RESTRICTED SERIAL NO. 14107

MODEL LM-7

AIRCRAFT FREQUENCY MEASURING EQUIPMENT

(AIRCRAFT USE)

(Serial Numbers of Equipment 3022 to 3351)

Manufactured for

U. S. NAVY DEPARTMENT

BUREAU OF SHIPS

Supplementary Contract NOs-69767

Dated 30 June 1941

By

BENDIX RADIO CORPORATION

BALTIMORE, MARYLAND

ERRATA

Page 21, Section 5–4, Line 6:	44°C *should read* 80°C
Lines 8 and 9:	In the range of −4°C to +40°C *should read* In the range of −32°C to +65°C
Page 22 Section 6	Insert the following paragraph: If a 24/28-volt power supply is used and the VOLTAGE SELECTOR switch is set for 24/28-volt operation, the operating potentials on all tubes will be below the maximum Navy ratings, even when the supply voltage is 28 volts.
Page 27 Table II, Symbol Desig. Y–101:	Bendix Dwg. No. L1847 *should read* AC57458–1

RESTRICTED SERIAL NO. 14107

INSTRUCTION BOOK

for

MODEL LM-7

AIRCRAFT FREQUENCY MEASURING EQUIPMENT

(AIRCRAFT USE)

FREQUENCY RANGE 195 to 20,000 KCS

This instruction book is furnished for the information of commissioned, warranted, enlisted, and civilian personnel of the Navy whose duties involve design, instruction, operation, and installation of radio and sound equipment. The word "RESTRICTED" as applied to this instruction book, signifies that this instruction book is to be read only by the above personnel, and that the contents of it should not be made known to persons not connected with the Navy.

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I. B. 347

WARNING

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE EQUIPMENT WITH HIGH VOLTAGE SUPPLY ON. DO NOT DEPEND UPON DOOR SWITCHES OR INTERLOCKS FOR PROTECTION, BUT ALWAYS SHUT DOWN MOTOR GENERATORS OR OTHER POWER EQUIPMENT. UNDER CERTAIN CONDITIONS DANGEROUS POTENTIALS MAY EXIST IN CIRCUITS WITH POWER CONTROLS IN THE OFF POSITION DUE TO CHARGES RETAINED BY CAPACITORS, ETC. TO AVOID CASUALTIES ALWAYS DISCHARGE AND GROUND CIRCUITS PRIOR TO TOUCHING THEM.

THE ATTENTION OF OFFICERS AND OPERATING PERSONNEL IS DIRECTED TO THE LATEST REVISION OF BUREAU OF ENGINEERING CIRCULAR LETTER NO. 5a OF 3 OCTOBER 1934, ON THE SUBJECT OF "RADIO —SAFETY PRECAUTIONS TO BE OBSERVED."

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REPLACEMENT OF DEFECTIVE MATERIAL

The equipment, including all parts and spare parts, except vacuum tubes, is guaranteed for a service period of ONE YEAR with the understanding that, as a condition of this contract, all items found to be defective as to design, material, workmanship or manufacture will be replaced without delay and at no expense to the Government; provided that such guarantee and agreement will not obligate the contractor to make replacement of defective material unless the failure, exclusive of normal expected shelf life deterioration, occurs within a period of TWO YEARS from the date of delivery of the equipment to and acceptance by the Government, and provided further, that if any part or parts (except vacuum tubes) fail or are found defective to the extent of ten percent (10%) or more of the total number of similar units furnished under the contract (exclusive of spares), such part or parts, whether supplied in the equipment or as spares, will be conclusively presumed to be of defective design, and as a condition of contract subject to one hundred percent (100%) replacement by suitable redesigned units.

Failure due to poor workmanship while not necessarily indicating poor design, will be considered in the same category as failure due to poor design. Redesigned replacements which will assure proper operation of the equipment will be supplied promptly, transportation paid, to the Naval activity using such equipment, upon receipt of proper notice and without cost to the Government.

All such defective parts will be subject to ultimate return to the contractor. In view of the fact that normal activities of the Naval Service may result in the use of equipment in such remote portions of the world or under such conditions as to preclude the return of the defective item or unit prior to replacement without jeopardizing the integrity of Naval Communications, the exigencies of the Service therefore may necessitate expeditious repair of such item or unit in order to prevent extended interruption of communications. In such cases the return of a defective item or unit for examination by the contractor prior to replacement will not be required. The report of a responsible authority, including details of the conditions surrounding the failure will be acceptable for effective adjustment under the provisions of this contractual guarantee.

The above period of TWO YEARS and the service period of ONE YEAR will not include any portion of the time that the equipment fails to give satisfactory performance due to defective items and the necessity for replacement thereof. All replacement parts will be guaranteed to give ONE YEAR of satisfactory service.

Report of Failure of any part of this equipment, during its life, shall be made on Form N Aer. 4112—"Report of Unsatisfactory or Defective Material," in accordance with the latest instructions issued by the Bureau of Aeronautics. Copies of this report shall be forwarded to the Bureau of ships (3 copies), and to the Inspector of Naval Material (1 copy), Bendix Radio Division of Bendix Aviation Corporation, Baltimore, Maryland. Copies required for other activities shall be forwarded in accordance with existing instructions. Such reports of failure shall include:

(a) Supplementary Contract NOs. 69767. Date of Contract: 4 Dec. 1940

(b) Model letters of equipment.................................Navy Type.......................................

(c) Serial number of equipment...

(d) Date of acceptance by the Navy..

(e) Date placed in service..

(f) Part which failed...

(g) Nature and cause of failure...

(h) Covered by contract guarantee...

(i) Replacement needed ....
(Yes or No)

(j) Remedy used or proposed...

(k) Name of reporting activity...

INSTRUCTION BOOK
for
MODEL LM-7 AIRCRAFT FREQUENCY MEASURING EQUIPMENT

1. INTRODUCTION

1-1. FUNCTION

The Model LM-7 Aircraft Frequency Measuring Equipment has been specially designed to provide a simple, accurate, and reliable frequency indicating equipment of the crystal calibrated type for use in various types of Naval aircraft. It is adaptable for adjusting adjacent radio transmitters and receivers to any desired frequency in the range from 195 to 20,000 Kcs. The equipment provides accuracies of 0.02 percent in the 195- to 2000-Kcs band, and 0.01 percent in the 2000- to 20,000-Kcs band, at any ambient temperature in the range from minus 32 to plus 65 degrees Centigrade.

1-2. COMPARISON WITH MODEL LM-2, LM-4, LM-4a, LM-5, AND LM-6 EQUIPMENTS

The Model LM-7 Aircraft Frequency Measuring Equipment is similar to the Model LM-2, LM-4, LM-4a, LM-5, and LM-6 Equipments except for the fact that the Model LM-7 is arranged for operation from either a 12-volt or 24-volt power supply by means of internal link connections. Also several minor improvements have been made, including a new and improved shockmounting base which is interchangeable with the shockmounting bases on the Model LM-2, LM-4, LM-4a, LM-5, and LM-6 Equipments. Corresponding parts on all models are completely interchangeable.

1-3. COMPOSITION

Each Model LM-7 Aircraft Frequency Measuring Equipment consists of the following component units:

Item	*Quantity*	*Description*	*Lbs.*
A	1	Model LM-7 Aircraft Frequency Measuring Equipment complete with one set of vacuum tubes (1 each of Navy types -76, -77, and -6A7, and 1 crystal, Navy Type CRR-40023A). Dimensions 8½″ x 8⅛″ x 8⁷/₁₆″	11.50

Item	*Quantity*	*Description*	*Lbs.*
B	1	Shockproof Mounting Base Dimensions 7″ x 7 7/8″ x 1/2″	0.50
C	1	Shielded Power Cable, per Bendix Dwg. No. AL71724-3, 5-conductor, 9 feet long, 5-contact shielded plug at each end (shipped disassembled)	1.90
D	1	Calibration Book (typed)	....
E	2	Instruction Book	....
F	1	Waterproof Slip Cover	0.25
G	1	Set of Basic Spare Parts (not shipped with equipment——shipped to supply base in bulk)	

1-4. ADDITIONAL EQUIPMENT REQUIRED

The Model LM-7 Aircraft Frequency Measuring Equipment is complete and self-contained, except for power supply. For standard installations in Naval aircraft, the required operating power is drawn from the junction box of any aircraft radio equipment of the Model GF or RU Series, provided: that the associated junction box is fitted with a spare power outlet, and that the wiring thereto is first modified in accordance with the instructions given in Section 3.

1-5. POWER CONSUMPTION

All power required for the operation of this equipment is drawn through four conductors of the shielded power cable. The current drains at the specified voltage limits are as follows:

Filaments:	11 to 15 volts, 0.61 to 0.73 ampere
	24 to 28 volts, 0.32 to 0.35 ampere
Plates:	200 to 260 volts, 0.007 to 0.010 ampere; or
	260 to 475 volts, 0.013 to 0.030 ampere.

These values are typical for operation with the modulation switch on the ON position, under which condition maximum plate current is drawn.

Note: The specified accuracies will be obtained (after correcting the heterodyne oscillator to calibration at the nearest crystal check point, see Section 4-1) at any input voltages between the above specified limits, provided: that neither voltage varies by more than plus or minus 10% during the period intervening between the correcting and measuring operations.

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2. DESCRIPTION OF UNITS

2-1. AIRCRAFT FREQUENCY MEASURING UNIT

The Model LM-7 Aircraft Frequency Measuring Unit contains a crystal controlled oscillator used as a reference standard; a heterodyne oscillator having two fundamental tuning ranges which, with their useful harmonics, provide continuous coverage from 195 to 20,000 Kcs; a 500-cycle modulator, a high gain detector provided with independent means for coupling to each of three sources of excitation, an audio frequency amplifier, and a voltage regulator circuit which provides essentially constant plate voltage to the heterodyne oscillator from any RU or GF plate supply between the limits of 260 and 475 volts. There are eight operating controls; a filament power switch S-102A, B, for both the filament and plate supplies; a plate power switch S-103, for standby filament operation without plate load; a crystal oscillator switch S-104A, B; a two-position frequency band switch S-101A, B for the heterodyne oscillator; the heterodyne oscillator worm and gear drive tuning control; together with its dial units and dial hundreds scales; the corrector control; an RF coupling control R-106; and a modulation on-off switch S-105A-D. All of these controls are mounted on the front panel, together with an RF coupling terminal, a calibration card on which the settings for seven important frequencies may be logged, and an output phones jack J-101. Two swinging cover plates marked H and L, near the corrector control allow access to the adjusting screws for the low and high band trimmer capacitors C-103 and C-104, respectively. A power input receptacle J-102 is located on the right side of the unit near the lower front corner. Two sets of input voltage control links mounted inside the cabinet on the voltage selector control panel provide means for regulating the voltages applied to the measuring unit. One set of links marked "12V, 24V" allows the use of either indicated voltage for filament supply; whereas, the remaining set of links marked "200-260, 260-475" allows the use of either indicated voltage range for plate supply. All parts are carried on an aluminum panel and chassis assembly and housed in an aluminum cabinet which is provided with a pocket at the bottom for stowing the calibration book. The external surfaces are finished in a durable black wrinkle lacquer. Figures 1 to 9, inclusive, show the general construction, arrangement of parts, and overall dimensions.

The cathode, inner grid, and anode grid of the Navy Type -6A7 vacuum tube V-102 (see Figures 11-A and 12) constitute the active elements of the crystal controlled oscillator, which operates at the fixed frequency of 1000 Kcs when the crystal switch S-104A, B is on. The circuit is of a design which generates considerable harmonic energy in order that it may be employed to calibrate the heterodyne oscillator at several points over its entire range. The necessary plate circuit impedance is built up across an untuned inductor L-103, which is housed in a bakelite case of rugged construction and thoroughly sealed against moisture. Likewise, the crystal Y-101 is supplied in a hermetically sealed and evacuated metal holder which provides permament protection against humidity, corrosion, and dirt intrusion. One of the smaller type metal tube envelopes is employed in the construction of this holder, so that it plugs into a standard octal tube socket X-106. The cut of the crystal and the internal construction of the holder are such that, under any conditions of barometric pressure, humidity, voltage, vibration, shock or tilt, only the specified output frequency and the harmonics thereof are obtained. The crystal is ground for operation at a normal temperature of plus 10°C. The temperature coefficient of the combined crystal, holder, and circuit, as expressed in percentage of the frequency, is less than 0.0001 percent per degree Centigrade as measured over an ambient range of 80°C.

The Navy Type -77 vacuum tube V-101 is used in an electron coupled circuit as the heterodyne oscillator (Figures 11 and 12). As previously stated, there are two continuously variable ranges which may be manually selected by the frequency band switch S-101A, B. In the low frequency position, a fundamental range of 195 to 400 Kcs is employed; which, by calibrating the first, second, fourth, and part of the fifth harmonics, gives continuous coverage over the range from 195 to 2000 Kcs. In the high frequency position of S-101A, B, the fundamental range of 2000 to 4000 Kcs is calibrated over the same order of harmonics to give continuous coverage throughout the range from 2000 to 20,000 Kcs. The two inductors L-101 and L-102, in the tuned circuits, are wound on ceramic forms and thoroughly sealed against moisture. Tuning over both fundamental ranges is accomplished by the temperature-compensated variable capacitor C-101, which is designed throughout to have a low temperature coefficient. This is augmented by the variable corrector capacitor C-102 and the adjustable trimmer capacitors C-103 and C-104 which permit separate adjustments to the low and high bands to compensate for extreme conditions of humidity. C-101 is capable of continuous rotation in either direction without stops, and the dial assembly includes a 100/1 ratio worm-gear drive-mechanism so that 50 revolutions of the vernier dial are required for 180° rotation of the main scale (on the capacitor shaft). The main, or dial hundreds, scale is engraved with 50 divisions over its useful 180° sector; and the vernier is marked with 100 dial units divisions over the entire 360°. The arrangement thus provides 5000 effective readable divisions, of which the calibrated ranges occupy approximately the portion between 250 and 4750. Backlash in the gear mechanism has been reduced to less than three-tenths of one division on the dial units scale.

The heterodyne oscillator circuits are calibrated from the crystal at a temperature of plus 10°C, and the dial settings of the successive harmonics (crystal check points) are noted along the calibration. The temperature coefficient of each range of the heterodyne oscillator, expressed in percentage of frequency, is less than 0.002 percent per degree Centigrade, as measured over a range of 97°C. The corrector capacitor C-102, which is connected in parallel with C-101, makes it possible to reset the heterodyne oscillator to agree with the crystal calibration at any harmonic for any ambient temperature between the limits of minus 32° and plus 65°C. Thus, after the tube filaments have been lighted for at least ten minutes, and the heterodyne oscillator has been corrected to the nearest crystal check point, the heterodyne oscillator is capable of being reset to within 0.02% of the absolute for any frequency in the range of 195 to 2000 Kcs, and to within 0.01% for any frequency between 2000 and 20,000 Kcs. These accuracies are obtainable under the most unfavorable combined influences due to 10% changes in filament and/or plate voltage, errors in calibration, changing tubes, crystal grinding errors, and variations of ambient temperature between minus 32° and plus 65°C.

It was previously stated that the three inner elements of the Navy Type -6A7 tube V-102 are used in the crystal oscillator circuit. The remaining elements of this tube (comprising the control grid, screen grid, and plate) are used as a high gain screen grid detector; to which, by structure, the crystal oscillator is electronically coupled. The RF voltage developed across the load resistor R-104 in the plate output circuit of the electron coupled heterodyne oscillator is introduced into the control grid circuit of this detector through a small fixed capacitor C-105. The RF coupling terminal, mounted on the front panel, is also coupled to the control grid of the detector, through the RF coupling control potentiometer R-106, and the coupling capacitor C-106. This connection is made through S-104B of the crystal switch when it is in the OFF position only. S-104A serves to remove the crystal circuit anode voltage when it is in the OFF position. As a result of these three coupling means, and dependent on the position of the crystal switch, the detector functions to mix the heterodyne oscillator output either with the fundamental and successive harmonics of the crystal oscillator, or with the transmitter frequency to be measured. When the crystal switch is thrown to the ON position, section S-104B grounds the RF coupling terminal through R-106, and opens the circuit to the detector control grid through C-106, thereby preventing interference from external sources while correcting the heterodyne oscillator to the crystal calibrator.

The detector plate works into an audio choke L-104, and the beat frequency voltages developed across this choke are coupled through capacitor C-108 to the grid of the Navy Type –76 vacuum tube V-103, provided the modulation switch S-105A-D is in the OFF position. The grid of V-103 returns to ground through grid leak resistor R-112, the desired bias potential being obtained from the IR drop across the series cathode resistor R-111. The plate of V-103 returns to the positive plate supply through the primary of the output transformer T-101 and the filter resistor R-108, the latter being bypassed to the cathode through capacitor C-112. Cathode bypass to ground is provided through C-110A. The secondary of T-101 is completely insulated from the primary, so that no DC potentials are present in the output. This transformer and the audio choke L-104 are both completely enclosed in evacuated metal containers, insuring permanent protection against humidity. The secondary of T-101 is connected to the phones jack J-101 through sections S-105C, D of the modulation switch (OFF position), the winding ratio being designed to match the plate impedance to 600-ohm phones (see A and B, Figure 11).

The detector and audio amplifier combination is so designed that the output impressed across the phones is essentially a linear function of the input voltage for the output range of 0.06 to 50.0 milliwatts (beat frequency of 250 cycles). The audio system is peaked at 250 cycles. At frequencies of 100 cycles and 500 cycles the output is approximately 1.5 DB below the 250-cycle reference.

As previously stated, the heterodyne oscillator and the RF coupling terminal E-101A are coupled to the control grid of the detector through capacitors C-105 and C-106, respectively, when the crystal switch is in the OFF position. Therefore, under the same conditions, the heterodyne oscillator is coupled to the RF coupling terminal through C-105 and C-106 in series. Thus, the RF coupling terminal serves the dual purpose of detector input terminal for the measurement of frequencies of external origin, and a heterodyne oscillator output terminal for use in calibrating receivers. When the unit is employed for the latter purpose, 2500 microvolts or more of radio frequency energy will be available between the RF coupling terminal and ground at any frequency within the calibrated range. In the heterodyne oscillator fundamental ranges, where outputs of several thousand microvolts are available, the RF coupling potentiometer R-106 provides means for attenuation to a minimum of approximately 100 microvolts.

MCW receivers may also be calibrated from this RF source, if the modulation switch S-105A-D is thrown to the ON position. Under this condition, the grid of vacuum tube V-103 is disconnected from the audio coupling capacitor C-108 by switch section S-105A, and connected to the primary of T-101, through the modulator feedback capacitor C-114 (the primary of T-101 remains connected to the positive plate supply through the filter resistor R-108, this resistor being bypassed to the cathode through C-112). The plate of V-103 then returns to the positive plate supply through switch section S-105B, the secondary of T-101, and switch section S-105D. The plate is also connected through switch section S-105C to the capacitor C-113 (which tunes the secondary of T-101 to approximately 500 cycles), and through the modulator coupling capacitor C-107 to the suppressor grid of the heterodyne oscillator tube V-101. Thus, in the ON position of the modulation switch, the output phones jack is rendered inoperative while the vacuum tube V-103 and its associated circuits function as an audio oscillator. This oscillator provides approximately 40% modulation of the RF output throughout the calibrated range (see C, Figure 11).

All power required for the operation of this unit is introduced through the power input receptacle J-102. The common negative-filament and negative-plate supply lead to vacuum tubes V-102 and V-103 connects to terminal 27 thereof, which is grounded to the chassis. Section S-102A of the filament power switch connects the positive supply terminal 25 to the filaments of tubes V-101, V-102, and V-103. The setting of the links for the particular supply voltage used, determines the filament circuit connections. Thus, when a 12-Volt supply is used, the series connected filaments of V-101 and V-102 are in parallel with the series filament circuit of V-103 and R-113. In the case of a 24-volt supply, corresponding link connections will connect the filament circuits of V-101, V-102, and V-103 (which contains R-113) in series. Section S-102B of this switch connects the positive high voltage input terminal 26 through the series plate power switch S-103 to the plate and screen circuits of vacuum tubes V-102 and V-103 and to the voltage regulator resistor R-103. Thus, with the filament switch in the ON position, and the plate switch turned off, the filament of all tubes may be maintained at operating temperature without any drain from the high voltage supply.

It will be noted that the plate and screen power supply connections for the heterodyne oscillator tube V-101 are not mentioned in the previous paragraph. Different models of the GF and RU series equipments vary as regards dynamotor output voltage and connections. Also, in certain models of the RU receivers, ground is connected to an intermediate point on a bleeder resistor across the dynamotor (in order to provide negative biasing potentials), and operation of the volume controls in these receivers produces corresponding fluctuations in the voltage available between terminals 27 and 35 at the junction box spare outlets. In order to maintain the calibration accuracy specified for the heterodyne oscillator, it is necessary that the plate and screen voltage supply to vacuum tube V-101 be held within certain limits. A special voltage regulator circuit has therefore been included to permit the use of the Model LM-7 with any model of the GF or RU series. It is first necessary, however, that terminals 36 and 26 of the GF or RU Junction Box spare outlet be wired direct to the dynamotor negative and positive terminals, respectively (see Section 4). In the LM-7 the voltage regulator circuit comprises the two neon glow tubes V-104 and V-105, the regulator cutout resistor R-116, and the regulator limiting resistor R-103, all of which are connected in series across the dynamotor output terminals (when both power switches are turned on). The two neon tubes in series strike at about 210 volts and, because of their variable resistance characteristics, the arcing voltage thereafter remains fixed at approximately 130 volts. The V-101 plate and screen circuits are fed from the constant voltage drop across these tubes when the dynamotor input is between the limits of 260 and 475 volts, and the corresponding links are set to correspond (regulator cutout resistor R-116 shorted out). For those installations where the dynamotor input is between 200 and 260 volts, the proper links are set to correspond, in which case the combined voltage drop due to the flow of plate and screen current to V-101 through resistors R-103 and R-116 is such as to reduce the voltage across the neon tubes to a value below that at which they will strike. Between the input limits of 200 and 260 volts, the self biasing resistors R-101 or R-102, in combination with the regulating action of resistors R-103, R-104, R-105, R-114 and R-116, serve to meet the requirements; whereas, if the voltage regulator was designed for operation throughout the entire input range of 200 to 475 volts, the neon tubes would be subjected to destructive currents at the higher values of input.

By reason of extreme refinements involving the type and design of the basic circuits, the relative arrangement of parts, character of intercircuit couplings, shielding, etc., the performance of this unit has been developed to a degree where no "locking in" will occur between the heterodyne oscillator and either source of RF with which it may be coupled, at any difference or beat frequency down to 5 cycles per second. Although the phones become rapidly less efficient in audibly reproducing beat tones below 100 cycles per second, characteristic "rushes," coincident with the rise and fall of the beat frequency pulses, are aurally recognizable well below the low frequency limit of audibility.

2-2. SHOCKPROOF MOUNTING BASE

The structure of the shockproof mounting base may be seen in Figures 1 and 9. It consists of a rectangular aluminum frame member which is suitably drilled for rigid mounting to the airplane structure and fitted with special Lord plate-form rubber mountings at each of the four corners. These rubber mountings are provided with vertically projecting shouldered and grooved metal studs, to which the measuring unit may be firmly secured by the operation of two snap-slide tabs located at the bottom of the front panel. The size of the rubber mountings and the special manner in which they are assembled to the aluminum frame are such as to assure safe anchorage and adequate shockproofing of the unit in normal aircraft service. Flexible bonding connections are furnished between each of the mounting studs and the metal base, thus providing four direct ground paths between the measuring unit shielding and the fuselage of the airplane.

2-3. SHIELDED POWER CABLE

The cabling employed in the shielded power cable supplied with the equipment consists of five rubber-covered stranded conductors. These conductors are enclosed in a rubber sheath covered with a braided tinned-copper shield and a final outer covering of rubber. As shown in Figure 10, the cable is fitted with a Navy Type CLT-49067A straight shielded plug P-201 at the power supply and a Navy Type CLT-49068A right angle plug P-202 for the input receptacle on the indicator unit. The angle plug is so designed that it may be oriented to lead away in any one of eight directions. As shown in Figure 12, only the plug contacts 25, 26, 27, and 36 are used in the operation of the equipment.

2-4. CALIBRATION BOOK

The low frequency fundamental range of the heterodyne oscillator is calibrated at each one-tenth kilocycle between 195 and 400 Kcs, or a total of 2051 points. Likewise, the high frequency fundamental range is calibrated in increments of one kilocycle between 2000 and 4000 Kcs, or a total of 2001 points. These fundamental frequencies are legibly printed in columnar formation on the successive pages of the calibration book, together with associated columns listing the second, fourth, and portions of the fifth harmonics. The dial settings, as determined by individual calibration, are then typed in opposite each such group. All figures representative of ordinary frequencies and their dial settings are both printed and typed in black, while those which refer to the crystal oscillator and its harmonics (crystal check points) are shown in red. The nearest crystal check points are also in red across the bottom of each page and the first and last frequencies and dial settings tabulated thereon are indicated across the top. There are 42 inside pages, thumb tabbed as to page number. The calibration comprises pages 2 to 42 inclusive; Page 1 being an index to the dial settings. In addition, an index of frequencies in the high range is printed on the front cover, and another for the low frequency range is given on the rear cover. A brief summary of the essential steps in operating the equipment is printed on the inner surface of the front cover. The calibration is printed on high quality white rag index paper which is both oil- and waterproof, and the cover boards are specially selected for durability. A spiral spring type of binding is employed, so that the book lies flat when opened to any page.

Provision is made for stowing the calibration book in a metal pocket provided at the bottom of the measuring-unit cabinet. It is recommended that the unmounted copy be carefully preserved in a safe place, as the cost of duplication constitutes an appreciable percentage of the total cost of the equipment. As specified in the Contract, the dial settings are not typed into the spare copy, but the unmounted copy of the laboratory record is supplied therewith.

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3. INSTALLATION

Prior to installation, it will be necessary to modify the wiring in the junction box associated with the Model GF or RU Series Aircraft Radio Equipment from which the operating power for the Model LM-7 Aircraft

Frequency Measuring Equipment is to be drawn. Briefly, the required modification comprises 2 additional connections to the spare outlet, as follows:

(a) Connection of terminal 36 to the negative high voltage dynamotor input terminal, and
(b) Connection of terminal 26 to the positive high voltage dynamotor input terminal.

These required modifications, and the corresponding settings for the VOLTAGE SELECTOR switch on the LM-7 terminal board, are shown specifically in the following tabulation for each usable model of the GF and RU series:

Equipment Model	*Junction Box Type No.*	*Outlet to be Modified*	*Connections to be Added*		*VOLTAGE SELECTOR Link Position LM-7*
			(a)	*(b)*	
RU-2	CBY-23011A	74	36 to 14	26 to 18	200-260
GF-1 RU-3	CBY-62003	74	36 to 14	26 to 18	260-475
GF-2 RU-3A	CBY-62004	74	36 to 14	26 to 18	260-475
RU-4	CBY-62007	76	36 to 14	26 to 35 or 18	260-475
GF-3 RU-4A	CBY-62008	76	36 to 14	26 to 18	260-475
RU-5	CBY-62007	76	36 to 14	26 to 35 or 18	260-475
GF-4 RU-5A	CBY-62008	76	36 to 14	26 to 18	260-475
RU-6	CBY-62007A	76	None	26 to 35 or 18	260-475

GF/RU and RU Models later than the above do not require modification of outlets. Following these changes, it is recommended that the modified spare outlet be stenciled with the term "LM-2/LM-7" in readable red letters.

Note: The above changes do not preclude the use of the modified outlet for operation of other auxiliary equipment, provided that such equipment makes use only of terminals 25, 27, and 35.

As shipped from the factory, the Model LM-7 Aircraft Frequency Measuring Equipment is attached to its shockproof mounting base, and all vacuum tubes are inserted in their respective sockets and clamped. To remove the measuring unit, release the snapslides located at the bottom of the panel by pulling them out from the panel, and lift the unit from the mounting base. The six nickel-plated screws located along the side and top edges of the panel, and the three screws across the rear of the cabinet should then be removed, and the chassis should be drawn forward and removed from the cabinet for inspection for possible damages sustained during shipment. Prior to replacing, make certain that the voltage selector links are set to the correct position for the particular supply voltages used. Also, test the vacuum tube grid clips for firm contact with their respective control grid terminals, and make sure that the crystal holder is pushed well into its socket.

This equipment should be installed in such a location that the shielded power cable will reach to the spare outlet on the GF or RU Junction Box and all panel controls will be readily accessible and clearly visible to the radio operator. If the airplane has not already been stenciled, the centers for the required mounting screw holes may be laid out from the data given in Figure 9, or they may be spotted directly from the shockproof mounting base. The base should then be secured to the supporting surface, using four No. 10-32 R. H. machine screws, suitable washers, lock-washers, and nuts. Scrape the paint under the heads of the mounting screws so that the base will be well grounded to the fuselage. Before replacing the measuring unit, see that the snapslides are pulled all the way forward, then push the tabs all the way back after the unit has been carefully seated on each of the four mounting studs. Test each anchorage consecutively, by pulling upward at the four bottom corners of the measuring unit.

Set the power, crystal, and modulation switches to their off positions, and insert the angle plug P-202 into the power input receptacle located on the lower right hand side of the measuring unit. In service, this plug is assembled so that the cable will lead away toward the rear. If this does not fit into the arrangement of the installation, remove the four screws which secure the plug cap, turn the shell to the most convenient of the eight possible angles, and replace the screws. Do not twist the shell more than ½ turn from its initial position in either direction; otherwise, the cable conductors may be strained or broken. Plug the other end of the shielded power cable into the modified spare outlet receptacle on the junction box of the GF or RU Series equipment to be used as the power source.

A short antenna must now be provided for coupling to the receivers and transmitters which are to be adjusted. This should preferably be a fixed wire (not over 4 or 5 feet long overall) permanently mounted on stand-off insulators; provided it may be so installed that about two feet of its remote end will run parallel, and close, to the transmitter and receiver antenna leads. Where these conditions cannot be realized, a flexible insulated pick-up wire may be employed, with means provided to prevent its becoming a hazard during flight. One end should be skinned and secured to the RF coupling terminal on the measuring unit. Then, if the remote end be fitted with a completely taped test clip (jaws dulled), it will be possible to secure the lead at various coupling points, as desired, without grounding or contacting thereto. Under no circumstances should the RF coupling terminal be conductively coupled to any part of the transmitter or receiver being measured, unless a special coupling terminal is provided on the equipment for this purpose.

Plug a pair of low-impedance headphones (600 ohms at 1000 cycles) into the phone jack; then turn the filament switch to the ON position (the receiver power switch must also be turned on). Allow the vacuum tube filaments to warm for at least ten minutes, then the equipment will be ready for use.

4. OPERATION

WARNING: OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE EQUIPMENT WITH HIGH VOLTAGE SUPPLY ON.

4-1. CORRECTING TO CALIBRATION

Before attempting to make any frequency adjustments, the heterodyne oscillator should always be corrected to agree with the calibration through comparison with the crystal oscillator at the crystal check point nearest to the frequency desired. Comparison between the crystal and heterodyne oscillator may be made at many points over the calibrated range through the employment of the fundamental or harmonic frequencies of either or both oscillators (see Section 4-3). Comparison between the two oscillators is effected by rotating the heterodyne tuning control through a portion of the scale range corresponding to the crystal check point desired, and noting the beat tones as heard in a pair of 600-ohm headphones plugged into the PHONES Jack (the MODULATION switch must be set to the OFF position).

To correct the heterodyne oscillator preparatory to setting on any desired frequency within the calibrated range, proceed as follows:

A. From the HIGH or LOW frequency indices on the front and rear covers of the calibration book, determine in which band the desired frequency is located, and set the FREQuency BAND switch to correspond.

B. Also, from the frequency indices, ascertain on which page the desired frequency is listed, and turn thereto. The crystal check point nearest the desired frequency, together with the dial setting, will be found noted in red at the bottom of this page.

C. Set the heterodyne oscillator scales to agree with this crystal check point dial setting (CRYSTAL and both POWER switches ON; MODULATION switch OFF). A beat note will most probably be heard in the phones, as a complete absence of beat tone can result only from four possible conditions: When the heterodyne oscillator is exactly on calibration, when it is so far off calibration that the beat frequency is above audibility, when the MODULATION switch is set to ON, and when the equipment is defective. However, should no beats be heard, which of the first two of these conditions may exist can be determined by rotating the CORRECTOR dial to the points where the beats become audible, and noting the direction of change. If the third or fourth condition is the cause, no beats should be heard at any point in the complete heterodyne oscillator range.

D. With the heterodyne oscillator dials on the desired crystal check point setting, the heterodyne oscillator frequency should be adjusted as close to the crystal oscillator frequency as possible, by rotation of the CORRECTOR dial only. Adjust the CORRECTOR to produce zero beat at the strongest beat point within its range. After the operator has become familiar with the equipment, it will be found that this adjustment can be precisely made to practically zero beat. This is possible because the design is such that all "locking in" tendencies have been minimized, and characteristic "rushes" due to the rise and fall of the beat frequency peaks are aurally recognizable well below the lower limit of audible tone.

When so corrected, the heterodyne oscillator frequency will agree with the calibration (to the reset accuracies previously quoted) throughout the range of frequencies included on all the pages to which this particular crystal check point applies, provided: that the ambient temperature remains constant, and the filament and/or plate supply voltages do not vary by more than 10% (see Section 4-2).

4-2. READJUSTMENT OF TRIMMER CAPACITORS

It may be found that the heterodyne oscillator cannot be corrected to agree with the calibration as explained in Section 4-1, particularly if the frequency measuring unit is installed in a locality where either extreme condition of humidity prevails. Under such conditions, and then only, it becomes necessary to reset the heterodyne trimmer capacitors C-103 and C-104. Access to the trimmer adjusting screws may be had through the holes in the upper right hand corner of the indicator panel after swinging aside the L and H cover plates. An ordinary screwdriver will be required to make these adjustments, the necessary procedure being as follows:

A. Place the unit in operation, with the FREQuency BAND switch set to LOW and MODULATION switch to OFF. Allow the unit to warm for a period of at least ten minutes before proceeding.

B. Set the DIAL UNITS and DIAL HUNDREDS scales to agree with the reading given for 400 Kcs on Page 22 of the calibration book. Set the CORRECTOR dial at midscale (4.5 divisions).

C. After determining that the dials are set correctly as in B, insert the screwdriver through the L hole in the panel and rotate the trimmer capacitor C-103 toward the right, while listening in the phones, until the heterodyne oscillator is set to zero beat with the crystal calibrator.

D. Check the ability of the CORRECTOR to reset the heterodyne oscillator to zero beat at all crystal check points listed on the back cover of the calibration book, proceeding as outlined in Section 4-1.

E. If the unit cannot be corrected at all crystal check points in the LOW band with the trimmer adjustment that was made with the CORRECTOR set at 4.5 for 400 Kcs, the processes outlined in C and D should be repeated, with the CORRECTOR set to 6 divisions for 400 Kcs.

F. By thus progressing, a setting of the L trimmer will be found where it will be possible with the CORRECTOR to reset the unit to zero beat at all crystal check point readings given for the LOW band in the calibration book.

G. Cover the L trimmer, and repeat the above described processes with the FREQuency BAND switch set to HIGH and the DIAL UNITS and DIAL HUNDREDS scales set to agree with the reading given for 4000 Kcs on Page 42 of the calibration book. Adjust the trimmer capacitor C-104 through the H hole to the position where it is possible with the COR-

RECTOR to reset the heterodyne oscillator to zero beat at all crystal check points listed for the HIGH band.

4-3. BEAT POINT IDENTIFICATION

It was stated in Section 4-1 that "comparison between the crystal and heterodyne oscillator may be made at many points over the calibrated range through the employment of the fundamental or harmonic frequency of either or both oscillators." When correcting the heterodyne oscillator to calibration, it will be found that there are numerous beat points at various harmonic combinations which are not listed as crystal check points in the calibration book. In most cases, the intensity of these unlisted beat points is relatively low. In order that there may be no confusion as to the actual crystal check points, however, the beat points encountered at the various lowest harmonic combinations of the two oscillators (and, their relative outputs for a typical Model LM-7 and RU-4A combination with 13 volts power supply) are given in the following tabulations (the calibrated crystal check points are marked with asterisks):

LOW BAND

Beat Point (Het. Fund Freq.)	*Lowest Het. Harmonic*	*Lowest Crys. Harmonic*	*Relative Output, MW. (500-Cycle Beat)*
195.12	41	8	0.25
195.65	46	9	0.19
200.00*	5	1	90.0
204.54	44	9	0.11
205.13	39	8	0.16
205.88	34	7	0.21
206.89	29	6	0.31
208.33	24	5	0.49
209.30	43	9	0.12
210.53	19	4	2.50
212.12	33	7	0.29
214.28	14	3	14.0
216.21	37	8	0.19
217.39	23	5	1.10
218.75	32	7	0.30
219.51	41	9	0.17
222.22*	9	2	24.0
225.00	40	9	0.17
225.81	31	7	0.40
227.27	22	5	1.20
228.57	35	8	0.29
230.76	13	3	8.5
233.33	30	7	0.41
235.29	17	4	4.0
236.84	38	9	0.20
238.09	21	5	1.55

Beat Point (Het. Fund Freq.)	*Lowest Het. Harmonic*	*Lowest Crys. Harmonic*	*Relative Output, MW. (500-Cycle Beat)*
240.00	25	6	0.92
242.42	33	8	0.38
243.24	37	9	0.28
250.00*	4	1	140.0
257.43	35	9	0.31
258.06	31	8	0.45
259.25	27	7	0.55
260.86	23	6	0.82
263.15	19	5	1.30
264.71	34	9	0.35
266.66	15	4	6.80
269.23	26	7	1.00
272.72	11	3	16.50
275.86	29	8	0.70
277.77	18	5	4.60
280.00	25	7	1.05
281.25	32	9	0.40
285.71*	7	2	55.0
290.32	31	9	0.45
291.66	24	7	1.40
294.11	17	5	5.0
296.29	27	8	0.85
300.00*	10	3	24.0
304.35	23	7	1.90
307.69	13	4	15.2
310.34	29	9	0.80
312.50	16	5	7.40
315.79	19	6	3.90
318.18	22	7	2.1
320.00	25	8	1.30
321.43	28	9	0.95
333.33*	3	1	190.0
346.15	26	9	1.20
347.82	23	8	1.85
350.00	20	7	2.70
352.94	17	6	5.0
357.14	14	5	11.0
360.00	25	9	1.25
363.63	11	4	29.0
369.42	19	7	3.8
375.00*	8	3	48.0
380.95	21	8	2.30
384.61	13	5	15.0
388.88	18	7	3.95
391.30	23	9	1.70
400.00*	5	2	140.0

HIGH BAND

Beat Point (Het. Fund Freq.)	*Lowest Het. Harmonic*	*Lowest Crys. Harmonic*	*Relative Output, MW. (500-Cycle Beat)*
2000*	1	2	310.0
2125	8	17	8.0
2143	7	15	14.5
2166	6	13	25.0
2200	5	11	50.0
2250*	4	9	80.3
2286	7	16	8.9
2333	3	7	193.0
2375	8	19	4.0
2400	5	12	32.5
2428	7	17	6.5
2500*	2	5	260.0
2571	7	18	5.8
2600	5	13	28.0
2625	8	21	2.1
2667	3	8	168.0
2714	7	19	3.7
2750*	4	11	54.0
2800	5	14	20.0
2833	6	17	6.8
2857	7	20	2.1
2875	8	23	0.8
3000*	1	3	275.0
3125	8	25	1.0
3143	7	22	2.4
3167	6	19	6.1
3200	5	16	13.9
3250*	4	13	37.5
3286	7	23	1.4
3333	3	10	90.0
3375	8	27	0.3
3400	5	17	9.8
3428	7	24	0.9
3500*	2	7	210.0
3571	7	25	0.7
3600	5	18	6.6
3625	8	29	0.2
3667	3	11	71.0
3714	7	26	0.5
3750*	4	15	17.2
3800	5	19	4.6
3833	6	23	1.8
3857	7	27	0.32
3875	8	31	0.15
4000*	1	4	280.0

Note: 0.1 milliwatt of the above listed outputs is electrical noise level. Under flight conditions, those beat points which are listed at levels of 5.0 milliwatts or less will probably not be heard.

4-4. TRANSMITTER ADJUSTMENTS

Briefly, the method of adjusting a transmitter to a desired frequency consists of zero beating the transmitter frequency with the proper heterodyne oscillator frequency, effecting the comparison by means of a pair of headphones plugged into the PHONES jack located on the front panel of the measuring unit. The CRYSTAL and MODULATION switches should be in the OFF position during the process.

Specifically the procedure is as follows:

A. Correct the heterodyne oscillator to calibration at the crystal check point nearest to the desired frequency, as explained in Section 4-1.

B. Turn the CRYSTAL switch to OFF.

C. Turn the measuring unit tuning control to the dial setting of the desired frequency, as given in the calibration book. Do not disturb the CORRECTOR adjustment as made in A above.

D. With the measuring unit pick-up lead loosely coupled to the transmitter output, tune the transmitter to give an audible beat in the phones.

E. Adjust the RF COUPLING control to obtain a comfortable signal level in the headphones.

F. Tune the transmitter to zero beat with the measuring unit.

Note: Operations B to F should be accomplished in the shortest possible interval following operation A, otherwise voltage and/or temperature changes may cause the frequency measuring unit to drift.

4-5. RECEIVER ADJUSTMENTS

4-5-1. General

The method of adjusting a receiver to a desired frequency consists of tuning the receiver to the proper heterodyne oscillator output frequency, effecting the comparison by means of a pair of headphones connected to the receiver output circuit. The method varies with the character of signal reception involved.

4-5-2. CW Receiver Adjustments

To tune a CW receiver to a desired frequency, proceed as follows:

A. Correct the heterodyne oscillator to calibration at the crystal check point nearest the desired frequency, as explained in Section 4-1 (the MODULATION switch must be set to OFF).

B. Turn the CRYSTAL switch to OFF, and transfer the phones from the crystal frequency measuring unit to the receiver output jack.

C. Turn the measuring unit tuning control to the dial setting of the desired frequency, as given in the calibration book. Do not disturb the CORRECTOR adjustment as made in A above.

D. Couple the measuring unit pick up lead loosely to the receiver to give an audible signal in the phones.

E. Adjust the RF COUPLING control to obtain a comfortable signal.

F. Adjust the receiver tuning to that side of zero beat which results in best reception conditions for the particular operator concerned.

Note: The notation at the end of Section 4-4 applies to this and all other operations for which the Model LM-7 Aircraft Frequency Measuring Equipment may be employed.

4-5-3. MCW Receiver Adjustment

To tune an MCW receiver to a desired frequency, the following procedure applies:

A. Correct the heterodyne oscillator to calibration at the crystal check point nearest to the desired frequency, as explained in Section 4-1 (the MODULATION switch must be set to OFF).

B. Turn the CRYSTAL switch to OFF, and transfer the phones from the crystal frequency measuring unit to the receiver output jack.

C. Turn the measuring unit tuning control to the dial setting of the desired frequency, as given in the calibration book. Do not disturb the CORRECTOR adjustment as made in A above.

D. Turn the MODULATION switch to ON.

E. With the measuring unit pick-up lead loosely coupled to the receiver antenna lead, tune the receiver to give an audible signal in the phones.

F. Adjust the RF COUPLING control to obtain a comfortable signal.

G. Adjust the receiver tuning for maximum response.

4-6. FREQUENCY MEASUREMENTS

The Model LM-7 Aircraft Frequency Measuring Equipment may also be employed for accurately measuring a frequency emitted from an external source, whether it be of local or remote origin, provided that such frequency lies within the calibrated range.

If it is desired to measure accurately the emitted frequency of an adjacent transmitter or oscillator, the order of which is approximately known, the heterodyne oscillator is first corrected to the crystal check point nearest to the approximately known frequency, as explained in Section 4-1 (the MODULATION switch must be set to OFF). The actual frequency is then determined (after loosely coupling the measuring unit pick-up wire to the source and turning the CRYSTAL switch to OFF) by turning the measuring unit tuning control to the zero beat point found nearest the setting given for the approximate frequency, and reading from the appropriate frequency column, opposite the resultant dial setting, in the calibration book.

If the order of the frequency to be measured is unknown, it may first be determined to an approximation most readily with the aid of an absorption type wavemeter, following which the actual frequency is determined as explained in the preceding paragraph.

When it is desired to measure accurately a frequency of remote origin, the signal is first tuned in on the radio receiver, and the approximate frequency noted from the receiver calibration. The heterodyne oscillator is next corrected to calibration at the nearest crystal check point. The CRYSTAL switch is then turned to OFF, the phones are transferred back to the receiver output jack; the measuring unit pick-up wire is loosely coupled to the receiver antenna lead, and the measuring unit tuning control is turned until its signal is heard in the phones. If the signal in question is CW in character, the receiver is tuned to zero beat therewith, and the measuring unit is tuned to zero beat with the receiver. If the signal is modulated, both the receiver and measuring unit are adjusted for maximum response, and the MODULATION switch is turned to ON. In both cases, the frequency read from the appropriate column in the calibration book (for the resultant measuring unit dial setting) is the frequency of the signal in question.

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5. MAINTENANCE

5-1. GENERAL ROUTINE

The Model LM-7 Aircraft Frequency Measuring Equipment is ruggedly constructed to withstand the shocks and strains which may be expected in aircraft service. Nevertheless, this equipment is extremely accurate and sensitive, and is therefore deserving of the careful handling normally accorded to instruments of precision.

All material used in the construction of this equipment is of the highest quality, and parts are rigidly inspected before and after assembly. In addition, all units such as resistors, capacitors, tubes, etc., which are subject to rapid deterioration through overloading, are operated at varying safety factors between the orders of from 3 to 10.

Normally, the only servicing required will be the occasional replacement of vacuum tubes. This should be done at regular intervals, dependent on the amount of usage to which the equipment is subjected. It is further recommended that a single drop of Pioneer Ball Bearing Oil for Aircraft Instruments #2 be placed on the gear teeth of the heterodyne oscillator capacitor driving mechanism occasionally. Do not lubricate any other part of the equipment.

5-2. SERVICING DATA

5-2-1. GENERAL

Any of the Navy Model OE series of radio analyzing equipments may be used for the location of electrical faults throughout the Model LM-7 Equipment.

5-2-2. RESISTORS AND CAPACITORS

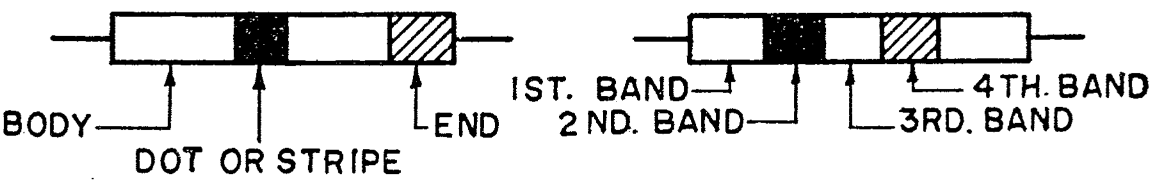
The cartridge resistors and small moulded capacitors supplied in this equipment are marked in accordance with the RMA Standard Color Code, to wit:

RMA COLOR CODE FOR RESISTORS AND CAPACITORS					
COLOR	1st band	2nd Band	3rd Band	#4th Band	Res. (Ohms)
	Body	End	Dot or Stripe	# Band	Res. (Ohms)
	1st Dot	2nd Dot	3rd Dot	#4th Dot	Cap. (MMF)
Black	.	0	.		.
Brown	1	1	0	*100	.
Red	2	2	00	*200	.
Orange	3	3	000	*300	.
Yellow	4	4	0000	*400	.
Green	5	5	00000	*500	.
Blue	6	6	000000	.	.
Purple	7	7	0000000	.	.
Gray	8	8	00000000	.	.
White	9	9	000000000	.	.
Red	.	.	.	.# ±2%	.
Gold	.	.	.	.# ±5%	.
Silver	.	.	.	.# ±10%	.
LEGEND	1st NUMERAL	2nd NUMERAL	CIPHERS TO FOLLOW	*VOLTAGE OR #TOLERANCE	

Resistors, Tolerance

* Micamold Capacitors

OLD STYLE MARKING NEW STYLE MARKING



In addition, all electrical parts are stamped with symbol designations corresponding to those shown in the diagrams, and their nominal values can be determined by reference to Table II. Actual values can readily be measured with the ohmmeter portion of the selective analyzer and the capacity meter units of the Navy Model OE Equipment, respectively, by following the instructions furnished therewith.

5-2-3. Circuit Wiring

To facilitate tracing of circuits in the Model LM-7 Equipment, various color combinations are used in the insulating coverings of all inter-element wiring. It will be noted that this coding is arranged to permit the character of any circuit to be identified at a glance. Thus the following single colors are assigned to basic circuits:

Circuits	*Color*	*Circuits*	*Color*
Plates	Red	Filaments	Yellow
Screens	Blue	Ground	Black
Grids	Green	Negative B	Slate
Suppressors	Orange	Audio Output	Brown
Cathodes	White		

Auxiliary circuits are then wired with mixtures of the above colors, as follows: red and blue for a circuit to a screen dropping resistor from the plate supply, blue from there to the screen, and blue and black to the screen bypass to ground. These combinations, as employed in the wiring of the frequency measuring chassis, are shown by symbol letters throughout the wiring diagram (Figure 13) and explained in the legend thereto. The color coding of the conductors in the shielded power cable is shown in the full schematic diagram, Figure 12. The ohmmeter portion of the selective analyzer and the test prods furnished with the Model OE Equipment may be used in testing for continuity, grounds, etc., in all such circuits. All power supply circuits to the Model LM-7 Equipment should be opened while the ohmmeter is being used.

5-2-4. VOLTAGE ANALYSIS

In general, any abnormality in voltage or currents, as measured at the individual vacuum tube elements, will serve as a guide to the underlying causes of operational faults. The following tabulation, showing vacuum tube terminal voltages with respect to ground (chassis), is typical for a Model LM-7 Aircraft Frequency Measuring Equipment when installed in conjunction with a Model RU-4A Aircraft Radio Equipment, with receiver switch on Manual and the volume control set at maximum:

Cable Terminal Number	*Socket Terminal*	*VOLTAGE TO GROUND, 14/12 Volt Supply*				
		V-101	*V-102*	*V-103*	*V-104*	*V-105*
25	Filament 1	13.1/10.9	6.55/5.4	7.1/5.6	.	.
27	Filament 2	6.5/5.4	0/0	0/0	.	.
27	Cathode	−52/−45	0/0	+5.0/+4.0	.	.
27	Inner Grid	.	−6.8/−6.0	.	.	.
26	Anode Grid	.	129/116	.	.	.
36	Control Grid	−59/−47	−1.43/−1.0	−5.5/−6.0	.	.
26	Screen	74/83	+57.0/+50.0	.	.	.
36	Suppressor	−57/−44	.	.	.	.
26	Plate 1	68/76	150/120	215/168	+74/+84	.
.	Plate 2	.	.	.	.	−58/−44

The following values were obtained with a voltmeter having a resistance of 20,000 ohms per volt, and with the various switches on the Model LM-7 Equipment set to the following positions:

Switch	*Position*
FREQ. BAND	LOW
CRYSTAL	ON
MODULATION	OFF
VOLTS	260-475
POWER (FIL. & PLATE)	ON

Similar measurements may be taken for comparison with these values, using the selective analyzer and the socket selector units of the Navy Model OE Equipment; the meter used in the equipment has a sensitivity of 20,000 ohms per volt. All such measurements should be made in accordance with the procedures outlined in the instructions furnished with the particular analyzing equipment in use, and the values obtained, for a normal equipment, should agree with the above to within plus or minus 5%.

5-3. INDUCTOR DATA (WINDING INFORMATION) FIG. 15

A. L-101; Low Frequency Coil Assembly

B. L-102; High Frequency Coil Assembly

C. L-103; RF Choke Coil

D. L-104; AF Choke Coil, no drawing, Part #CRP-30380, Manufacturer #14

5-4. CRYSTAL SPECIFICATIONS

The crystals for use in the Model LM-7 Equipment shall be ground so as to prevent the possibility of oscillation on any frequency other than the desired fundamental or harmonics of the fundamental, when operating at a temperature of 20° Centigrade. The temperature coefficient is not to exceed 0.0001 percent (1 cycle) per degree centigrade measured over a range of 20 ~~44~~°C. The crystals shall provide a high degree of oscillation activity and freedom from spurious frequencies when installed in random selected indicators of the same group at all temperatures in the range of −32 ~~−4~~°C to +65 ~~+40~~°C. The crystals shall be within 0.001 percent (10 cycles at 10°C) of the specified frequency when installed in random selected indicators of the same group.

The crystals shall be mounted in the holder so as not to vary more than .001 percent (10 cycles) for:

A. Prolonged vibration under simulated airplane conditions, i.e., vibration of 1/16 inch amplitude and with frequencies up to 3600 cycles per second.

B. After violent shaking by hand.

C. After turning equipment in any position, i.e., upside down or on side, etc., and returning to the normal operating position.

The crystal shall be ground to a frequency of 1000 Kcs with dimensions of 17.85 mm × 14.72 mm × 1.69 mm.

6. VACUUM TUBE DATA

The following tabulation shows the maximum operating characteristics for the tubes employed in the Model LM-7 Aircraft Frequency Measuring Equipment:

Symbol:	V-101	V-102	V-103	V-104 & V-105
Function:	Heterodyne Oscillator	Crystal Osc & Detector	AF Amp & Modulator	Voltage Regulators
Name:	Triple Grid Amplifier	Pentagrid Converter	Super Triode	Neon Glow
Navy Type No:	–77	6A7	–76	None
Nearest Com'l Equivalent:	77	6A7	76	T-4½
Base:	Small 6 pin	Small 7 pin	Small 5 pin	2 Contact Bayonet
Heater Voltage (EF):	6.3 V*	6.3 V*	6.3 V*	.
Control Grid Voltage (Eg_1):	–3.0 V	–3.0 V	–13.5 V	.
Screen Voltage (Eg_2):	100.0 V	100.0 V	.	.
Plate Voltage (Ep_1):	250.0 V	250.0 V	250.0 V	90.0 V
Anode Grid Voltage (Ep_2):	.	200.0 V	.	.
Heater Current (If):	330.0 MA	330.0 MA	330.0 MA	.
Screen Current (Ig_2):	0.8 MA	2.2 MA	.	.
Plate Current (Ip_1):	15.0 MA	3.5 MA	6.8 MA	30.0 MA
Anode Grid Current (Ip_2):	.	4.0 MA	.	.
Transconductance (Sm):	1475 μMho	520 μMho	1640 μMho	.

* By specification, the Model LM-7 Equipment is required to operate from the power supply of the Model GF or RU Equipment with which it is installed at any primary power supply potential between the limits of 11 and 15 volts. At the 15-volt limit, the filaments of V-101, V-102 and V-103 are subjected to an operating potential of 7.3 volts. This is in excess of the maximum Navy ratings, but within the tolerance recommended by commercial tube manufacturers.

CONTINUOUS OPERATION AT THIS UPPER LIMIT WILL, HOWEVER, RESULT IN RAPID DETERIORATION. IN THE INTEREST OF LONGER TUBE LIFE, IT IS THEREFORE RECOMMENDED THAT THE PRIMARY POWER SUPPLY BE HELD TO 14 VOLTS OR LESS.

NOTE: ALL TUBES SUPPLIED WITH THE EQUIPMENT, OR AS SPARES ON THE EQUIPMENT CONTRACT, SHALL BE USED IN THE EQUIPMENT PRIOR TO EMPLOYMENT OF TUBES FROM GENERAL STOCK.

Table I

LIST OF MAJOR UNITS FOR MODEL LM-7 FREQUENCY MEASURING EQUIPMENT

Navy Type Designation	Name of Unit	Quantity	Mfr's. Desig.	Weight Lbs.
.	Model LM-7 Frequency Measuring Unit	1	.	11.50
.	Shockproof Mounting Base	1	.	.50
.	Shielded Power Cable	1	.	1.90
.	Calibration Book	1	.	.
.	Instruction Book	2	.	.
.	Weatherproof Slip Cover	1	.	0.25

Table II

PARTS LIST BY SYMBOL DESIGNATIONS FOR MODEL LM-7 AIRCRAFT FREQUENCY MEASURING EQUIPMENT

CAPACITORS

Symbol Desig.	Function	Description	Navy Type Number	Navy Dwg. or Spec. Number	Mfr.	Mfr's. Desig.	Bendix Dwg. No.
C-101	Heterodyne Tuning	20-170 Mmf, Var air with 5 Mmf thermal compensator	.	.	1	.	AC57439-1
C-102	Corrector Capacitor	1.5-3.0 Mmf, Var air	.	.	6	Special	C57387
C-103	LF Het Trimmer	3-10 Mmf, Adj air	.	.	6	Special	C57380
C-104	HF Het Trimmer	Same as C-103	.	.	.	.	.
C-105	Heterodyne Coupling	10 Mmf ±10%, 500V DCW, Mica	-48710-10	RE 48A 148	4	5W-5Q1	A26112-1
C-106	Antenna Coupling	25 Mmf ±10%, 500V DCW, Mica	-48711-10	RE 48AA 148	4	5W-5Q25	A26112-2
C-107	Modulator Coupling	.04 Mfd +10%, −3%, 200V DCW, Paper	-48430	RE 13A 488C	4	HC507	A212
C-108	Audio Coupling	.02 Mfd ±10%, 600V DCW, Mica	-48428-10	RE 13A 389K	4	4S-11020	A26111-1
C-109A	Het RF Bypass	0.1/0.1/0.1 Mfd +10%, −3%, 400V DCW, Oil paper	-48713A	RE 48AA 129	4	"D"	A205-2
C-109B	Het Pl & Screen Bypass						
C-109C	Het Negative Bypass						
C-110A	Audio Cathode Bypass	0.1/0.1/0.1 Mfd +10%, −3%, 400V DCW, Oil paper	-48709	RE 48AA 138	4	"D"	A207-2
C-110B	Plate Supply Bypass						
C-110C	Negative HV Bypass						
C-111A	Det Screen Bypass	Same as C-109	-48713A	.	.	.	.
C-111B	Crystal Anode Bypass						
C-111C	Det Plate Bypass						
C-112	Audio Plate Bypass	0.5 Mfd +10%, −3%, 400V DCW, Oil paper	-48704	RE 48AA 138A	4	"D"	A203-2
C-113	Modulator Tuning	Same as C-107	-48430	.	.	.	.
C-114	Modulator Feedback	.0005 Mfd ±10%, 500V DCW, Mica	-48691-10	RE 48A 148B	4	5WS	A26112-3
C-115	Audio Choke Bypass	.001 Mfd ±10%, 600V DCW, Mica	-48645-10	RE 48AA 112	4	4S	A26111-2

Table II—*Continued*

Symbol Desig.	Function	Description	Navy Type Number	Navy Dwg. or Spec. Number	Mfr.	Mfr's. Desig.	Bendix Dwg. No.
		MISCELLANEOUS ELECTRICAL PARTS					
E-101A	Push Post Assembly	Nickel plated brass	.	.	18	.	A29383
E-101B	Terminal Post Insulator	Ceramic pair	.	RE 13A 317F	9	.	A11092
E-102 to E-107	Wire Clamp	Ceramic pair	.	RE 13A 317F	9	.	A1693
E-109 to E-112	Feed Through Bushing	Ceramic pair	.	RE 13A 317F	9	.	A4143
E-108, 113	Grid Clip	Spring release type	.	.	11		A221-1
		JACKS AND RECEPTACLES					
J-101	Phone Jack	Open circuit, Short	-49025	.	2	#1	A219
J-102	Power Receptacle	5 Cont, for 1¼″ plug	-49036	RE 49AA 122B	1	.	AA306-1
		INDUCTORS AND REACTORS					
L-101	Low Frequency Coil	4.065 MH, Ceramic form, 330 turns, 7-42 Litz	.	.	1	.	AC57442-1
L-102	High Frequency Coil	42 microhenry, 35¼ turns #28 DSC	.	.	1		AC57441-1
L-103	RF Choke	1.7 MH universal winding, sealed, 40 ohms DC ±5%	-47110	.	1	.	AA1665-1
L-104	AF Choke	600 H @ 1.0 MA DC, 6700 ohms DC, Evacuated	-30380	.	14	U-3250	A27006

Table II—*Continued*

Symbol Desig.	Function	Description	Navy Type Number	Navy Dwg. or Spec. Number	Mfr.	Mfr's. Desig.	Bendix Dwg. No.
		RESISTORS					
R-101	Het LF Cathode	10,000 ohms ±10%, ½-watt, Comp, Pigtail	-63360	RE 13A 372J	8	BT-½	A11207-29
R-102	Het HF Cathode	5,000 ohms ±10%, ½-watt, Comp, Pigtail	-63360	RE 13A 372G	8	BT-½	A11207-23
R-103	Voltage Regulator	25,000 ohms ±5%, 2.91-watt, WW, Lug terminals	-63606E		13		A15679-3
R-104	Heterodyne Plate	50,000 ohms ±10%, ½-watt, Comp, Pigtail	-63360	RE 13A 372G	8	BT-½	A11207-42
R-105	Heterodyne Negative HV	Same as R-102	-63360				
R-106	RF Coupling Control	500 ohms Pot ±10%, 1-watt, Impregnated strip	-63500		3	72-118 Mod	A2033
R-107	Detector Grid Leak	1.0 Megohm ±10%, ½-watt, Comp, Pigtail	-63360	RE 13A 372G	8	BT-½	A11207-57
R-108	Audio Plate	20,000 ohms ±10%, 1-watt, Comp, Pigtail	-63288	RE 13A 372G	8	BT-1	A3527-5
R-109	Crystal Oscillator Grid	Same as R-104	-63360				
R-110	Detector Screen	Same as R-104	-63360				
R-111	Audio Cathode	3,000 ohms ±10%, ½-watt, Comp, Pigtail	-63360	RE 13A 372G	8	BT-½	A11207-20
R-112	Audio Grid	Same as R-107	-63360				
R-113	Audio Filament	20 ohms ±5%, 2.91-watt, WW, Lug terminals	-63501E	RE 13A 372J	13		A15679-1
R-114	Heterodyne Suppressor	Same as R-102	-63360				
R-115	V-102 Positive HV	15,000 ohms ±5%, 2.91-watt, WW, Lug terminals	-63571E		13		A15679-2
R-116	Regulator Cutout	25,000 ohms ±10%, ½-watt, Comp, Pigtail	-63360	RE 13A 372G	8	BT-½	A11207-38

Table II—*Continued*

Symbol Desig.	Function	Description	Navy Type Number	Navy Dwg. or Spec. Number	Mfr.	Mfr's. Desig.	Bendix Dwg. No.
SWITCHES							
S-101A, B	Frequency Band	DPDT rotary, 1-section	-24022A	.	12	.	C57436
S-102A, B	Power On-Off	DPST toggle	-24025	RE 24AA 118B	7	.	A100457
S-103	Standby	SPST toggle	-24041	RE 24AA 118B	7	.	A100456
S-104A, B	Crystal On-Off	DPDT toggle	-24033	RE 24AA 118B	7	.	A100455
S-105A, B C, D	Modulation On-Off	4PDT rotary, 1-section	-24024A	.	12	H	C56558
TRANSFORMERS							
T-101	Output and Modulator	20,000/600 ohms imp. ratio, Pri 1200 ohms DC, Sec 60 ohms DC	-30315A	.	14	U-3239	A27004
VACUUM TUBES AND SOCKETS							
V-101	Heterodyne Oscillator	Triple grid, Type 77	-77	RE 13A 600B	15	77	.
V-102	Crystal Osc and Det	Pentagrid converter, Type 6A7	-6A7	RE 13A 600B	15	6A7	.
V-103	Audio Amp. and Mod.	Super triode, Type 76	-76	RE 13A 600B	15	76	.
V-104, 105	Neon Bulb	2-element, ¼-watt, Bayonet base		.	5	T-4½ Special	A9879
X-101	V-101 Socket	6-contact, Ceramic	-49329	RE 49AA 311	11	.	AA12336-1
X-102	V-102 Socket	7-contact, Small, Ceramic	-49333	RE 49AA 311	11	.	AA12337-1
X-103	V-103 Socket	5-contact, Ceramic	-49328	RE 49AA 311	11	.	AA12335-1
X-104, 105	V-104, V-105 Socket	2-contact, Bayonet type	.	.	10	A3946A	A11586
X-106	Crystal Receptacle	8-contact, Octal, Ceramic	-49326	RE 49AA 310	.	XC8	AA12338-1
CRYSTAL AND HOLDER							
Y-101	Crystal	Crystal and holder 1000 Kcs, A Cut, ±.0001%/°C	-40023A	.	1	MX-5C	L1847

Table II—*Continued*

Symbol Desig.	Function	Description	Navy Type Number	Navy Dwg. or Spec. Number	Mfr.	Mfr's. Desig.	Bendix Dwg. No.
		SECTION 2 (201 TO 299) ACCESSORIES					
		PLUGS					
P-201	Cable Plug	Straight plug, 5-contact	-49067A	.	17	LU-160-M5	AC56586-2
P-202	Cable Plug	90° plug	-49068A	.	17	LU-170-M5	AC56587-1
		CABLING					
W-201	Power Cable	Cable, 5-conductor shielded rubber covered, .495″ OD, 110″ long	.	.	16	.	A11503

Table III

PARTS LIST BY NAVY TYPE NUMBERS FOR MODEL LM-7 AIRCRAFT FREQUENCY MEASURING EQUIPMENT

Quantity	Navy Type Number	All Symbol Designations Involved	Description
MISCELLANEOUS—CLASS 10			
1	.	E-101A	Push post, Nickel plated brass
2	.	E-108, 113	Grid clip, Spring release type
SWITCHES—CLASS 24			
1	-24022A	S-101A, B	.
1	-24024A	S-105A, B, C, D	.
1	-24025	S-102A, B	.
1	-24033	S-104A, B	.
1	-24041	S-103	.
AF TRANSFORMERS AND REACTORS—CLASS 30			
1	-30315A	T-101	.
1	-30380	L-104	.
VACUUM TUBES—CLASS 38			
1	-6A7	V-102	
1	-76	V-103	.
1	-77	V-101	.
2	.	V-104, 105	2-element, 1/4 watt neon, Bayonet base
CRYSTALS—CLASS 40			
1	-40023A	Y-101	.
RF TRANSFORMERS—CLASS 47			
1	-47110	L-103	.
1	.	L-101	4.065MH, Ceramic form, 330 Turns 7-42 Litz
1	.	L-102	42 Microhenry, 35 1/4 turns #28 DSC
CAPACITORS—CLASS 48			
1	-48428-10	C-108	.
2	-48430	C-107, 113	.
1	-48645-10	C-115	.
1	-48691-10	C-114	.
1	-48704	C-112	.
1	-48709	C-110A, B, C	.
1	-48710-10	C-105	.
1	-48711-10	C-106	.
2	-48713A	C-109A, B, C C-111A, B, C	.
1	.	C-101	20-170 Mmf, Var air, with 5Mmf thermal compensator
1	.	C-102	1.5-3.0 Mmf, Var air
2	.	C-103, 104	3-10 Mmf, Adj air

Table III—*Continued*

Quantity	Navy Type Number	All Symbol Designations Involved	Description
		PLUGS AND RECEPTACLES—CLASS 49	
1	-49025	J-101	.
1	-49036	J-102	.
1	-49067A	P-201	.
1	-49068A	P-202	.
1	-49326	X-106	.
1	-49328	X-103	.
1	-49329	X-101	.
1	-49333	X-102	.
1	.	X-104, 105	2-Contact, Bayonet type
		INSULATORS—CLASS 61	
1	.	E-101B	Insulator, Ceramic pair
7	.	E-102 to E-107	Wire clamp, Ceramic pair
4	.	E-109 to E-112	Feed thru bushing, Ceramic pair
		WIRES AND CABLING—CLASS 62	
1	.	W-201	Cable, 5-conductor, Shielded rubber covered .495″ OD, 110″ long
		RESISTORS—CLASS 63	
1	-63288	R-108	20,000 ohms
1	-63360	R-111	3,000 ohms
3	-63360	R-102, 105, 114	5,000 ohms
1	-63360	R-101	10,000 ohms
1	-63360	R-116	25,000 ohms
3	-63360	R-104, 109, 110	50,000 ohms
1	-63360	R-107, 112	1 Megohm
1	-63500	R-106	500 ohms
1	-63501E	R-113	20 ohms
1	-63571E	R-115	15,000 ohms
1	-63606E	R-103	25,000 ohms

Table IV

SPARE PARTS LIST BY NAVY TYPE NUMBERS FOR MODEL LM-7 AIRCRAFT FREQUENCY MEASURING EQUIPMENT

Quantity	Navy Type Number	All Symbol Designations Involved	Description
		MISCELLANEOUS—CLASS 10	
1	.	.	Calibration book
1	.	.	Bristol wrench
.	.	.	Calibration data (unmounted)
		TRANSFORMERS—CLASS 30	
1	CRP-30315A	T-101	.
		VACUUM TUBES—CLASS 38	
2	CRC-6A7	V-102	.
2	CRC-76	V-103	.
2	CRC-77	V-101	.
4	.	V-104, 105	2-element, 1/4-watt neon, Bayonet base
		CRYSTALS—CLASS 40	
1	CRR-40023A	Y-101	.
		CAPACITORS—CLASS 48	
1	CD-48428-10	C-108	.
1	CD-48430	C-107, 113	.
1	CD-48645-10	C-115	.
1	CD-48691-10	C-114	.
1	CD-48704	C-112	.
1	CD-48709	C-110A, B, C	.
1	CD-48710-10	C-105	.
1	CD-48711-10	C-106	.
1	CD-48713A	C-109A, B, C C-111A, B, C	.
		PLUGS AND RECEPTACLES—CLASS 49	
1	CLT-49067A	P-201	.
1	CLT-49068A	P-202	.
		INSULATORS—CLASS 61	
1 pr.	.	E-101B	Insulator, Ceramic pair
1 pr.	.	E-102 to E-107	Wire clamp, Ceramic pair
1 pr.	.	E-109 to E-112	Feed through bushing, Ceramic pair
		WIRES AND CABLING—CLASS 62	
110 in.	.	W-201	Cable, 5-cond, Shielded rubber-covered, .495″ OD, 110″ long
1	.	.	Nickel-silver cable marker
2	.	.	Rubber tubing spray shield
3 in.	.	.	#12 Black insulating tubing

Table IV—*Continued*

Quantity	Navy Type Number	All Symbol Designations Involved	Description
		RESISTORS—CLASS 63	
1	CIR-63288	R-108	20,000 ohms
1	CIR-63360	R-111	3,000 ohms
1	CIR-63360	R-102, 105, 114	5,000 ohms
1	CIR-63360	R-101	10,000 ohms
1	CIR-63360	R-116	25,000 ohms
1	CIR-63360	R-104, 109, 110	50,000 ohms
1	CIR-63360	R-107, 112	1 Megohm
1	CBN-63500	R-106	500 ohms
1	COM-63501E	R-113	20 ohms
1	COM-63571E	R-115	15,000 ohms
1	COM-63606E	R-103	25,000 ohms

Table V

LIST OF MANUFACTURERS

Code No.	Mfr's. Prefix	Name and Address
1	CRR	Bendix Radio Corporation 920 E. Fort Avenue, Baltimore, Maryland
2	CRA	Carter Division, Utah Radio Products Co. 812 Orleans Street, Chicago, Illinois
3	CBN	Centralab 900 East Keefe Avenue, Milwaukee, Wisconsin
4	CD	Cornell Dubilier Elec. Corp. 1000 Hamilton Boulevard, South Plainfield, New Jersey
5	CG	G. E. Vapor Lamp Co. Hoboken, New Jersey
6	CHC	Hammarlund Mfg. Co. 424 West 33rd Street, New York, N. Y.
7	CHH	Hart and Hegeman Div., Arrow-Hart & Hegeman Hartford, Connecticut
8	CIR	International Resistance Co. 401 North Broad Street, Philadelphia, Pennsylvania
9	CBU	Isolantite, Inc. 343 Courtland Street, Belleville, New Jersey
10	.	Frank W. Morse 301 Congress Street, Boston, Massachusetts
11	CNA	National Company, Inc. Malden, Massachusetts
12	COC	Oak Manufacturing Co. 1260 Clybourn Avenue, Chicago, Illinois
13	COM	Ohmite Manufacturing Co. 4835 West Flournoy Street, Chicago, Illinois
14	CRP	Raytheon Manufacturing Co. 190 Willow Street, Waltham, Massachusetts
15	CRC	RCA Radiotron Division RCA Manufacturing Co., Inc. Harrison, New Jersey
16	.	Simplex Wire & Cable Co. 79 Sidney Street, Cambridge, Massachusetts
17	CLT	Mfd. by Lundquist Tool & Mfg. Co. 57 Jackson Street, Worcester, Massachusetts
18	.	American Radio Hardware Co. 476 Broadway, New York, N. Y.

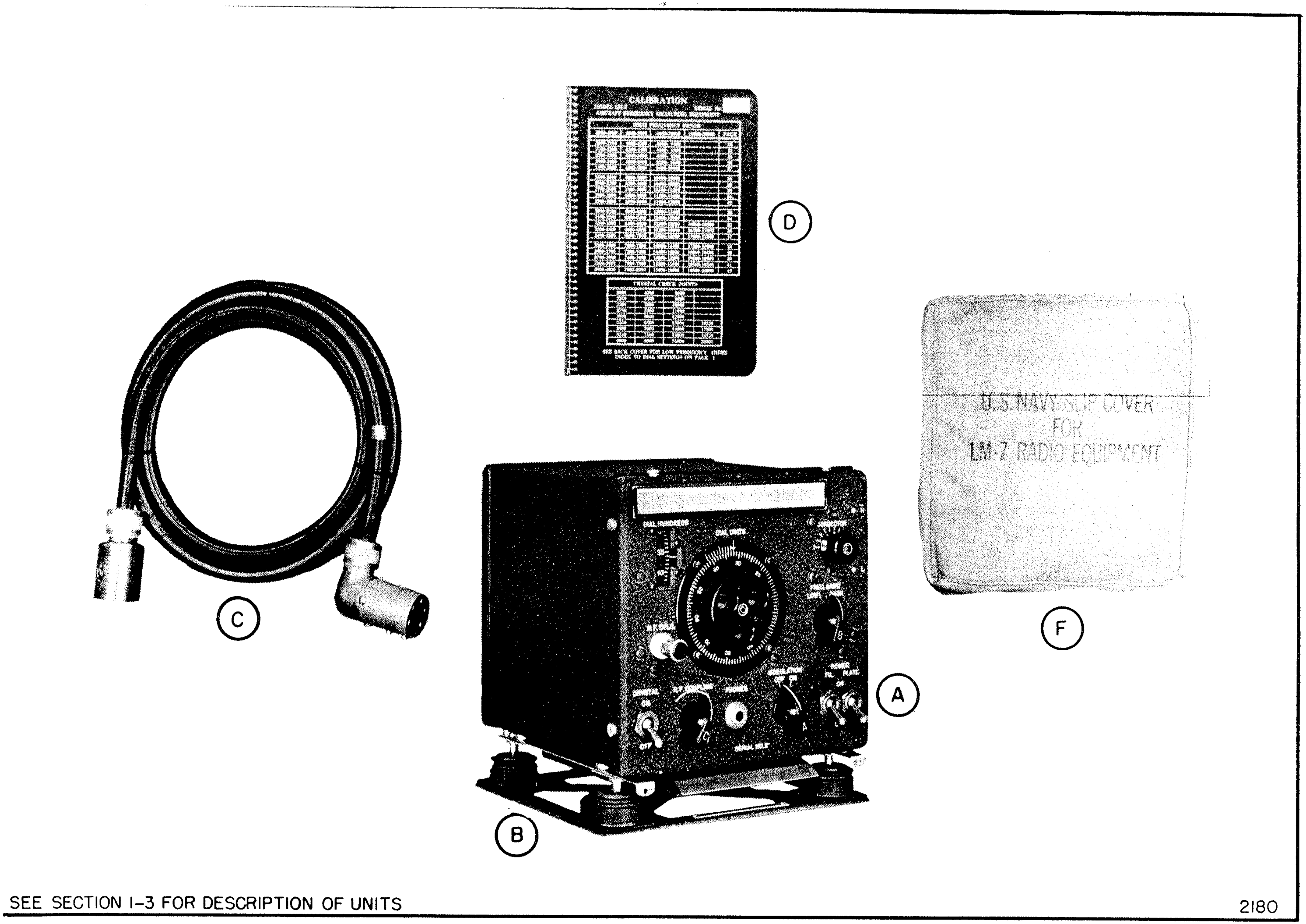


FIG. 1.—COMPOSITE VIEW

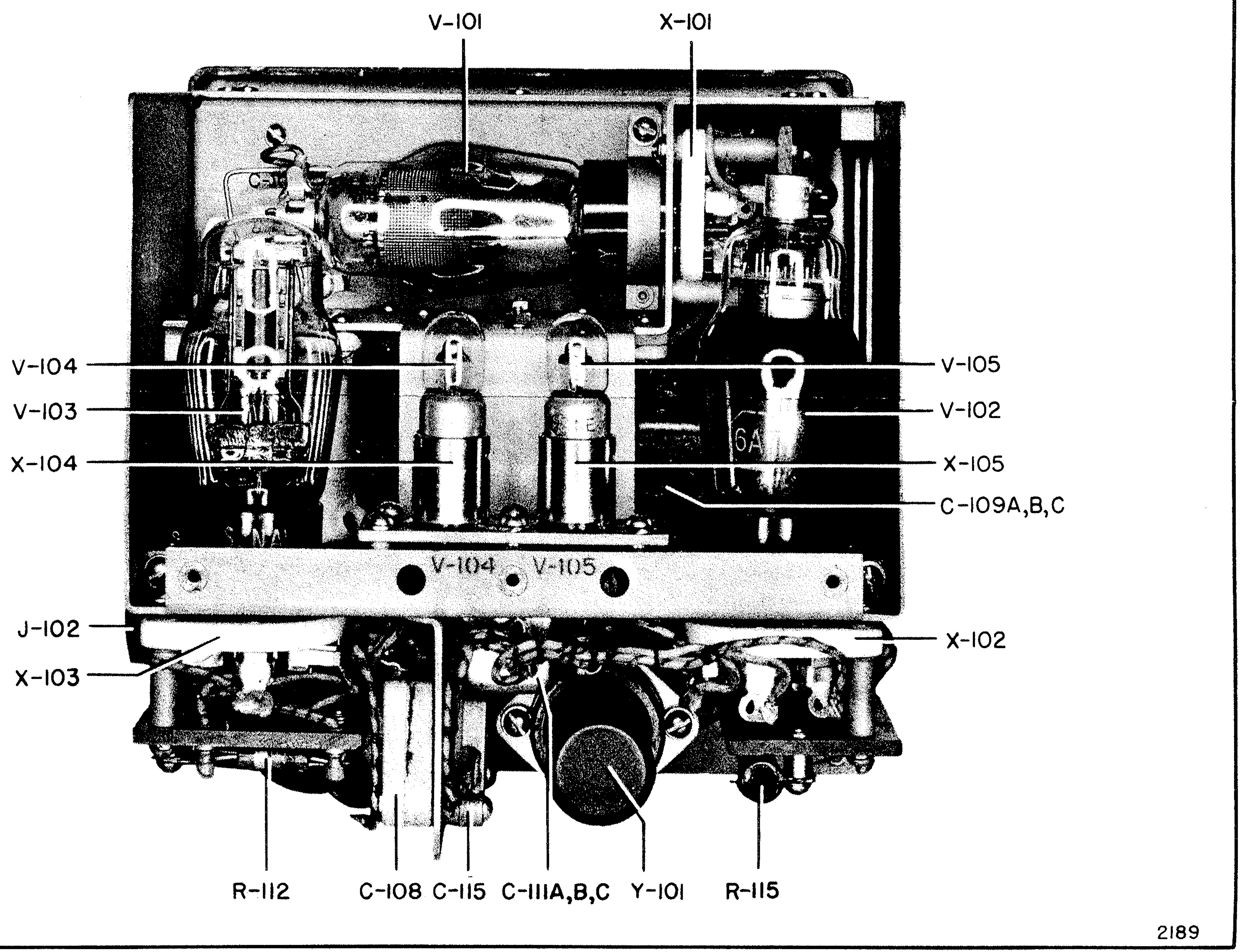


FIG. 2.—REAR VIEW OF CHASSIS

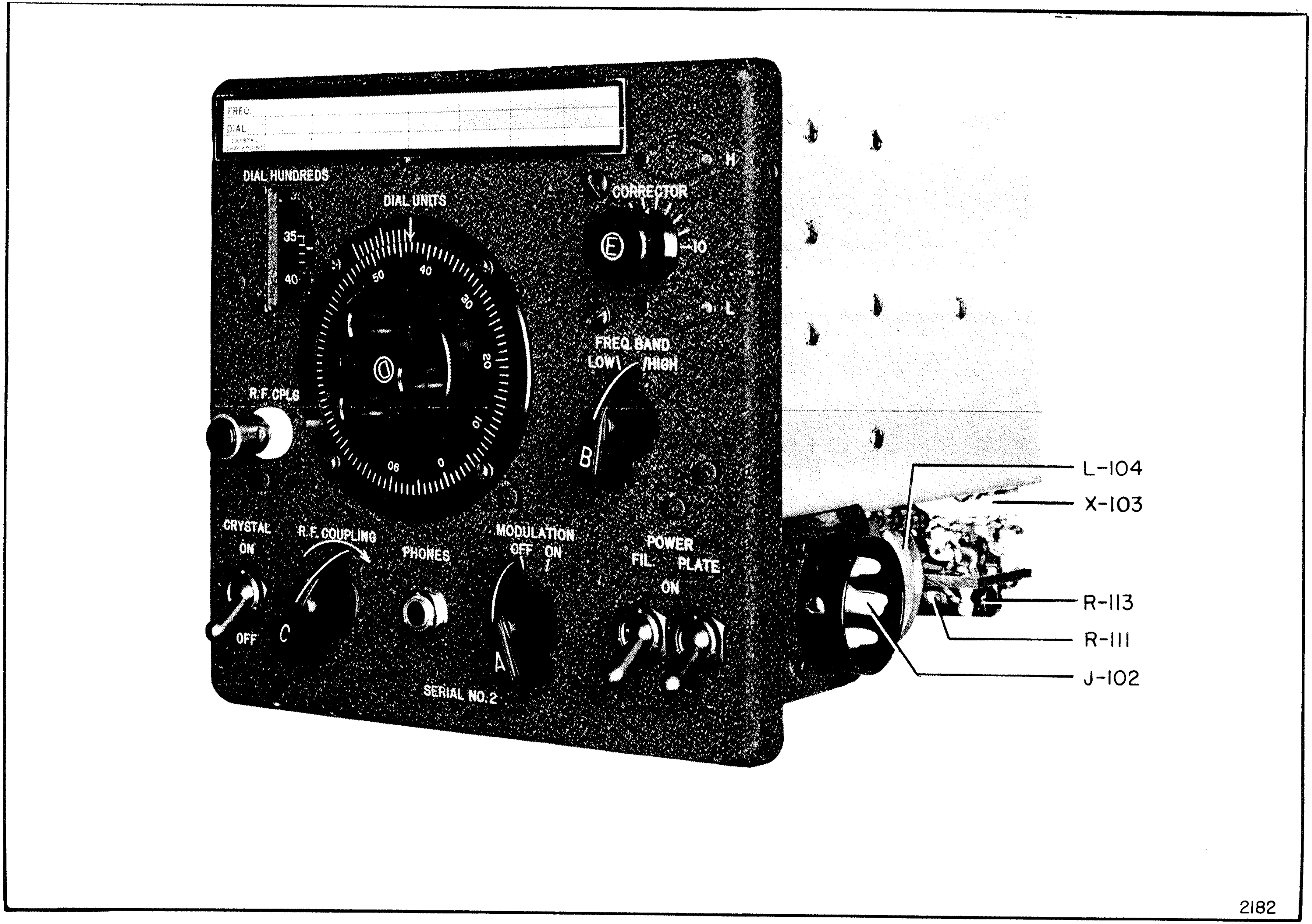


FIG. 3.—LEFT FRONT OBLIQUE OF CHASSIS

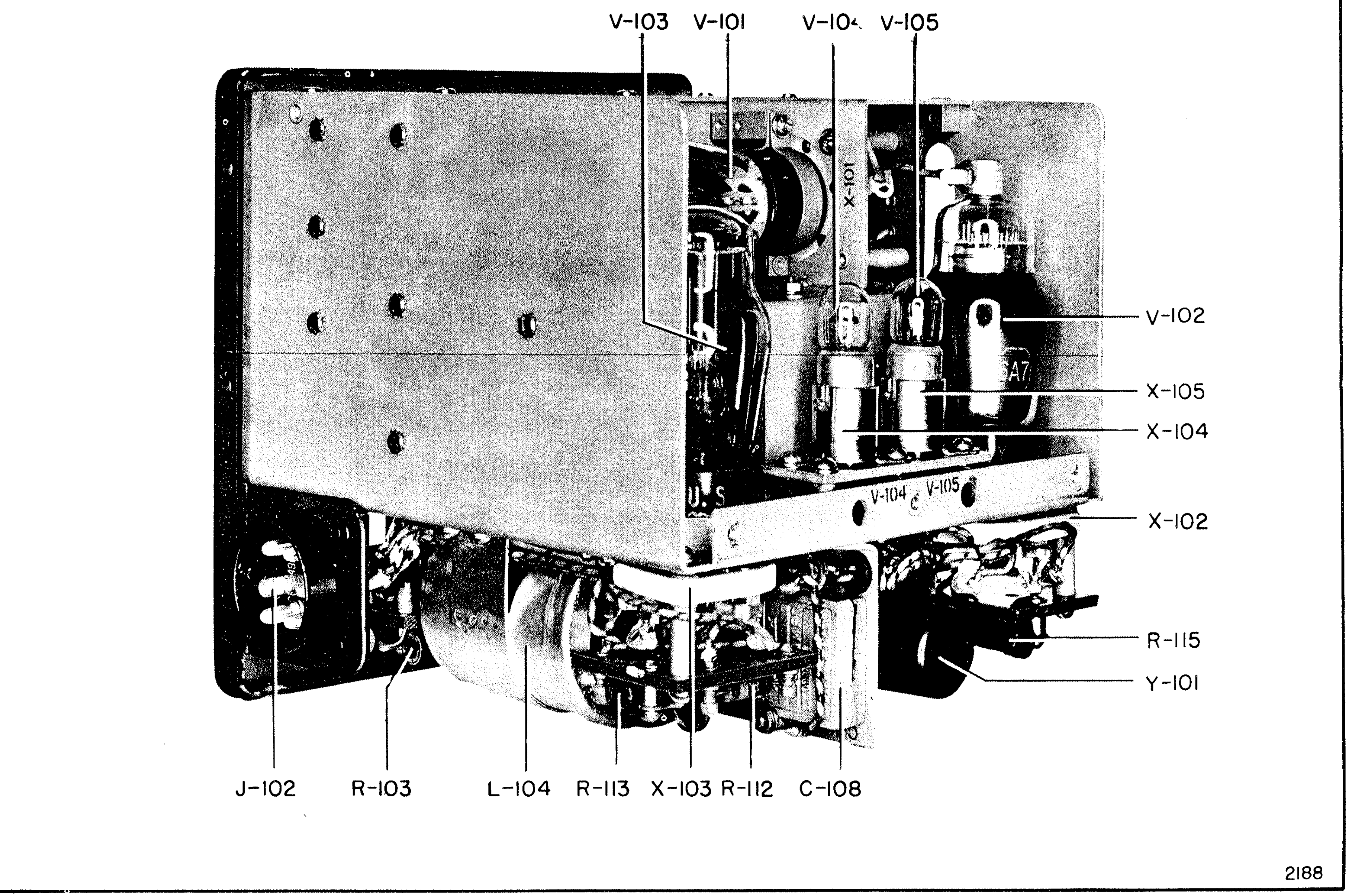


FIG. 4.—LEFT REAR OBLIQUE OF CHASSIS

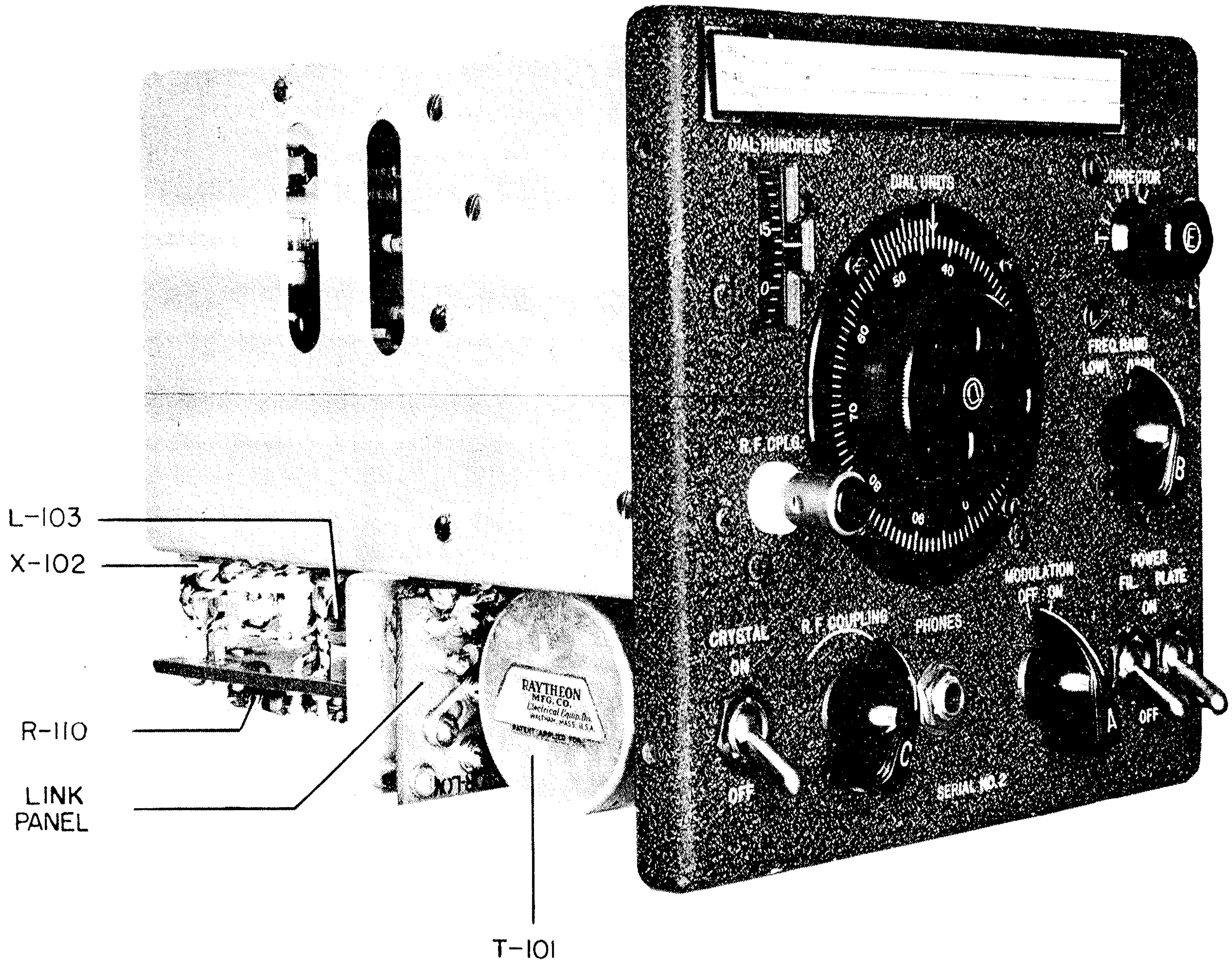


FIG. 5.—RIGHT FRONT OBLIQUE OF CHASSIS

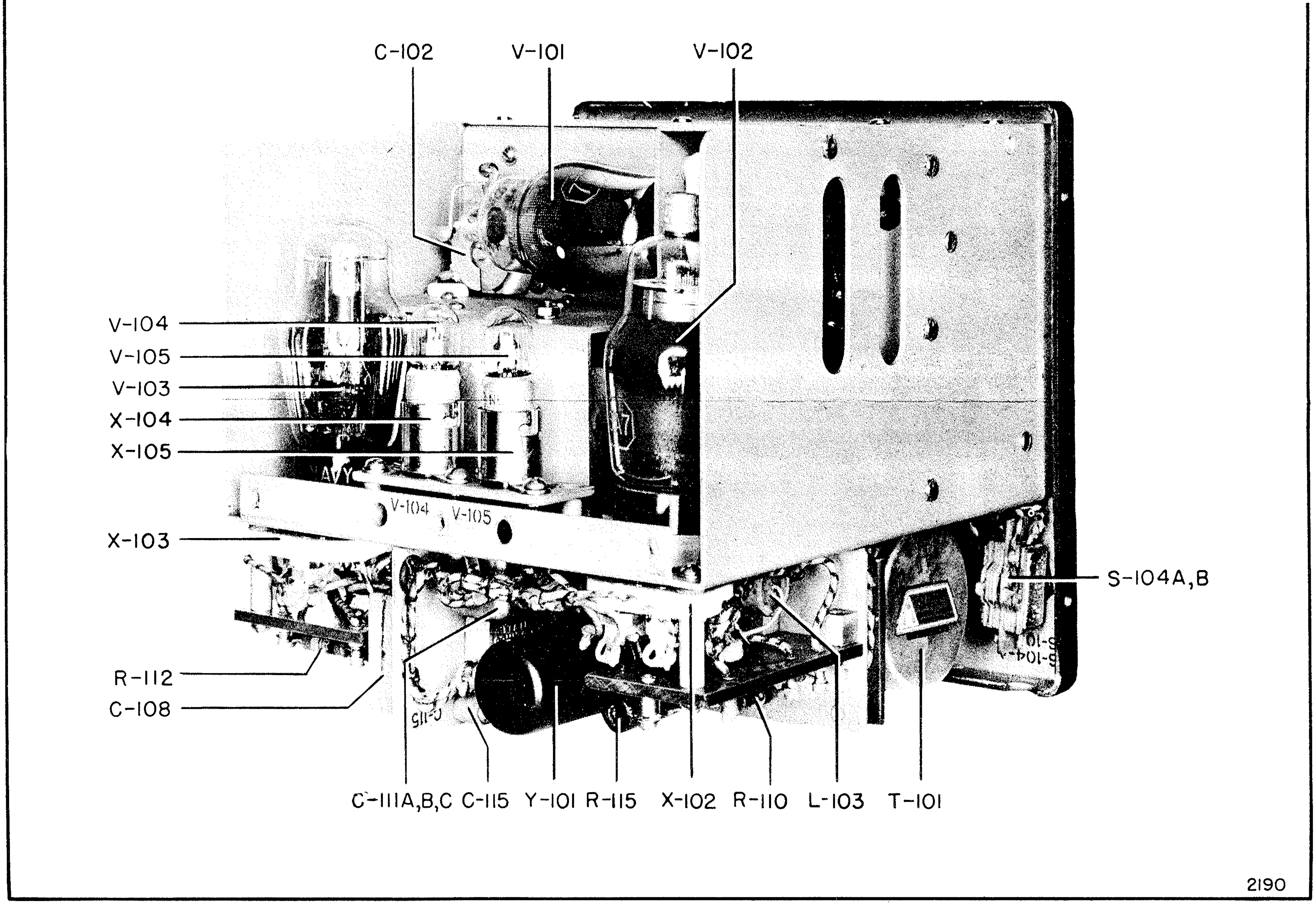


FIG. 6.—RIGHT REAR OBLIQUE OF CHASSIS

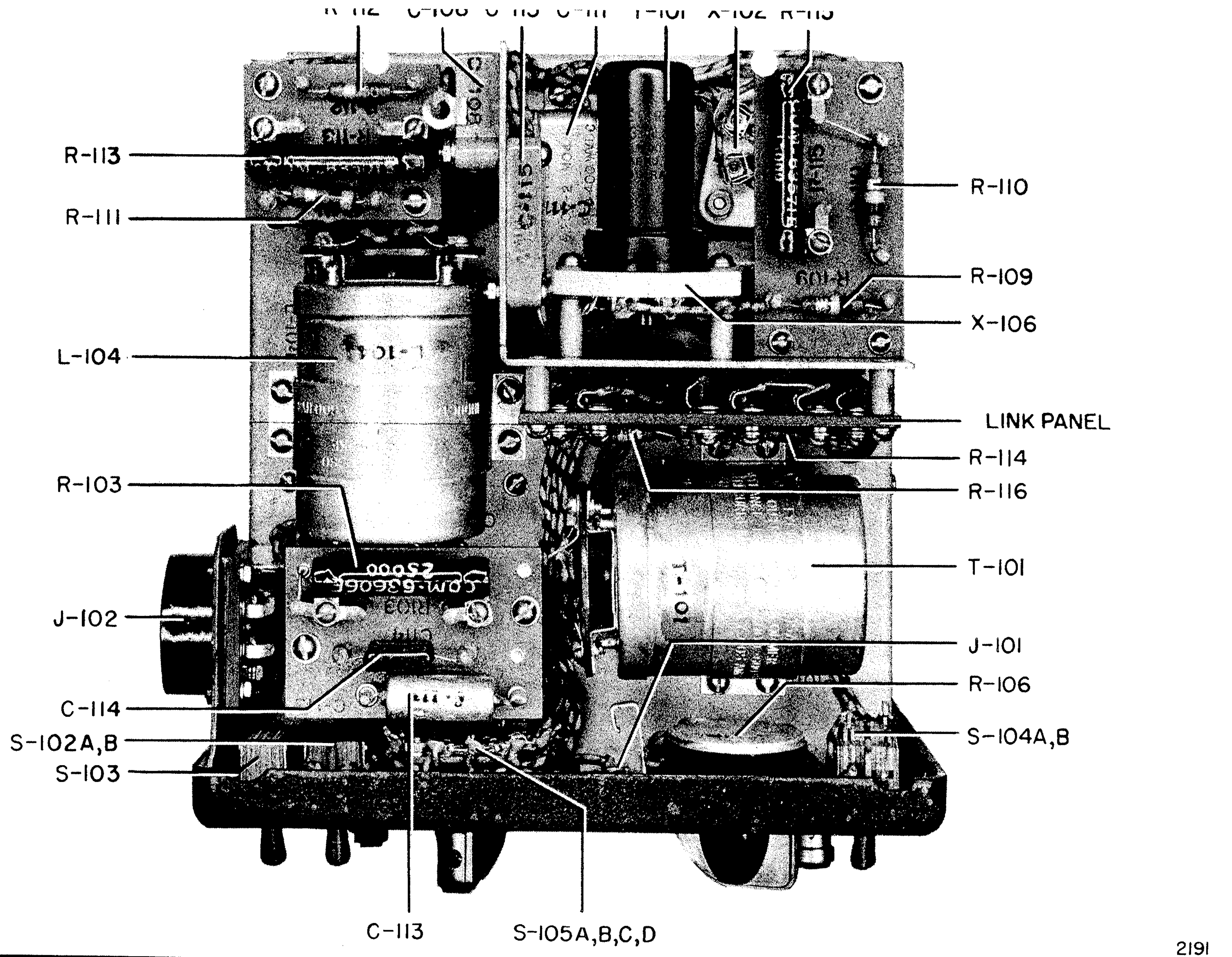
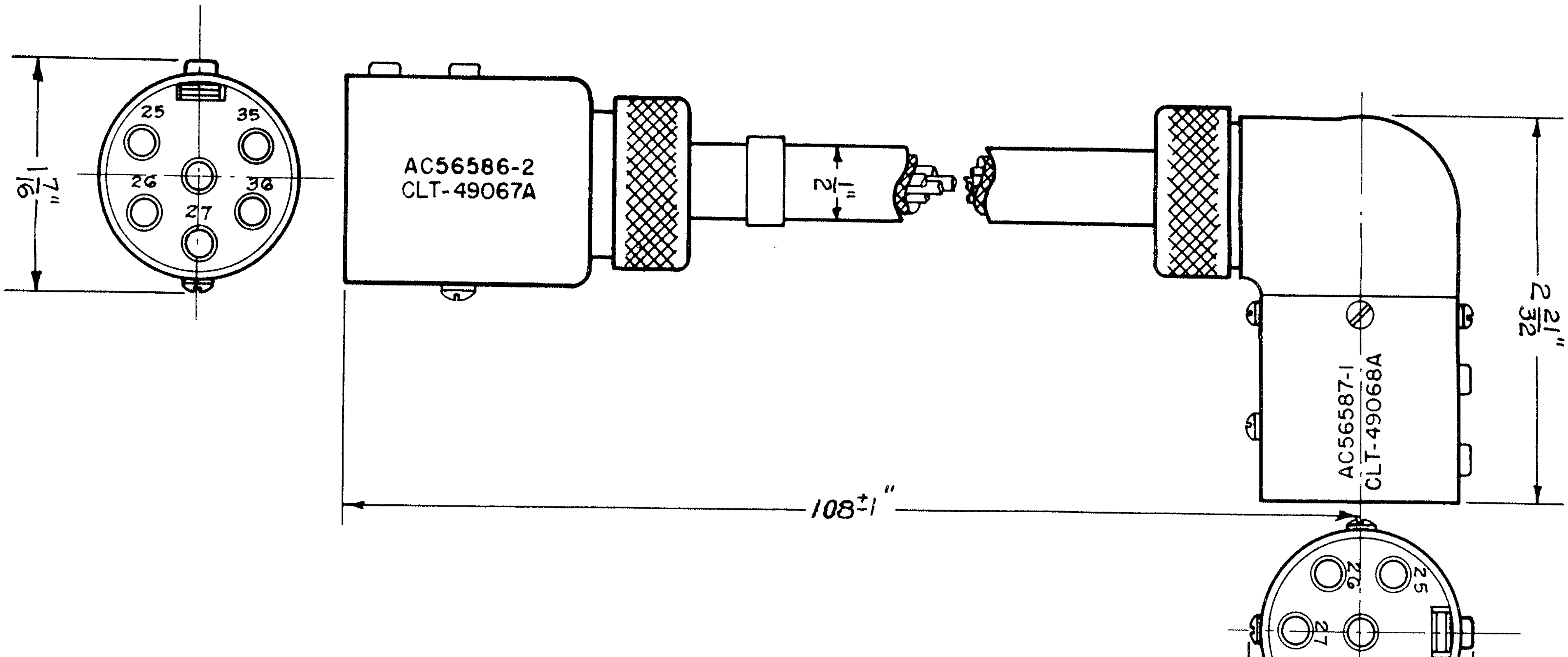


FIG. 8.—BOTTOM VIEW OF CHASSIS



COLOR CODE

27	BK	BLACK
25	BR	BROWN
35	G	GREEN
26	R	RED
36	W	WHITE

MINIMUM BENDING RADIUS 3"
CABLE WEIGHT PER FOOT 2.4 OZ

FIG. 10.—POWER CABLE DETAILS

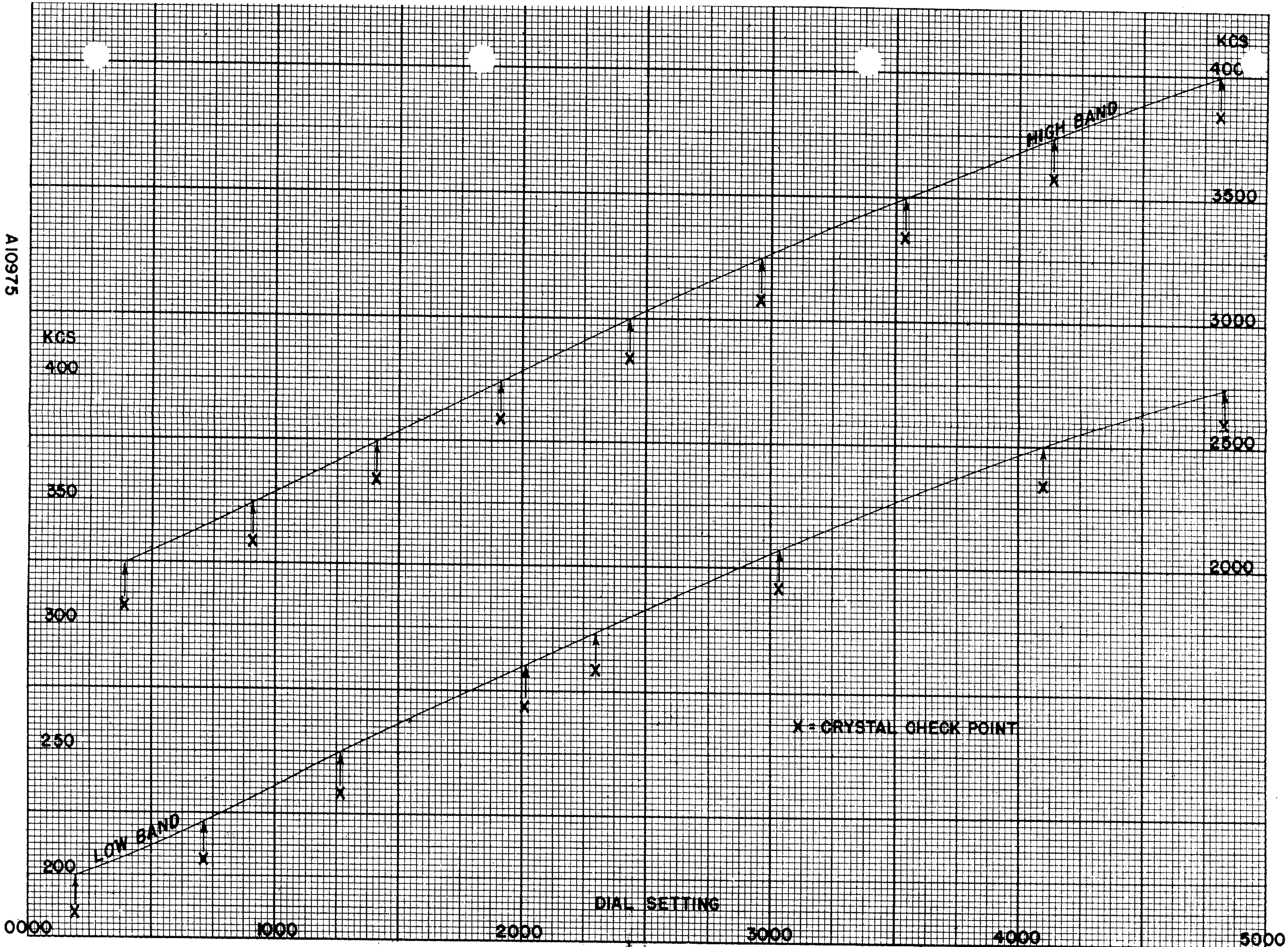


FIG. 14.—TYPICAL HETERODYNE OSCILLATOR TUNING CURVES

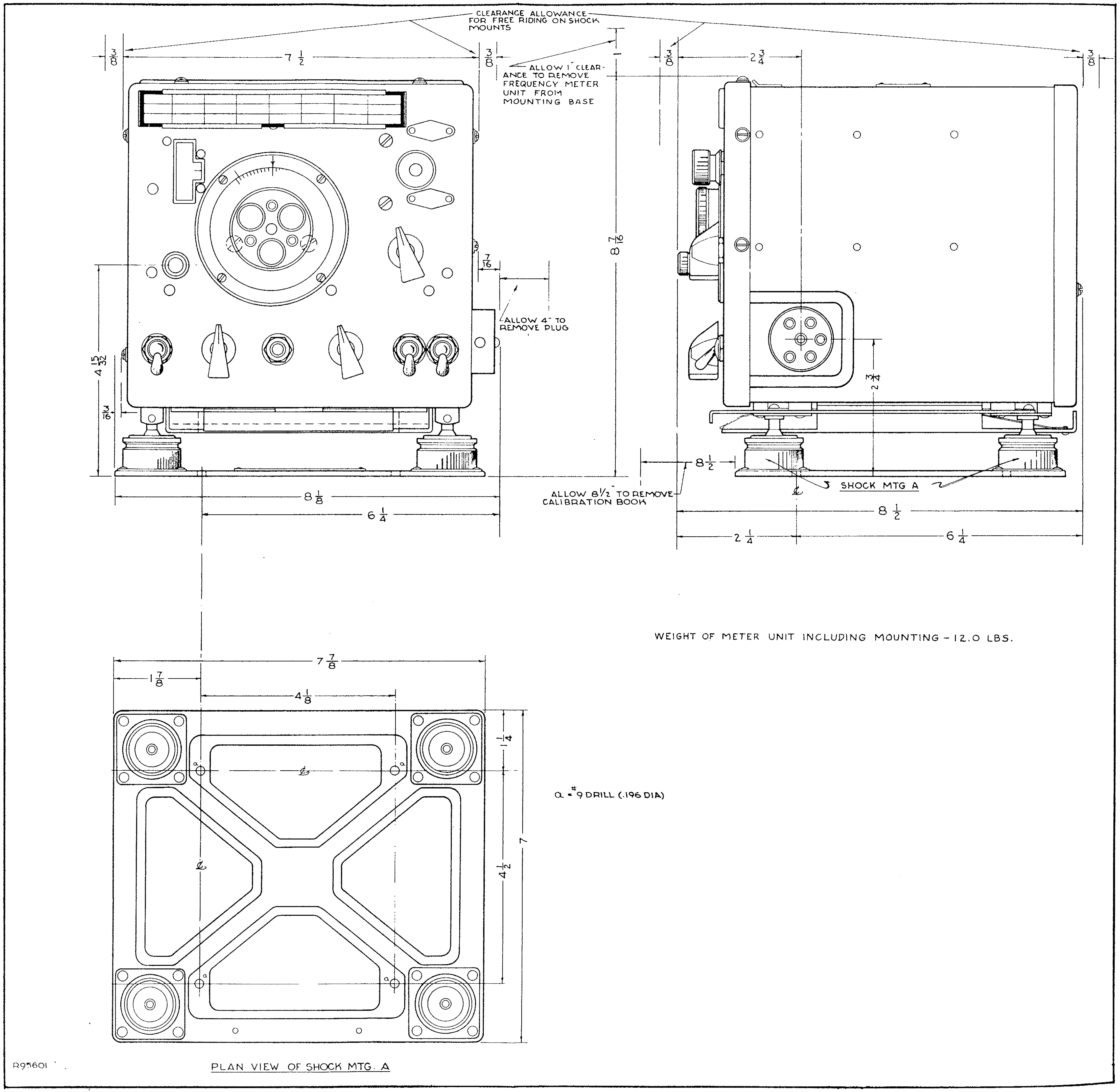


FIG. 9.—OUTLINE AND MOUNTING DIMENSIONS

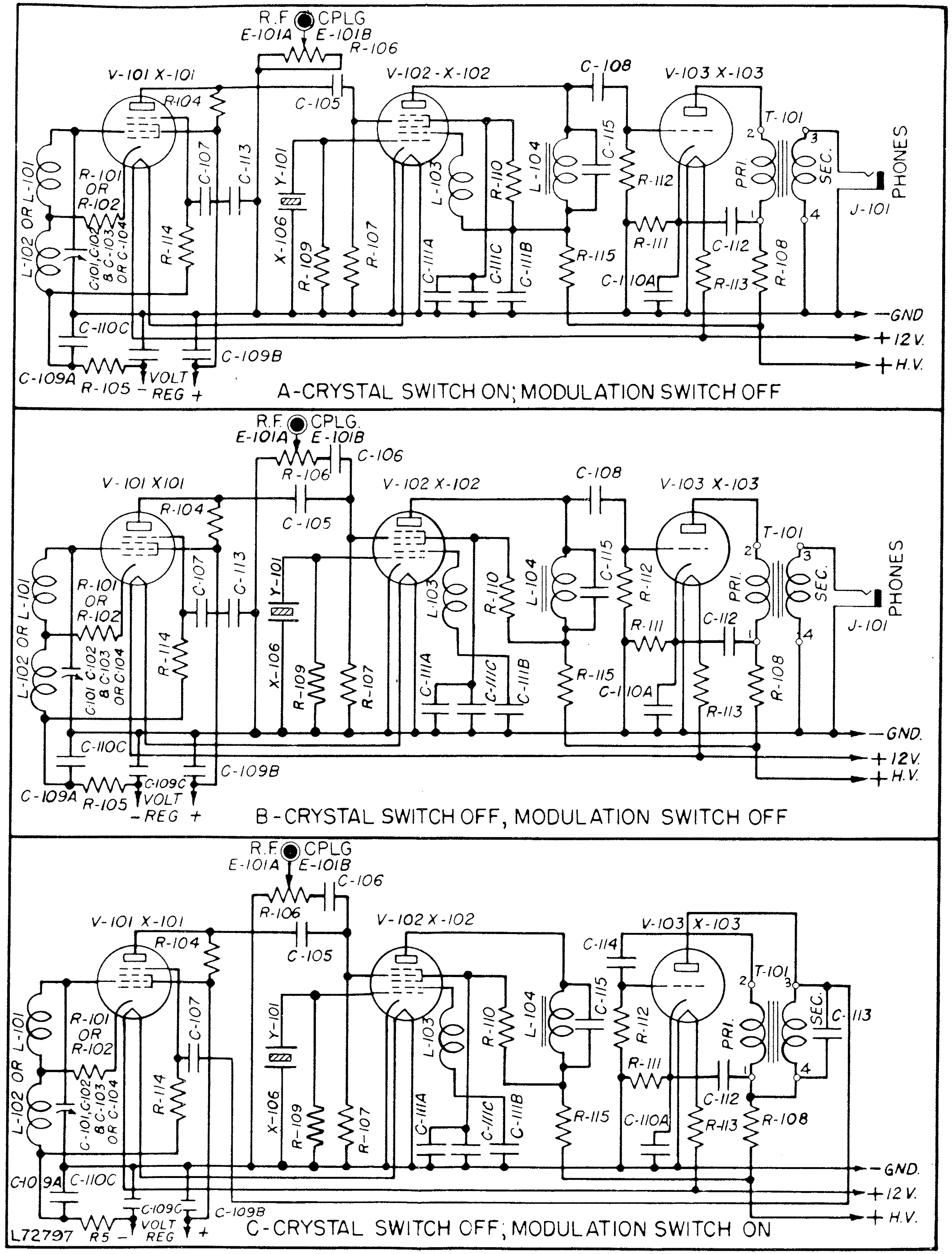


FIG. 11.—FUNDAMENTAL CIRCUITS

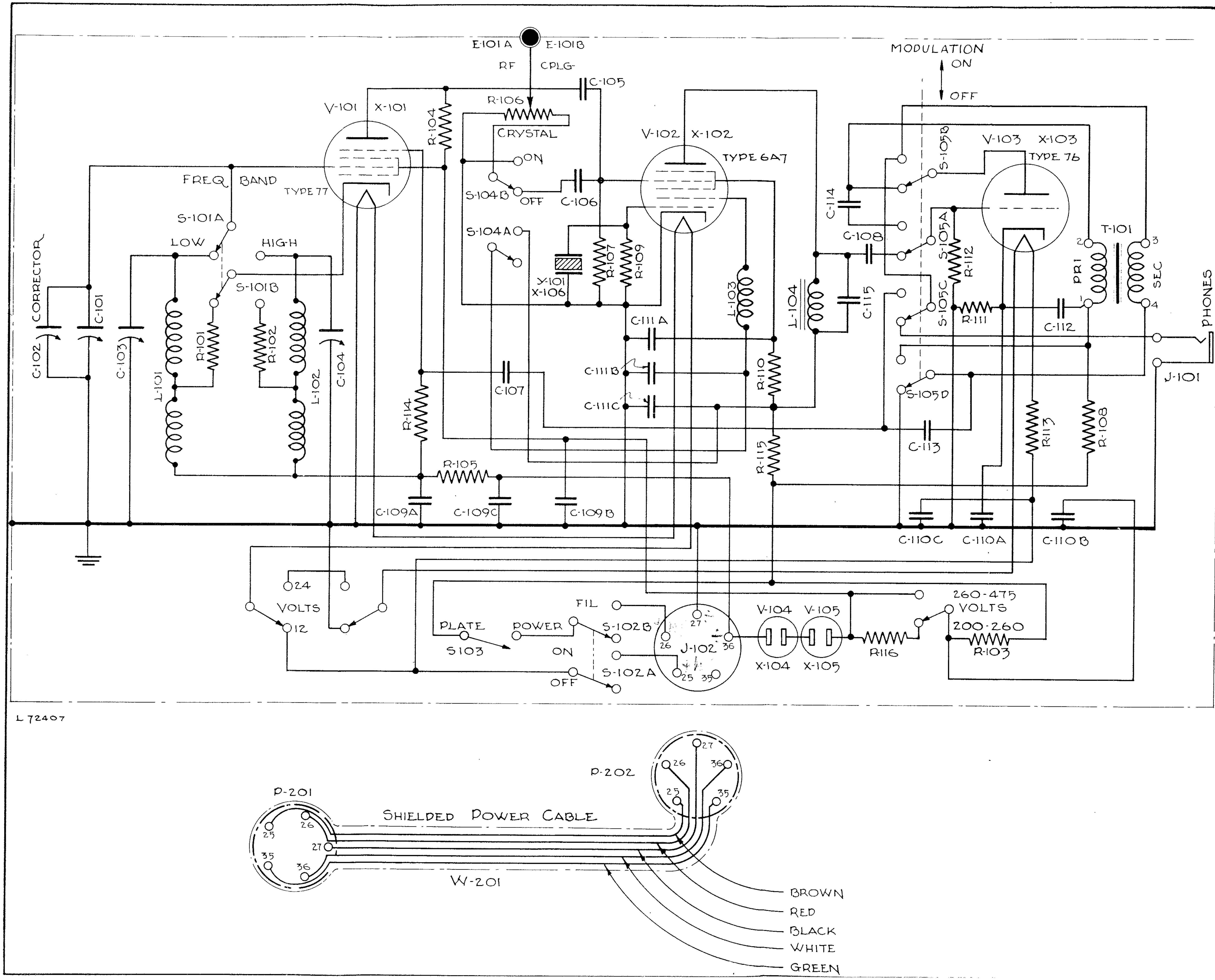
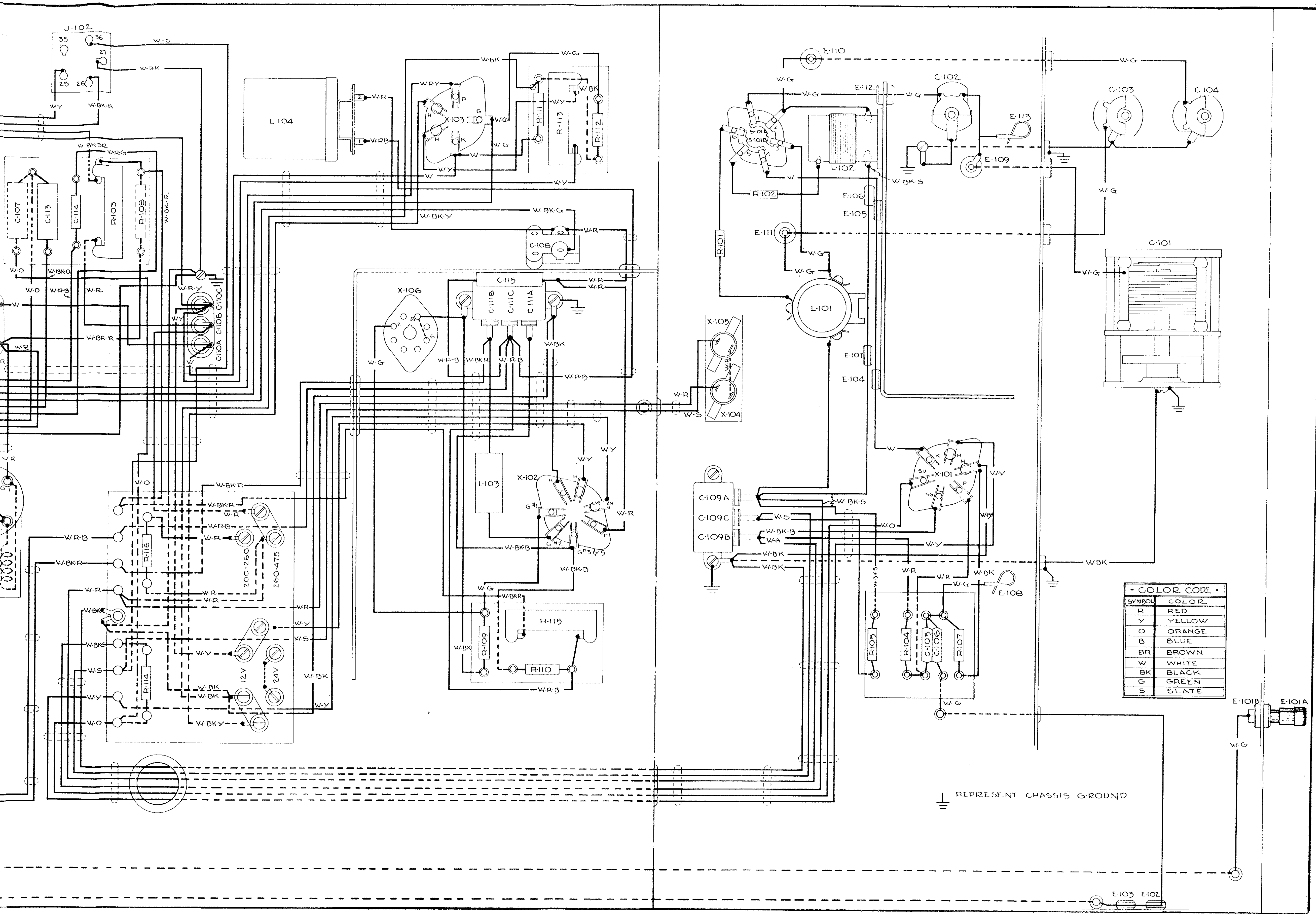


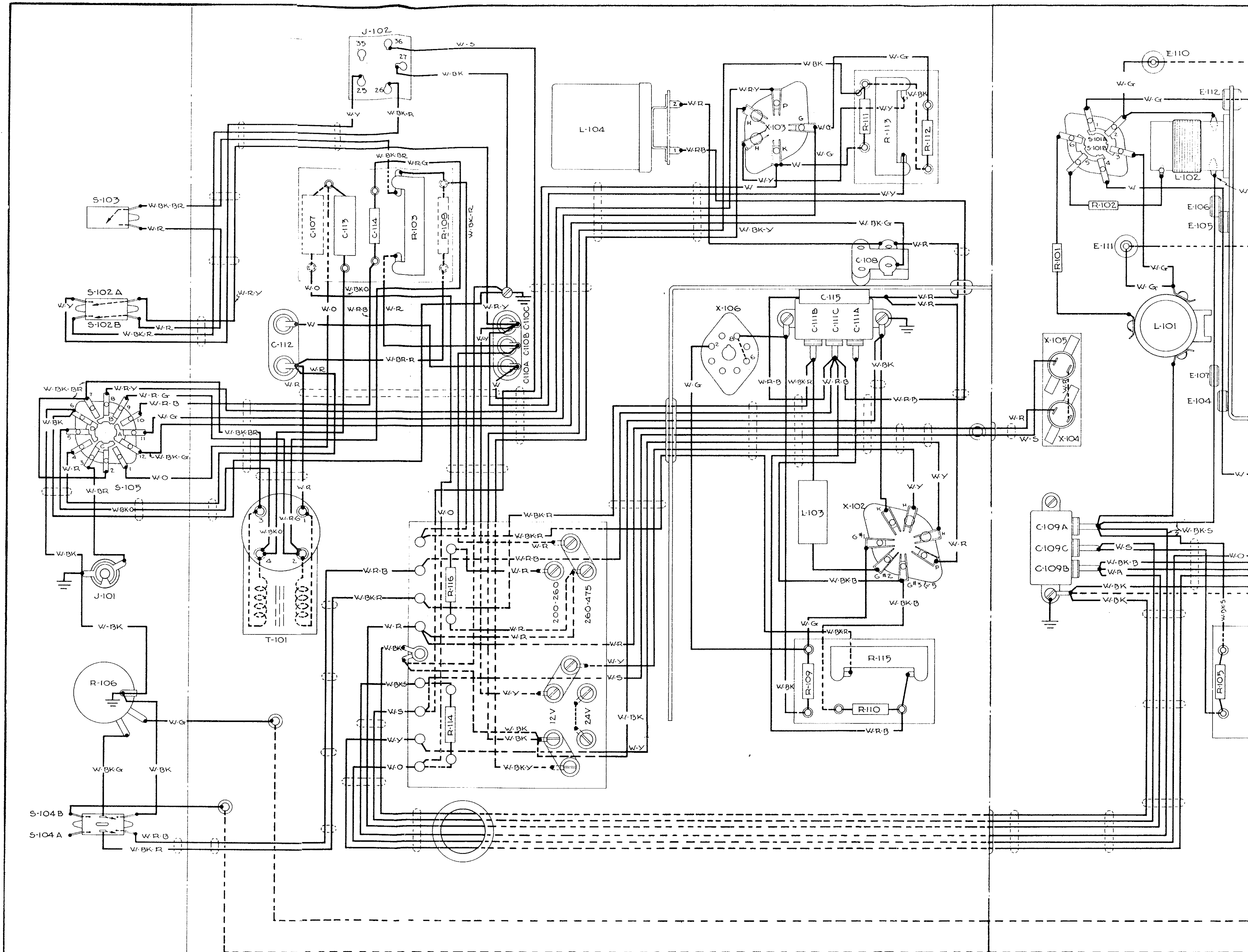
FIG. 12.—FULL SCHEMATIC DIAGRAM



COLOR CODE

SYMBOL	COLOR
R	RED
Y	YELLOW
O	ORANGE
B	BLUE
BR	BROWN
W	WHITE
BK	BLACK
G	GREEN
S	SLATE

FIG. 13—NG DIAGRAM


J-102
S-103
S-102 A
S-102 B
C-107
C-113
C-114
R-103
R-108
C-112
C110A C110B C110C
S-105
J-101
T-101
R-106
S-104 B
S-104 A
R-116
R-114
200-260
260-475
12V
24V
L-104
X-103
R-111
R-113
R-112
C-108
C-115
C-111B C-111C C-111A
X-106
L-103
X-102
R-115
R-109
R-110
E-110
E-112
S-101A
S-101B
L-102
R-102
E-106
E-105
E-111
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X-105
X-104
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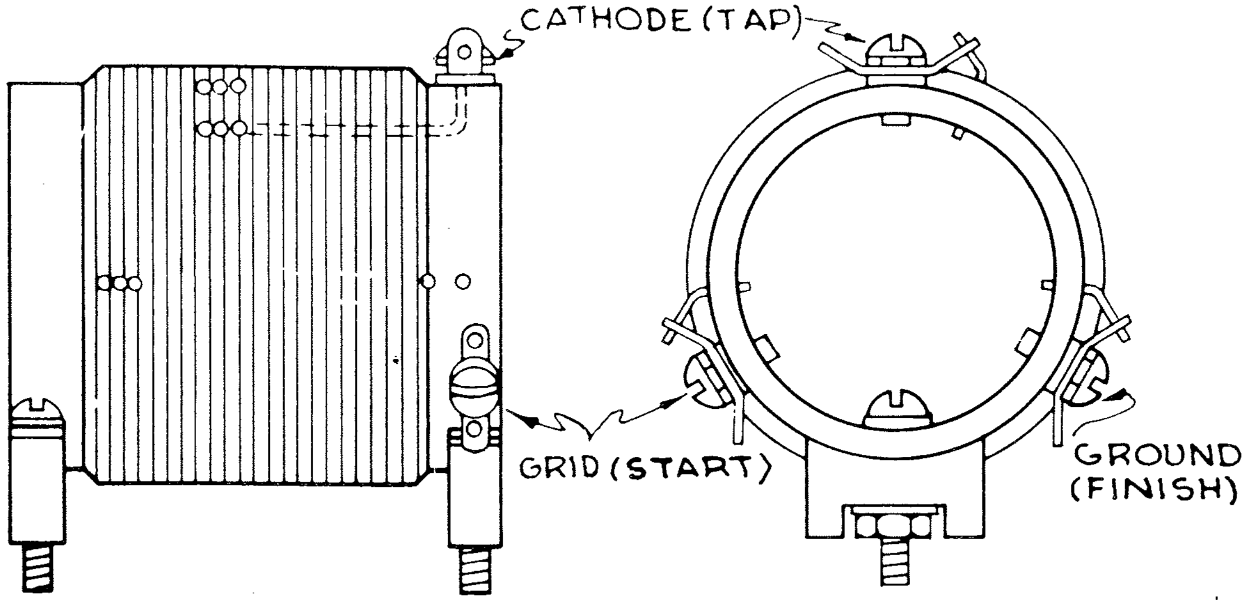
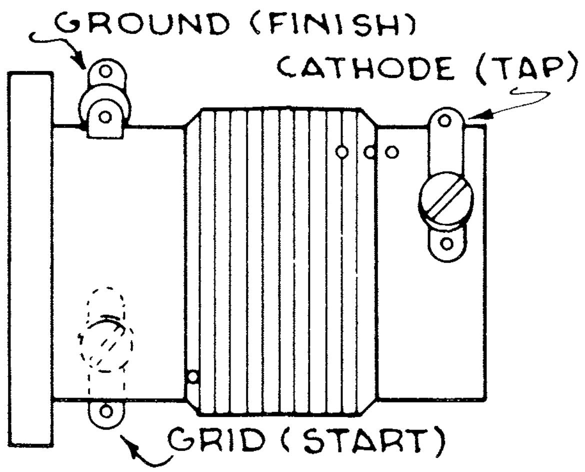
C-109C
C-109B
R-105

N90916

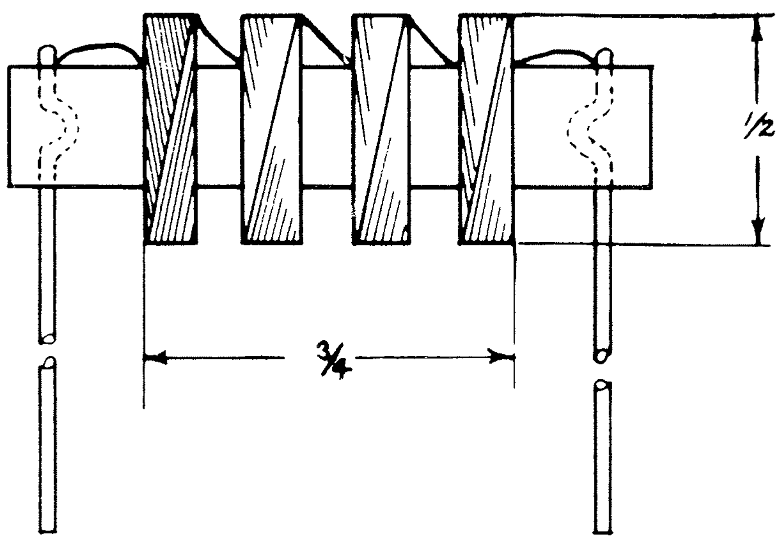


LOW FREQUENCY COIL, L-101
341 TURNS OF #7/42 LITZ SSC WIRE, CLOSE WOUND, 4 BANK WINDING WITH TAP AT FIRST HOLE FROM GRID END.
INDUCTANCE 3.9 TO 4.06 MH
Q 121 @ 350 KCS AND 90 @ 175 KCS.



HIGH FREQUENCY COIL, L-102
35 1/4 TURNS OF #28 DSC COPPER WIRE, CLOSE WOUND, TAP 21 2/3 TURNS FROM GRID END.
INDUCTANCE 37.0 TO 42.3 MMH.
Q125 @ 3500 KCS AND 113 @ 1750 KCS.

ABOVE COILS BOILED IN SUPERLA WAX AND COLD DIPPED IN HALOWAX



RF CHOKE COIL, L-103
UNIVERAL MACHINE SETTING
S.T. 1/8 CAM 116-60 GAINER 25
4 PI WINDING EACH PI 189 TURNS

INDUCTANCE 1.7 MH ± 3%
D.C. RESISTANCE 40 Ω MAXIMUM
CURRENT CARRYING CAPACITY .125 A.

C57868

FIG. 15.—COIL WINDING DATA