



DESCRIPTIVE SPECIFICATION RA-3333-D

10-KW FREQUENCY-MODULATION BROADCAST AMPLIFIER

G-E MODEL 4AF3A3

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GENERAL ELECTRIC COMPANY

SCHENECTADY, NEW YORK

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I. INTRODUCTION

These specifications cover the necessary units or radio transmitting equipment and associated apparatus for amplifying frequency-modulated radio-frequency power from an input level of 1 kw to an output level of 10 kilowatts, and for taking the required power from a suitable 60-cycle alternating-current supply.

The units of radio transmitting equipment described herein are as follows:

10-KW Amplifier Unit
Rectifier and Control Unit

The following external apparatus is also included:

Main-rectifier Plate Transformer

II. TUBE COMPLEMENT

<u>Quantity</u>	<u>Type</u>	<u>Function</u>
2	GL-889-R	10-KW R-F Amplifier
6	GL-872-A	Main Rectifier
2	GL-866/866-A	Bias Rectifier
1	6X5	Carrier Rectifier
1	83	Feed-back Rectifier
1	6SJ7	Feed-back Amplifier
2	6L6	Feed-back Modulator

III. POWER SUPPLY

This amplifying equipment is designed to operate from a 230-volt, 60-cycle, 3-phase, 3-wire supply. The line voltage should not vary more than ± 5 per cent, due to regulation and other causes. The input is approximately 20.5 kw at 90 per cent power factor when the amplifier is loaded to give 10-kw r-f output. An additional 1 kw of 230-volt, 60-cycle, single-phase power is required for control purposes.

The customer should provide a disconnect switch or circuit breaker, with inverse-time overload protection, in the input power circuit external to the trans-

mitter; and such other apparatus as may be required by local underwriter's regulations. This will permit all power to be readily removed from the equipment when desired.

All substation equipment and power-line metering will be external to the transmitter and is not covered by these specifications.

IV. PERFORMANCE SPECIFICATIONS

A. Output Power

The rated power output of this equipment is 10 kw. The output remains the same as that of the unmodulated carrier for all percentages of modulation from 0 to 100 per cent.

B. Output Frequency Range

This equipment is designed to operate on a single mean frequency in the range from 42 to 50 mc, and all tuned circuits can be adjusted to operate at any frequency within this band.

C. R-F Driving Power

This amplifying equipment is designed to operate successfully with 1000 watts of frequency-modulated r-f driving power applied at the grid input terminals.

D. Carrier Noise Level

The residual carrier-noise "hum" level, with no applied modulation, must be considered in two parts: that due to undesired frequency modulation and that due to undesired amplitude modulation.

The frequency-modulated carrier noise is produced in or ahead of the frequency modulator and is not affected by the 10-kw amplifier stage.

Residual amplitude-modulated carrier noise or hum is at least 60 db below 100 per cent amplitude modulation.

E. Other Characteristics

Audio-frequency response, harmonic distortion, stability, and frequency deviation are determined by the frequency-modulated exciter unit.

V. ECONOMY OF OPERATION

The economies resulting from the use of frequency modulation, as compared to any conventional system, are nowhere better demonstrated than in the use of transmitting equipment operating at the higher power levels. Among these economies are the following:

- A. Lower power consumption from power line and smaller transformer capacity in substation, because:
 - 1. No high-level modulator is required.
 - 2. R-f amplifier tubes operate at Class "C" telegraph rating, resulting in higher plate efficiency.
- B. Initial and replacement tube costs are lower, because:
 - 1. No high-level modulator is required.
 - 2. Smaller r-f tubes can be used for a given power output because of high plate efficiency and high power output per tube possible when operating at Class "C" telegraph rating.
- C. It is possible to use a forced-air cooling system rather than a water-cooling system at this power level due to low plate dissipation when operating tubes at Class "C" telegraph rating.

- D. The transmitter as a whole is smaller, simpler and hence more reliable due to the design features noted above.

VI. CONTINUITY OF SERVICE

Precautions have been taken in the design of this equipment to provide conservative operation of all components, reliability, simplicity of operation and control, flexibility, and means of quickly locating and correcting troubles.

Protective devices are provided throughout the equipment so that apparatus is protected both against severe overload and against transient phenomena which may be caused by power line surges. Visual indicators and instruments make it possible to observe conditions in the radio, control and power circuits.

An automatic reclosing circuit described in Section VIII-C, prevents lost time in case of momentary a-c or d-c overloads.

Two solenoid-operated relays make it possible to instantly transfer the antenna transmission line from the output circuit of the 10-kw amplifier to that of the IPA Unit (1 KW) should it become necessary to service any of the p-a equipment during normal operation. The solenoids are operated by a switch located in the Control Unit or in the customer's control console.

VII. CONSTRUCTION

A. General

The 10-kw FM power-amplifier unit and the rectifier unit are shown on enclosed photographs. The G-E 250-watt exciter and 1-kw ipa are styled to match the 10-kw amplifier and when placed side by side give the appearance of a single unit. The type number of the complete transmitter is GF-110-B. Identification, dimensions and weights of the various units are shown for the complete

transmitter on enclosed drawing P-7763288. The amplifier and rectifier units are completely self-contained except for the main plate transformer which can be placed either indoors or outdoors. Grounded steel cabinets provide radio-frequency shielding as well as high-voltage protection to station personnel.

Considering the transmitter as a whole, flexibility is permitted in the location of transmitter units to meet installation requirements. The units may be placed on a line or in groups of two each keeping the same sequence as shown on drawing T-7661442.

B. 10-Kw Amplifier Unit

The 10-kw amplifier unit contains tube mountings, r-f circuits, blowers, filament transformers, d-c overload relays, carrier rectifier circuits, and cutback relays. Small drop doors, when open, expose the tuning and control knobs. A grille at eye level matches those of the G-E exciter and i-p-a units. This unit is provided with full-length access doors, both front and rear which are equipped with safety interlocks and grounding switches.

C. Rectifier and Control Unit

The Rectifier Unit contains tube mountings, filament transformers, the main-rectifier filter reactor and capacitor, the bias rectifier, the feed-back amplifier, and control equipment.

Again maximum accessibility is obtained by full-length doors, both front and rear, which are provided with safety interlocks and grounding switches.

Circuit-breaker type switches for various low-current branch circuits operating at 230 volts are mounted behind small drop doors. This type of switch combines overload protection, convenience, and ease of operation. No fuses are used in the equipment.

D. Plate Transformer

The pyranol-filled main-rectifier plate transformer is provided with low-voltage, tap-changing switches. High-voltage and low-voltage junction boxes on opposite sides of the transformer tank are provided with wiping sleeves for a three-conductor, high-voltage, lead-covered cable and a 3-conductor lead-covered low-voltage cable respectively.

VIII. CIRCUITS

A. 10-Kw Amplifier

The 10-kw amplifier operates Class "C" and utilizes two Type GL-889-R forced-air-cooled tubes in a balanced push-pull circuit, enabling power to be supplied to the output tank circuit during each half of the radio-frequency cycle. This type of circuit, used with a quarter-wave, resonant-line plate-tank circuit, results in high plate efficiency. A similar resonant line is used for the grid-tank circuit.

The following r-f circuit controls are provided on the power-amplifier panel:

- Vernier grid tuning
- Vernier plate tuning
- Output coupling
- Output tuning

The initial surge of filament current is limited to a safe value by the use of suitable high-reactance filament transformers. A plate-overload relay is used for each tube. A mercury type air-pressure interlock is furnished to protect against inadequate air flow.

A low-power feed-back amplifier, which grid modulates the power-amplifier stage, limits the amplitude-modulation carrier noise to at least 60 db below 100 per cent amplitude modulation. By use of this system, it is possible to use alternating current for heating the p-a tube filaments.

B. Power and Rectifier Circuits

The main 230-volt, 3-phase incoming power circuit is connected through the rectifier plate contactor to the plate transformer primary. A low-current branch of the incoming power circuit is connected to a distribution panel, where feeders to the various auxiliaries are connected through circuit-breaker type switches.

The main rectifier uses six Type GL-872-A hot-cathode, mercury-vapor rectifier tubes in a three-phase, full-wave circuit. Tap switches on the primary of the plate transformer provide a means of changing the voltage in steps which are approximately 50 per cent, 75 per cent, 85 per cent, 95 per cent, 100 per cent and 105 per cent of normal. The d-c output voltage, when operating on the 100 per cent tap with 230 volts applied to the primary of the transformer, is approximately 7200 volts. A filter-capacitor charging resistor is used to limit the surge current through the rectifier tubes when plate voltage is applied. After the filter capacitor has reached operating voltage, a relay operates to short the charging resistor.

A bias-rectifier for the 10-kw amplifier is located in the Rectifier and Control Unit. This rectifier uses two Type GL-866-A/866 hot-cathode, mercury-vapor tubes in a single-phase, full-wave circuit.

C. Control Circuits

A three-position selector switch in the Control Unit makes it possible to operate the transmitter with automatic, semiautomatic, or manual control. With the selector switch in automatic position, operation of the transmitter START push-button will automatically apply all necessary voltages to the entire transmitter in the proper sequence. With "semiautomatic" operation, the same sequence of starting is followed; but the PA Plate ON push button must be manually operated. When the selector switch is in the MANUAL position, operation of the transmitter START button will apply filament and control power

to all units in readiness for manual application of plate power to each unit. Operation of the transmitter STOP push button will remove power from all units of the transmitter in the proper sequence regardless of the position of the selector switch. However, with the antenna transfer switch in the i-p-a position, operating the transmitter STOP button will remove power only from the power amplifier and the main rectifier.

When the antenna is connected to the i-p-a - output by the cutback relay, the control and protective devices make it possible to safely enter the F-A and Control Units while the exciter and ipa are in operation.

The various control circuits in the 10-kw amplifier are interlocked so that each successive operation takes place in proper sequence. Complete protection to apparatus and operating personnel is provided by the control system.

Protective devices guard against stoppage of air flow, main rectifier and r-f unit overloads and improper circuit adjustments. Indicating lights and instruments in the various circuits afford means for detecting unusual conditions.

The main rectifier plate control circuit is provided with an automatic-reclosing relay. This relay will provide one immediate reclosure if the plate contactor is opened due to an overload, provided that plate voltage has been applied at least 15 seconds. If the overload relays again open the plate contactor, plate voltage must be reapplied manually by pushing the "plate on" switch; however, if no overload occurs within 15 seconds of the reclosure, the reclosing relay is automatically ready for another reclosure. A d-c over-current relay is provided for each r-f tube and two a-c over-current relays are provided in the main rectifier three-phase supply line.

A carrier rectifier coupled to the 10-kw amplifier plate circuit furnishes power for operation of a "carrier-off" alarm signal. Auxiliary contacts are provided for the connection of an external "carrier-off-time" electric clock which the customer may wish to furnish.

D. Instruments

Small rectangular instruments mounted on the Rectifier and Control Unit indicate the following:

- Individual p-a cathode currents
- Plate transformer primary currents
- A-c line voltage
- Grid bias voltage
- Rectifier filament voltage
- P-a tube filament hours
- Rectifier tube filament hours

Large rectangular instruments mounted on the P-A Unit indicate the following:

- Filament voltage
- Grid current
- Plate voltage
- Total plate current
- R-f output

IX. SAFETY TO OPERATING PERSONNEL

The grounded-metal cabinets and panels effectively prevent the operating personnel from coming in contact with dangerous voltages. As a further safety precaution, lead-covered cable (rather than copper tubing) is recommended for the high-voltage connections from the plate transformer to the main rectifier and from the main rectifier to the power amplifier.

Each access door is equipped with a "safety grounding switch" which operates to ground and short-circuit all voltages greater than 230 volts before the door can be opened. Interlocks remove the source of power before grounding the high-voltage circuits in case the door is inadvertently opened with power on.

The door interlocks may be conveniently connected so as to remove plate voltage in the customer's r-f driver and exciter units when any door in the amplifying equipment is opened.

X. TEST AND INSTALLATION

This equipment is factory tested for compliance with these specifications.

It is assumed that the mechanical installation and wiring at the transmitter station will be performed by the customer, in accordance with suitable drawings and instruction books furnished with the equipment.

XI. DRAWINGS AND INSTRUCTION BOOKS

Two sets of installation drawings are furnished. These show over-all dimensions of units and location of terminal boards and r-f line connections. The external connection diagram or running list shows all inter-unit wiring and recommended wire size, insulation and terminals.

Two copies of the instruction book are furnished. These books contain the following information:

- Description of equipment
- Installation instructions
- Analysis of operation
- Safety precautions
- Initial adjustments
- List of renewal parts
- Descriptive bulletins on component parts
- Vacuum tube pamphlets
- Complete schematic diagram
- External wiring diagrams with running lists.

XII. APPARATUS TO BE FURNISHED BY CUSTOMER

The following apparatus is to be furnished by the customer:

1. Substation and associated apparatus.
2. 1-kw frequency-modulated r-f driver and input r-f lines to the 10-kw amplifier.
3. R-f output transmission lines, matching networks and antenna.
4. External cable and terminals.
5. Operator's control unit, or desk.

6. Frequency monitoring equipment.

The General Electric Company is in a position to furnish recommendations and quotations on any or all of the above items. However, the nature of each depends on local conditions and customer's preference. Such recommendations and quotations will be promptly furnished on receipt of customer's requirements.

With regard to the customer's Remote Control Unit, it should be noted that terminals are provided on the amplifying equipment to permit convenient extension of control circuits to such an external unit.

XIII. COMPLIANCE WITH F.C.C. "GOOD ENGINEERING PRACTICE" REQUIREMENTS

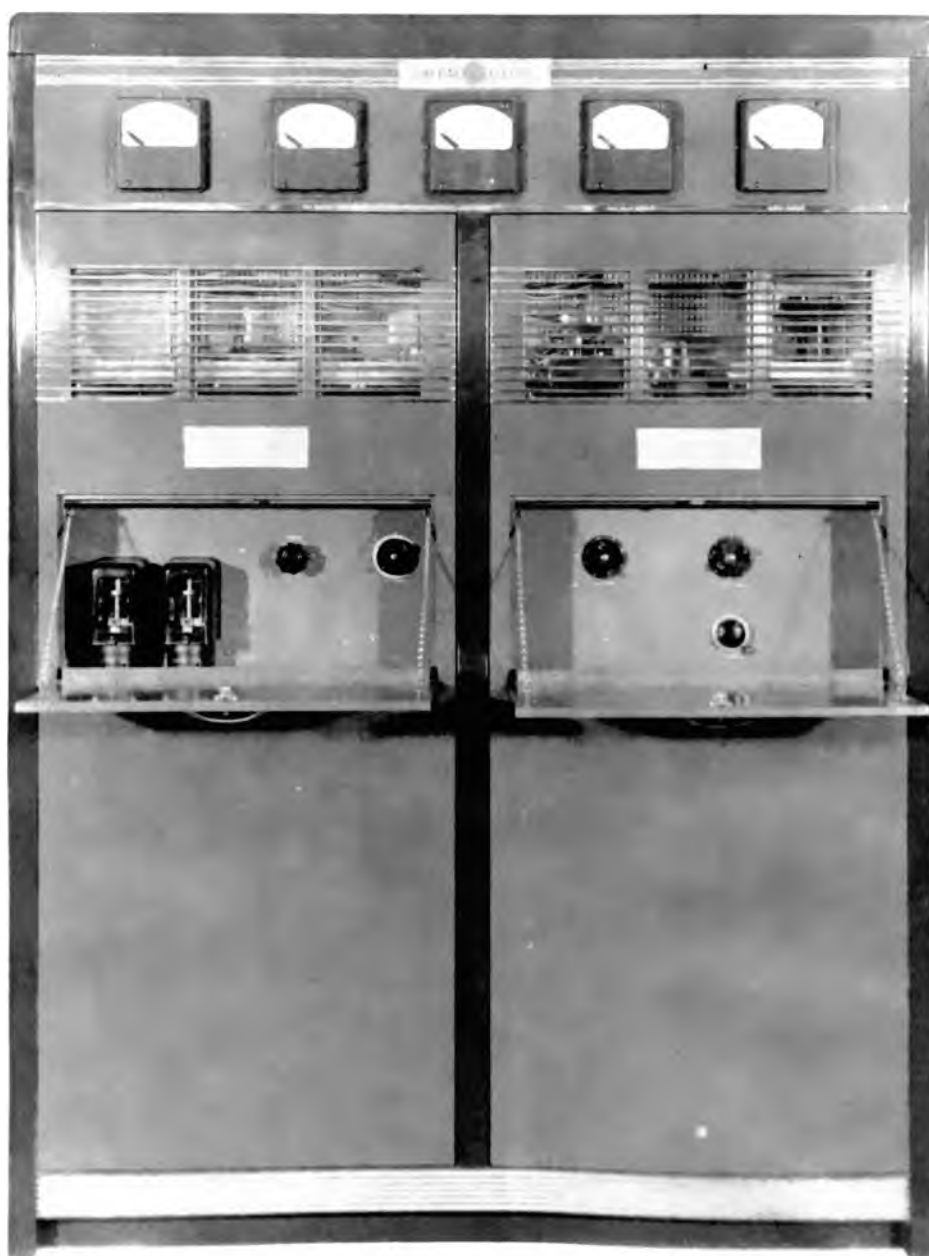
The equipment covered by these specifications complies fully with the Federal Communications Commission STANDARDS OF GOOD ENGINEERING PRACTICE CONCERNING HIGH FREQUENCY BROADCAST STATIONS issued July 29, 1940.

XIV. SCOPE OF SPECIFICATION

In the construction of the equipment described above, the full intent of these specifications will be met. However, it is assumed that any departures from it, desirable for reasons of improved design or operation, will be permissible.

XV. ENCLOSURES

P-7763288	Installation requirements drawing, complete 10-kw FM transmitter Type 3F-110-B.
P-7763430	Outline of amplifier.
M-6890968	Outline of plate transformer.
GET-958	Technical Information Bulletin.
	G-E transmitting tube Type GL-889-R.
586517	Front view of amplifier with main doors closed and drop doors open.
586521	Front view of rectifier with main doors closed and drop doors open.
586515	Front view of rectifier doors open.
586516	Rear view of power amplifier, doors open.

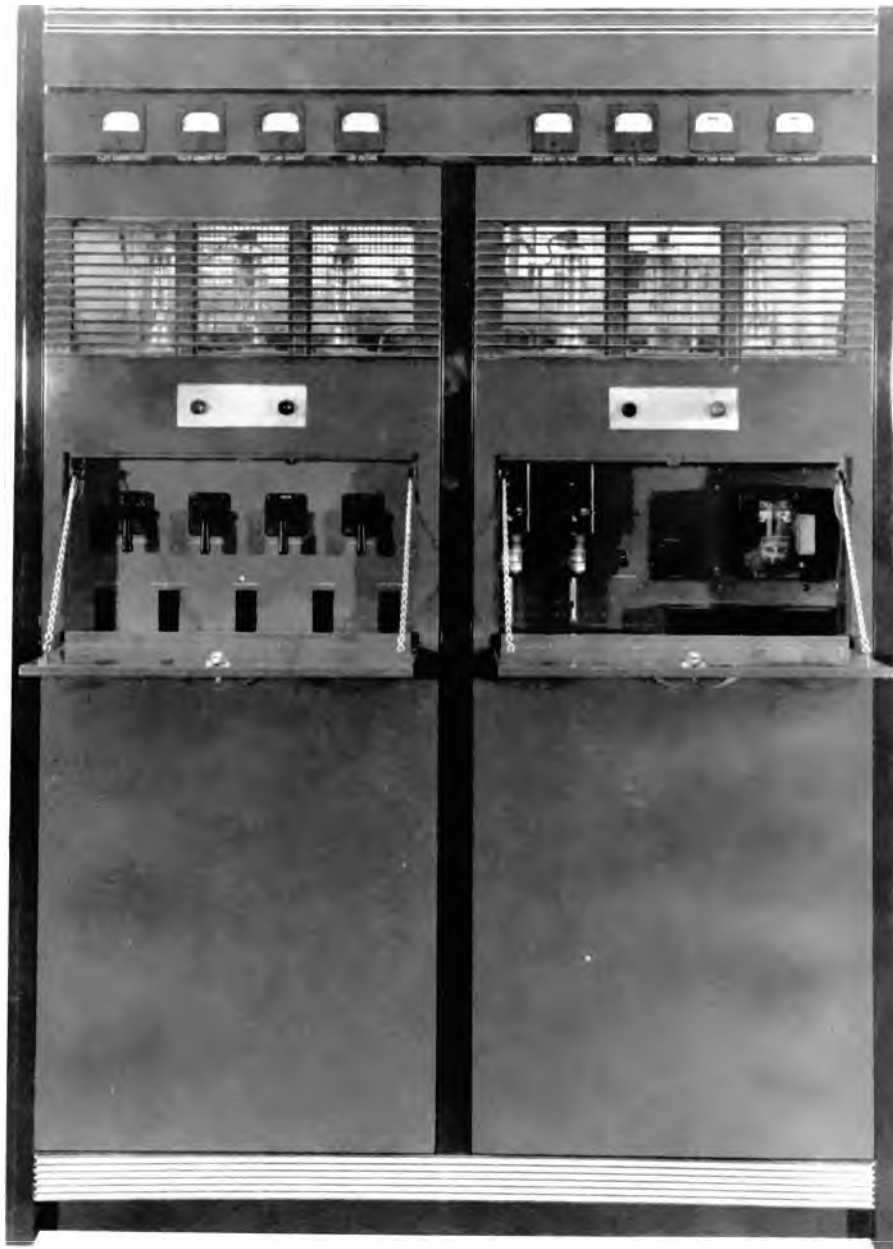


586517 Q-E POWER-AMPLIFIER UNIT, TYPE AF-6-A. PART OF 10-KW FREQUENCY-MODULATION (FM) RADIO-BROADCAST AMPLIFIER EQUIPMENT, TYPE AF-3-A. CONTROL DOORS OPEN. FRONT VIEW.

FILING NO.6914

E384

12-8-41

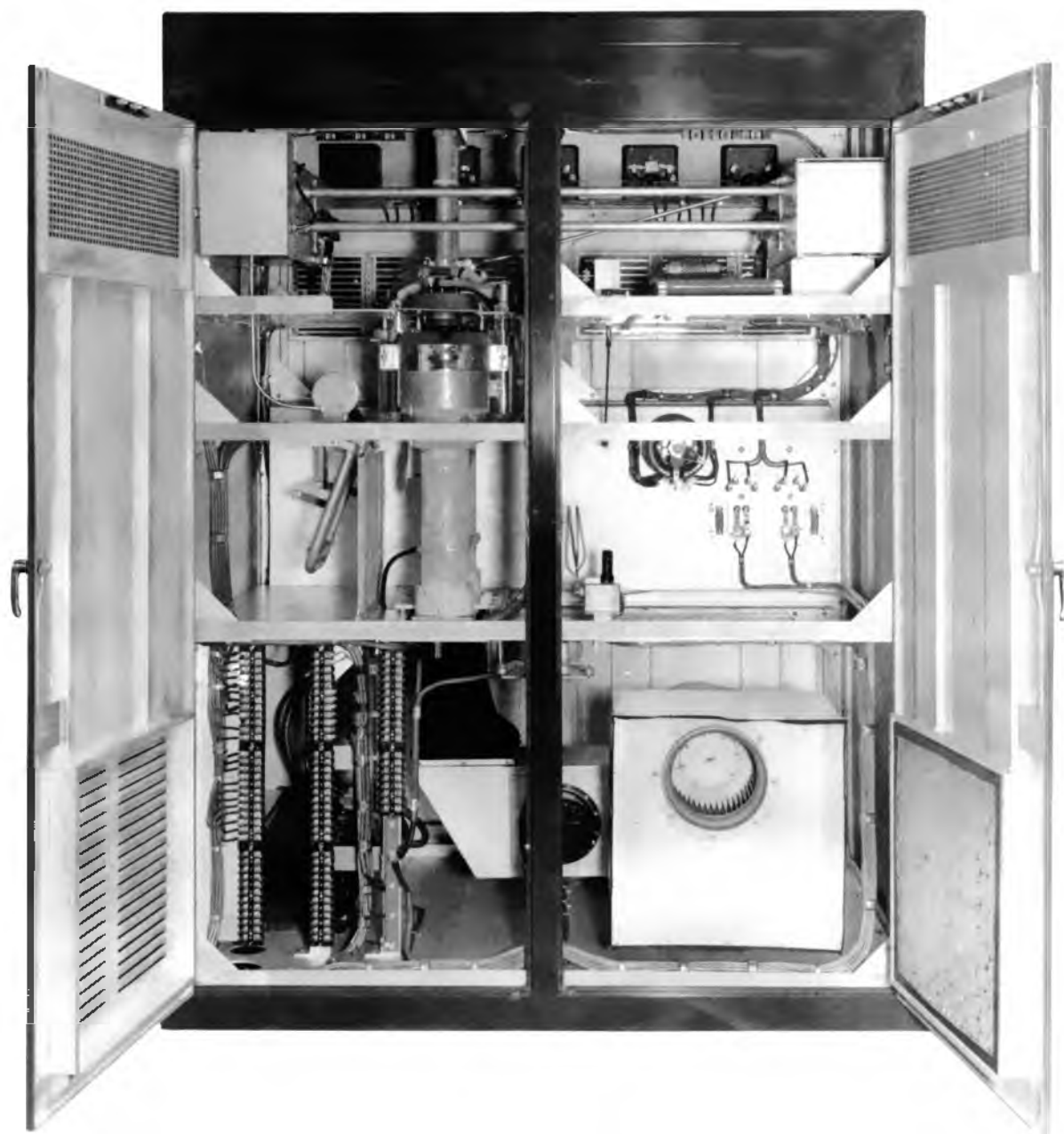


586521 G-E RECTIFIER AND CONTROL UNIT, TYPE MR-8-A. PART OF 10-KW FREQUENCY-MODULATION (FM) RADIO-BROADCAST AMPLIFIER EQUIPMENT, TYPE AF-3-A. CONTROL DOORS OPEN. FRONT VIEW.

FILING NO.6914

E384

12-8-41

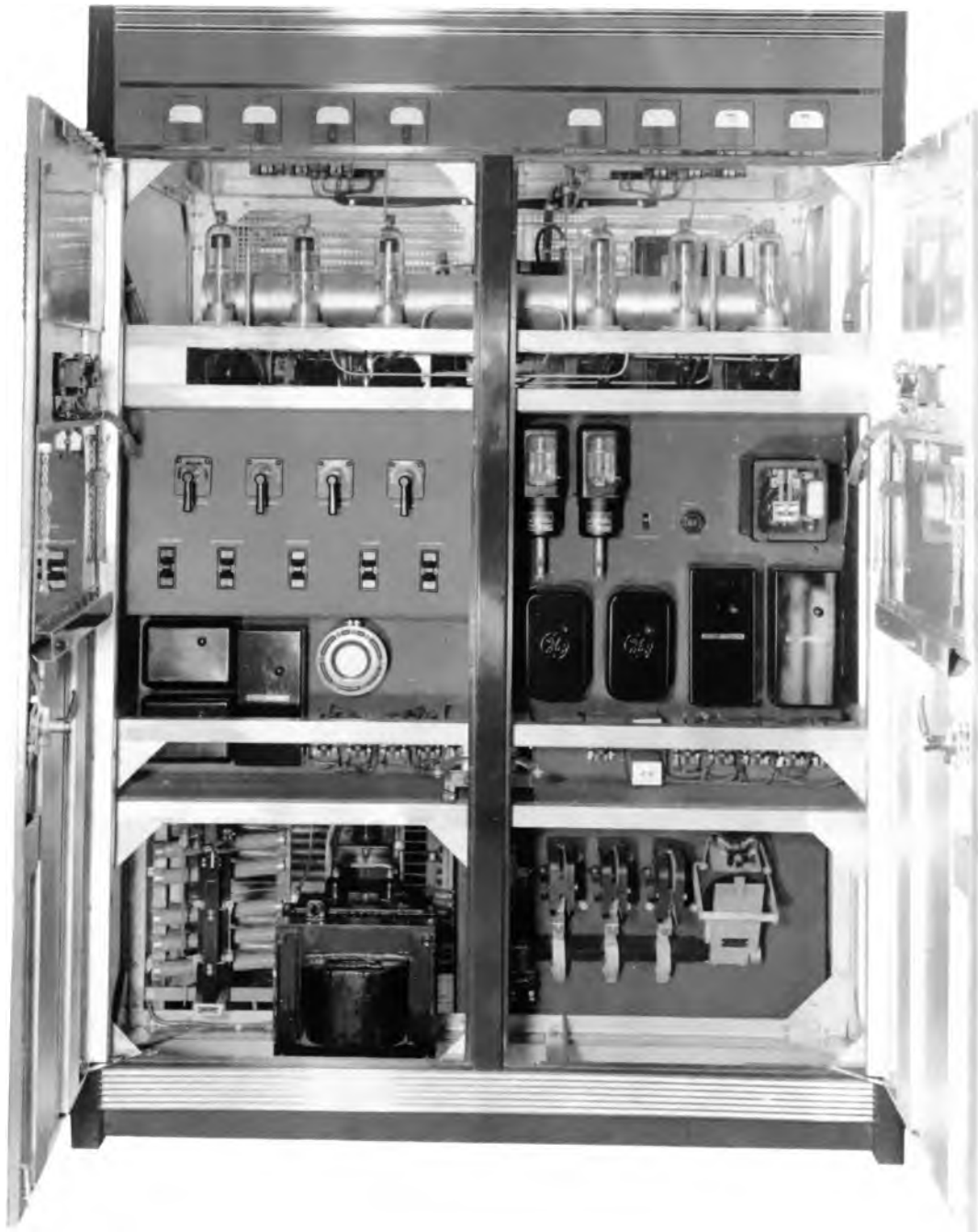


586516 G-E POWER-AMPLIFIER UNIT, TYPE AF-6-A. PART OF 10-KW FREQUENCY-MODULATION (FM) RADIO-BROADCAST AMPLIFIER EQUIPMENT, TYPE AF-3-A. DOORS OPEN. REAR VIEW.

FILING NO.6914

E384

12-8-41

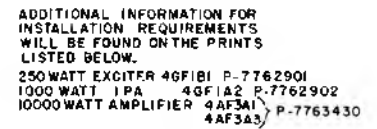


586515 G-E RECTIFIER AND CONTROL UNIT, TYPE MR-8-A. PART OF 10-KW FREQUENCY-MODULATION (FM) RADIO-BROADCAST AMPLIFIER EQUIPMENT, TYPE AF-3-A. DOORS OPEN. FRONT VIEW.

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12-8-41



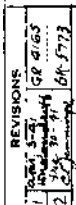
RT	
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Figure 1. Schematic diagram of the experimental setup.

F
RTE-3
R
PRINTS
TO

7 107 500 8-4-40-

THIRD ANGLE PROJECTION



FREQUENCY RANGE - 42-50 MC

FIRST NAME FOR TYPE AF-3-A

DRUGS BY Florida Home Child TRAINED BY A. Williams Mar 11/91

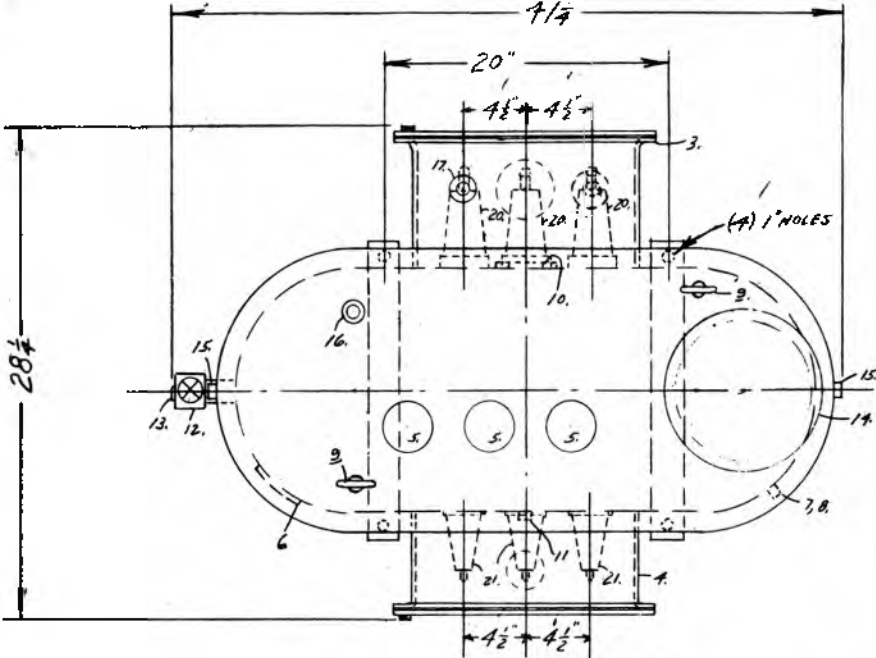
Inspected By: W. J. H. Co. 1st Inspection: Mar. 22, 1944

GENERAL ELECTRIC
SCHENECTADY WORKS

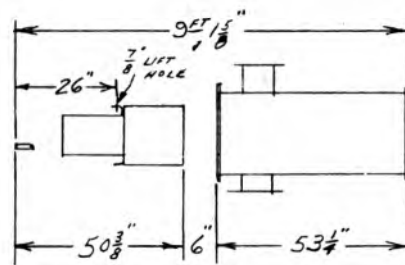
P-7763430

AT

PM 10T 1000 2 10 40



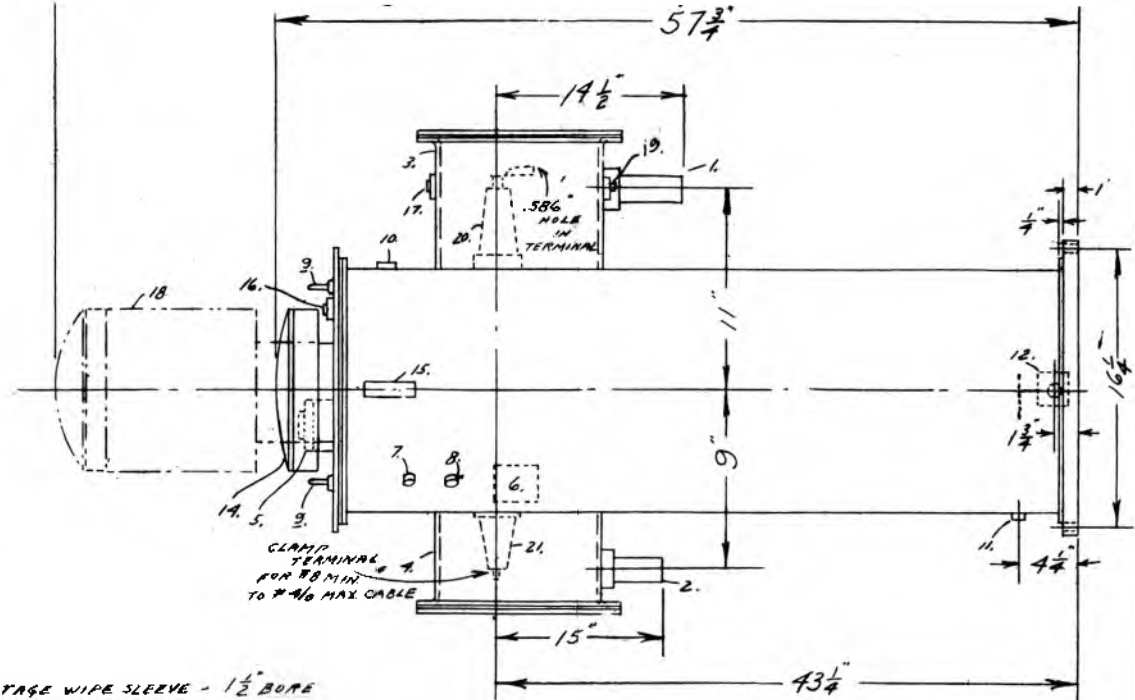
LOW VOLTAGE SIDE



CRANE LIFT

APPROXIMATE WEIGHTS

CORE AND COILS.....	700
PYRANOL (72 GAL).....	950
TANK AND FITTINGS.....	450
TOTAL.....	2100



1. HIGH VOLTAGE WIPE SLEEVE - 1 1/2" BORE
2. LOW VOLTAGE WIPE SLEEVE - 2" BORE
3. HIGH VOLTAGE JUNCTION BOX (COMPOUND FILLED)
(SEE NOTE)
4. LOW VOLTAGE JUNCTION BOX (AIR FILLED)
5. RATIO ADJUSTER CONTROL
6. NAMEPLATE
7. AIR VENT
8. LIQUID LEVEL INDICATOR & SAMPLING VALVE
9. EYE NUT FOR LIFTING COVER (3/8" OPENING)
10. INDEX PLATE
11. PROVISION FOR GROUND (3/8" - 16 BOLT)
12. DRAIN VALVE 1" AMER. STD. FEMALE THD.
13. PYRANOL SAMPLING VALVE

14. PRESSURE RELIEF DIAPHRAGM (6" OPENING)
15. LIFTING LUG
16. FILLING PLUG 1" STD. PIPE PLUG
17. FILLING PLUG FOR H.V. JUNCTION BOX.
18. GAS ABSORBER (NOT FURNISHED, USE DEPENDS
ON LOCAL REQUIREMENTS.)
19. DRAIN PLUG FOR H.V. JUNCTION BOX. 1" STD. PIPE PLUG
20. HIGH VOLTAGE BUSHING
21. LOW VOLTAGE BUSHING

NOTE - 7 GAL. #227 G.E. CABLE COMPOUND.

CODE 55		53A
OUTLINE		P3
FIRST MADE FOR DISTRIBUTION TRANSFORMER		203
DESIGN BY <i>P. B. Smith</i> 10/21	TRACED BY	206
FINISHED BY <i>P. B. Smith</i> 10/21	INSPECTED BY <i>D. C. Haynes</i> 10/21	
GENERAL ELECTRIC PITTSFIELD WORKS		
M-6890968		

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100.

P.O. A 810-M-979