SECTION 4

CIRCUIT DESCRIPTION

4.1. ELECTRICAL DESCRIPTION.

4.1.1. PRIMARY POWER CIRCUITS.

(a) Filament, Blower, Bias, and Control Circuits. - With the FILAMENT ON-OFF switch in the ON position, 230 volts are applied to the primary windings of the two filament transformers, T-107 and T-109, the primary winding of the bias transformer, T-106, the blower motor, B-101, the lumiline meter lights, I-102 and I-103, and the thermal time delay, K-101.

(1) Control Circuits. - As seen from figure 7-2, the instant the FILAMENT ON-OFF switch is thrown to the ON position, voltage is impressed across the thermal relay. The thermal time delay relay, K-101, contains a small heating element and a set of contacts. The amount of resistance in series with the relay governs the amount of current flowing through it and hence the length of time required to heat the relay to the point where the contacts close. At the end of its delay period, which is adjustable from 10 to 45 seconds by means of R-171, the contacts close. If the door and blower interlocks are closed, the plate contactor relay, K-102, will now be energized. The plate contactor relay, K-102, performs two main functions. It places a shunt resistor, R-172, across the thermal relay, lowering the voltage applied to the thermal relay heater and, also, completes the circuit between the PLATE ON-OFF breaker, S-107, and the primaries of the high and low voltage transformers, T-108 and T-110. It also shorts the time delay relay contacts.

The thermal time delay relay, which contains a heater, a bi-metallic strip, and a set of contacts, operates in the following manner to provide a time delay period which is dependent on the tube filament temperature. The temperature within the relay, as controlled by the heater, affects the bi-metallic element which operates to open or close the relay contacts. If the power is removed for an instant and then returned, there will be not filament time delay period since the element will not have cooled to the point where the contacts have opened. Likewise, the filaments will not have cooled to the point where a warm-up period is necessary. This is a distinct advantage over a motor operated relay which provides a set delay period regardless of the temperature of the tube filaments. The motor operated relay will prevent return to the air until the entire time delay period has elapsed whether there is an instantaneous power interruption, or whether the power has been removed for several hours. The thermal time delay relay then provides the quickest possible return to the air after a power interruption.

FREQ.	C-146 APPROX. DIAL READ.	L-108 TURNS* FROM END	C-148 uuf	C-149 uuf	C-150 uuf	C-151 uuf	C-147** APPROX. DIAL READ.	L-109 TAPS*** USED
550	60	0	800	2000	800	800	60	1-8
600	55	1	800	2000	800	400	50	1-8
650	25	2	800	2000	800	400	35	1-8
700	10	3	800	2000	800	OUT	20	1-8
750	10	5	OUT	2000	800	OUT	50	1-8
800	30	0	800	800	800	800	15	1-8
850	28	1	800	800	800	800	50	2-7
900	22	2	800	800	800	800	20	2-7
950	10	3	800	800	800	800	10	2-7
1000	20	5	800	800	400	400	55	2-7
1050	20	6	800	800	400	400	40	2-7
1100	15	7	800	800	400	400	30	2-7
1150	15	8	800	800	400	400	15	2-7
1200	12	9	800	800	400	400	35	2-7
1250	23	10	800	800	400	OUT	75	3-6
1300	75	5	400	400	400	OUT	45	3-6
1350	80	6	400	400	400	OUT	32	3-6
1400	80	7	400	400	400	OUT	32	3-6
1450	70	7	400	400	400	OUT	30	3-5
1500	70	8	400	400	400	OUT	30	3-5
1550	65	8	400	400	400	OUT	60	3-5
1600	75	9	400	400	400	OUT	60	3-5
1650		9						
1700		10						

NOTES:

* Number of turns shorted at each end.

** For 72 ohm output. Readings for 50 ohm output will be somewhat higher.

*** Taps are numbered from top to bottom, 1 to 8.

Table 4-1. 20V Output Tank Tuning Data

FREQUENCY	L-108	C-145	C-148	C-149	C-150	C-151
550-590	150 uh	400 uuf	800 uuf	2000 uuf	800 uuf	800 uuf
600-790	150 uh	400 uuf	800 uuf	2000 uuf	800 uuf	400 uuf
800-990	81 uh	400 uuf	800 uuf	800 uuf	800 uuf	800 uuf
1000-1290	81 uh	400 uuf	800 uuf	800 uuf	400 uuf	400 uuf
1300-1600	81 uh	0	400 uuf	400 uuf	400 uuf	0

Table 4-2. 20V Output Tank Components for 50 or 72 Ohm Resistive Load.

(b) High and Low Voltage Circuits. - Throwing the PLATE ON-OFF switch to the ON position impresses 230 volts across the primary windings of the high and low voltage transformers T-108 and T-110, provided, however, that the plate contactor relay has been energized. Illumination of the FILAMENT ON lamp indicates a readiness for plate power.

4.1.2. RF SECTION. - The rf portion of the 20V transmitter is composed of straightforward rf circuits which include the following:

(a) Oscillator. - (Refer to figure 7-1.) The crystal oscillator, V-101, is a type 6AU6 pentode connected in a Pierce oscillator circuit. The inherent stability of the Pierce circuit combined with the new low temperature coefficient crystals has eliminated the need for a crystal oven. For frequencies in the AM broadcast band, the oscillator employs a resistance load. Since the 20V is also available for high frequency applications, the resistive load may be replaced by a tuned tank circuit for frequency doubling.

(b) Buffer Amplifier. - (Refer to figure 7-1.) The buffer stage, V-102, employs a type 6SJ7 tube operating as a Class C amplifier. The plate tank circuit is composed of L-102, C-114, C-115, and C-113. The Buffer operates as a straight amplifier in the AM broadcast band. (See

table 4-3 for schematic diagram of the buffer tank for the various frequency ranges.) For high frequency applications it may operate as a doubler stage.

(c) RF Driver Amplifier. - (Refer to figure 7-1.) The Driver stage, V-103, employs a type 807 tube operating as a Class C amplifier. The plate circuit is composed of L-104, C-124, C-125, and C-126. The Driver operates as a straight amplifier for all applications. (See table 4-3 for a schematic diagram of the driver tank for the various frequency ranges.)

(d) Power Amplifier. - The Power Amplifier, V-104 and V-105, employs two type 4-400A tetrodes connected in parallel and operating Class C. Although neutralization is unnecessary in the AM broadcast band, provisions have been made for connecting a neutralizing capacitor, C-131, from the Power Amplifier plate to the low end of the grid tank circuit when needed in the higher frequency applications. A resistor, R-121, connected in the cathode circuit of the Power Amplifier, acts as a low impedance source for feeding a monitor speaker or amplifier system.

The plate circuit is composed of a "pi-section" followed by an "L section". The variable tuning and loading capacitors are positioned from the front panel by means of flexible shaft drives.

The coil, L-110, acts as a static drain and as a voltage source for feeding the modulation monitor. It is connected from the output end of the "L section" to ground.

4.1.3. AUDIO CIRCUITS. - The audio circuits employed in the 20V are also of straightforward design requiring no detailed description. Only the salient points of each circuit are mentioned.

(a) 1st Audio Amplifier and Audio Driver. - The first two audio stages, V-106 through V-109, employ type 6SJ7 pentodes connected as triodes and operating as Class A push-pull amplifiers. The input circuit to these stages consists of a terminating pad feeding the primary of the audio input transformer, T-104. An audio balance control, R-146, is connected in the cathode circuit of the Audio Driver stage.

(b) Modulator. - The modulator stage, V-110 and V-111, employs two type 4-250A tetrodes operating Class AB_1 in a push-pull circuit. Approximately 12 db of feedback is provided from the plates of the Modulator stages to the grids of the 1st Audio Amplifier.

4.1.4. FILAMENT SUPPLIES. - Filament power for the bias supply rectifier tube and the high voltage supply rectifier tubes is supplied by T-106 and T-107 respectively. The remainder of the tubes obtain their filament power from the filament transformer T-109.

4.1.5. PLATE AND BIAS SUPPLIES.

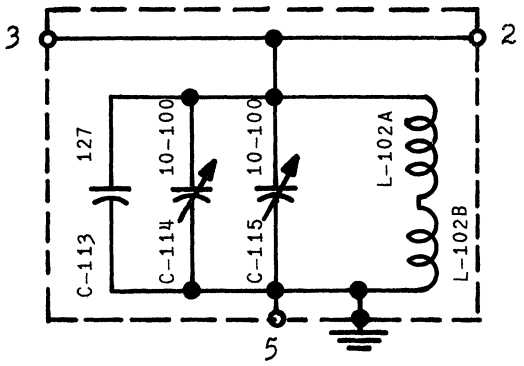
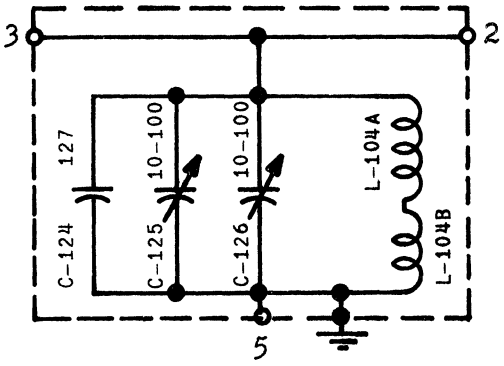
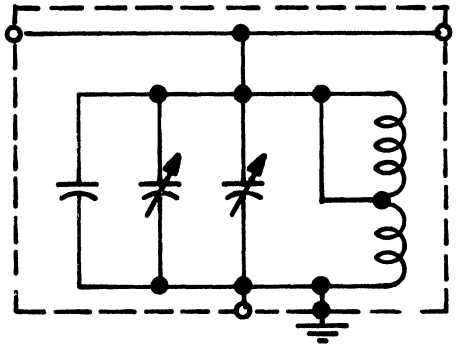
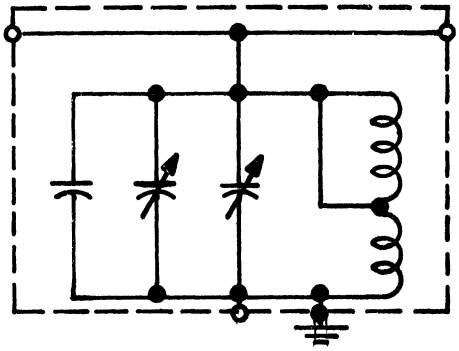
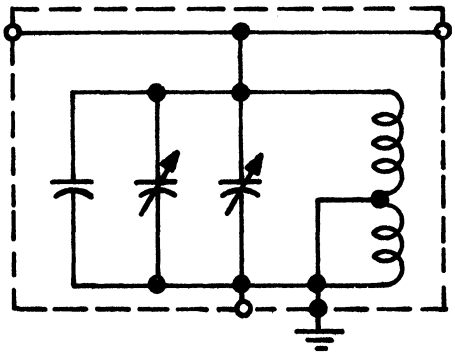
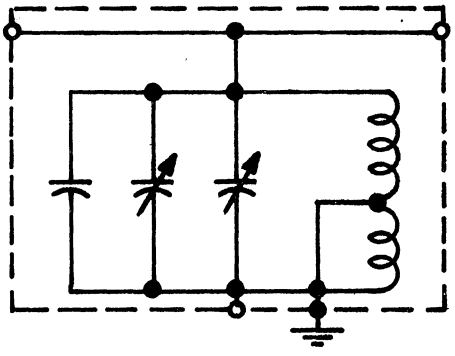
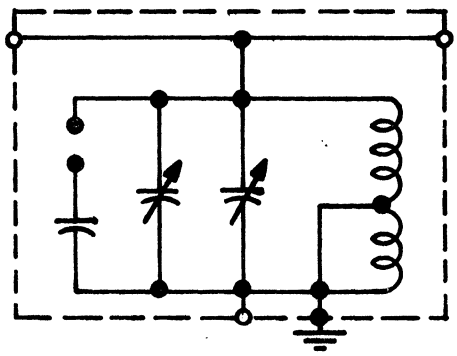
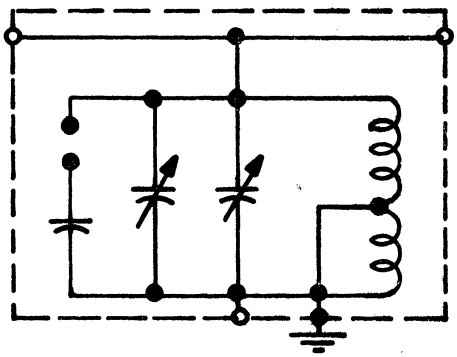
FREQUENCY RANGE	BUFFER PLATE TANK CIRCUIT (T-102)	DRIVER PLATE TANK CIRCUIT (T-103)
550 kc to 700 kc		
700 kc to 950 kc		
950 kc to 1100 kc		
1100 kc to 1600 kc		

Table 4-3 T-102 and T-103 Internal Connections

(a) High Voltage Supply. - The high voltage supply utilizes a pair of 872A half-wave mercury vapor rectifier tubes in a single phase full wave rectifier circuit. The output of the single section choke input filter is 3100 volts at 1 amp. The filter is composed of two chokes, L-114 and L-115, in series, which are followed by two capacitors, C-170 and C-184, connected in parallel to ground. The first choke, L-114, is tuned by means of C-169 to form a parallel resonant circuit at the ripple frequency. This supply furnishes the plate voltage for the plates of the Modulator and Power Amplifier tubes as well as the screen voltage for the Power Amplifier tubes.

(b) Low Voltage Supply. - The low voltage supply consists of a pair of type 866A half wave mercury vapor tubes in a single phase, full wave, rectifier circuit. The output from the two section choke input filter is 550 volts at 250 ma. With the exception of the plates and screens of the Power Amplifier and the plates of the Modulator tubes, the low voltage supply furnishes the plate and screen voltage for all tubes in the equipment.

(c) Bias Voltage Supply. - The bias supply employs a type 5U4G full wave high vacuum rectifier tube in a single phase full wave circuit. It utilizes a two section choke input filter and is capable of delivering a negative 110 volts at 80 ma. It supplies bias voltage to the Modulator, RF Driver, and the Power Amplifier stages.

SECTION 5

MAINTENANCE

This transmitter has been constructed of materials considered to be the best obtainable for the purpose, and has been carefully inspected and adjusted at the factory to reduce maintenance to a minimum. To insure peak performance and prevent the failure or the impairment of the operation of the equipment, a definite schedule of routine periodic checks and maintenance procedures should be adhered to.

5.1. CLEANING.

5.1.1. GENERAL. - The greatest enemy to uninterrupted service in equipment of this type is corrosion and dirt. Corrosion is accelerated by the presence of dust and moisture. It is impossible to keep moisture out of the equipment in certain localities, but foreign particles and dust can be periodically removed by means of a soft brush or a dry oil-free jet of

air. Although the cabinet is equipped with a dust filter which will remove most of the dust particles, there is always a slight accumulation of dust in the vicinity of circuits maintained at a high potential above ground. Remove dust as often as a perceptible quantity accumulates at any place in the equipment. It is very important the capacitors, tap switches, etc., be kept free from dust so as to prevent undue wear. In general, it will be found that contacts such as the tap switches, tube prongs and cable plug connectors are most affected by corrosion. When it is necessary to operate the equipment in localities where corrosion is a problem, e.g. near salt water, inspection of wiping contacts, cables, plugs, and relays, etc., should be made more frequently in order to keep the equipment in good condition.

* TAP CONNECTORS, RF, YOU MEAN?

5.2. AIR FILTER.

The bronze air filter will give more satisfactory life if it is cleaned approximately once every two weeks. A small vacuum cleaner is a satisfactory means of removing the surface dirt. Whenever the bronze element appears to be clogged appreciably by dirt and grease, the filter should be removed, washed in carbon tetrachloride and then recharged by immersing it in SAE #30 oil, and allowing all excess oil to drain off.

5.3. LUBRICATION.

Lubricate the bearings of the blower motor with No. 10 oil. Use only a small amount at one time since too much oil will shorten the life. Lubricate the bearings periodically.

The bearings of the pulleys on each flexible condenser drive cable should be lubricated at two points with No. 30 oil at least every four weeks.

5.4. ROUTINE CHECKS.

5.4.1. TUBE CHECK.

(a) A check on the emission of all tubes should be made at least every 1000 hours of service.

(b) Keep a record of the length of time the tube filaments and plates are in use.

(c) Operate tubes as near their rated value of voltage and current as possible.

(d) Replace tubes that have been in service a long time with new tubes.

(e) Visually inspect the elements inside of the tubes. Elements may have become warped, increasing the probability of short-circuits.

(f) When the type 872A, or type 866A, mercury vapor tubes are put into service for the first time, the filaments should be operated at normal temperature for at least 20 minutes before plate voltage is applied. See paragraph 3.1.4.

5.4.2. MECHANICAL INSPECTION. -

(a) Check all connections at least once a month. Tighten any nuts, bolts, or screws that may have become loose.

(b) Check all contacts of cable receptacles and plugs to assure clean, firm mechanical and electrical connections.

(c) Inspect and burnish interlock switches on the rear doors weekly.

(d) Examine all mechanical parts of moving assemblies, such as tuning controls, etc., for excessive wear.

5.5. TROUBLE SHOOTING.

5.5.1. TUBE FAILURE. - The most frequent cause of trouble in equipment of this type is tube failure. Check tubes by replacement. Tubes are the most likely trouble and are the simplest corrective measure which can be performed. Low emission tubes may be the cause of erratic or poor performance of the equipment. If there is any doubt concerning the emission of any tube, it should be checked immediately and replaced if defective. Tubes with electrical noises cause excessive distortion or hum. This fault may be more difficult to isolate to a particular tube; however, a tube suspected of faulty operation may be checked by replacing with a like tube known to be in good condition.

5.5.2. LOCATION OF TROUBLE. - The transmitter may fail to function either at the time of attempting to start it, or it may fail during operation. In either case, the procedure for making a test is to check the circuits in the order of succession they are made operative in the process of starting the transmitter.

This procedure should aid in isolating the trouble to one or two units. A check of both circuit breakers and all fuses in the transmitter should be made to ascertain the power circuit affected by the trouble.

The following tables of operating voltages and current measurements are supplied to assist the operator in trouble shooting. Open and short circuits will usually be accompanied by a change in the voltage applied to one or more of the tubes. A check of the various tube voltages and current measurements against the values shown in the tables will assist in locating the source of trouble.

5.5.3. SERVICING THE EQUIPMENT. - The major portion of components are mounted in the vertical chassis within the cabinets. This adds consid-

erable accessibility to all components, as access to all components is readily attained from either front or the rear of the transmitter. The lower panel in the rear of the cabinet can be removed promptly if deemed necessary to gain access to components that need servicing. One-man replacement of all components has been designed into this equipment wherever practical.

WARNING

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF VOLTAGES WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL SHOULD AT ALL TIMES OBSERVE PROPER SAFETY PRECUATIONS. DO NOT MAKE ADJUSTMENTS INSIDE THE CABINET WHILE ANY OF THE POWER SUPPLIES ARE OPERATING. DO NOT DEPEND UPON INTERLOCK FOR PROTECTION. THE EQUIPMENT SHOULD BE COMPLETELY SHUT DOWN BEFORE THE REAR DOORS ARE OPENED.

TABLE 5-1

20V NORMAL OPERATING CHARACTERISITICS, AM BROADCAST BAND

Tube	Tube Type	Function	Normal Operating Characteristics		
V-101	6AU6	Oscillator, Pierce Circuit	Plate Voltage	270	volts
			Crystal Current	1.6	ma.
			Cathode Current	4.0	ma.
V-102	6SJ7	Buffer Amplifier	Plate Voltage	280	volts
			Screen Voltage	130	volts
			Grid Current	0.1	ma.
			Cathode Current	6.5	ma.
V-103	807	RF Driver Amplifier	Plate Voltage	550	volts
			Screen Voltage	260	volts
			Cathode Current	55	ma.
			Grid Current	1	ma.
V-104, V-105	4-400A	Power Amplifier	Output (watts)	1100 550	watts
			Plate Voltage	3100 2200	volts
			Plate Current	500 330	ma.
			Screen Voltage	470 330	volts
			Grid Current	20 20	ma.
			Plate Efficiency	73.5 75.8	%
V-106, V-107	6SJ7	1st Audio Amplifier (Triode Connected)	Plate Voltage	300	volts
			Cathode Current	2	ma./tube
V-108, V-109	6SJ7	Audio Driver Amplifier	Plate Voltage	265	volts
			Cathode Current	7	ma./tube
V-110, V-111	4-250A	Modulator	Plate Voltage	3100	volts
			Cathode Current		
			No Signal	120	ma.
			100% Mod. 1100 w	450	ma.
			100% Mod. 550 w	320	ma.
V-112	5U4G	Bias Voltage Rectifier (Values are output from filter)	Voltage	-110	volts
			Current	100	ma.
V-113, V-114	872A	High Voltage Rectifier (Values are output from filter)	Voltage	3100	volts
			Current	1	amp.
V-115, V-116	866A	Low Voltage Rectifier (Values are output from filter)	Voltage	- 550	volts
			Current	- 250	ma.

POWER INPUT TO TRANSMITTER
230 volts, single phase, 60 cycle source

	KVA	KW	PF
Filament switch ON	.78	.66	85%
550 watts output, no modulation	3.28	2.45	75%
550 watts output, 100% modulation	4.0	3.2	80%
1100 watts output, no modulation	3.7	2.95	80%
1100 watts output, 100% modulation	4.82	4.0	83%