank circuit which acts as a step-up auto-transformer. The R.F. path is completed to ground at the "cold" end by C33B (1. mfd.).

81. A tuned circuit, consisting of L3A, which has a fixed polyiron core, in series with C33B (.1 mfd.), C3A (16-550 mmfd. variable) and C36A (.01 mfd.) forms the P.A. tank circuit. This is tuned to the signal frequency by the tuning condenser C3A. C33B serves to by-pass, or decouple the +540 V. sender supply lead, and C36A acts as a blocking condenser to keep +540 V. off the tuning condenser plates (i.e.–C3A). The signal is fed through coupling condenser C2A (.0005 mfd.) to the control grid of V1A.

82. V1A (6K7G) is the R.F. amplifier.

(a) The suppressor grid is directly grounded.

(b) The cathode is connected to ground through R2A (220 ohms) and a portion of R/C-105A (10,000 ohms). This gives self-bias to the valve. The cathode is by-passed by C4B (.1 mfd.) to prevent degeneration. The +265 V. line from pin 6, PL-2B, is connected through S/C-104A (A ON-OFF), through Section 2 of A relay S5A, R45A (22,000 ohms) and resistor, R4A (22,000 ohms) to the junction of the V1A cathode resistor R2A, and the R.F. gain control R/C-105A, through the gain control to ground. This taps the cathode in on a voltage divider network placing the junction of R2A and R/C-105A at any potential between 0 and +30 V. with respect to ground,d epending on the position of the R.F. GAIN control. This bias potential, added to the self-bias, controls the gain of V1A as the control grid is connected to ground through the A.V.C. network. This system prevents overload distortion.

(c) In addition to its normal cathode bias, negative bias from the A.V.C. line is supplied to the control grid of V1A through R.F. choke, L10A, which prevents the R.F. from escaping to the A.V.C. line.

(d) The screen grid of V1A is connected to the +H.T.1 screen line by dropping resistor R44A (39,000 ohms) and to ground by R7.1J (100,000 ohms). This places the screen in a voltage divider network for better screen voltage regulation, and R7.1J bleeds the charge off this +H.T.1 screen line when it is opened on Send by Section 2 of S5A. This causes V1A, V1B, and V1C to become inoperative very rapidly, preventing an annoying "chirp" on switching to Send. C4A (.1 mfd.) in conjunction with R44A acts as a screen decoupling network.

(e) The plate of V1A is connected to band switch S11A/5 through L22B on low band and through L23B on high band and through R5A (2,200 ohms) to the +H.T.1 line. R5A (2,200 ohms) and C4C (.1 mfd.) form a plate decoupling network to the +265 V. line. L22A and B and L23 A and B are R.F. transformers coupling V1A to V2A. They have polyiron cores.

(f) The incoming signal applied to the control grid of V1A is amplified by that valve. The amplified signal appearing in the plate circuit is induced from the primary to the secondary of the R.F. transformer L22, and is applied through S11A/6 and coupling condenser C5A (.01 mfd.) to the control grid of V2A mixer or frequency changer. The other end of L22A is grounded, as is also the "cold" end of L23A. The R.F. transformers, L22 and L23 are tuned to the signal frequency by C9A (530 mmfd. maximum variable) a section of the M.C. gang which is common to both coils.

(g) C10A (4–30 mmfd. variable ceramic) in parallel with the main gang, is the high band trimmer. However, it is still in the circuit on low band, C10A and C9A being common to both bands. C10.1A (10 mmfd.) is a padder across L22A. While on high band, the low band secondary of L23A and its trimmer, C10D, are shorted out to prevent absorption.

(h) C10D (4–30 mmfd. variable ceramic) across L23A is the low band trimmer. Coupling condenser, C5A, in series with the main gang, is used in **series** to make this tuned circuit track exactly with the tuned driver and sender frequency changer circuits, as these circuits are tuned by identical sections of the M.C. gang, in series with similar C5 (.01 mfd.) blocking condensers to keep +H.T.1 off the condenser plates. Therefore, C5A also becomes a tracking padder.

83. V2A (6K8G), a triode-hexode, is the receiver frequency converter.

(a) The triode section acts as the receive conversion oscillator, the oscillatory circuit used being a tuned plate, untuned grid. It is more stable than the conventional tuned grid type. The common cathode connects to ground through R3A (270 ohms) which is by-passed by C4E (.1 mfd.). R6B (47,000 ohms) provides grid leak bias, connecting the oscillator grid to the cathode. C7A (30 mmfd. ceramic) couples the grid to either the high or low band grid coil through band switch S11A/7. R2F (220 ohms) and R39B (820 ohms) are in series with the high and low band grid coils L24B and L25B respectively. They serve to suppress harmonic generation in the local oscillator, and to provide more even feedback across the band. The plate circuit is shunt fed from the +H.T.1 line through decoupling resistor R34B (47,000 ohms); and C2B (.0001 mfd.) serves as a D.C. blocking condenser, coupling the plate to its tuned circuit.

(b) Both high and low band circuits are tuned by the M.C. gang section C9B (530 mmfd. variable) in parallel with high band trimmer C35A (4–30 mmfd. variable ceramic).

(c) C8A (.0031 mfd.) in series with L/C-103A connects the "cold" end of the high band coils to ground. Being effectively in series with the C9B gang condenser and trimmers, C8A acts as a series tracking padder to ensure that the receive conversion oscillator will track the R.F. stage with a constant lead of 465 Kc/s. right across the band.

(d) L/C-103A, (one turn) with an adjustable powdered iron core allows the oscillator frequency to be shifted approximately ± 1 Kc/s. at 2.0 Mc/s. and +4Kc/s. at 8.0 Mc/s. for minor netting correction. This is adjustable from the front panel, the core being pushed in or pulled out of the coil slightly to change inductance. When on high band the low band coil L25A is shorted by S11A/8 to prevent absorption by this coil.

(e) The low band is tuned by the same M.C. gang section, C9B and trimmers, with the addition of the low band trimmer, C35B (3–13 mmfd. variable ceramic). C11A (6.5– 140 mmfd. variable air capacitor) is connected from the "cold" ends of L25A and B to ground to act as an adjustable padder for tracking correction at the low frequency end of the low band. C12A (1780 mmfd.) in series with L/C-103A also is connected between the "cold" ends of L25A and B to ground where it acts as a padder in series with the main gang for tracking purposes. L/C-103A serves the same purpose as it did on high band.

84. The hexode section of V2A is used as the receive mixer.

(a) This valve is self-biased by cathode resistor R3A, by-passed by C4E. R42A (10,000 ohms) shunted across C5A from the control grid, connects through S11A/6 and either L23A or L22A to ground for cathode biasing purposes.

(b) From the +H.T.1 line is a voltage divider network to ground consisting of R45A (22,000 ohms), R4A (22,000 ohms) and R.F. gain control, R/C-105A (10,000 ohms variable). The screen grid taps in on this network at the junction of R45A and R4A. R45A serves as a decoupling resistor, in conjunction with C4D (.1 mfd.) which bypasses the screen to ground. The remainder of the bleeder network from screen to ground aids in regulation of screen voltage, besides being primarily a portion of the R.F. gain control circuit.

(c) The mixer plate voltage is fed from the +H.T.1 line through R5B and the primary of the I.F. transformer L8A to the mixer plate. R5B (2,200 ohms) in conjunction with C4F (.1 mfd.) serves as a plate decoupling network.

(d) When the signal frequency is applied to the mixer control grid, the amplified signal will appear in the mixer plate circuit. The conversion oscillator has its grid connected to an injector grid in the mixer portion of V2A, so that it is electronically coupled, so that incoming signal frequencies and amplified oscillator frequencies, differing from each other by 465 Kc/s. will heterodyne together producing a sum frequency and a difference frequency beat note in the mixer plate circuit, each of which will contain the original signal frequency modulations. This difference beat note (465 Kc/s.) is the one to which all the I.F. amplifier circuits are tuned.

85. The 1st I.F. transformer, L8A, consists of a primary and secondary winding. The primary has C13A (140 mmfd. ceramic compensator) shunted across it. This lumped capacity provides a high percentage of total resonant capacity in the circuit, so that changing valves will have minimum effect on resonant frequency. The primary is tuned to resonance at 465 Kc/s. by an adjustable polyiron core. The secondary of L8A has its low potential end connected to the A.V.C. line which is by-passed to ground by C38A. The high potential end connects to the control grid of the 1st I.F. amplifier, V1B. C13B (140 mmfd. ceramic compensator) shunted across the secondary serves the same purpose as C13A. The secondary is permeability-tuned by an adjustable powdered iron core to 465 Kc/s. Some types of I.F. transformers used require damping resistors, R7A and R7B (100,000 ohms) shunted across the primary windings of L8A and L8B. They aid in attaining proper I.F. band width. I.F. transformers requiring these resistors can be identified by the fact that their aligning slugs must be wax-sealed. I.F. transformers manufactured by R.C.A. Victor or Canadian Marconi Co. do NOT use these resistors and attain proper performance by using tight coupling between primary and secondary windings to provide broad response at the resonant frequency to pass the necessary sideband frequencies required for intelligibility on R/T. The 465 Kc/s. beat note in the plate circuit of V2A appears in the primary of L8A. It reaches large proportions in this resonant circuit while all non-resonant frequencies are suppressed. The I.F. (465 Kc/s.) signal is induced from the primary to the resonant secondary, and applied between ground (by-passed A.V.C. line) and the control grid of V1B.

86. V1B is the 1st I.F. amplifier stage.

(a) The suppressor grid is grounded.

(b) The cathode is by-passed to ground by C4H (.1 mfd.) and connects through R9A (1000 ohms) to the R.F. gain control line (junction of R4A, R2A and R/C-105A—See para. 82 (b)—cathode of V1A). This gives the valve a combination of cathode bias and variable bias to control the gain (this being a variable mu valve).

(c) The screen grid is connected to the screen of V1A, and uses the same filters or decouplers. It is fed from the +H.T.1 screen line, controlled by the "A" relay.

(d) The control grid connects through the secondary of L8A to the A.V.C. line for additional bias.

(e) Signals applied to the control grid will be amplified and appear in the plate circuit. +265 V. is fed to the plate from the +H.T.1 line, through the primary of the second I.F. transformer, L8B. The +H.T.1 end of L8B primary is by-passed to ground by C4I (.1 mfd.) which acts as a decoupler.

87. The second I.F. transformer, L8B, is identical with L8A, with permeability tuned primary and secondary, and lumped capacitors C13C and C13D (140 mfd. ceramic compensators). One end of the secondary applies the I.F. signal to the control grid of V1C, and the other end is connected to the A.V.C. line, by-passed to ground by C38A.

88. V1C (6K7G) is the 2nd I.F. amplifier stage.

(a) The suppressor grid is connected directly to ground.

(b) The cathode is grounded by R3B (270 ohms) by-passed by C4K (.1 mfd.) providing self-bias.

(c) The screen grid is fed from +H.T.1 screen line through decoupling and voltage dropping resistor, R19B (82,000 ohms) and is by-passed to ground by decoupling condenser C4O (.1 mfd.).

(d) The control grid connects through the secondary of L8B to the A.V.C. line for A.V.C. bias. I.F. signals applied to the control grid are amplified, and appear in the plate circuit.

(e) The plate is fed from the +H.T. 1line through R5C and the primary of L9A. R5C (2,200 ohms) in conjunction with C4L (.1 mfd.) acts as a plate decoupling network.

89. The 3rd I.F. transformer, L9A, has its primary and secondary permeability tuned to465 Kc/s. with lumped capacitors C13E and C13F (140 mmfd. ceramic compensators) shunted across them. The I.F. amplifiers V1B and V1C, with the six tuned circuits of L8A, L8B and L9A produce a greatly amplified I.F. signal to the exclusion of all others. The band width is 6 Kc/s.

90. V3A (6B8G) is a double-diode pentode. One diode section is used as the second detector. The cathode of V3A is by-passed to ground by C16A (12. mfd. electrolytic). One end of the secondary of I.F. transformer L9A is connected to the 2nd detector diode of V3A. The other end is by-passed to ground by C14A (.0001 mfd.) and from ground to the cathode through C16A. The "cold" end of L9A also has a D.C. path to cathode through R7C (100,000 ohms) and R1B (470,000 ohms). This places the diode at zero bias with respect to cathode. On each incoming cycle of the I.F. signal, each time the diode is made positive with respect to cathode, electrons will flow internally from cathode to diode, returning to cathode through R7C and R1B. Each time the diode is made negative with respect to cathode, this electronic flow will cease. Therefore the I.F. signal is rectified or detected. We now have left a rectified I.F. half cycle flow of electrons through the resistor network from diode to cathode externally. The varying amplitude of the I.F. peaks outlines the desired audio modulation. R7C, by-passed to ground by C14A and C15A (.0005 mfd.), constitutes an I.F. pi-filter. The I.F. pulsations are by-passed to ground, but A.F. is rejected, so that at the junction of R7C and R1B, only the audio modulations remain. (See Fig. 12).

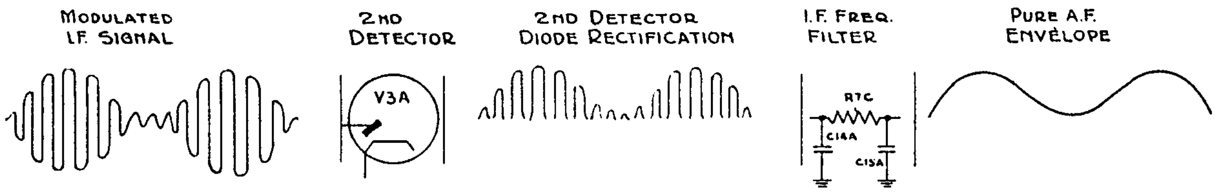


FIG. 12—WAVEFORMS IN 2nd DETECTOR STAGE.

91. R1B connecting the bottom of R7C to cathode is the load resistor across which these audio voltages are developed, and they are applied through C17A (.002 mfd.) to the AF GAIN A control potentiometer, R13A (1. meg.), the other end of which is by-passed to ground by C4N (.1 mfd.) and from there to cathode by C16A. Audio voltages developed across R13A are selected by the moving arm and applied through a shielded cable and through the "A" relay, No. 4 section, S5A, to the control grid of the pentode section of V3A.

92. The pentode section of V3A is used as an A.F. amplifier.

(a) The suppressor grid is connected to cathode internally.

(b) The cathode connects to ground through R9E (1000 ohms) and R11A (3,300 ohms) which are by-passed by C16A (12. mfd. electrolytic). This places the cathode approximately 27 volts above ground potential.

(c) The control grid has a D.C. path through No. 4 section of the "A" relay, S5A, and a portion of R13A to the junction of R9E and R11A. Thus only, the voltage drop across R9E (approximately -7 V.) is applied to the control grid for bias, instead of the entire -27 V.

(d) The screen grid is decoupled by C4M (.1 mfd.) to ground and receives its voltage through dropping and decoupling resistor R12A (68,000 ohms) and No. 3 section of the "A" relay S5A, to the +265 V. line.

(e) The plate +H.T.1 voltage is fed from the same source as the screen, i.e.—from the +H.T.1 side of the screen resistor R12A, through the primary of the audio output transformer, T2A to the plate. The +H.T.1 line is decoupled by a 20 or 32 mfd. condenser to ground in the supply unit.

(f) Audio signals applied to the control grid of V3A are amplified and appear at the plate circuit in the primary of T2A. C17B (.025 mfd.) and C15E (.0005 mfd.) in series, from the plate to ground, serve to by-pass some of the higher frequencies. In the M.C.W. position of function switch S7A there is also a path from the plate of V3A to ground through C23A (.005 mfd.) and R21A (27,000 ohms) through section 5 of S7A to ground. This will further limit H.F. response. One end of the secondary of T2A is grounded, and the tap connects through pin 4 of PL-2A to the control unit and across the dynamic headphones to ground, completing the circuit. The other end of the secondary is not used on Receive, although it still is connected into the circuit and its path through C22A (.025 mfd.), R6F (47,000 ohms) and C4N (.1 mfd.) to ground does act as a fixed load on the secondary at all times.

93. The 2nd dectector diode of V3A is coupled through C18A (20 mmfd.) to the A.V.C. diode section so that I.F. impulses are also applied between this diode and cathode, from the secondary of L9A. The A.V.C. diode is tied to ground through the A.V.C. load resistor R8A. (1. meg.) so that it is at ground potential. This means that it has a negative bias of -27 V. on it with respect to cathode, due to the cathode bias network. Incoming I.F. cycles must have positive peaks in excess of +27 V. to overcome this bias before the diode can draw electrons from the cathode and cause the A.V.C. to function. This is the "delayed" action spoken of in this delayed A.V.C. circuit. The A.V.C. will not limit weak signals as it does not start to operate until the incoming signals reach a peak of more than +27 volts at this point. Electrons flowing internally from cathode to diode on the positive I.F. peaks return to ground via the A.V.C. load resistor R8A, and from there through the cathode network to cathode. The voltage drop across R8A leaves the diode with a negative D.C. potential with respect to ground. This point is fed through R8B (1. meg.) and RC-103A (1. meg.) to the A.V.C. line supplying negative bias to the control grids of V1C, V1B and, through L10A, to V1A. This line is by-passed to ground by C38A (.1 mfd.) which with R8A, R8B and R/C-103A forms a time constant filter to eliminate I.F. and A.F. pulsations and to slow down the A.V.C. response so that it will not react to each burst

of static or other interfering signals. The stronger the applied I.F. signal to the A.V.C. diode, the greater the electronic flow through R8A. This increases the voltage drop, applying a stronger negative potential to the A.V.C. line. This increases the bias on the A.V.C. valves and reduces their gain. The converse is true with weak signals, so long as they are over the 27 V. minimum below which the A.V.C. will not act. The junction of R8B and R/C-103A connects to the AVC ON-OFF switch, S/C-105A, by means of which this junction may be grounded. This means that the A.V.C. line is connected in series with R/C-103A (1. meg.) to a point of ground potential. This is essential on C.W. or any form of keyed carrier reception, or the A.V.C. circuit will operate at each incoming dot and dash, producing a degenerative effect.

94. The triode section of V2B (6K8G) is the B.F.O. and netting oscillator. This is a Colpitts' oscillatory circuit consisting of slug-tuned L5A (adjustable polyiron core) with C20A (.002 mfd.) and C19A (90 mmfd. ceramic compensator). C7B (30 mmfd.) is the grid coupling condenser, and R6D (47,000 ohms) to ground provides grid leak bias.

(a) The cathode is connected to ground through R2B (220 ohms) by-passed by C4Q (.1 mfd.) providing cathode bias.

(b) The plate circuit is shunt fed through decoupling and plate load resistor, R34C (47,000 ohms). When netting switch S/C-105B is closed, +H.T.1 voltage is supplied from the +265 V. line, through S/C-105B and R34C to the triode plate of V2B.

(c) The secondary of L5A has one end grounded, and from the other end R16A (½ ohm) completes the circuit to ground, acting as a fixed load. L5A is iron core-tuned to exactly 465 Kc/s., the centre of the I.F. channel.

95. When the B.F.O. is oscillating, its signal is injected into the I.F. channel producing the results described in para. 76. This netting signal is injected into the I.F. channel in two ways:

(a) By stray couplings in parallel leads and a common power supply, etc.

(b) The oscillator grid connects to the injector grid in the hexode portion of V2B. There is interelectrode capacity between this and the hexode control grid. This control grid connects by means of the shielded cable through R42C (10,000 ohms) and C21A (30 mmfd.) to the Osc. grid of V2A, the receive conversion oscillator. From there, through the injector grid, it couples into the mixer section of V2A and into the I.F. channel. It actually grid modulates V2A Osc.

96. When function switch S7A is switched to C.W. (Rec.) +265 V. is supplied from the +H.T.1 line to the plate of the oscillator section of V2B through section 6 of S7A. At L5A coil the additional load of R14A (6 ohms variable) is shunted across the secondary. It connects the high potential end of the secondary, through section 7 of the S7A function switch and section 1 of "A" relay, S5A, to ground. This additional load acts to detune the B.F.O. from 465 Kc/s. by approximately 1½ Kc/s., variable over a range of approximately 1 Kc/s. This signal is injected into the I.F. channel as described in Para. 95.

The "A" Sender

97. The triode section of V2A, the conversion oscillator for the receiver, tuned by the M.C. gang, becomes the master oscillator for the sender. The R.F. generated by this oscillator is fed to the mixer grid of V2B, the sender frequency changer, which converts the V2A oscillations to exactly the frequency of the incoming signal to which the receiver is tuned. For example:—If the "A" receiver's incoming signal were 6000 Kc/s., then the M.C. dial would be set to 6 Mc/s. But the receive conversion oscillator (V2A) would be oscillating at exactly 6465 Kc/s. in order to produce a 465 Kc/s. I.F. beat note in the receive mixer (at zero beat with 465 Kc/s. B.F.O. on NET). On Send the B.F.O. (V2B triode section) oscillates at exactly 465 Kc/s. Mixing the V2A triode frequency (6465 Kc/s.) and the B.F.O. frequency (465 Kc/s.) in V2B sender mixer section produces a 6000 Kc/s. "difference beat frequency" exactly the same as the receiver's incoming signal frequency. A "sum" beat note of 6930 Kc/s. is also present in V2B mixer plate circuit, along

with the two parent frequencies, but a tuned V2B mixer output circuit suppresses unwanted frequencies, and applies the desired "difference beat frequency" to the control grid of V5A.

98. V5A, the driver-buffer, amplifies the "difference beat frequency" applied to its control grid by the V2B mixer. Its tuned output circuit further suppresses the unwanted frequencies, and applies the desired one to the control grid of V4A and to V6A diodes.

99. V6A has its diodes excited from V5A. One diode is used in an automatic drive control circuit to stabilize the amplitude of V5A's R.F. output over the entire band. It accomplishes this by controlling the bias on V5A in a circuit very similar to delayed A.V.C. The other diode is used to rectify some of the R.F. output of V5A and apply the resultant D.C. to the set meter as a "Drive" indicator.

100. V4A is the R.F. power amplifier. Its control grid is excited from V5A, and its plate output circuit feeds amplified R.F. through the P.A. tank and variometer to the aerial. V4A is grid modulated on R/T or M.C.W. by V3A.

101. The pentode section of V3A becomes a microphone amplifier and modulator on R/T, and an audio oscillator and modulator on M.C.W. It is not used on C.W.

102. The following circuit changes take place in the "A" sender, when switching "A" relay, S5A, to Receive:—

(a) V2B (mixer section) plate and screen +H.T.1 circuit is opened by section 2 of S5A rendering the mixer section inoperative.

(b) V2B (B.F.O. section) plate +H.T.1 circuit is opened by section 3 of S5A so this section becomes inoperative unless the netting switch is used, or S7A is switched to C.W

(c) V5A plate and screen +H.T.1 circuit is opened by section 2 of S5A rendering the valve inoperative.

(d) In V4A the cathode short to ground is opened by section 1, S5A. The cathode is always connected to the junction of R18B (270,000 ohms) and R19A (82,000 ohms). This junction is by-passed to ground by C15C (.0005 mfd.). R18B and R19A form a voltage divider network from the +H.T.1 line to ground, placing a cathode bias of +62 V. on the cathode of V4A on Receive. As the control grid of V4A has a D.C. path to ground, it is 62 V. negative with respect to cathode, which is sufficient for "cut off." The screen +H.T.1 circuit is opened by section 2 of S5A. This, along with cathode bias, prevents any H.T. 2 current from flowing in V4A plate circuit which has no switches.

(e) V6A (Drive Meter-rectifier section) cathode is at all times connected to the cathode of V4A, (See [d] above) and is therefore cathode biased also on Receive.

(f) V3A control grid is connected to A GAIN control, R13A, by section 4 of S5A.

103. The triode section of the master oscillator (V2A) operates exactly as it did on Receive (See Para. 83 [a]). The R.F. output is fed from the oscillator control grid through C21A (30 mmfd.), R42C (10,000 ohms) and the small coaxial tube to the control grid of V2B mixer section. R7L (100,000 ohms) connects to ground the junction of R42C and the coaxial tube, forming a voltage divider network to control the amount of excitation applied to V2B. It also serves as a grid return path, placing the mixer grid of V2B at D.C. ground potential for cathode biasing purposes.

104. V2B (6K8G) is the sender frequency changer, the triode section being the B.F.O. The +H.T.1 line is connected through section 3 of the "A" relay, S5A, to the B.F.O. plate circuit. This causes the B.F.O. to oscillate at exactly 465 Kc/s., as it did on Receive when used as a netting oscillator (See Para. 94). The R.F. generated, is applied from the oscillator control grid to the injector grid of V2B hexode section.

105. The hexode section of V2B is the sender mixer.

(a) The cathode is grounded through R2B (220 ohms), by-passed by C4Q (.1 mfd.), giving the valve cathode bias.

(b) The screen grid voltage is fed from the +H.T.1 line through section 2 of S5A and section 1 of function switch S7A (R/T). R45B (22,000 ohms) serves as a voltage dropping resistor, and a screen decoupling network in conjunction with C4U (.1 mfd.) which by-passes the screen to ground.

(c) The control grid has master oscillator excitation from V2A applied to it. The injector grid has the B.F.O. frequency applied to it. The plate circuit has both these frequencies appearing on it in amplified form, and also the "sum" and "difference" heterodyne beat frequencies. The "difference" beat frequency is the desired one because the master oscillator frequency equals the receiver incoming signal plus 465 Kc/s. When this is blended with the B.F.O. frequency (465 Kc/s.) the difference beat frequency is the same as the receiver incoming signal frequency.

(d) The gang-tuned mixer output circuit, consisting of high band tank circuit L7A, or low band tank L21A, suppresses the unwanted frequencies, and applies the desired one between grid and cathode of V5A driver via grid coupling condenser C2C (.0001 mfd.) and C4T (.1 mfd.) which by-passes the "cold" end of the tank circuit to ground.

(e) Plate voltage is fed from the same source as the screen and passes through R5E (2,200 ohms) filter decoupler in conjunction with C4T. From there the +H.T.1 is fed through either L7A or L21A, and across band switch S11A/1 to mixer plate.

(f) M.C. gang section C9D (530 mmfd. variable), with high band trimmer, C10C (4–30 mmfd. variable ceramic) and series padder C5C (.01 mfd.) are common to both bands. C5C serves to block +H.T.1 and keep it off the tuning gang plates.

(g) Inductance L7A has a fixed polyiron core. A part of L7A is wound with fine wire and is not included in the tunable portion of the circuit. Its purpose is to match the mixer output tracking with that of the receiver mixer, V2A, which has to track over the same frequency range, and is tuned by a similar M.C. gang section. While on high band, the tunable portion of the low band coil L21A is short circuited by S11A/2 to prevent absorption of "Drive" by this coil.

(h) L21A is the inductance employed on low band. It is similar to L7A above, only it is tunable over a lower frequency range. All the high band capacitors are still in the circuit, with the addition of the low band trimmer C10E (4–30 mmfd. variable ceramic).

106. V5A (EF50), the driver-buffer, serves as an R.F. "Drive" frequency amplifier, and as a buffer stage to prevent reaction between the frequency changer, V2B, and the power amplifier, V4A.

(a) The suppressor grid is connected to ground.

(b) The cathode connects to ground through R20B (100 ohms) by-passed by C4S (.1 mfd.) providing cathode bias.

(c) The control grid has a D.C. path to ground through R1E, R1D, and R1C, and is supplied with negative bias from the automatic drive control circuit of V6A.

(d) The screen grid voltage is fed from the same source as the screen of V2B mixer (See Para. 105 [b]), through R17A (3900 ohms) which serves as a decoupling network in conjunction with C20B (.002 mfd.) which by-passes the screen to ground.

(e) Plate voltage is fed from the same source as the screen, through R5D (2200 ohms) and either L4A or L6A, across S11A/3 to the plate of V5A. R5D, in conjunction with C4R (.1 mfd.) serves to decouple the +H.T.1 line feeding the plate circuit. Drive frequency voltages applied to the control grid are amplified by the valve and appear in the plate circuit. The gang-tuned driver output circuit, consisting of high band tank circuit L4A, or low band tank L6A, suppresses unwanted frequencies, and applies the desired one between control grid and cathode of V4A via coupling and D.C. blocking condenser C2E (.0001 mfd.) and C34A (7–45 mmfd. variable ceramic). C4R by-passes the "cold" end of the tank coils to ground. C2E is also coupled to the drive rectifier diode of V6A, and through C2D (.0001 mfd.) to the automatic drive control diode.

107. The driver output tuned circuits are similar in every way to the mixer output tuned circuits (See Para. 105 (f), (g), and (h)). The M.C. gang section C9C (530 mmfd. variable) with high band trimmer C10B (4-30 mmfd. variable ceramic) and series padder C5B (.01 mfd.) are common to both

bands. C5B serves to keep +H.T.1 off the tuning gang plates. When switching to low band, the additional low band trimmer C10F (4-30 mmfd. variable ceramic) is added to the circuit.

108. V6A (6H6) is a double-diode, one diode acting as a meter rectifier. The cathode is connected to the cathode of V4A which is grounded on Send by section 1 of S5A, the "A" relay. The diode plate connects to the junction of C2E and C34 A, so it receives "Drive" voltages from V5A. On incoming drive R.F. cycles, when the diode is negative with respect to cathode nothing happens. On the other half-cycle when the diode is positive with respect to cathode, it attracts electrons from the cathode which places a D.C. negative potential on the diode. Thus the drive is rectified. These electrons complete their external circuit to ground and back to cathode through the load resistors R15B (220,000 ohms) and R42B (10,000 ohms) which form a voltage divider network. The junction of these two resistors is by-passed to ground by filter condenser C15M (.0005 mfd.). A lead from this junction passes through meter switch S8A (on DRIVE position) and through the meter to ground. Rectified current flows through the meter, shunted by R42B, and gives a reading on the set meter that is directly proportional to the drive output voltage of V5A driver.

109. The automatic drive control section of V6A has its cathode by-passed to ground by C15B (.0005 mfd.). It also connects to the junction of R18A (270,000 ohms) and R43A (100,000 ohms variable) which form a voltage divider network from the +H.T. 1 line to ground. By adjusting R43A, the cathode may be biased between 0 and +70 volts with respect to ground. The proper adjustment is +40 V. The diode plate has a D.C. path to ground through R1C, so there is negative bias of 40 V. on it. This diode is coupled to V5A driver via C2D (.0001 mfd.) and C2E (.0001 mfd.). Therefore the positive drive peaks must be greater than +40V. in order to overcome this bias before the circuit will commence to function. If this drive is over +40 V. on the positive peaks, the diode becomes more positive than cathode, attracting electrons to it which flow externally across the load resistor R1C (470,000 ohms) to ground. This places the diode at a negative D.C. potential, due to rectified drive. This negative potential is tapped off the diode through filter network R1D (470,000 ohms), by-passed by C15D (.0005 mfd.), and is applied through R1E to the control grid of V5A driver. R1E (470,000 ohms) is a grid load to V5A to prevent escape at that point of applied drive from V2B. R1D and C15E form a "time constant" so that momentary minor disturbances will not affect drive bias. Decreased output results in converse action, down to a +40 V. minimum. Thus drive is held from exceeding a given level across the band.

110. The pentode section of V3A (6B8G), the microphone amplifier and modulator, functions exactly as it did on Receive (See Para. 92) except:—

(a) The control grid connects through section 4 of S5A relay and section 8 of function switch S7A to the secondary of the 50 to 1 step-up microphone transformer, T3A. Through the secondary of T3A it connects to the junction of R9E and R11A in V3A cathode network, placing 7 V. cathode bias on the pentode section. There is a grounded electrostatic shield between the primary and the secondary of T3A. One end of the primary is grounded, and the other end connects to pin 1 of PL-2A and from there, through the control unit (when switched to "A") across a dynamic microphone to ground, completing the circuit. Microphone voltages (A.F.) applied to the control grid of V3A in this manner are amplified by the valve and appear in the plate circuit at the A.F. output transformer, T2A.

(b) Plate and screen voltages are now applied from the +H.T.1 line through section 9 of function switch S7A on R/T. The secondary of T2A functions exactly as it did on Receive (See Para. 92 (f)) only now it serves to provide the "A" receiver headphone channel with "sidetone" from the operator's microphone. The primary of T2A becomes a modulation choke, and from the plate end, C17B (.025 mfd.) and C15E (.0005 mfd.) form an A.F. voltage divider network to ground. From the junction of these two, the desired amplitude of A.F. voltage is tapped off through R7G to the control grid of V4A, providing grid modulation. R7G (100,000 ohms) in conjunction with C15E acts as a filter to prevent "Drive" R.F. from escaping from the control grid of V4A to the modulator.

111. V4A (807) is the grid modulated R.F. power amplifier.

(a) The cathode is grounded on Send by section 1 of S5A. -H.T.2 (-540 V.) connects from pin 7 of PL-2B to ground through R/C-104A (1500 ohms). The normal voltage drop across this due to cathode current is approximately 40 volts. This resistor is heavily by-passed by C/C-107A (12. mfd. electrolytic).

(b) The control grid connects through filter resistor R7D to the junction of -H.T.2 line and R/C-104A so it has a bias of approximately -40 V. on it with respect to the cathode of V4A.

(c) The screen grid is by-passed to ground by decoupling condenser C15F (.0005 mfd.) and connects through decoupling resistor R20A (100 ohms) to section 1 of function switch, S7A. From there, on R/T, it connects through section 2 of S5A relay to the +H.T. 1 line.

(d) The plate connects through R22A (47 ohms) and the P.A. tank coil L3A to pin 4 of PL-2B, +H.T.2 (+540 V.). C33B (.1 mfd.) from the "cold" end of L3A to ground serves to decouple the +H.T.2 line. R22A suppresses parasitic oscillations in the P.A. tank.

(e) R.F. drive voltages applied to the control grid are amplified and appear in the plate circuit. This excitation, controlled by C34A, MUST be sufficiently attenuated so that the unmodulated plate current is running at roughly ½ saturation tc allow for upward expansion on the positive A.F. peaks, when modulated. Under modulation, the A.F. voltages applied to the control grid through R7G and network alternately increase and decrease the average grid bias on each A.F. half cycle. At 100% modulation, the plate current will rise to saturation on the positive A.F. peaks, and drop towards zero on the negative A.F. peaks. Thus, the R.F. output of V4A is effectively amplitude modulated. The tuned P.A. tank circuit further suppresses unwanted frequencies.

112. The P.A. tank circuit consists of the inductance L3A, with a fixed powdered iron core and the P.A. tuning condenser C3A (16-550 mmfd. variable). C36A (.01 mfd.) serves to block +H.T.2 from the tuning condenser plates. R.F. power developed in the P.A. tank is fed from a tap on L3A, through the coupling condenser C1A (.004 mfd.) to "AERIAL A" socket, S04A, on the front panel. Choke L2B prevents loss of R.F. through the meter circuit.

113. The variometer consists fundamentally of a continuously-variable inductance. The basic idea consists of a total inductance composed on two coils. One of these can be rotated so that its magnetic field either aids or opposes the other, thus smoothly varying the total inductance. It is used to add inductance artificially to the normal short aerial rod (12′) to bring it to resonant ¼ wavelength so that aerial currents of the desired frequency will find very low impedance offered by the circuit, and can thus reach the large proportions required for the radiation of R.F. energy. The variometer is fed from the AERIAL A socket, S04A, by a coaxial feeder. R.F. cannot pass through choke L2.1A so it passes through C24A (.001 mfd.) through the variometer coils, L1A, and the primary of the aerial current meter transformer, T1A, and out of the variometer to the aerial proper. The No. 19 set variometer can be continuously rotated through 360° due to the brush and slip ring feed. At each 180° phase relation position, a switch changes the two coils from series to parallel, or vice versa. Red shows through the dial window to indicate switching changeover.

TABLE 11—VARIOMETER CHART

Variometer Calibration	Position of Coils	Used On	Inductance
0–100	series	low band	added
200–100	parallel	high band	reduced

114. R.F. aerial currents flowing through the single lead primary of T1A induce voltages in the secondaries whose junction is grounded. The unequal secondaries feed the full-wave dry rectifier, W1A, through damping resistors R10A (470 ohms) and R28A (27 ohms) which tend to distribute the load more evenly. T1A has unequal secondaries for a definite reason. The smaller winding is roughly resonant to 6 Mc/s, the centre of the H.F. Band, and the larger is roughly resonant to 3 Mc/s, the centre of the L.F. Band. Thus false resonant peaks are avoided on AE. current meter readings, which are more approximately constant across both bands. C26A (.001 mfd.) by-passes the centre of W1A to ground, completing the R.F. circuit for each secondary, thus acting as a filter for the rectified D.C. The grounded secondary tap is connected to ground on the No. 19 set chassis via the metal shield of the coaxial feeder, and S04A on the front panel. The centre of W1A has a path to ground through the meter as illustrated in Fig. 13, so rectified D.C. proportional to the aerial current may show an indication on the meter when S8A is switched to AE. C26A and choke L2A serve to filter the rectified D.C., as does choke L2B and C17C (.002 mfd.). L2.1A serves to prevent R.F. from the coaxial feeder escaping to the meter rectified circuit. R29A (20,000 ohms variable) can be adjusted to control the amount of rectified D.C. fed to the meter.

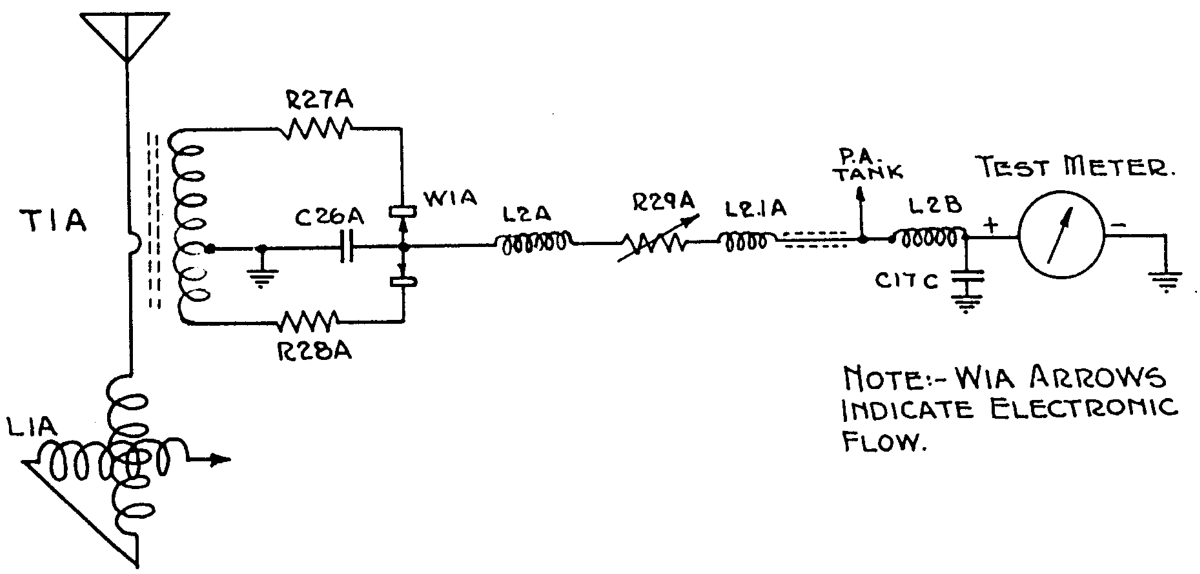


FIG. 13—METER RECTIFIER CIRCUIT

115. On M.C.W. the R.F. channel and the side-tone channel are identical with that used on R/T. Modulation of V4A is accomplished by the same circuits as on R/T, but V3A is now connected to act as an audio oscillator, controlled by the key, for modulating V4A when the key is depressed.

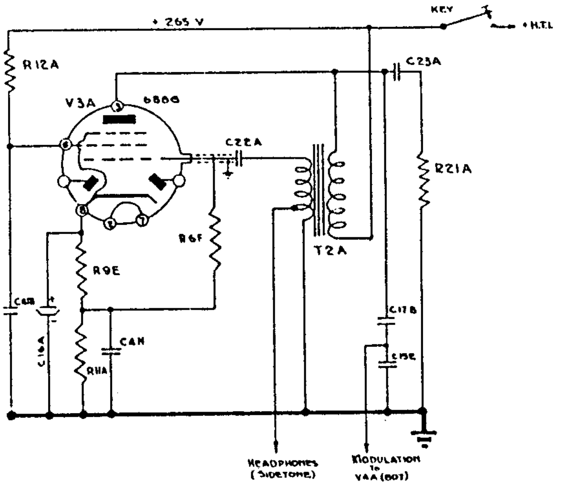


FIG. 14—V3A AS AN AUDIO OSCILLATOR

116. The secondary of T2A now becomes a grid coil while the primary becomes a plate tickler coil, producing audio oscillations by regenerative feedback. The control grid connects through section 4 of "A" relay to section 8 of junction switch S7A. In M.C.W. position this connects through coupling condenser C22A (.025 mfd.) to the secondary of T2A, the other end of which is grounded. This same lead also has a D.C. grid return path through R6F (47,000 ohms) to the junction of R9E and R11A in the cathode network of V3A. This places 7 V. cathode bias on V3A pentode section control grid.

117. The plate circuit now has a D.C. path from the plate of V3A to the +H.T.1 lead through the primary of T2A to section 9 of function switch S7A, to section 2 of S7A, through the key jack and depressed key, and back through J1A to section 3 of S7A. In M.C.W. position section 3 connects to the +H.T.1 line. The screen voltage comes from the same source. Thus it can be seen that the key controls only the plate and screen voltage to V3A for M.C.W. keying.

118. On C.W., V3A (pentode section) is not used as modulation is not required. Its plate and screen circuit is opened by section 9 of function switch S7A. Valve V4A is no longer biased by R/C-104A in the -H.T.2 return lead. The junction of -H.T.2, R/C-104A and grid resistor R7D (100,000 ohms) is now grounded by section 5 of S7A on C.W. The grid current through R1D on the positive drive peaks now provides grid leak bias. -H.T.2 now being grounded, also places +540 V. on the plate with respect to cathode, instead of the former +500V. This increased plate voltage, and reduced grid bias allows the plate current to approach saturation, and full R.F. power output may be obtained from V4A.

119. Keying is accomplished by opening and closing the +H.T.1 lead which feeds the screen grid of the power amplifier, V4A; the screen and plate of the driver, V5A; and the screen and plate of the mixer portion of V2B. This lead feeds from the above-mentioned valves to section 1 of S7A function switch which is in the C.W. position. Through this switch it feeds through section 2 of S7A to the key jack. From here it feeds through the depressed key, back through J1A to section 3 of S7A, through section 2 of the "A" relay to the +H.T.1 line. Due to the increased R.F. output on C.W., section 4 of S7A shunts R10C (470 ohms) in parallel across the meter to ground when meter switch S8A is on AE.

Supply Unit No. 2

120. The Canadian Supply Unit No. 2 is interchangeable with the British Mk. III Supply Unit. It was designed primarily for use with the Wireless Set (Cdn.) No. 19 Mk. III. This supply unit allows operation from three optional L.T. sources:—

(a) 12 volt — 2-wire systems (or ground return)

(b) 24 volt — 2-wire systems (or ground return)

(c) 24 volt — 3-wire systems (or ground return) (A 12 V. tap and approximately balanced current drain)

The more Standard type of operation is that described in (c) above.

121. The Supply Unit No. 2 consists fundamentally of:—

(a) PL-1C — 6-point L.T. inlet plug.
(b) PL-2C — 12-point power outlet plug (connected by cable to PL-2B on the No. 19 set.)
(c) A vibrator supply and filter having an input of 12 V. and a H.T. 1 output of 265 V.
(d) A dynamotor supply and filter having an input of 12 or 24 V. and a H.T.1 output of 265 V. and H.T.2 output of 540 V.
(e) S/C-102A—dynamotor 12 V. -24 V. switch.
(f) S/C-103A—vibrator-dynamotor Rec.-Send relay.
(g) S/C-101A—VIBR-OFF-DYN — a three-throw power switch. In OFF position it opens all battery leads.

122. The vibrator supply may be selected, if desired, by switch S/C-101A on the front panel of the supply unit. It may be used only with:—

(a) 12 volt, 2-wire OR
(b) 24 volt, 3-wire systems.

On 24 volt, 2-wire systems, the vibrator is inoperative. The vibrator supplies H.T.1 for "standby" Receive operation of the "A" set, and Send or Receive operation of "B" or I.C. set, at far greater battery economy than a dynamotor could provide. ANY TWO of "A", "B", or I.C. may be powered at one time from the vibrator supply, but NOT ALL THREE as it throws too great a strain on the vibrator circuit. On using the pressel circuit to throw the "A" set on Send, relay S/C-101A in the supply unit automatically switches from vibrator to dynamotor to handle the increased load on H.T.1 and to provide H.T.2.

123. The dynamotor supply may be selected, if desired, by switch S/C-101A on the front panel of the supply unit. It then will provide H.T.1 and H.T.2 for Send or Receive, and will operate on any of the L.T. systems described in Para. 120. It is a 4-commutator machine with 2 series and 2 shunt field windings. The armature contains a H.T.2 winding (540 V.), a H.T.1 winding (265 V.) and two 12 volt motor windings. Each motor winding operates in conjunction with one series and one shunt field. These fields are cumulatively compounded to compensate for added load on Send. The motor windings, each in conjunction with its fields, may be operated either in series with each other, from a 24 V. source, or in parallel with each other from a 12 V. source. This is controlled by switch S/C-102A located internally in the supply unit. This switch may be locked in either the 12 or the 24 V. position, and MUST BE SET for the L.T. system available. 24 V. operation is the desirable type where available.

124. When using 3-wire, 24 V. operation (See Table 12) -24 V. and the vehicle chassis ground are connected to pin 1 of PL-1C. This connects to the supply unit ground and to pin 1 of PL-2C. This connects through the 12-point connector cable to pin 1 of PL-2B on the front panel of the No. 19 set, where it is grounded to the No. 19 set chassis, thus establishing a common -24 V. and ground all the way through.

TABLE 12—BATTERY CONNECTIONS TO PL-1C

Type of Operation	Connections	Position of S/C-102A
2-wire, 12V.	-12 V. to pins 1 and 6 +12V. to pins 3 and 4	12 V.
2-wire, 24V. (vibrator inoperative)	-24 V. to pin 1 +24 V. to pin 4	24 V.
3-wire, 24V.	-24 V. to pin 1 +12 V. to pins 3 and 6 +24 V. to pin 4	24 V.

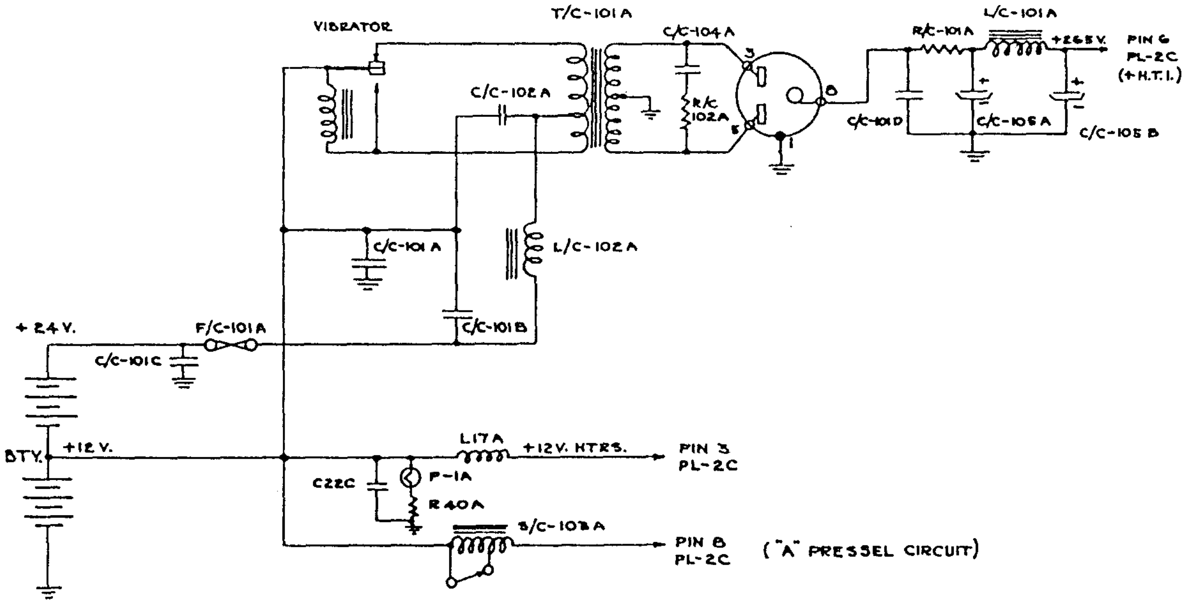


FIG. 15—VIBRATOR ON RECEIVE

125. When S/C-101A is on "Vibr" and S/C-103A is on Receive, the 12 V. heaters (and relays) of the No. 19 set are fed between +12 V. and Bty. minus (ground). The negative of the battery (–24 V.) is distributed as in Para. 124. +12 V. connects through pin 3 of PL-1C to section 2 of the power switch, S/C-101A. From there, in the vibrator position, it connects through section 2 of relay S/C-103A on Receive and through choke L17A to pin 3 of PL-2C. From pin 3 it is connected by external cable to pin 3 of PL-2B on the No. 19 set where it may be used to power valve heaters (and relays) whose other ends are grounded, thus completing the circuit. L17A, by-passed to ground by C22C (.025 mfd.) serves to act as an hash filter on this +12 V. lead. Pilot lamp, P1A (12 V.) in series with resistor R40A (20 ohms) to ground indicates when the master switch, S/C-101A is on "Vibr." or "Dyn."

126. The 12 V. vibrator is fed between +24 V. and +12 V., +24 V. connects through pin 4 of PL-1C to section 3 of S/C-101A. This lead is by-passed to ground by filter capacitor C/C-101C (.1 mfd.). In the "Vibr." position of S/C-101A it feeds to section 3 of relay S/C-103A and in Receive to the 10 amp. fuse F/C-101A. Through there, it feeds through L/C-102A to the tap on the primary winding of the vibrator transformer T/C-101A. From the primary transformer, the primary circuit is completed through the vibrator points to pin 6 of PL-1C which is connected to +12 V. on the Bty. Thus, the load on the 24 V. battery is to some extent balanced, with the heaters across one half, and the vibrator across the other. Although the "A" and "B" set relay coils are in parallel with heaters, they draw no current on Receive as their circuits are not completed to ground.

127. H.T.1 (265 V.) from the secondary winding of the vibrator transformer V/C-101A is rectified by V/C-101A (OZ4A full-wave gaseous rectifier). H.T.1 minus is the grounded tap on the transformer secondary, and rectified H.T.1 plus is fed from the V/C-101A "cold" cathode through the filter network to section 4 of S/C-103A relay. On Receive it feeds from here to section 4 of power switch S/C-101A. In "VIBR" position it feeds through the switch to pin 6 of PL-2C, which connects by external cable to pin 6 of PL-2B on the No. 19 Set front panel, supplying H.T.1 (+265 V.) to the set.

128. The operation of relay S/C-103A on Send with S/C-101A on "VIBR" is outlined herewith. As in Paras. 126 and 127, +12 V. connects through pin 3 of PL-1C to section 2 of S/C-101A. In "VIBR" position it also connects

from there through section 1 of S/C-101A, and through section 1 of S/C-103A to the relay coil tap. From this tap it feeds through the low resistance of a portion of the relay coil to pin 8 of PL-2C. By external cable this is connected to pin 8 of PL-2B on the No. 19 set and to pin 7 of PL-2A. When the microphone pressel switch or key jack circuit is closed on "A" Send, pin 7 of PL-2A is grounded, completing the circuit through the vibrator relay coil. A heavy current flows through the tapped portion of the relay coil, due to this circuit, and strongly energizes it to overcome the spring tension and throw the S/C-103A relay to Send. As section 1 of S/C-103A is now NOT connected to the tap, the relay current is forced to flow through the entire relay coil, which reduces the current to a value just sufficient to "hold" the relay.

129. The following circuit changes are effected by relay S/C-103A on moving to Send position :—

(a) In the primary circuit of the dynamotor +24 V. feeds through pin 4 of PL-1C to section 3 of S/C-101A as in Para. 126. In "VIBR" position it connects through to Section 3 of S/C-103A. However, as the relay is now on Send, this lead does not feed through the vibrator, but feeds down to the dynamotor. With switch S/C-102A in the 24 V. position, this +24 V. lead feeds through the two 12 V. motor armature circuits in series, to ground, completing the 24 V. dynamotor circuit, as illustrated in Fig. 16.

(b) Following through the valve heater circuit described in Para. 125, it will be seen that it has been opened by the relay S/C-103A on Send. Referring to Fig. 16, there will be a 12 V. drop in potential across each motor-armature circuit. At the junction of the two armature circuits, the potential will be +12 V. with respect to ground, and can be used as a voltage divider network to feed the heater circuits. This junction connects through section 2 of S/C-103A on Send and through filter L17A to pin 3 of PL 2C and the No. 19 set heater and relay circuits.

(c) H.T.1 (265 V.) is now generated in the H.T.1 armature winding of the dynamotor. The negative brush is grounded, and the positive brush is by-passed to ground by C/C-101E (.1 mfd.). From the positive brush, the H.T.1 lead passes through fuse 1-B (250 Ma.) to section 4 of S/C-103A. C32A (32. mfd. electrolytic) serves to bypass to ground all frequencies, A.F. or R.F. found on the H.T.1 line. Section 4 of S/C-103A, on Send, feeds through section 4 of S/C-101A on "VIBR" to pin 6 of PL-2C and from there to the No. 19 Set.

(d) 540 V. is generated in the H.T.2 armature winding. The negative brush is by-passed to ground by C4CP (.1 mfd.) and feeds through pin 7 of PL-2C to the No. 19 Set. The positive brush is by-passed to ground by C/C-106A. (.1 mfd.) and

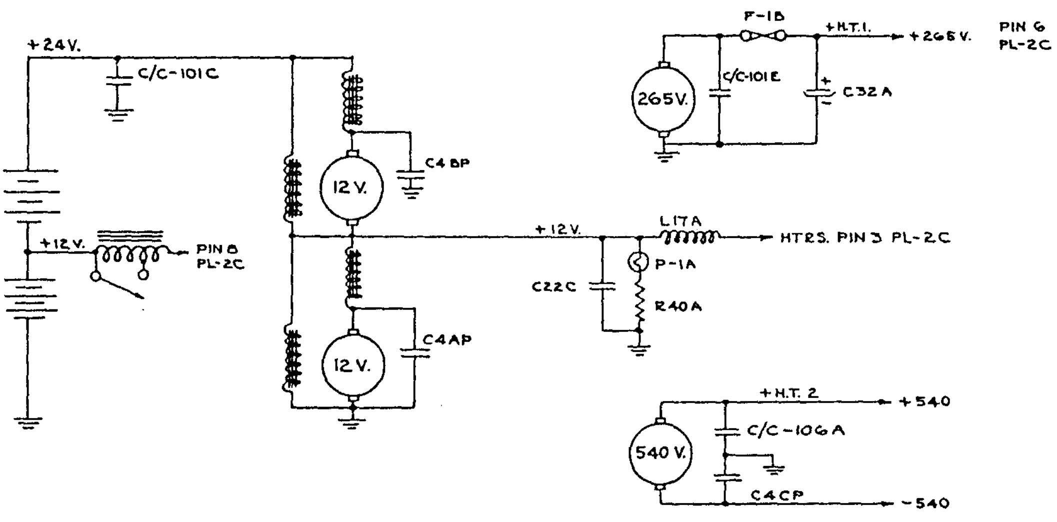


FIG. 16—DYNAMOTOR—24 V. OPERATION

H.T.2 is fed through filter choke L18A and fuse 1-A (250 Ma.) to pin 4 of PL-2C. From there it is fed to the No. 19 set.

130. When S/C-101A is on "DYN", the vibrator circuit is inoperative. The dynamotor and heater circuits are the same as in Para. 129, likewise H.T.1 and H.T.2. +24 V. for dynamotor, etc., feeds from pin 4 of PL-1C through section 3 of S/C-101A on "DYN" to the dynamotor circuit. +12 V circuit from pin 3 of PL-1C is now open, so relay S/C-103A is also inoperative.

131. In 2-wire, 24 V. operation, (See Table 12), as there is no +12 V. battery tap, the vibrator which normally operates between +24 V. and +12 V. has no negative (+12 V.) path, and so is inoperative. Therefore S/C-101A must be switched to "DYN". Also, with no 12 V. tap, relay S/C-103A is inoperative. The entire power supply action is now the same as in Para. 130.

132. 2-wire, 12 V. operation is similar to that described in Para. 124 except:—

(a) Only a 12 V. battery is used, which connects to pins 3 and 4 of PL-1C (positive) and pins 1 and 6 of PL-1C (negative) so as to place heater and vibrator circuits in parallel from the same 12 V. source.

(b) S/C-102A is locked in the 12 V. position, to place the two dynamotor motor windings in parallel for 12 V. operation.

(c) On Send or "DYN" the heater circuit still taps off the junction of the two motor windings, but, being now in parallel, there is still +12 V. available at that point for the heaters.

133. 12 V. D.C., is the primary power source. It is necessary to convert it to A.C. in the primary winding of T/C-101A. This is accomplished by an automatic vibrating switch. The 12 V. vibrator is fed from the battery through the 10 amp. fuse F/C-101A to the centre tap of the primary winding of T/C-101A. C/C-101B (.1 mfd.) and C/C-102A (.5 mfd.) in conjunction with L/C-102A act as a filter to keep vibrator hash out of the plus battery line. These two filter capacitors by-pass the— "Vibr." lead (on each side of L/C-102A) to the "Vibr." minus lead, which is in turn by-passed to ground through C/C-101A (.1 mfd.). On 2-wire, 12 V. operation, this "Vibr." minus lead is actually grounded, so the by-pass, C/C-101A, becomes superfluous. When battery current is first applied to the circuit, the vibrator points are "up", due to spring tension. There is now a complete circuit from battery minus through the vibrator points, and through the "upper" half of the transformer primary to the centre tap, and through the pi-filter to battery plus. There will also be a very slight current through the vibrator coil and through the "lower" half of the transformer primary to the centre tap. The magnetic field in the transformer caused by this would tend to oppose that caused by the current in the opposite direction through the upper half, but, due to the resistance of the vibrator coil, this "lower" current is so slight it can be ignored. The tap on primary of T/C-101A is slightly off-centre to counteract this effect. However, it does energize the vibrator coil which draws down the vibrator armature by magnetic attraction so that it breaks the circuit through the "upper" half of the primary winding of T/C-101A, and makes contact with the "lower" contact point, passing a strong current through the "lower" winding to the centre tap. This strong current in the opposite direction reverses the magnetic field in the transformer. However, as soon as the vibrator armature contacts the lower point, the vibrator coil is shorted out, and loses its magnetism, so spring tension returns the armature to its upper contact point, and the cycle starts over again, once more reversing the transformer magnetic field. This cycle repeats rapidly at a frequency determined by many constants, chiefly, however, by the mass of the vibrating armature. C/C-103A across the primary acts as a buffer, and prevents arcing at the contact points. The alternating magnetic field cuts across the secondary winding, inducing A.C. voltages in it. C/C-104A (.004 mfd.) in series with R/C-102A (15,000 ohms) across the secondary is a capacitor of a very critical value. It is a buffer to smooth out R.F. hash, and produce a clear cut "square-wave" secondary voltage. Its reactance "reflects back" into the primary circuit to accomplish this. R/C-102A is to reduce short circuit

currents to a minimum in case of breakdown of C/C-104A. The vibrator unit is a plug-in Mallory G634C. The centre tap of the secondary winding T/C-101A is grounded and serves as "negative". V/C-101A is a gaseous full-wave rectifier, type OZ4A. On each A.C. half cycle, electrons flow from the "cold" cathode to one or the other of the two plates, leaving the cathode with a positive charge. R/C-101A (47 ohms) in conjunction with C/C-101D (.1 mfd.) serves as an R.F. hash filter to the rectified +265 V. line. L/C-101A, in conjunction with C/C-105A and C/C-105B (20. mfd. electrolytic) forms a pi L.F. ripple filter.

134. The dynamotor action is really a combination of that of a generator and a transformer.

(a) The machine is fundamentally a D.C. electric motor. On the same armature are also two generator windings. As the armature rotates, these generator windings will be cutting the lines of force of the common magnetic field winding so they will have A.C. voltages induced in them. These are each rectified into D.C. by their individual commutator and brush action, and distributed to the H.T.1 and H.T.2 circuits, through their appropriate ripple filters.

(b) D.C. fed to the motor armature windings is converted into A.C. in those windings by the commutator and brush action. These A.C. currents produce an alternating magnetic field in the armature core. The secondary windings, being wound on the same core, have voltages induced in them by this ordinary A.C. transformer action.

135. The Supply Unit No. 2 may also be used with Wireless Set (Cdn.) No. 19 Mk. II, if adapted, as outlined in FZ 254/3.

Audio Equipment

136. Microphone and Receiver Headgear No. 1:

(a) Microphone, Hand, No. 7 has a capsule of the moving coil, or dynamic type, for greater clarity of speech. To exclude noise it is necessary to speak directly into the mouthpiece of the microphone. The pressel switch contacts are used to connect the microphone into the circuit, and also, to actuate the relays when switching from Receive to Send.

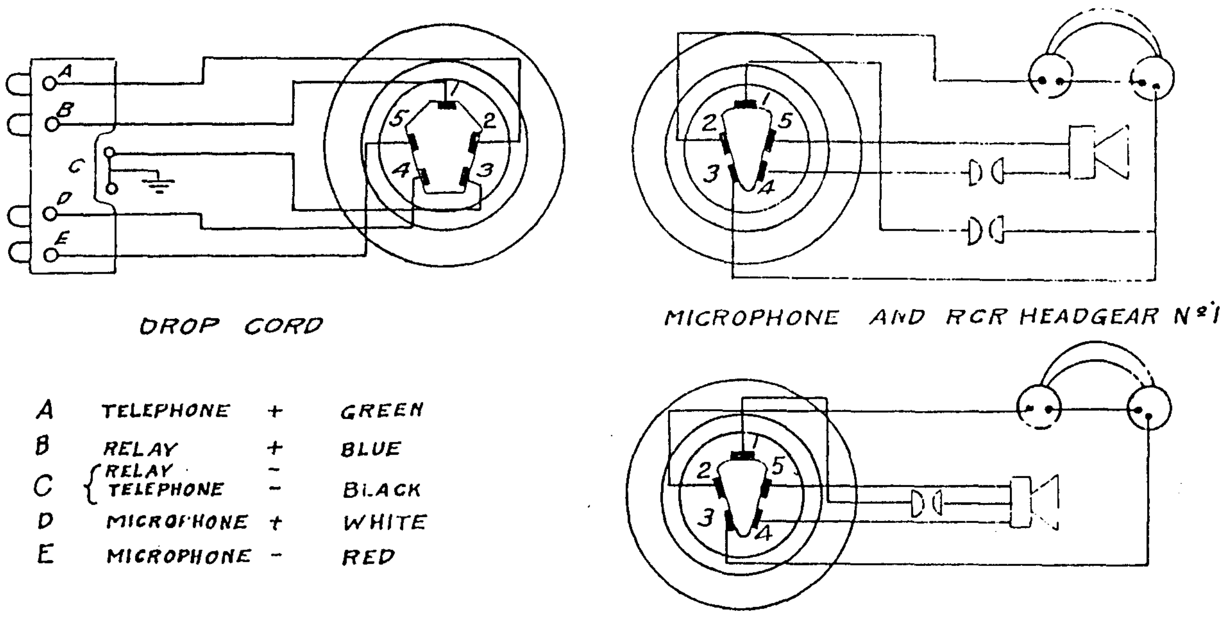


FIG. 17—CONNECTIONS FOR MICROPHONE AND RECEIVER HEADGEAR
Nos. 1 and 2

(b) The headphones are also of the moving coil type and are fitted with rubber caps to exclude noise. Moving coil units are used to give good response over a wide frequency band. This gives greatly increased intelligibility under noisy conditions. Both microphone and headphones are similar to midget P.M. speakers as used on standard broadcast receivers.

137. Microphone and Receiver Headgear No. 2: The microphone fitted to the above gear is of the carbon granule power type and is intended for use directly coupled to the I.C., A.F. output channel without any amplification. A 12 V. exciting source is required. It was designed for use with Junction, Distribution, Nos. 1 and 2 where the vehicle installation has no I.C. Mic. input lead wired to the driver. Connections for the two types of headgear are shown in Fig. 17.

Control Systems

138. Control units are used in conjunction with the No. 19 set in order to allow the most flexible employment of its many facilities. As the No. 19 set is used in many different types of vehicle, it is necessary to provide a great variety of control boxes to satisfy the requirements of specific installations. Most of these control units have more than one drop cord, for connection to headgear, but not all drop cords have access to the complete facilities of the No. 19 set; some being used for I.C. only.

139. In a standard tank installation, there are two control boxes mounted in the turret. Either the operator or the crew commander may control the No. 19 set independently.

140. Briefly, the control units serve to:—

(a) Connect various headgear to the No. 19 set.

(b) Allow "A", "B", and I.C. portions of the set to be used simultaneously but independently by specific crew members.

(c) Allow all facilities to be used simultaneously and concurrently by the crew commander.

(d) The "rebroadcast" function allows incoming messages on the "A" set to be simultaneously rebroadcast to other tanks nearby over the "B" set, and vice versa.

(e) When rebroadcast facilities are employed, the operator's microphone is cut out of the circuit so that he may only listen. However, the commander has full control from his headgear and may add his comments to the rebroadcast.

141. On the operator's control box is located a red "A-set unattended" pilot light. This is illuminated when both the operator and crew commander are switched to "B". It is also illuminated when the N/R switch is turned to Rebroadcast. This lamp does not light when both control units are switched to I.C. because the "A" set is not then considered unattended; both the "A" and "B" sets feed into the I.C. channel under these circumstances and may be heard in the background as sidetone.

142. Control Unit No. 1 is a single-size unit having a 12-point input plug, a control switch and two drop leads. The left hand bottom lead can be switched to "A", "B" or I.C. while the right hand lead is permanently on I.C. This unit is normally connected by a 12-point connector to Control Unit No. 2, which in turn is connected by a 12-point connector to the communications plug on the No. 19 set. Control Units No. 1 and 2 together give full switching facilities except Rebroadcast. (See Table 13.)

143. Control Unit No. 1 Mk. II is similar to Unit No. 1 with the addition of a four-way terminal strip to enable additional connections to be made to the I.C. amplifier circuits. It supersedes Control Unit No. 1.

144. Control Unit No. 1 A is a No. 1 unit with both drop leads, connected in parallel to the selector switch, so that both leads may have access to full facilities.

145. Control Unit No. 1 A Mk. II is a No. 1 Mk. II unit, modified so that both drop leads are connected in parallel to the selector switch, giving both leads access to full facilities. It supersedes No. 1 A.

146. On some early two-man turret installations, only the one control unit was used (No. 1 or No. 1 A). In this case the fuse in the control unit is removed. This, of course, did not provide full switching facilities, and has been superseded by Control Unit No. 3.

147. Control Unit No. 2 is a single unit with 12-point input and output plugs. It has a selector switch, one switched drop lead and one "A unattended" indicator lamp. It is normally used with a No. 1 or a No. 1 A control unit, and the lamp lights when both controls are switched to "B." For switching facilities see Table 13.

148. Control Unit No. 2 Mk. II supersedes Unit No. 2. It provides Rebroadcast facilities in addition to the normal functions of a No. 2 unit. See Table No. 15.

149. Control Unit No. 3 is a double-size unit with a 12-point input plug and an "A unattended" indicator lamp. It has two drop leads, switched independently by separate selector switches. This unit combines the circuits of Nos. 1 and 2, without the I.C. drop lead. It was designed for use in a two-man turret, and provides full facilities except rebroadcast. See Table 13.

150. Control Unit No. 3 Mk. II supersedes Unit No. 3 and provides rebroadcast facilities. See Table No. 15.

151. Control Unit No. 3 A is a No. 3 unit with the addition of an I.C. drop lead. It was designed for use in three-man turrets. See Table No. 13.

152. Control Unit No. 3 A Mk. II supersedes Unit No. 3 A and provides rebroadcast facilities. See Table No. 15.

153. Control Unit No. 3 B is a No. 3 unit with the addition of an extra drop lead connected in parallel to one of the switched drop leads. It is primarily intended for use with ground stations and training sets. See Table No. 13.

154. Control Unit No. 3 B Mk. II supersedes Unit No. 3 B and provides rebroadcast facilities. See Table No. 15.

155. Control Unit No. 3 C is a double-sized unit which has a switched operator's drop lead, an I.C. drop lead, an "A unattended" indicator lamp, a 12-point connector socket, two selector switches (A-I.C.-B), a 4-way terminal strip (switched) for extension to crew commander, and a 4-way terminal strip (I.C. connections). This unit was developed for the M3 MED. (American) turret, where the set, control unit, and operator are located in the hull of the tank, and the commander's extended drop lead is wired through the slip rings and into the turret, and terminates in a Junction Distribution No. 3 to which the commander's headgear is connected. The commander uses the buzzer on Junction Distribution No. 3 to signal to the operator, to whose phones the buzzer circuit is connected, and the operator then controls the commander's selector switch for him. See Table 13.

156. Control Unit No. 3 C Mk. II supersedes No. 3 C and provides rebroadcast facilities. See Table No. 15.

157. Control Unit No. 4 is a single unit designed for use in A.C.V's. It has a switched operator's drop lead, a 12-point input connector socket, a 12-point output connector socket, a selector switch, and an "A1(19) — I.C. — B — A2(14)" switch.

158. Control Unit No. 5 is a single unit designed for A.C.V's, having a switched operator's drop lead, and I.C. drop lead, a 12-point connector plug and an "A1(19) — I.C. — B — A2(14)" switch.

159. Control Unit No. 6 is a single unit designed for use in A.C.V's, having a switched operator's drop lead, a modulation attenuator control, a 12-point input plug, a "Rec. — A2 — R/B" switch, a "MOD." switch, a 4-way terminal strip, a 3-way terminal strip, and an "A1(19)—I.C. — B — A2(14)" switch. This unit has provision for receiving or rebroadcasting on a No. 19 set, or, alternatively, a No. 14 Set.

160. Control Unit No. 7 is a double-size unit designed for A.C.V's, having two switched operator's drop leads, two "A1(19) — I.C.— B — A2(14)" switches and one 12-point connector socket.

161. Control Unit No. 8 is a single-size unit for special installations, which has a switched operator's drop lead, a 15 ft. drop lead (special connections), an "A — I.C. — B" switch and a 12-point connector plug. The 15 ft. lead has its phone circuit connected in parallel with the operator's lead, but its microphone circuit is permanently connected to I.C. (See Table 14.)

162. Junction Distribution No. 1:—

(a) This is a single-size box which has an I.C. drop lead, a buzzer and call button, and a 3-way terminal strip for output connections.

(b) This box may be used only with a carbon power Mic. (Microphone and Receiver Headgear No. 2) as it is coupled only to the I.C. output channel for speech; no I.C. Mic. input lead being available in this installation.

(c) It is normally a driver's box, I.C. only, and connects to the nearest 12 V. supply for Mic. and buzzer current. It connects to the No. 19 set through two screened leads (Speech and Signal) via the tank slip rings and supply unit.

(d) The buzzer signal lead is connected to the commander's headset to call his attention when his control unit is not switched to I.C.

(e) The output from the power microphone transformer is fed directly to the I.C., A.F. output circuit, via the supply unit. Thus a two-way conversation may be carried on with the turret crew, using one wire through the slip rings, and an earth return. The driver will be heard by the turret crew, who cannot reply unless the I.C. amplifier is switched on. For this reason the I.C., A.F. output lead which passes through the power unit and 6-point connector is labelled speech, since it serves both headphones and Mic. of the driver.

163. Junction Distribution No. 2 is similar to No. 1 less the press-button buzzer circuit. It is intended for a co-driver or forward gunner. It is connected in parallel with Junction Distribution No. 1 and must also use a power Mic. (Microphone and Receiver Headgear No. 2.)

164. Junction Distribution No. 3 is a single-size unit having two 3-way terminal strips for input connections, two drop leads (I.C.), and a buzzer and call button. This box is designed for use with Microphone and Receiver Headgear No. 1, so provision must be made for connection to the I.C. Mic. input circuit. The unit must be connected to the nearest 12 V. supply, and is used to connect extra crew members to the I.C. channel via a three or four-way shielded connector and a control unit. (See Fig. 30.) In some tank installations where the number of turret slip rings permit, Junction Distribution No. 3 is used for a driver and/or co-driver (forward gunner). This is to be appreciated as the moving coil microphone in Headgear No. 1 gives greatly improved performance over the power Mic. in Headgear No. 2, used with Junctions Distribution Nos. 1 and 2.

165. Junction Distribution No. 4 is a No. 3 unit without the buzzer or call button, and is used mostly for the co-driver (forward gunner). Up to four drop leads may be accommodated.

TABLE No. 13—CONTROL SWITCHING CHART No. 1

Control Units—No. 1 Mk. I or Mk. II; No. 2A Mk. I or Mk. II WITH Control No. 2
Control Units—No. 3, 3A and 3B

Commander		Operator		Receiver Output Fed Into I.C. Channel to Provide Calling Signal	General Remarks
Switch		Switch			
A	Send or Receive on A	A	Send or Receive on A. Operator and Commander can converse over side-tone, their conversation being broadcast over A Sender	B Set Receiver Output fed into I.C. Channel	ALL crew, permanently on I.C. can converse with each other without interfering with the operation of the sets, but can hear "side-tone" as indicated. Driver and forward gunner (or co-driver) use either:— (a) Jct. Dist. No. 1 or 2 and Headgear No. 2 or (b) Jct. Dist. No. 3 or 4 and Headgear No. 1 The Driver's Buzzer Signal is wired to crew commander's phones at all times, and may also be heard on whatever circuit the commander may be switched to.
		I.C.	Can talk with crew on I.C.		
		B	Send or Receive on B	NIL	
I.C.	Can talk with crew on I.C.	A	Send or Receive on A	B Set	
		I.C.	Can talk with crew on I.C.	A & B Set	
		B	Send or Receive on B	A Set	
B	Send or Receive On B	A	Send or Receive on A	NIL	
		I.C.	Can talk with crew on I.C.	A Set	
		B	Send or Receive on B. Operator and commander can converse over side-tone, their conversation being broadcast over B Sender. A unattended lamp on Control Unit lights warning that no one is listening to A Set except crew on I.C. Channel		

TABLE No. 13—(Cont'd.)

Control unit No. 1 Mk. I and Mk. II with control unit No. 2	One drop lead on control No. 1 is permanently connected to I.C.
Control unit No. 1 A Mk. I and Mk. II with control unit No. 2	Both drop leads on No. 1A are switched in parallel.
Control unit No. 3	Has Commander and Operator drop leads only.
Control unit No. 3A	Has one of its drop leads permanently connected to I.C.
Control unit No. 3B	Both drop leads on commanders half of box are switched in parallel.
Control unit No. 3C	One drop lead on control 3C is permanently connected to I.C. The commander's drop lead is extended and terminates in a Junction Distribution No. 3. The buzzer signal from the Jct. Dist. is applied to the operator's phones, and is used by the commander to indicate to the operator the desired circuit, as the operator must also handle the crew commander's switch. The crew can converse with each other on I.C. without interfering with the operation of the sets. The driver and co-driver are usually connected to the I.C. circuit by means of a Jct. Dist. No. 3, and Headgear No. 1.

TABLE No. 14—CONTROL SWITCHING CHART No. 2

Control Units No. 1 Mk. I or Mk. II; No. 1A Mk. I or Mk. II; No. 8

Control No.	Switch	1st Drop Lead	2nd Drop Lead	Receiver Output Fed Into I.C. Channel	General Remarks
No. 1	A	Send or Receive on A	Permanently connected to I.C.	NIL	When control units No. 1 or 1A, Mk. I or II are used without the control No. 2, the I.C. "side-tone" circuits are incomplete. Therefore one of the sets at least will always be "unattended", and sometimes both, as the set not switched to can no longer feed into the I.C. channel. The fuse should be removed from No. 1 or 1A Mk. I or II when used alone. Controls 1 and 1A, Mk. II, have a 4-way terminal strip for making connections to the I.C. circuit. On early installations, No. 1 or 1A was connected directly to the set, but has been superseded by No. 3. On control No. 8 the 1st drop lead is normal, but the I.C. drop lead is 15 ft. long. *On one special installation, however, the phone circuit of the I.C. drop lead is connected in parallel with the switched drop lead while the mic. circuit is left permanently on I.C.
Mk. I or	I.C.	Converse on I.C.			
Mk. II	B	Send or Receive on B			
No. 1A	A	Send or Receive on A	Switched in parallel with 1st drop lead. Operator and commander can converse over sidetone of A or B when switched, their conversation being broadcast.	NIL	
Mk. I or	I.C.	Converse on I.C.			
Mk. II	B	Send or Receive on B			
No. 8	A	Send or Receive on A	Permanently connected to I.C.	B Set	
	I.C.	Converse on I.C.		A & B Sets	
	B	Send or Receive on B	Note Remarks*	A Set	

TABLE No. 15—CONTROL SWITCHING CHART No. 3

Mk. II Control Units Nos. 2, 3, 3A, 3B, 3C — R/B (Rebroadcast) Control Units

OPERATOR			COMMANDER	
Switches			Switches	
N	A / I.C. / B	Normal switching facilities as described on Switching Chart No. I.	A	Normal switching facilities as described on Switching Chart No. I.
			I.C.	
			B	
R	B-A	"In B-Out A" B Receiver Output used to modulate A set which is automatically switched to send. Operator can hear A Sender side-tone, but his microphone and pressel sw. are out of the circuit. NOTE:—Modulation level of R/B is governed by B. Gain control.	A	Hears B receiver over A Sender side-tone and can add his speech to the rebroadcast (heard by Operator).
			I.C.	Can converse with crew on I.C. (except Operator).
			B	Hears B. Receiver and can send on B, the conversation being rebroadcast on A Sender.
R	A & B	A & B in parallel. Can Send or Receive on A & B simultaneously.	A	Send or Receive on A & B simultaneously.
			I.C.	Can converse with crew on I.C. (except Operator).
			B	Send or Receive on A & B simultaneously.
R	A – B	"In A-Out B" A Receiver output used to modulate B set which is automatically switched to Send. Operator can hear conversation over B Sender side-tone, but his mic., and pressel sw. are out of the circuit. NOTE:—Modulation level of R/B controlled by A Gain control.	B	Hears A Receiver over B Sender side-tone and can add his speech to the rebroadcast (heard by Operator).
			I.C.	Can converse with crew on I.C. (except Operator).
			A	Hears A Receiver and can send on A, the conversation being rebroadcast on the B Sender.
		NOTE:—See switching chart No. I for other details.		In some units there are two drop leads switched in parallel.

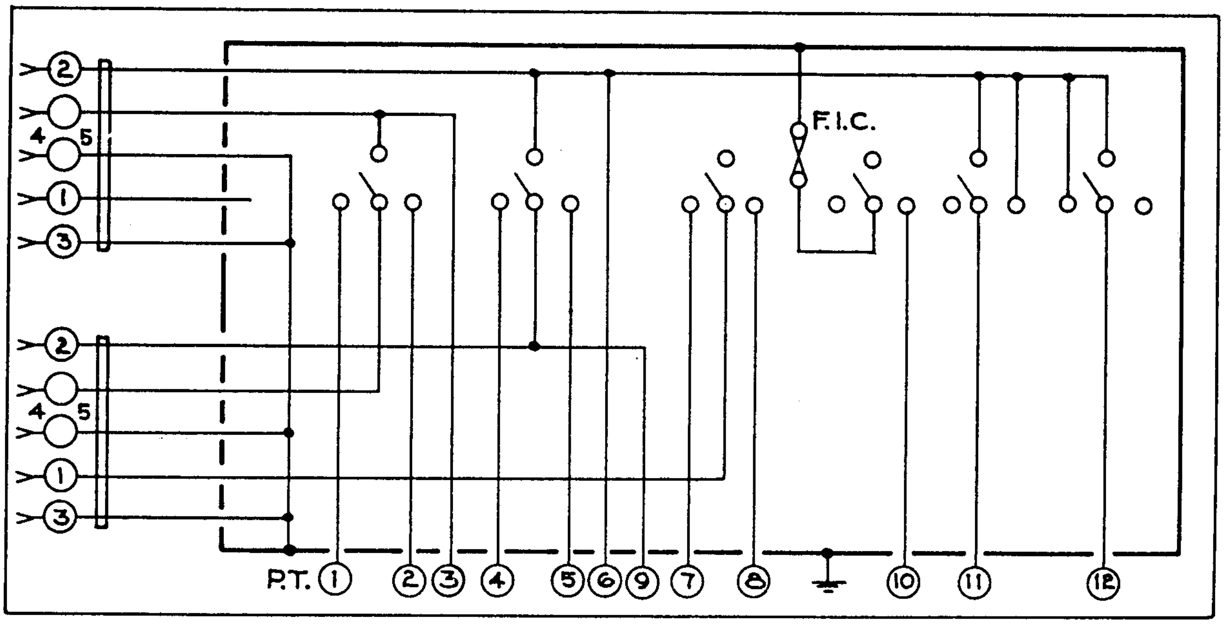


FIG. 18—CONTROL UNIT No. 1

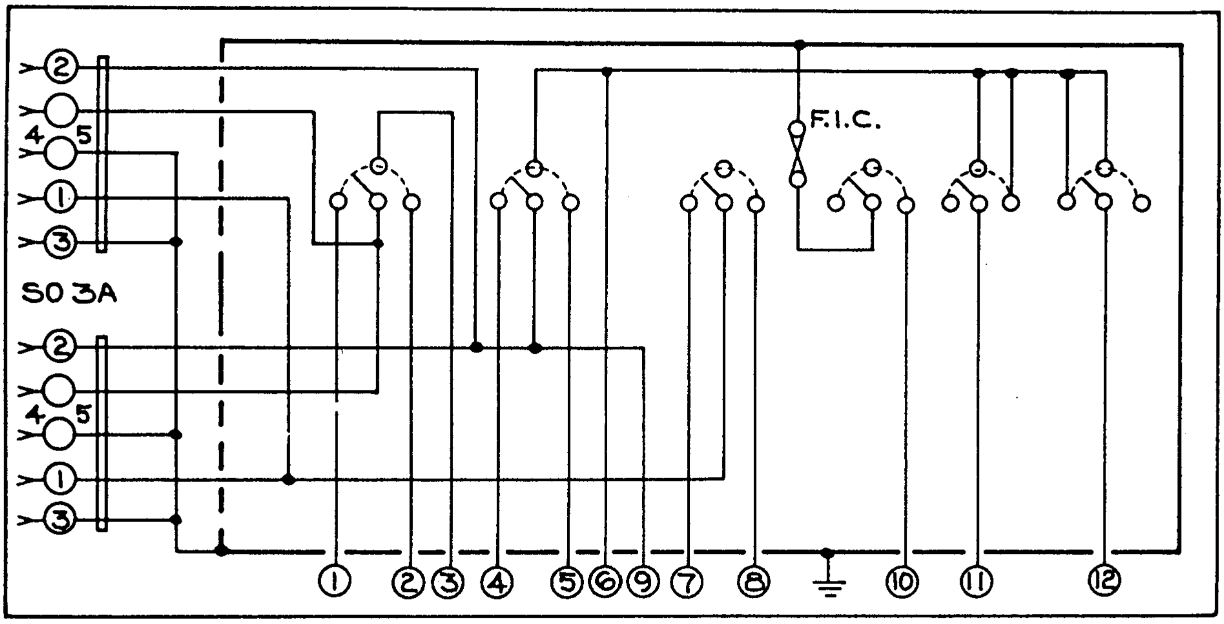


FIG. 19—CONTROL UNIT No. 1A

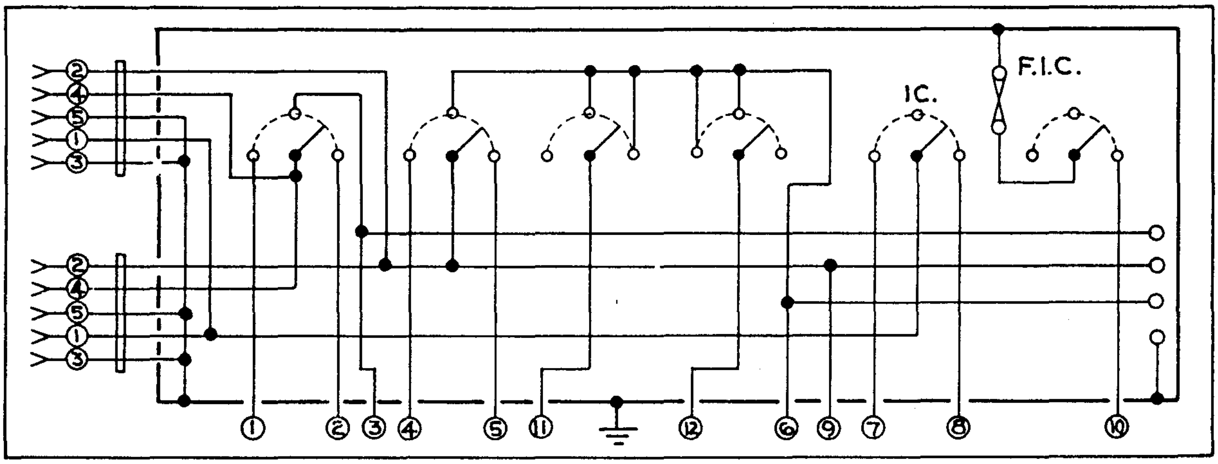


FIG. 20—CONTROL UNIT No. 1 A Mk. II

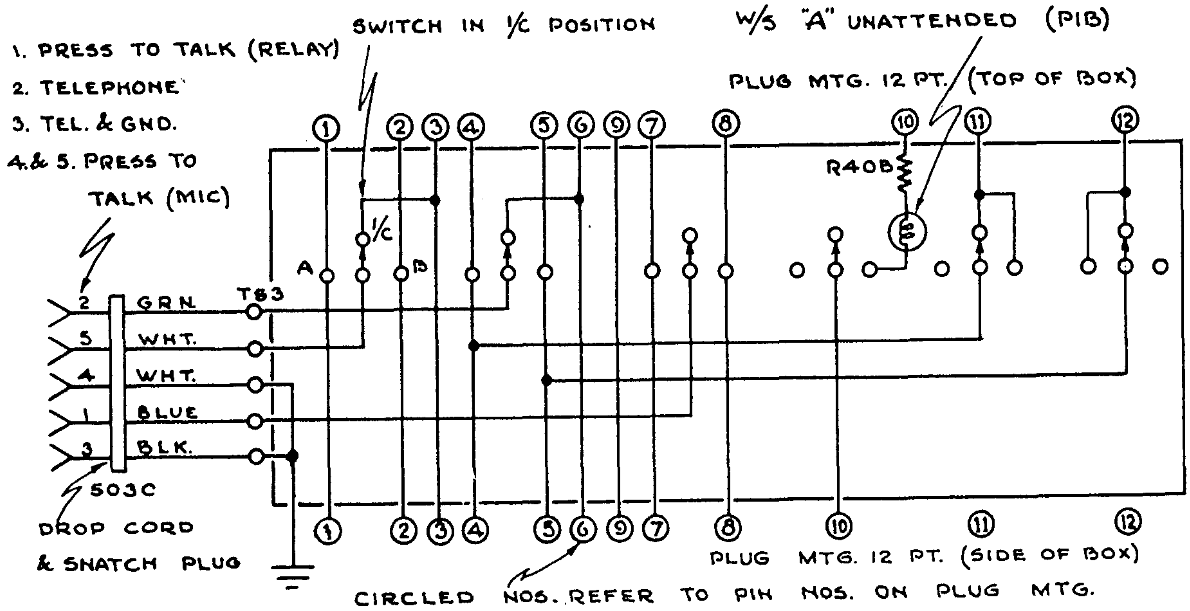


FIG. 21—CONTROL UNIT No. 2 Mk. I

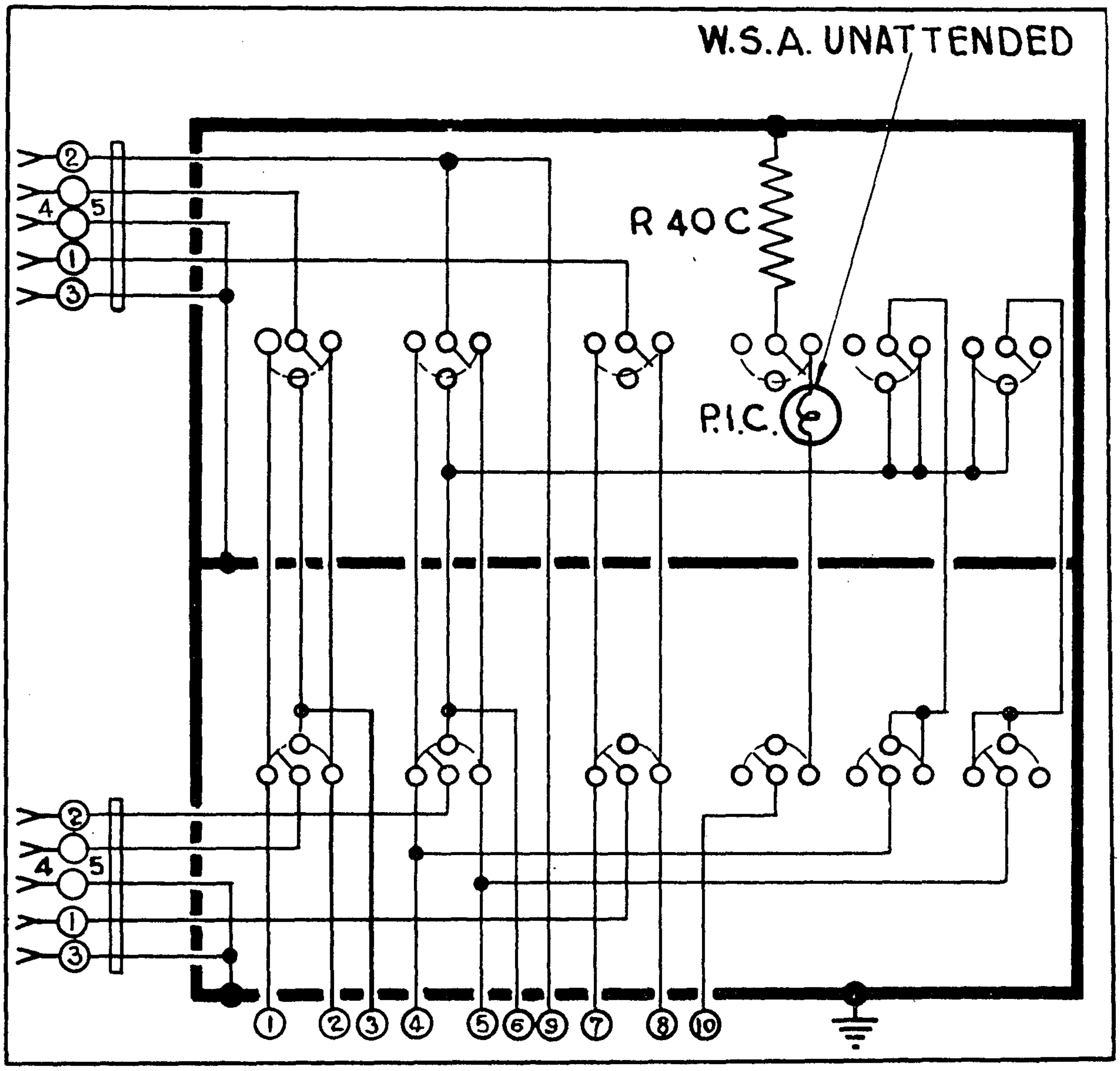


FIG. 22—CONTROL UNIT No. 3

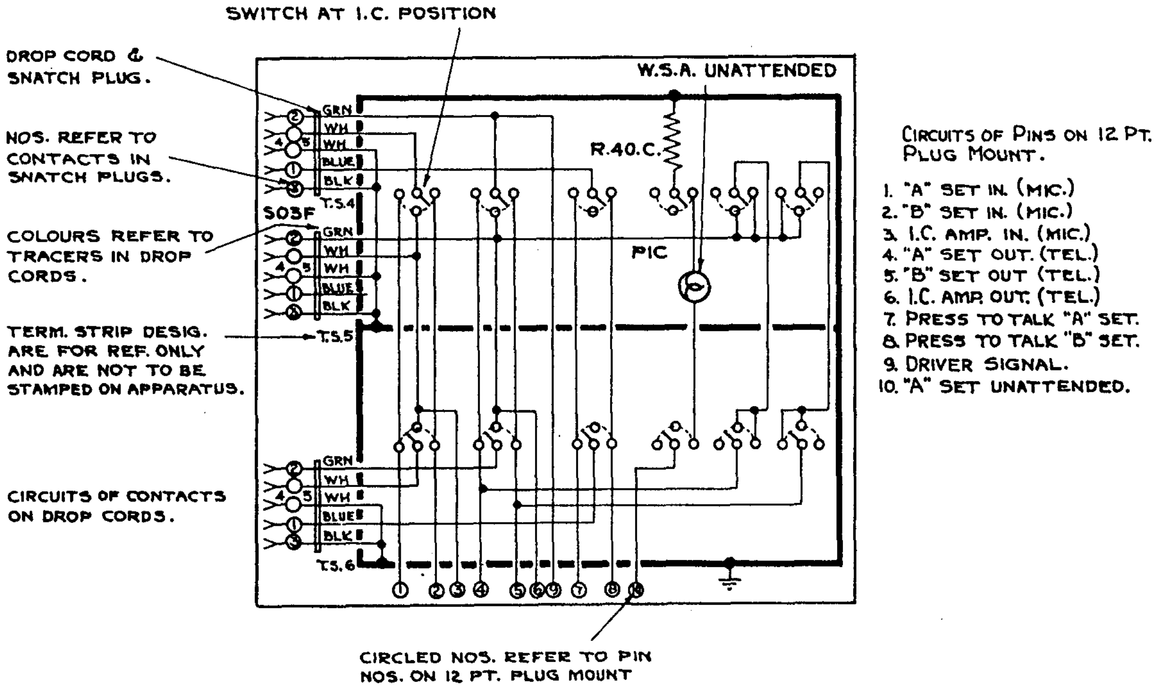


FIG. 23—CONTROL UNIT No. 3A

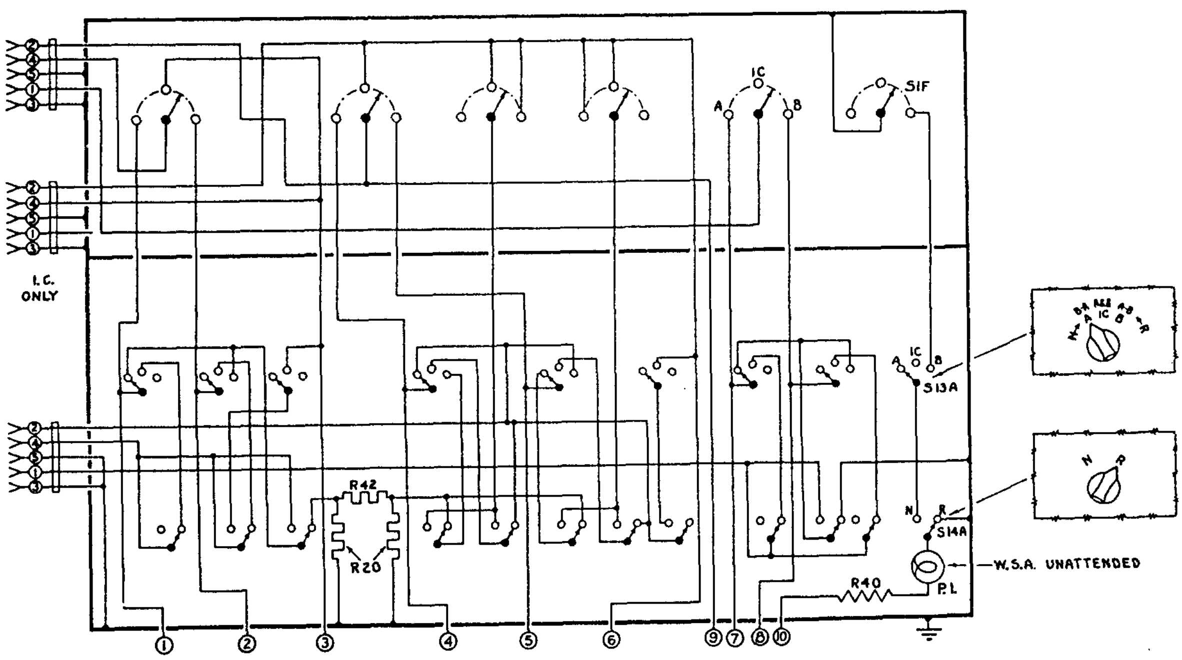


FIG. 24—CONTROL UNIT No. 3 A Mk. II

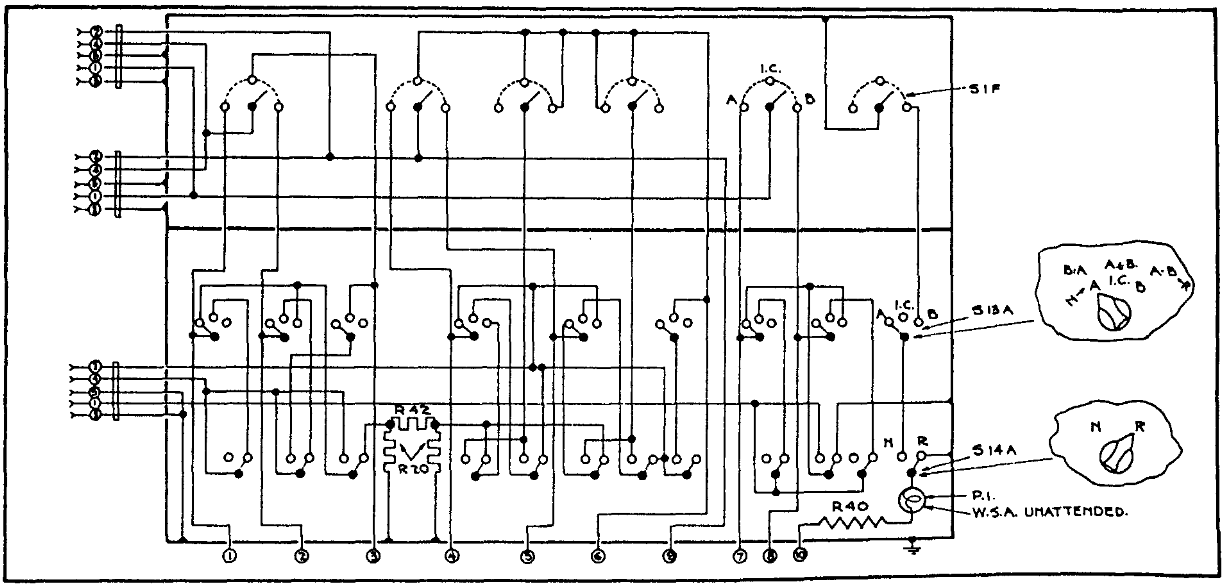


FIG. 25—CONTROL UNIT No. 3 B Mk. II

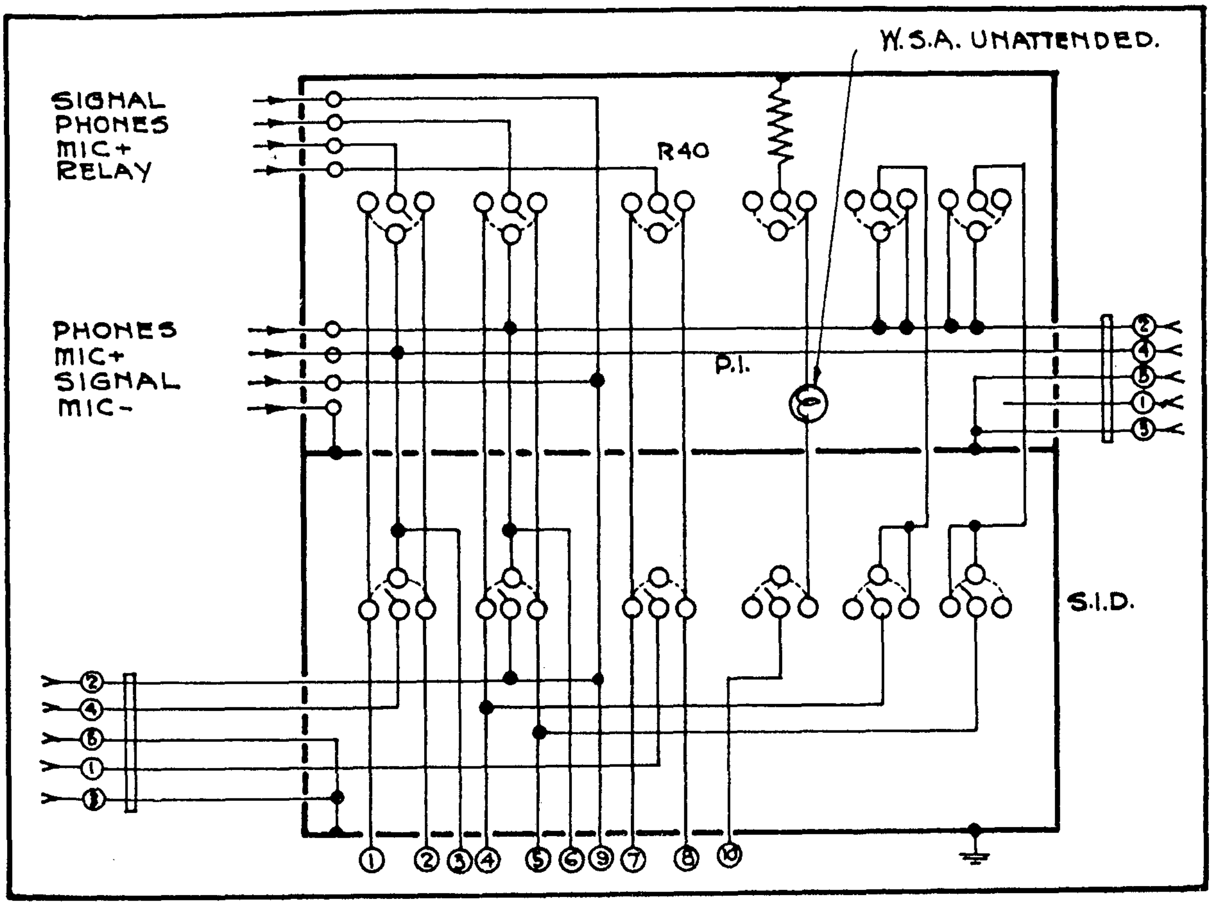


FIG. 26—CONTROL UNIT No. 3 C

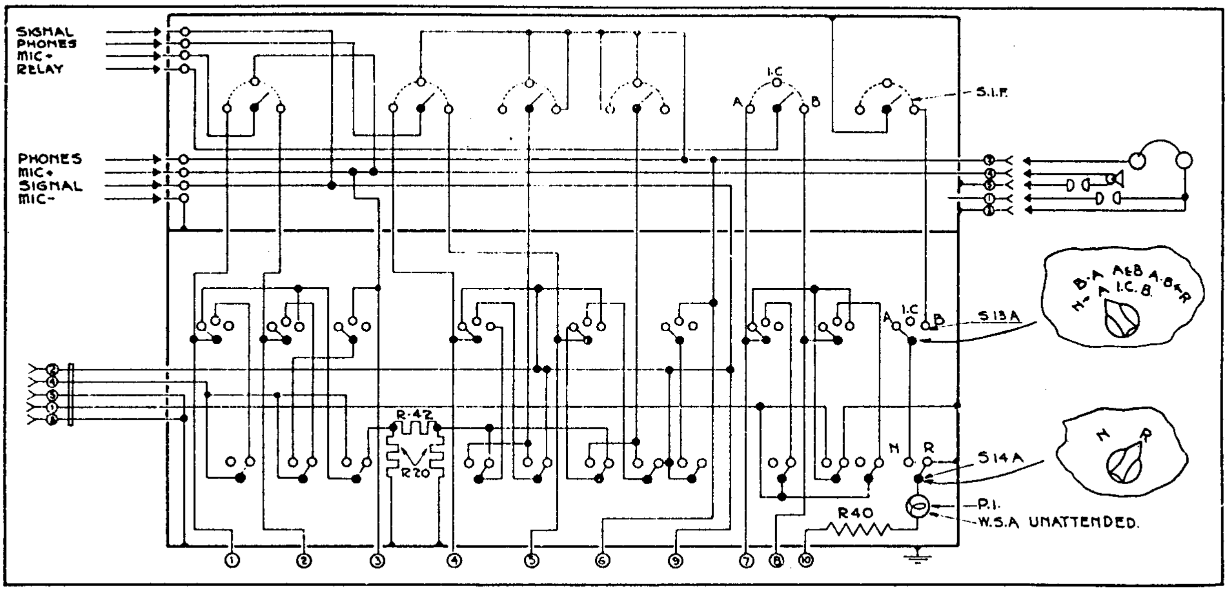


FIG. 27—CONTROL UNIT No. 3 C Mk. II

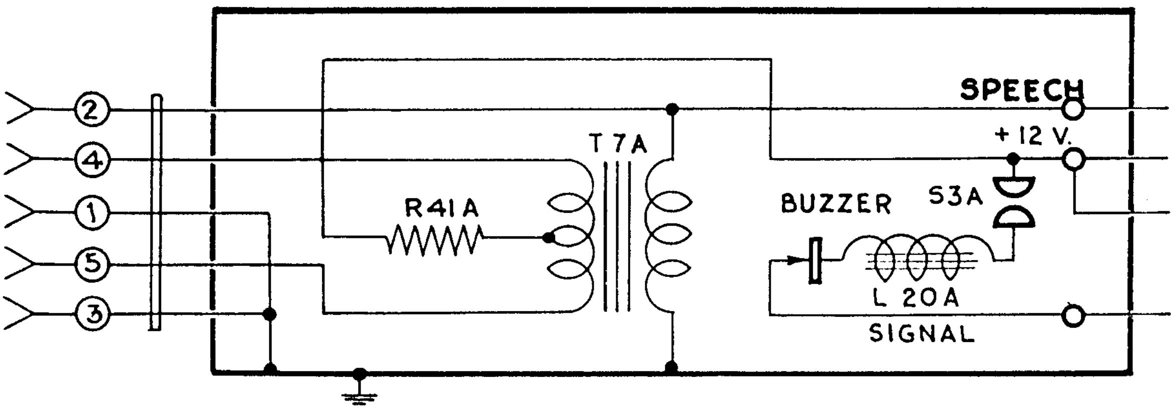


FIG. 28—JUNCTION DISTRIBUTION No. 1

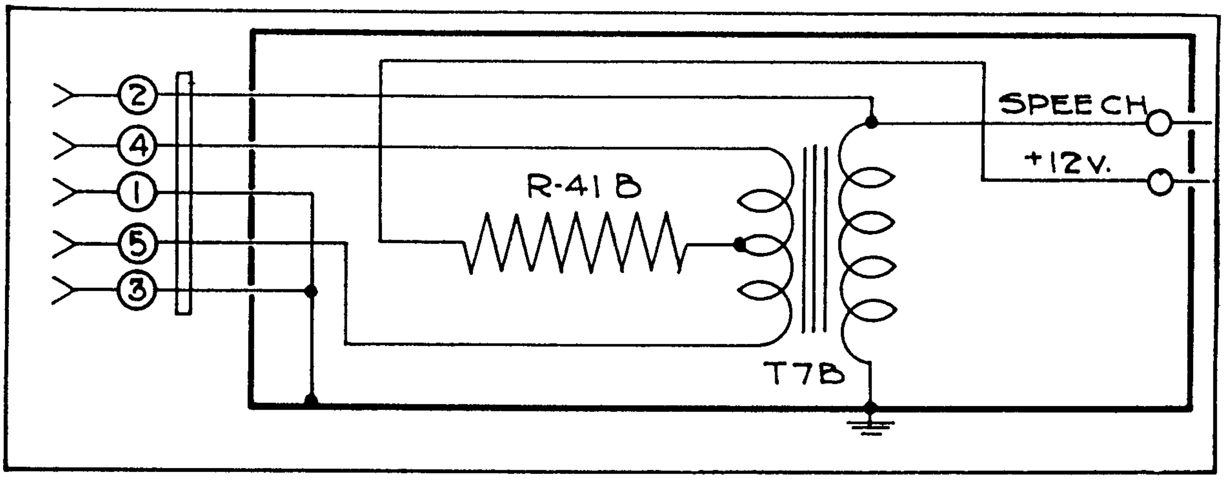


FIG. 29—JUNCTION DISTRIBUTION No.2

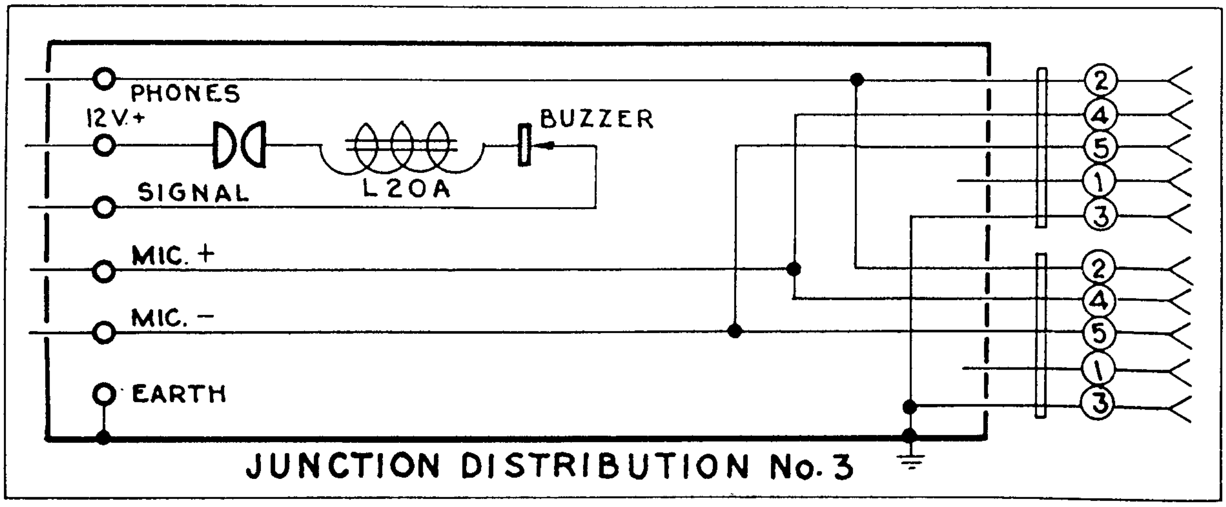


FIG. 30—JUNCTION DISTRIBUTION No. 3

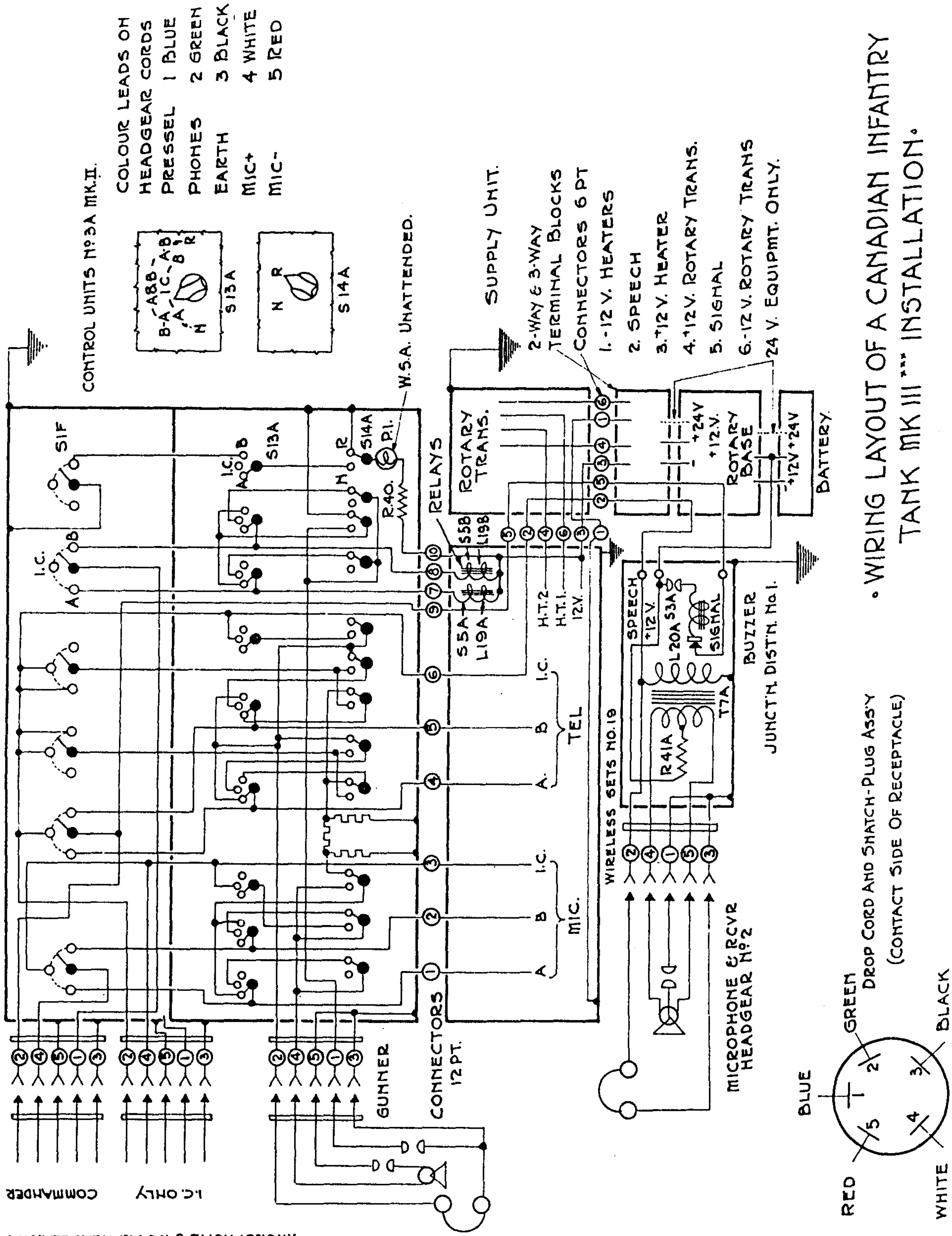


FIG. 31—WIRING LAYOUT CANADIAN INFANTRY TANK MK. III

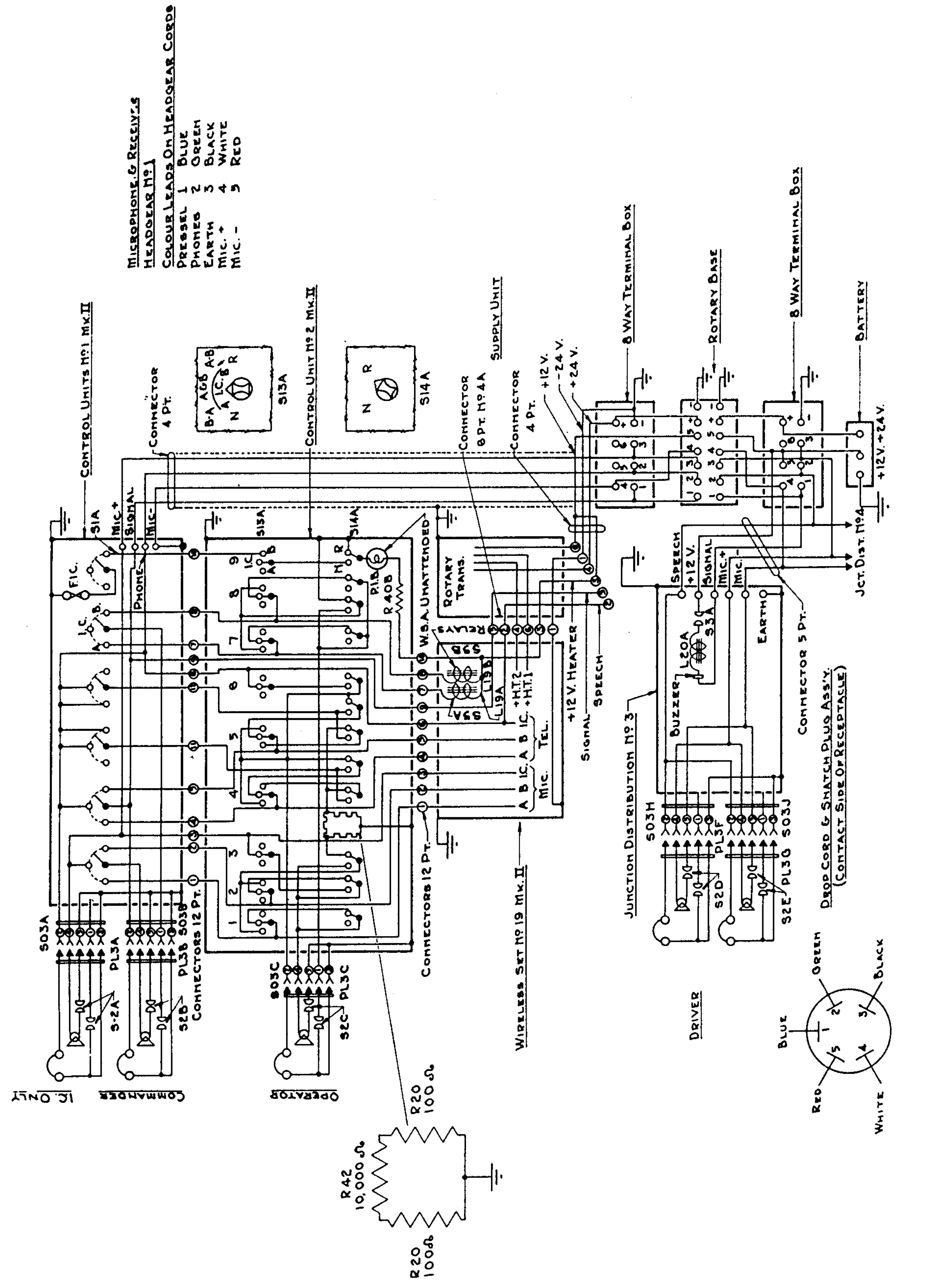


Fig. 32—WIRING LAYOUT U.S. MEDIUM M-4 TANK

CIRCUIT REF.	DESCRIPTION VALUE	TOLER'CE.	RATING	TYPE
C4X	.1 µF	± 20 %	500 V.	PAPER
C14B	.0001 "	"	1000 V.	MICA
C15K	.0005 "	"	"	"
C15L	" "	"	"	"
C29C	.01 "	+20%, -60%	600 V.	"
C31C	2.0 "	-0; +100%	350 V.	ELECTROL'C.
R1F	470000 Ω	± 20 %	1/4 W.	
R2D	220 "	± 10 %	1/2 W.	
R2E	" "	" "	"	
R7K	100,000 "	± 10 %	"	
R8F	1.0 MEG "	± 20 %	1/4 W.	
R9C	1000 "	± 10 %	"	
R21B	27,000 "	" "	"	
R23D	22,000 "	" "	"	
R23E	" "	" "	"	
R38A	56 "	± 5 %	1.0 W.	
R39A	820 "	± 10 %	" "	
S10B	"B" SET "ON-OFF" SWITCH.			
S10C	I.C. "ON-OFF" SWITCH.			
T4B	I.C. MIC. INPUT TRANSFORMER. 1:50			
T6A	I.C. SPEECH OUTPUT TRANSFORMER.			

PL2A 12 POINT COMMUNICATIONS PLUG	
1	"A" SET MIC. INPUT
2	"B" " " "
3	"I.C." " "
4	"A" SET A.F. OUTPUT
5	"B" " " "
6	"I.C." " "
7	"A" PRESSEL RELAY CIRCUIT (S-R)
8	"B" " " " "
9	DRIVERS BUZZER SIGNAL
10	"A" SET UNATTENDED LIGHT
11	NOT USED
12	" "

PL2B 12 POINT POWER PLUG	
1	GND.:- -H.T.1; -L.T.
2	I.C. OUTPUT - (SPEECH)
3	+ L.T. (12 V.) HTRS.
4	+ H.T.2 (540 V.)
5	DRIVERS BUZZER SIGNAL.
6	+ H.T.1 (265 V.)
7	- H.T.2
8	SUPPLY UNIT RELAY PRESSEL CIR.
9	NOT USED
10	" "
11	" "
12	" "

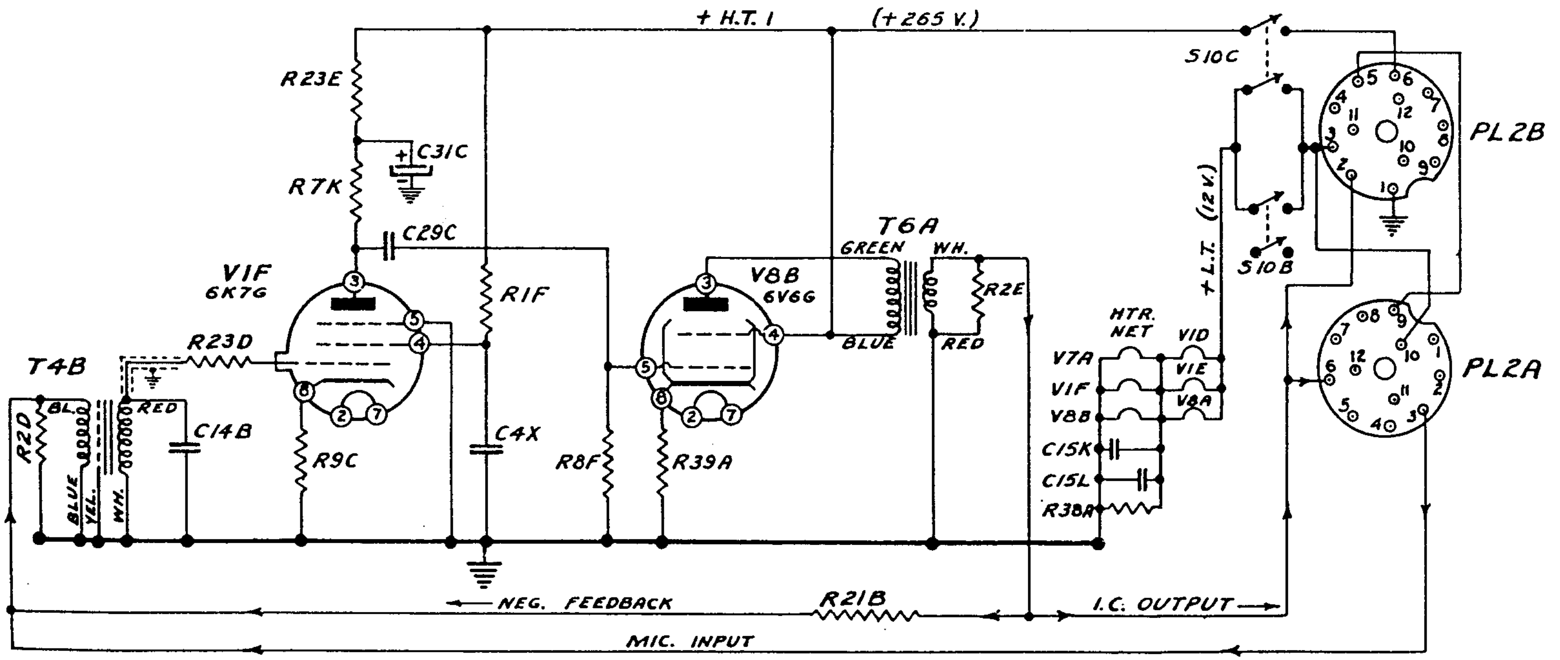


FIG. 33—CIRCUIT DIAGRAM OF I.C. AMPLIFIER

PL2A 12 PT. COMMUNICATIONS PLUG	
1	"A" SET MIC. INPUT
2	"B" " "
3	"I.C." " "
4	"A" SET A.F. OUTPUT
5	"B" " "
6	"I.C." " "
7	"A" PRESSEL RELAY CIRCUIT (S/2)
8	"B" " " "
9	DRIVER'S BUZZER SIGNAL
10	"A" SET UNATTENDED LIGHT
11	NOT USED
12	" "

PL2B 12 PT. POWER PLUG	
1	GND:- H.T.1 - L.T.
2	"I.C." A.F. OUTPUT (SPEECH)
3	+ L.T. (12V.) HEATERS
4	+ H.T.2 (540 V.)
5	DRIVER'S BUZZER SIGNAL
6	+ H.T.1 (265V.)
7	- H.T.2
8	SUPPLY UNIT RELAY PRESSEL CIRC.
9	NOT USED
10	" "
11	" "
12	" "

—NOTES:—

1- ALL SWITCHES CONNECTED BY ---- ARE GANGED ON "B" SEND RECEIVE RELAY S5B, AND ARE SHOWN IN THE RECEIVE POSITION.

2- ON SETS OF CDN. MANUFACTURE R33.1A (47000 Ω) IS SHUNTED ACROSS R33A TO PERMIT THE USE OF THE AMERICAN E-1148 VALVE (LOW MUTUAL TRANSCONDUCTANCE), WHEN BRITISH VALVES (CV6 OR VR135) ARE EMPLOYED, R33.1A SHOULD BE DISCONNECTED.

CIRCUIT REF.	DESCRIPTION
L11A	V.H.F. OSC. COIL
L12A	V.H.F. CHOKE
L13A	V.H.F. CHOKE (CATHODE V7A)
L14A	QUENCH OSC. COIL (SLUG TUNED)
L15A	QUENCH CHOKE
L19B	"B" SET SEND-REC. RELAY COIL
L26A	V.H.F. AERIAL LOADING INDUCT.
S5B	"B" SET SEND REC. RELAY SW.
S10B	" " ON-OFF SW.
S10C	I.C. " " "
T4A	"B" REC. INPUT TRANS.-1:50
T5A	"B" A.F. OUTPUT TRANSF.
S05A	"B" AERIAL FEEDER SOCKET

CIRCUIT REF.	DESCRIPTION: VALUE	TOL.	RATING	TYPE
C4V	.1 MFD.	±20%	500V.	PAPER (OIL-FILLED)
C4W	" "	"	"	"
C15G	.0005 "	"	1000V.	MICA
C15H	" "	"	"	"
C15J	" "	"	"	"
C15K	" "	"	"	"
C15L	" "	"	"	"
C16B	12.0 "	-0:+100%	50V	ELECTROLYTIC
C21B	.000007 "	±1 MMFD	1000	MICA
C25A	2.5/6.5 MMFD PER SECTION	—	SPLIT STATOR	VAR. AIR
C27A	.00002 MFD	±10%	1500V.	CERAMIC
C28A	.0007 "	±5%	1000V.	MICA
C29A	.01 "	+20-40%	600V.	"
C29B	" "	" "	"	"
C30A	.001 "	±15%	1000V	"
C30B	" "	" "	"	"
C31A	2.0 "	-0:+100%	350V.	ELECTROLYTIC
C31B	" "	" "	"	"
C57A	.0005 "	±2%	1000V.	MICA
R1A	470,000.	±20%	1/4 W	
R2C	220.	±10%	1/2 W	
R6G	47,000	" "	1/4 W	
R6H	"	" "	"	
R7H	100,000	" "	"	
R7J	"	" "	1/2 W	
R8D	1. MEG	±20%	1/4 W	
R9B	1,000.	±10%	"	
R9D	"	" "	1/2 W	
R11B	3,300.	" "	1/4 W	
R18C	270,000.	" "	"	
R23B	22,000.	" "	"	
R23C	"	" "	"	
R31A	2,200.	" "	1/2 W	
R32A	15,000.	" "	1/4 W	
R33A	27,000.	" "	1/2 W	
R33.1A	47,000.	" "	"	
R34A	"	" "	1.0 W	
R35A	100,000.	VAR.		POT.
R36A	39,000.	" "	1/4 W	
R37A	390.	" "	1.0 W	
R38A	56.	±5%	"	

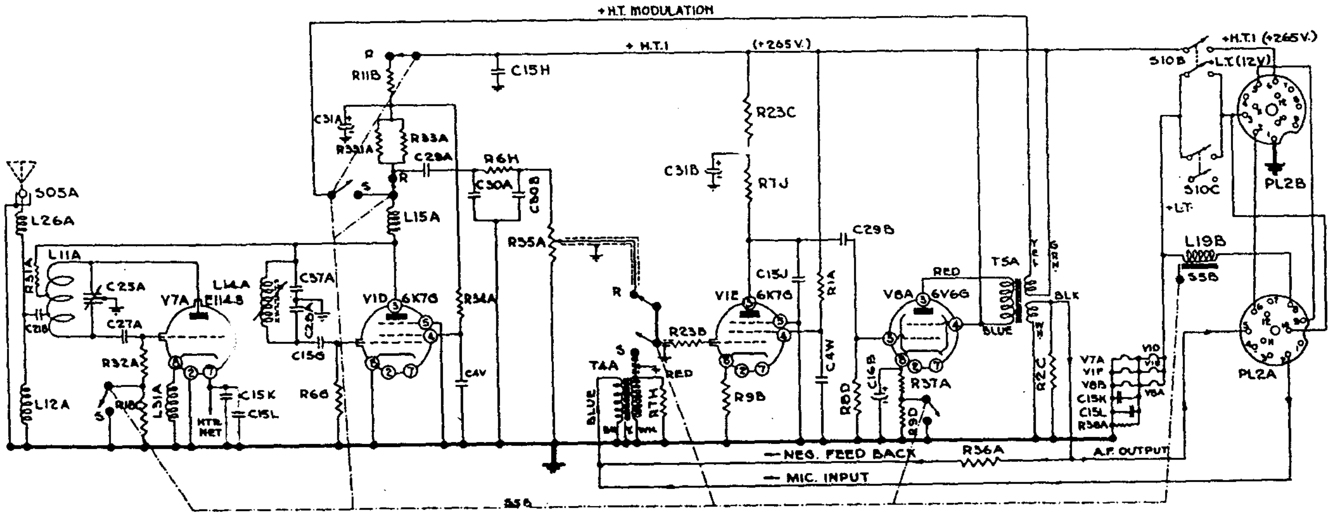


FIG. 34—CIRCUIT DIAGRAM OF "B" SENDER/RECEIVER

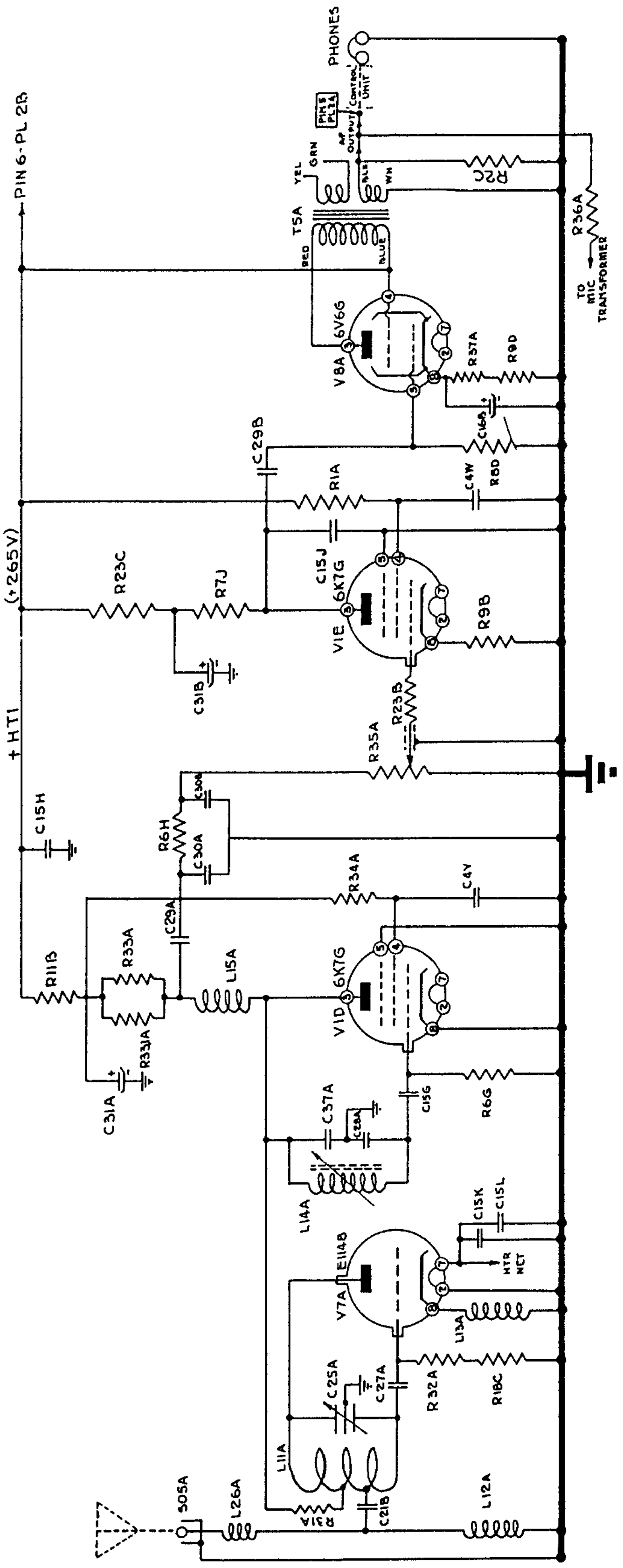


Fig. 35—SIMPLIFIED CIRCUIT DIAGRAM OF "B" RECEIVER

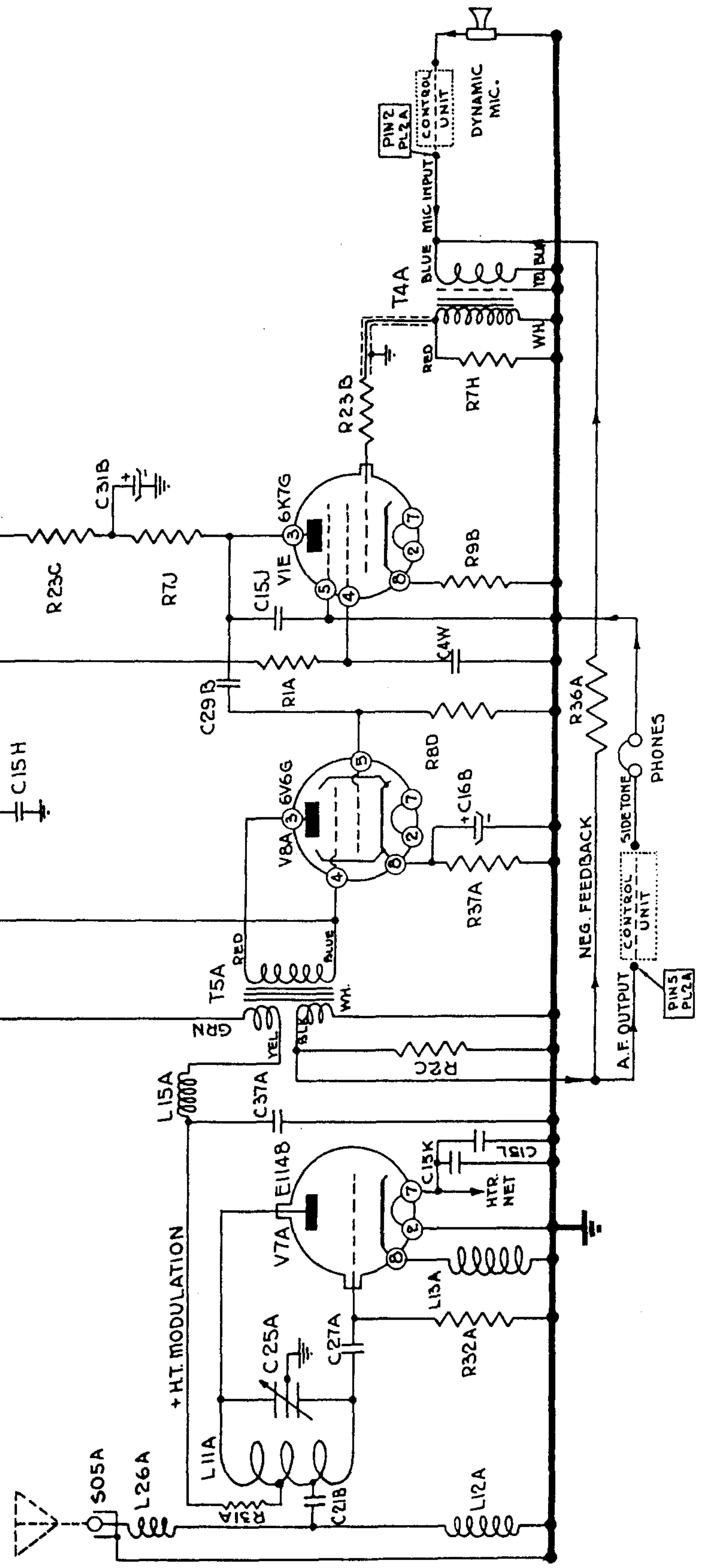


FIG. 36—SIMPLIFIED CIRCUIT DIAGRAM OF "B" SENDER

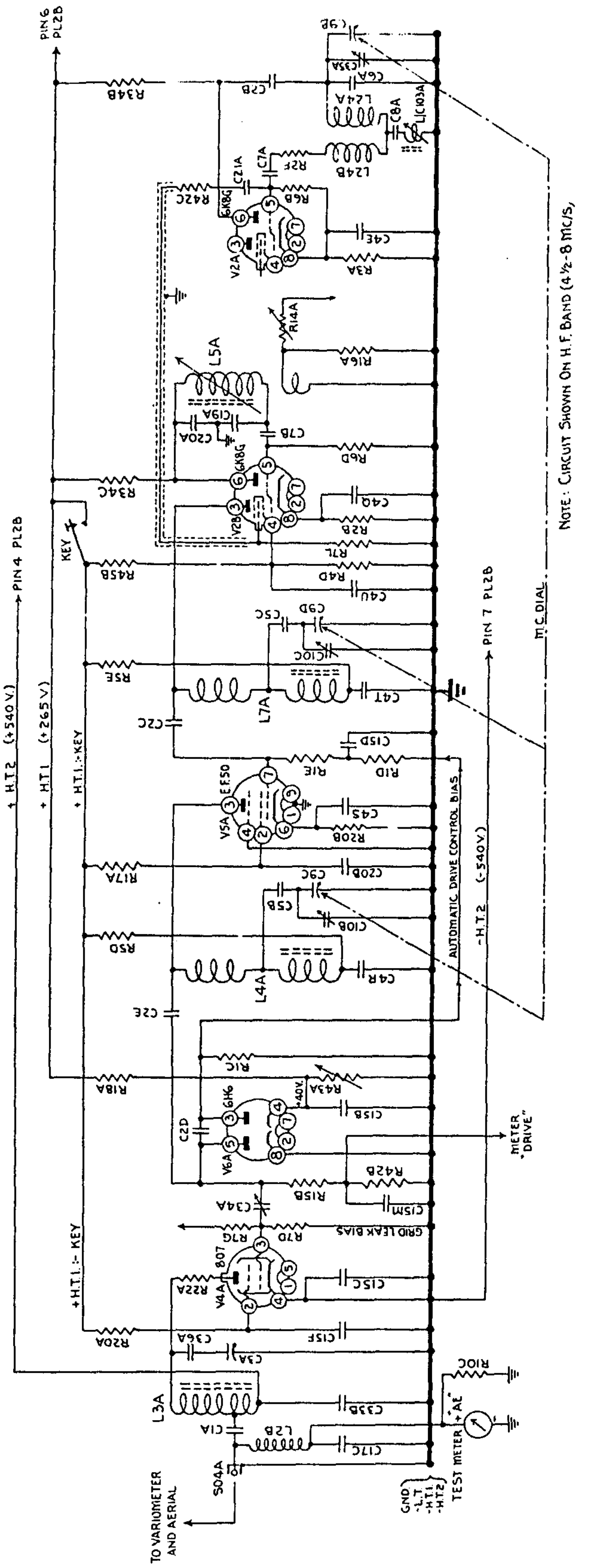
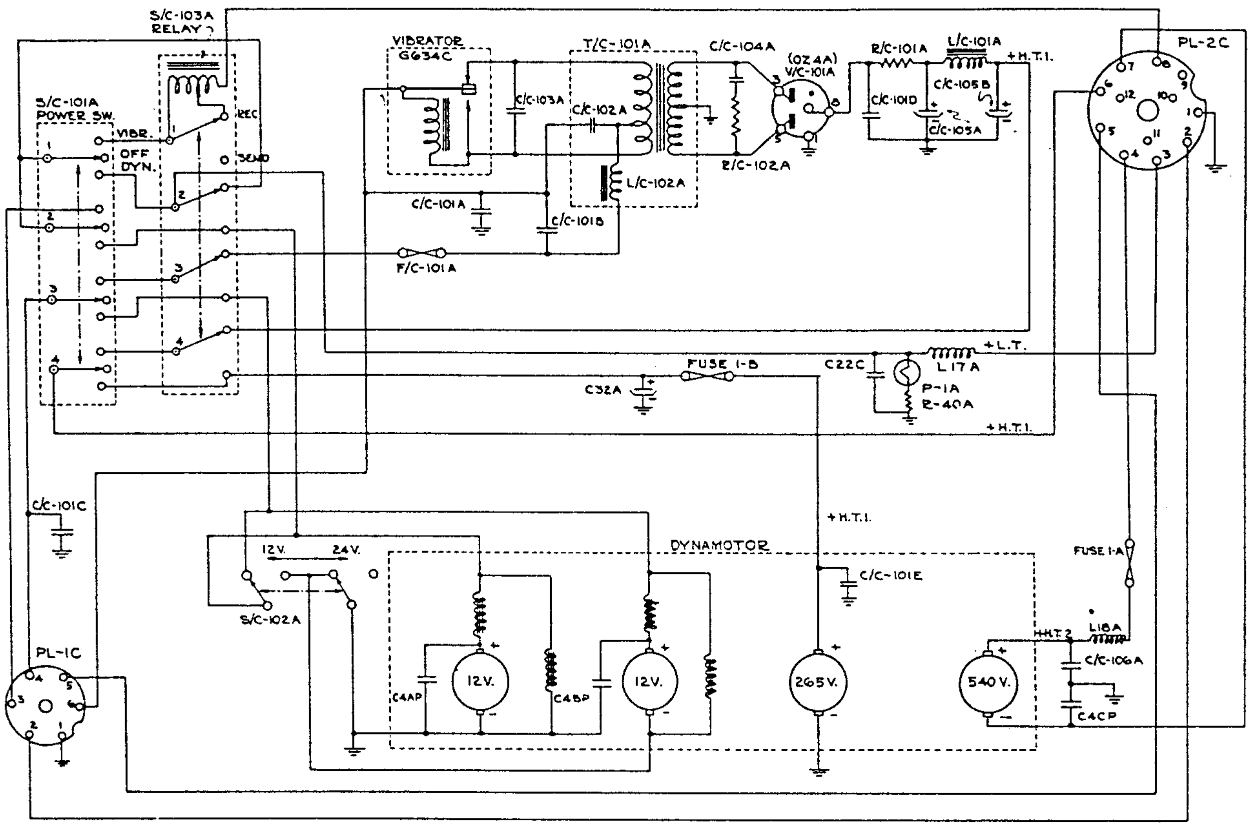


FIG. 40—SIMPLIFIED CIRCUIT DIAGRAM OF "A" SENDER ON C.W.

CIRCUIT REF.	DESCRIPTION VALUE	TOL.	RATING	TYPE
C/C-101A	.1 MFD.	± 20 %	500 V.	PAPER (OIL FILLED)
C/C-101B	"	"	"	"
C/C-101C	"	"	"	"
C/C-101D	"	"	"	"
C/C-101E	"	"	"	"
C/C-102A	.5 MFD.	"	30V.	"
C/C-103A	1. "	± 10 %	65V.	"
C/C-104A	.004 "	"	1000 V.	"
C/C-105A	20. "	−10 % +50 %	450V.	ELECTROLYTIC
C/C-105B	20. "	"	"	"
C/C-106A	.1 "	± 10 %	1500 V.	PAPER (OIL FILLED)
C-22C	.025 "	± 20 %	500V	"
C-32A	32. "	−10 % +50 %	450V.	ELECTROLYTIC
C-4AP	.1 "	± 20 %	500 V.	PAPER (OIL FILLED)
C-4BP	.1 "	"	"	"
C-4CP	.1 "	"	"	"
R/C-101A	47 Ω	"	1.0 W.	
R/C-102A	15000 Ω	± 10 %	1/2 W.	
R-40A	20 Ω	"	"	
S/C-101A	POWER SW. 3 POSITION			
S/C-102A	12V.-24V. DYNAMOTOR SW. (INTERNAL)			
S/C-103A	SEND-RECEIVE RELAY ("A" PRESSEL CIRCUIT)			
F/C-101A	10 AMPERE FUSE			
FUSE 1-A	1/4 " "			
FUSE 1-B	1/4 " "			
P-1A	PILOT LAMP, 12V., MINIATURE SCREW BASE			
L/C-101A	FILTER CHOKE :- ⊕ H.T.1 (VIBR.)			
L/C-102A	FILTER CHOKE, ⊕ L.T. (VIBR.)			
L-17A	L.T. CHOKE			
L-18A	R.F. CHOKE (540V.)			
T/C-101A	VIBRATOR TRANSFORMER			
VIBRATOR	MALLORY G 634C, PLUG-IN UNIT			
V/C-101A	0Z4A FULL WAVE RECTIFIER (COLD CATHODE GAS FILLED.)			

W.S. (CDN.) No 19 Mk. III
•• SUPPLY UNIT No 2 ••



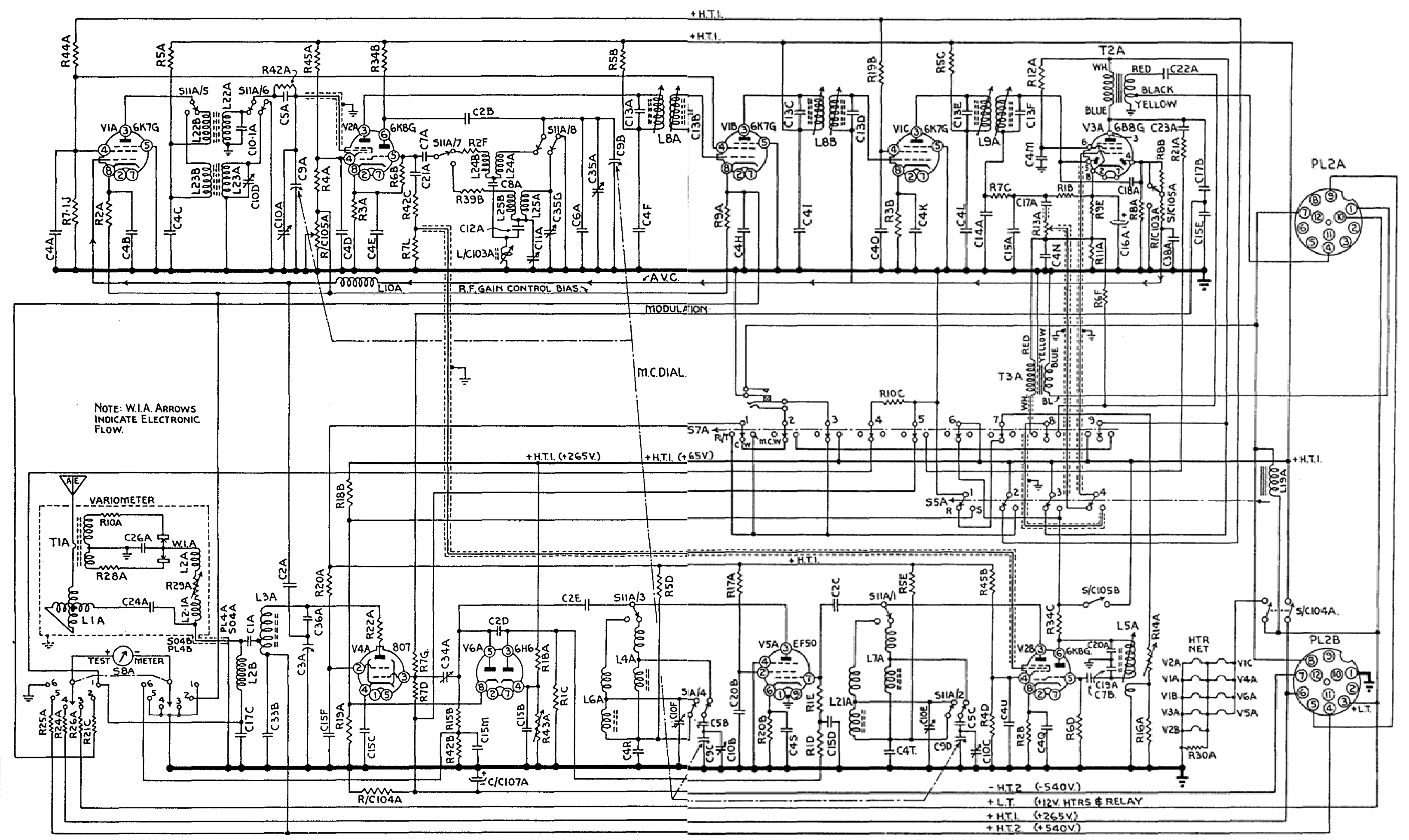
PL-1C (6 PT. POWER INLET SOCKET)
1 ⊖ 12V. HTRS; ⊖ DYN. & GND.
2 I.C. A.F. OUTPUT
3 ⊕ 12V. HTRS. & RELAY
4 ⊕ 12V. VIBR; ⊕ DYN.
5 DRIVERS SIGNAL LEAD
6 ⊖ 12V. VIBRATOR

PL-2C (12 PT. POWER OUTLET SOCKET)	
1 ⊖ 12V HTRS; ⊖ H.T.1; GND.	7 ⊖ H.T. 2
2 I.C. A.F. OUTPUT	8 "A" RELAY PRESSEL CIRC
3 ⊕ 12V. HTRS.	9 —
4 ⊕ H.T. 2 (⊕ 540V.)	10 —
5 DRIVERS SIGNAL	11 —
6 ⊕ H.T.1. (⊕ 265V.)	12 —

BTY. CONNECTIONS TO PL-1C

2 WIRE – 12 VOLT	3 WIRE – 24 VOLT	2 WIRE – 24 VOLT
⊖ 12V TO PINS 1 & 6	⊖ 24V. TO PIN 1.	⊖ 24 V. TO PIN 1
⊕ 12V. TO PINS 3 & 4	12V. TAP TO PINS 3 & 6	⊕ 24 V. TO PIN 4
SW. S/C-102A TO 12V.	⊕ 24V. TO PIN 4.	SW. S/C-102A TO 24 V.
	SW. S/C-102A TO 24 V.	SW. S/C-101A TO DYN.
		(VIBRATOR INOPERATIVE)

FIG. 41—CIRCUIT DIAGRAM OF SUPPLY UNIT No. 2



S8A.
1. AE.
2. A.V.C.
3. L.T.
4. H.T.I.
5. H.T.2
6. DRIVE

PL2A-12 PT. COMMUNICATIONS PLUG.

1. "A" SET. MIC.INPUT
2. "B" " " "
3. I.C. " "
4. "A" SET A.F. OUTPUT
5. "B" " " "
6. I.C. " " "
7. "A" SET RELAY PRESSEL CIRCUIT
8. "B" " " " "

**W.S. (CDN.) No 19 MK. III
"A" SET SENDER/RECEIVER
SCHEMATIC DIAGRAM**

PL2B-12 PT. POWER PLUG.

1. GND;-L.T.;-H.T.I.
2. I.C. "SPEECH"
3. +L.T. (+12V.)
4. +H.T.2 (+540V.)
5. DRIVERS SIGNAL LEAD
6. +H.T.I. (+265V.)
7. -H.T.2. (-540V.)
8. "A" SET RELAY PRESSEL CIRCUIT

NOTES:

1. FUNCTION SW. (S7A) SHOWN IN C.W. POSITION.
2. S/R RELAY (S5A) SHOWN IN RECEIVE POSITION.
3. BAND SW. (S11A) SHOWN IN H.F. BAND POSITION (4½-8mc/s)
4. ALL S11A/- SWITCHES ARE "GANGED"

FIG. 42—ENLARGED CIRCUIT DIAGRAM OF "A" SENDER RECEIVER

CIRCUIT REFERENCE	DESCRIPTION			
	VALUE	TOLERANCE	RATING	TYPE
C1A	.004 Mfd.	±20%	2200 V.	Mica
C2A	.0005	"	1000 V.	"
C2B	.0001	"	"	"
C2C	"	"	"	"
C2D	"	"	"	"
C2E	"	"	"	"
C3A	16–550 mmfd.	variable	——	variable, air.
C4A	.1 mfd.	±20%	500 V.	paper (oil filled)
C4B	"	"	"	" "
C4C	"	"	"	" "
C4D	"	"	"	" "
C4E	"	"	"	" "
C4F	"	"	"	" "
C4H	"	"	"	" "
C4I	"	"	"	" "
C4K	"	"	"	" "
C4L	"	"	"	" "
C4M	"	"	"	" "
C4N	"	"	"	" "
C4O	"	"	"	" "
C4Q	"	"	"	" "
C4R	"	"	"	" "
C4S	"	"	"	" "
C4T	"	"	"	" "
C4U	"	"	"	" "
C5A	.01	±10%	600 V	Mica
C5B	"	"	"	"
C5C	"	"	"	"
C6A	50. mmfd.	± 5%	1300 V.	Ceramic Compensator
C7A	30. "	±20%	1000 V.	Ceramic (Mica)
C7B	" "	"	"	" "
C8A	3100. "	±5%	600 V.	Mica
C9A	530. mmfd. max.	variable	——	4 gang, variable air.
C9B	" " "	"	——	(one unit)
C9C	" " "	"	——	
C9D	" " "	"	——	
C10A	4–30. mmfd.	"	——	variable ceramic.
C10B	" "	"	——	" "
C10C	" "	"	——	" "
C10D	" "	"	——	" "
C10E	" "	"	——	" "
C10F	" "	"	——	" "
C10. 1A	10. mmfd.	±20%	1000 V.	Mica
C11A	6.5–140 mmfd.	variable	——	variable air
C12A	1780. mmfd.	± 3%	1000 V.	Mica
C13A	.00014 mfd.	± 2%	350 V.	ceramic compensator
C13B	" "	"	"	
C13C	" "	"	"	

CIRCUIT REFERENCE	DESCRIPTION			
	VALUE	TOLERANCE	RATING	TYPE
C13D	" "	"	"	
C13E	" "	"	"	
C13F	" "	"	"	
C14A	.0001 "	±20%	1000 V.	Mica
C15A	.0005 "	"	"	"
C15B	" "	"	"	"
C15C	" "	"	"	"
C15D	.0005 mfd.	±20%	1000 V.	Mica
C15E	" "	"	"	"
C15F	" "	"	"	"
C15M	" "	"	"	"
C16A	12. "	-0%;+100%	50 V.	Electrolytic
C17A	.002 "	±20%	1000 V.	Mica
C17B	.025 "	"	"	Paper (oil filled)
C17C	.002 "	"	"	Mica
C18A	20. mmfd.	"	"	"
C19A	90. "	"	1300 V.	Ceramic Compensator
C20A	.002 mfd.	"	1000 V.	Mica
C20B	" "	"	"	"
C21A	.00003 "	"	"	"
C22A	.025 "	"	500 V.	paper (oil filled)
C23A	.005 "	"	600 V.	Mica
C24A	.001 "	"	5000 V.	"
C26A	.001 "	±25%	1000 V.	"
C33B	.1 "	±10%	1500 V.	paper (oil filled)
C34A	7.-45. mmfd.	variable	——	variable ceramic
C35A	4.-30 "	"	——	" "
C35B	3.-13 "	"	——	" "
C36A	.01 mfd.	±10%	2200 V.	Mica
C38A	.1 "	±20%	500 V.	paper (oil filled)
C/C-107A	12. "	±10%	100 V.	Electrolytic
R1B	470000.	±20%	¼ W.	
R1C	"	"	"	
R1D	"	"	"	
R1E	"	"	"	
R2A	220.	±10%	½ W.	
R2B	"	"	"	
R2F	"	"	"	
R3A	270.	"	"	
R3B	"	"	"	
R4A	22000.	"	1 W.	
R4D	"	"	"	
R5A	2200.	"	¼ W.	
R5B	"	"	"	
R5C	"	"	"	
R5D	"	"	"	
R5E	"	"	"	
R6B	47000.	"	"	

CIRCUIT REFERENCE	DESCRIPTION			
	VALUE	TOLERANCE	RATING	TYPE
R6D	"	"	"	
R6F	"	"	"	
R7C	100000.	"	"	
R7D	"	"	"	
R7G	"	"	"	
R7L	"	±20%	"	
R7.1J	"	"	"	
R8A	1. meg	"	"	
R8B	"	"	"	
R9A	1000.	±10%	"	
R9E	"	"	"	
R10A	470.	"	½ W.	
R10C	"	"	"	
R11A	3300.	"	"	
R12A	68000.	"	"	
R13A	1. meg.	variable pot.	——	
R14A	6.	"	——	
R15B	220000.	±20%	¼ W.	
R16A	½	± 5%	½ W.	
R17A	3900.	±10%	¼ W.	
R18A	270000.	"	½ W.	
R18B	"	"	"	
R19A	82000.	"	¼ W.	
R19B	"	"	½ W.	
R20A	100.	"	"	
R20B	"	"	"	
R21A	27000.	"	¼ W.	
R21C	"	"	"	
R22A	47.	"	½ W.	
R24A	1.2 meg.	± 5%	"	
R25A	"	"	1. W.	
R26A	29000.	± 2%	¼ W.	
R28A	27.	±10%	½ W.	
R29A	20000.	variable	——	
R30A	30.	± 5%	2. W.	
R34B	47000.	±10%	1. W.	
R34C	"	"	"	
R39B	820.	"	¼ W.	
R42A	10000.	"	"	
R42B	"	"	"	
R42C	"	"	"	
R43A	100000.	variable	——	
R44A	39000.	±10%	1. W.	
R45A	22000.	"	2. W.	
R45B	"	"	"	
R/C-103A	1. meg.	±20%	½ W.	
R/C-104A	1500.	±10%	2. W.	
R/C-105A	10000.	variable pot.	——	

CIRCUIT REFERENCE	DESCRIPTION
L1A	"A" Aerial Variometer
L2A	R.F. Choke—(variometer)
L2.1A	R.F. Choke—(variometer)
L2B	R.F. Choke—(meter)
L3A	Power Amplifier "Tank Coil" inductance
L4A	H.F. tank coil, Driver Output
L5A	B.F.O. coil (primary and secondary)
L6A	L.F. tank coil, Driver Output
L7A	H.F. tank coil, Sender-Mixer Output
L8A	1st I.F. transformer (primary and secondary)
L8B	2nd I.F. transformer (primary and secondary)
L9A	3rd I.F. transformer (primary and secondary)
L10A	R.F. Choke—A.V.C. line
L19A	Relay Coil, "A" Set
L21A	L.F. tank coil, Sender-Mixer Output (primary-V1A plate)
L22A	R.F. transformer (H.F.) Coupling V1A to V2A (secondary, tuned-V2A grid)
L22B	R.F. transformer (H.F.) Coupling V1A to V2A (Primary-V1A plate)
L23A	R.F. transformer (L.F.) Coupling V1A to V2A (secondary, tuned, V2A grid)
L23B	R.F. transformer (L.F.) Coupling V1A to V2A (Primary, V1A plate).
L24A	Rec. Conversion Osc. tuned coil—(H.F.), plate —V2A triode section
L24B	Rec. Conversion Osc. tickler coil—(H.F.), grid —V2A triode section
L25A	Rec. Conversion Osc. tuned coil—(L.F.), plate —V2A triode section
L25B	Rec. Conversion Osc. tickler coil—(L.F.), grid —V2A triode section
L/C–103A	Rec. "Flick Adjuster" coil, slug tuned
S5A	"A" Set Send-Receive relay switches
S7A	Function switch (R/T-C.W.-M.C.W.) 9 pole, 3 position
S8A	Panel Meter switch. 2 pole, 6 position
S11A	Band Sw. (H.F.;-4½-8 Mc/s.) (L.F.; 2-4½ Mc/s.) 12 pole, 2 position, ceramic.
S/C–104A	"A" Set ON-OFF; 2 pole, toggle switch.
S/C–105A	A.V.C. ON-OFF; single pole, toggle switch.
S/C–105B	"NET" single pole toggle switch.
J1A	Key Jack.
T1A	A.E. Current meter transformer.
T2A	A.F. Output transformer.
T3A	Mic. input transformer.

END