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MAYO

NRL INSTRUCTION BOOK NO. 25
Addendum 2

DESCRIPTION OF RADIO RECEIVING FACILITIES HUT MODERNIZATION NO. 2

February 1963

U. S. NAVAL RESEARCH LABORATORY
Washington, D.C.

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TABLE OF CONTENTS

-0-

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

-0-

LIST OF ILLUSTRATIONS (Continued)

-0-

LIST OF ILLUSTRATIONS (Continued)

-0-

TABLES

SECTION 1

INTRODUCTION

-0-

In the Spring of 1960 the U.S. Naval Research Laboratory enlarged its program of basic research into the many mysteries of outer space. This program involved the use of earth encircling satellites from which many forms of scientific data could be transmitted by radio signals to receiving stations located in various parts of the world where such data could be recorded for detailed study at a later date.

Because of the nature of many of the locations and the fact that it might be found desirable to change certain of the locations as different orbital paths of the satellites might be involved, it was believed desirable to install all the receiving and recording equipment for any one site in an enclosure that could readily be transported from site to site as might later be found necessary. A type of enclosure originally designed for and used by the U.S. Army, designated as HELICOP HUTS, was decided upon as being most suitable for the purpose. These are designed to be lifted bodily for transportation by a helicopter, crane or other lifting device, with all the electronic equipment intact. These huts can be obtained in different sizes as dictated by the amount of electronic gear required. Obviously it is desirable to employ as small a hut as is compatible with the facilities required at each site in order to economize on transportation and handling expense.

For the original experiments it was determined that huts approximately 8' x 6' in deck area would be sufficient for housing all the electronic gear required or anticipated. (All huts have approximately 6' 2" head room inside). These huts and the electronic facilities provided therein are described in detail in NRL Instruction Book No. 25, dated April 1960 and titled "INSTRUCTIONS FOR ASSEMBLY, INSTALLATION AND MAINTENANCE OF RADIO RECEIVING HUTS". They were installed and put into operation in the Spring of 1960.

The success obtained from the first series of experiments was so gratifying that more sophisticated experiments were indicated. These involved requirements for more receiving and recording channels, necessitating the installation of an additional radio receiver and a larger and more elaborate tape recorder. In addition, certain pieces of auxiliary equipment, such as a cathode-ray oscilloscope and better switching and monitoring facilities, were found desirable for inclusion.

Accordingly, in June 1961, the various huts were modified in the Field to permit the required improvements in performance. The details of the improved facilities resulting from the inclusion of the required additional equipment are contained in "Addendum 1" to NRL Instruction Book No. 25, the Addendum being dated June 1961 and titled "DESCRIPTION AND MAINTENANCE INSTRUCTIONS FOR MODERNIZED RADIO RECEIVING HUTS".

The experiments conducted since the Summer of 1961, involving the use of these "modernized" facilities have been so successful and illuminating as to dictate the planning of even more sophisticated research programs. It is anticipated that these will involve a greater number of receiving and recording channels.

It is obvious from a study of Addendum 1 of NRL Instruction Book No. 25 that the capacity limit of the present eight-foot huts now in the Field has been reached. Accordingly, in order to provide the additional facilities required for research programs planned for the near future, an additional hut must be provided at each of the receiving sites. However, because of the impossibility of definitely crystallizing the future requirements that might arise in any program involving basic research, as indicated by the unfortunate hindsight now apparent, the new additional huts that are being provided will be 12 feet in length. These new 12-foot huts are designed to be installed closely adjacent to the present 8-foot huts i.e., within 150 feet.

SECTION 2

PURPOSE OF THIS MANUAL

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2.1 HISTORICAL

When the original receiving and recording facilities were established at the various field sites in connection with the research program involved, one eight-foot hut was shipped to each of the respective sites. To preclude damage during shipment, all the various items of electronic and recording equipment were packed individually, the various boxes being firmly secured within the huts. Consequently it was necessary for the Forces at the various sites to make complete installations from the ground up. Because of this, the basic NRL Instruction Book No. 25 contained in great detail not only a description of each hut with the equipment installed but also complete installation instructions.

In the Summer of 1961 when it became necessary to improve and expand certain of the receiving and recording facilities, the necessary new equipment was shipped to the various sites and an Addendum (No. 1) to Instruction Book No. 25 was prepared containing detailed instructions for the installation of the additional equipment, as well as a description of the huts as modified. The huts, as modified, were thereafter referred to as "Modernized Huts", it being contemplated that any future up-dating would be designated by numerical suffixes, Modernization No. 1, Modernization No. 2, etc.

2.2 NOMENCLATURE

Because of the changes covered by this Instruction Book, it becomes necessary to effect a change in the nomenclature that must be used. Up to this time we have been involved with but one receiving and recording hut at each site so that it was not only correct but quite convenient to use the term "huts" as evidenced by the titles of Instruction Book No. 25 and its Addendum No. 1 both of which use the terminology "Radio Receiving Huts".

However, the latest modernization program involves the installation of two huts at each site for the housing of all the required receiving and recording equipment. These huts are of different physical size and differ slightly in the nature of the equipment they contain, as well as in their operational functions. Accordingly, the installation at each site will herein be referred to as the FACILITY, while the larger hut will be termed the PRIMARY hut and the smaller hut (those already installed) the SECONDARY hut.

2.3 SCOPE

Because of the magnitude of the changes to be made in the SECONDARY huts and the work involved in the installation of the equipment in the PRIMARY huts, field parties from the U.S. Naval Research Laboratory (NRL) will be sent to the respective sites to accomplish all the necessary installation, test and adjustment work and place each FACILITY in proper operating condition. All members of these parties have been involved in the design of the equipment at NRL and are thoroughly familiar with all features of the installations.

Accordingly this Manual will not contain any installation instructions. Similarly, the specific operating procedures involved in the use of the equipment will vary from time to time, depending on the particular research program or experiment involved. Additional manuals designated as Standard Operating Procedures (SOP) will therefore be issued from time to time as required.

Accordingly, this Manual will contain no Operating Instructions.

Similarly, many of the units of the equipment involved, such as radio receivers, tape recorders, time code generators, etc. are standard commercial or military products, completely covered as to description, adjustment and maintenance, by their individual Instruction Manuals. These manuals have been, or will be, made available to all sites.

Hence, no voluminous information on such items will be included in this Manual.

It will be the intention of this Manual to describe the instrumentation of each hut, as well as the FACILITIES as a whole, in such detail as to be a record for future use and to permit such testing and maintenance of the FACILITIES as might be required in the future.

SECTION 3

DESCRIPTION OF BASIC FACILITIES

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3.1 GENERAL

Each facility consists physically of the following basic items:

(a) One large PRIMARY hut.

(b) One smaller SECONDARY hut.

(c) One whip antenna mounted centrally on a 35-foot radial counterpoise system.

The two huts are mounted side by side and spaced some 100 to 150 feet apart, while the whip antenna is spaced some 50 to 75 feet from the SECONDARY hut. The intent is to maintain sufficient spacing to avoid reaction between the various antenna systems involved but at the same time to hold the maximum spacing down to a point that interconnecting line losses will not become excessive. There is, of course, an additional factor that requires consideration, namely the amount and nature of the land available at the respective sites. Compromises may therefore be necessary in certain instances.

Each hut carries on its overhead or roof, near the end furthest from its entrance door, two VHF YAGI antenna arrays. These are mounted coaxially, one above the other, on a common shaft that can be rotated from within the huts, through an azimuth of some 515°.

Figure 1 is an angular view of a PRIMARY hut showing the YAGI antennas mounted. It also shows the entrance doorway with the ventilation louvers at the bottom as well as the receptacles for the power and whip antenna cables to the right of the door. (It should be noted that the antenna assembly was a mock-up installed merely for photographic purposes so that none of the antenna bridles or coaxial leads are shown).

Fig. 1 - Primary Hut showing YAGI Antenna System installed

3.2 THE HUTS

The PRIMARY and SECONDARY huts are similar in design and construction, differing principally in their physical size and slightly with respect to the arrangement of the equipment they contain. Both huts are of aluminum construction, being double sheathed with two inches of "molded-in-place" thermal insulation between the two sheathes. Excluding lifting and securing bails, door handles, air conditioners and similar protuberances, the two huts have the following outside dimensions:

	Length	Width	Height
PRIMARY HUT	138 inches	80 inches	77 inches
SECONDARY HUT	100 inches	80 inches	77 inches

Internally they are both approximately four inches smaller in all dimensions because of the space occupied by the thermal insulation.

Both the PRIMARY and SECONDARY huts were manufactured by Craig Systems, Inc. of Lawrence, Mass. under the trade name of HELICOP HUTS and are designated as their Models S-141 and 150 respectively.

All of the huts (with the exception of those intended for Arctic installations) are equipped with both air conditioning and electric heating. Arctic huts have heating only but all are equipped with ventilating systems.

Ventilation is provided by two exhaust fans in each hut located in the bulkhead over the operating table while the door is provided with a louvered section containing an air filter to provide for air circulation.

Heating is provided by a thermostatically controlled 3,000 watt electric heater with a circulating fan.

The 8-foot (SECONDARY) huts in the field, with the exception of those in the Arctic, have already been provided with air conditioner units installed in the bulkhead over the operating table. These installations are described in the NRL Instruction Book #25.

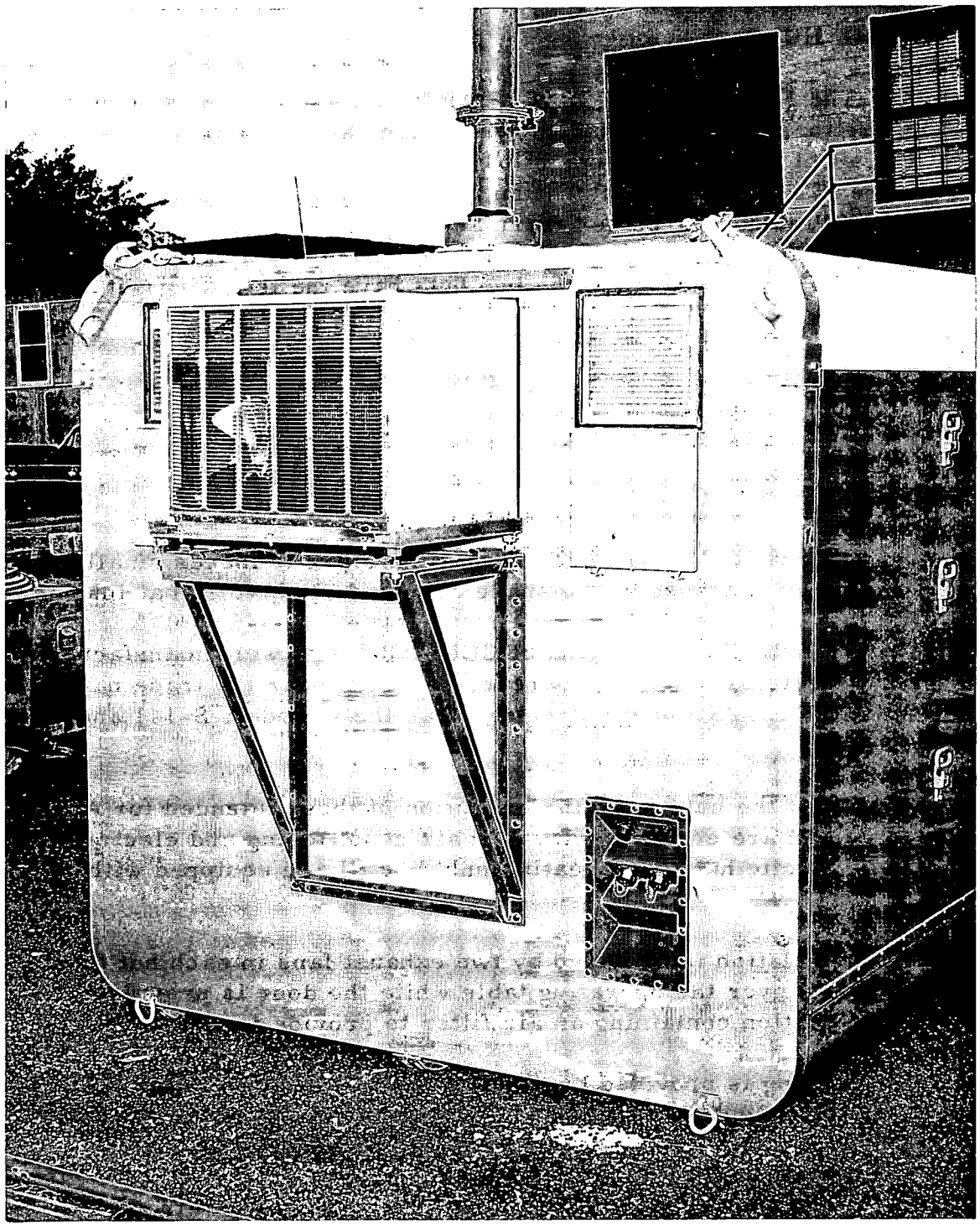

Fig. 2 - Primary Hut Showing Mounted Air Conditioner

The new 12-foot PRIMARY hut is provided with a 16,000 BTU General Electric air conditioner installed in the bulkhead between the two receiver racks. This is designated as GE type RH-801B. It is mounted on a bracketed platform secured to the outside of the hut. Figure 2 shows the external appearance of the mounted unit. The air conditioners operate on the same 230-volt circuits on which the heaters operate. It might be mentioned that the thermostats controlling these circuits are provided with cut-out switches to disable them when cooling is required.

For a more detailed description of the physical construction of the huts, see NRL Instruction Book No. 25.

3.3 THE ANTENNAS

3.31 The VHF Antennas - Both the new 12-foot huts and the old 8-foot huts already in the field carry electrically identical VHF antenna systems. Each system consists of two YAGI arrays carried coaxially on a common rotatable mast. The higher frequency unit, located closest to the roof of the huts, is a four-bay array. The four-bay arrays are identical with those already installed on the 8-foot huts in the field. The new two-bay arrays are similar in design and appearance to the two-bay arrays now in the field except that they are designed for optimum performance at a somewhat higher frequency. The antenna assemblies are rotatable through approximately 515 degrees by a large handwheel, through a planetary gear reduction system located on the operating table between the two receiver racks.

The mechanical details of the VHF antennas and their mountings are covered in great detail in NRL Instruction Book No. 25 and need not be repeated in this manual except to mention that the design of the main supporting shaft has been improved for the PRIMARY hut installations to facilitate the mounting of the antennas. The major improvement involves the hinging of the mast proper to the stub section above the roof of the hut so that the antenna spreaders and antennas can be secured with the mast folded down and the entire assembly then raised into place. In addition, steps have been permanently secured to the mast to permit easy climbing for access to the antenna terminations and leads. The SECONDARY huts in the field will not have the folding mast construction but will be provided, as an installation matter, with the mast steps.

3.32 The HF Antennas - One 25-foot tubular whip antenna is provided for each FACILITY. These are mounted in the field, some 30 feet removed from the SECONDARY hut and are provided with a radial counterpoise consisting of 16 copper wires above ground, each approximately 35 feet long, thereby creating a circular ground mat 70 feet in diameter. A coupling network is located at the base of the antenna which connects to the equipment through a coaxial cable entering the hut through a fitting located near the power entrance receptacle.

These antennas have been in the field since the original 8-foot huts were installed and are described in considerable detail in NRL Instruction Book No. 25 so that further description here is considered unnecessary.

3.4 INTERCOMMUNICATION SYSTEM

3.41 Purpose - Inasmuch as the two huts(that go to make up a receiving FACILITY) will be located some 100 to 150 feet apart and since the operators in the respective huts, during active operation, must closely coordinate their activities, reliable and rapid communication between the two huts is imperative. Therefore, voice communication is dictated.

3.42 Equipment Furnished - The INTERCOM system furnished is a commercial product manufactured by the Talk-A-Phone Company of Chicago, Illinois and designated as their "Talk-A-Phone Chief" system. The two units in the respective huts are identical, each containing the necessary power and amplifying equipment and operating from the 115-volt AC line. They are completely transistorized. Being commercial products they are designed for intercommunication between any number of stations up to six, six station selector buttons being provided on their face. However, inasmuch as only two stations are installed in each FACILITY, most of these station selector buttons are not used.

3.43 Description of System - Each unit consists of a rather flat but deep assembly and contains, in addition to the power, amplifying and switching equipment, a loud speaker and a standard hand set that rests, when not in use, on a cradle on the left hand side of the unit. Two methods of communication, selectable by a three-position switch, are provided for. In one method the loud speaker is employed, doubling as a microphone, and communication may be effected by merely talking toward the units. However, in the event the noise thus created is annoying, this method may be disabled and the hand sets used as in ordinary telephone communication. The stations in the respective huts are connected together through a special six-conductor cable.

3.44 Location of the Units - The units in the respective huts are installed as the top units in the left hand table racks with the hand sets to the left. They may be identified in several of the figures showing the operating table equipment by the six white buttons and the large white selector switch.

SECTION 4

DESIGN FEATURES

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4.1 GENERAL

In allocating and designing new equipment and providing an additional hut for the respective receiving sites, six factors were given paramount consideration:

a. Replacement of certain pieces of equipment, as at present installed, with equipments of new and more efficient and/or reliable design.

b. Providing an increased number of receiving and recording channels.

c. Providing for the future installation of additional receiving channels if required.

d. Providing for the maximum flexibility in the design of all units to care for any changes in requirements that might develop.

e. Providing for active operating spares for all items to definitely preclude complete breakdowns.

f. Providing for the maximum reliability of the time marking facilities.

4.2 ITEMS REPLACED

The following items at present installed in the single hut at each site have been removed or replaced by items of new and improved design:

a. The TAPETONE Converter Assemblies.

b. The EECO Time Code Generator with its Power Unit (to be mounted in the PRIMARY hut as an auxiliary time code source).

ITEMS REPLACED (Continued)

c. The Cathode Ray Oscilloscope

d. The MAGNECORD Tape Recorder and Amplifier.

e. The Local Audio Panels.

f. The Signal Panels.

g. The Mixer Unit.

In addition, certain of the mounting racks have been redesigned for greater convenience of mounting, operation and servicing. Most notably is the rack for mounting the TAPETONE converters which has been removed from beneath the operating table and replaced by a vertical cabinet rack reaching from deck to overhead and installed against the left hand bulkhead forward of the side-wall work-table.

The various new items of equipment will be described in greater detail in Section 9 of this Manual.

4.3 RECEIVING AND RECORDING CHANNELS PROVIDED

In the installations at present in the field, consisting of a single eight-foot hut, the receiving facilities provided for three VHF channels and one HF channel of reception. In the No. 2 modernization described herein, involving, among other features, the installation of an additional 12-foot hut, the receiving facilities will be increased to a minimum of six VHF channels and two HF channels, one or both of which may be used as additional VHF channels if required.

As to recording, the original installations, under Modernization No. 1 provided for seven recording channels, whereas under Modernization No. 2, duplicate seven-channel recorders will be provided, one in each hut, thereby making a total of 14 recording channels available.

4.4 PROVISIONS FOR ADDITIONAL RECEIVING CHANNELS

Space has been provided in the left hand table racks in each hut for the installation of a number of small fixed-frequency receivers (which might become available in the near future) by relocation of the

Talk-A-Phone unit, thereby assuring the possibility of an expansion of receiving channels. Similarly, sufficient space has been provided in the new Converter racks for the installation of up to four additional converters in each hut or a total of 16 in all.

4.5 FLEXIBILITY

All switching and patch panels have been provided with spare positions so that additional units may be added at any future date without requiring redesign and replacement of such units. These features will be shown in greater detail in the description and photographs of these units.

4.6 OPERATING SPARES

As will be described in greater detail in Section 8, the electronic equipment installed in both the PRIMARY and SECONDARY huts are exact duplicates (with the exception of the Time Code Generator equipments). Furthermore, the two huts are provided with cross connections between the receiver outputs and the recorder inputs. Hence any or all the data received by one hut may be recorded on its own recorder or on the recorder of the adjacent hut. The converters are all provided in duplicate in each hut. This, in effect, predicates that the entire facility is provided with 50% active spares.

4.7 TIME MARKING FACILITIES

Experience with the time marking facilities that have been in the field for the last several years has indicated that the Time Code Generator employed was of questionable reliability, not only with respect to tube and component failures but because it was voltage critical, dropping out under conditions of low line voltage. It is obvious that any drop-outs, even as short in duration as one second, completely nullify the required time marker accuracy. This line voltage criticalness is particularly serious at some sites where the line voltage regulation is particularly poor. Entirely new Time Code Generators (of different manufacture) are being supplied and installed as part of the new equipment described herein. These are

completely transistorized, which should greatly reduce, if not eliminate, outages due to tube and component failures, inasmuch as no vacuum tubes are employed and all voltages are quite low. But to overcome the most serious and common cause of drop-outs, those resulting from poor line voltage regulation or complete power failures, the Generators are designed to operate on nickel-cadmium batteries floated across a line-operated charging unit. Under conditions of normal line voltage, no power is taken from the batteries, but as the line voltage becomes low or completely fails, some or all the power is supplied by the batteries, which have sufficient capacity, when fully charged, to carry the generator (less the display units) for a period of six hours.

The new Time Code Generator is the one unit that is not supplied in duplicate in the present modification, because, from its design, little or no difficulty is anticipated with it and it is quite an expensive unit. However, to provide for further long-time reliability, the original EECO generators are installed in the PRIMARY huts beneath the work tables. These may be pressed into service in the event of a permanent failure of the new generators.

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SECTION 5

EQUIPMENT INSTALLED IN HUTS

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Upon completion of Modernization No. 2, as described in this manual, the respective huts of each FACILITY will contain the following items of equipment:

ITEM	PRIMARY	SECONDARY
Low VHF YAGI Antenna Array	1	1
High VHF YAGI Antenna Array	1	1
HF Whip Antenna	Common to both huts	
TAPETONE Converters - Low VHF	2	2
TAPETONE Converters - High VHF	2	2
R-390A/URR HF Radio Receivers	4	4*
Converter Control Unit	1	1
Converter Rack Fan Unit	1	1
Local Audio Panels	2	2
Line Driver-Detector Units	1	1
5" Cathode-Ray Oscilloscope-Tektronix Type RM-561	1	1
Patch Panel	1	1
Signal Panel	1	1
DATATAPE Recorders - CEC Type GR-2800	1**	1**
Time Code Generator - Astrodata Type 6140-500	1	0
Remote Time Display Unit - Astrodata Type 6520-500	0	1
Battery Power Unit for Astrodata Time Code Generator	1	0
Nickel-Cadmium Batteries in Battery Box - for Astrodata TCG	1	0
Time Code Generator - EECO Type ZA-19135	1	0
Time Code Generator Power Unit-EECO Type ZA-19263	1	0
Intercommunication Unit - "Talk-a-Phone Chief"	1	1

* May consist of 3 Type R-390A/URR and 1 Type R-391/URR

** Type GR-2500 Recorders may be installed in lieu of GR-2800 in both huts.

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SECTION 6

MOUNTING OF UNITS

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6.1 GENERAL

All the various units that go toward making up the complete complement of both huts are designed for mounting in standard 19" racks, either of the open or cabinet variety. Wherever possible all racks have been designed oversize as to height, with sections not immediately required for mounting units of the equipment covered by blank panels so as to permit future expansion of the facilities.

Specifically, the equipment for each hut is carried by or contained in four racks, namely:

Two racks mounted on the operating table, one on each side of the hand wheel for rotating the YAGI antenna assembly, hereinafter referred to as the LEFT HAND and RIGHT HAND table racks respectively.

A deck mounted rack for mounting the converters and certain other units, hereinafter referred to as the CONVERTER rack.

A deck mounted cabinet rack containing all the recording equipment, hereinafter referred to merely as the RECORDER.

6.2 THE TABLE RACKS

Both table racks in the PRIMARY huts and the LEFT HAND table racks in the SECONDARY huts are identical in design and construction and are new for this Modernization. The RIGHT HAND table racks used in the 8-foot SECONDARY huts in the past have been retained and used in this Modernization although the units contained therein differ from those previously installed. Accordingly the RIGHT HAND racks are slightly different in height from the LEFT HAND units.

All the racks are somewhat orthodox in design, being of the open variety and are constructed of square aluminum tubing and aluminum angles. Longitudinal guides are bolted in place on both sides to serve as runners and to support the weight of the various units.

The position of these runners can be changed to permit adaptation of the racks to receive units with larger or smaller panel heights. The racks have been made quite sturdy because of the weight they are required to carry and are intended to rest squarely on the operating table but are not secured, in order to permit them to be moved or turned to gain access to the terminals on the rear of the chasses involved.

6.3 THE CONVERTER RACKS

The racks, which are of sturdy aluminum construction, are designed for mounting on the decks of the huts close to the left bulkhead and extend to the overhead. They are of the semi-cabinet type, the sides being enclosed by punched ventilating grilles, with the backs being left open for access to the rear of the various units for connection and tube-changing purposes, etc. When installed, the bulkhead, close to which they mount, will essentially provide the necessary rear protection.

These racks have an over-all height of 72 1/2 inches, a width of 21 3/4 inches and a depth of 10 inches.

They are somewhat unconventional in design because of the nature of the Converters they will house and the proximity of the equipment panels to an operator. The electron tubes and crystal ovens of the Converters extend approximately 2" beyond their front panels and might be subject to damage if the panels were mounted flush with the face of the rack. For this reason the mounting strips for the Converters are located approximately three inches behind the face of the racks and the section provided for the Converters is covered by a door, (hinged to the left) covered by clear Plexiglas. The remainder of the units secure to the rack in the conventional manner with their panels flush with the face of the rack.

Space has been provided in the Converter compartment for a total of eight Converters (the power units being part of the Converters) although only four are required and are furnished for this installation. This added rack capacity is to provide for possible future expansion of facilities. Blank panels are supplied to cover the rack spaces not required with this Modernization.

6.4 THE RECORDERS

The GR-2800 recorders are supplied with all their component units mounted in a large sturdy cabinet. These cabinets are 68" high, 23" wide and 25" deep. The GR-2500 recorder cabinets, installed in several of the huts, are slightly larger.

All units mount with their panels flush with the front of the cabinets. The rear of the cabinets is provided with a single hinged door opening to the right.

Approximately the upper half of the cabinets is taken up by the Tape Transport unit consisting of a heavy aluminum plate on which all the tape drive units are mounted. This transport unit is hinged to the front of the cabinet, opening to the left and is protected by an additionally hinged Plexiglas cover.

The recorders are designed to stand directly on the deck and are so heavy and sturdy that they do not require any additional bracing or securing.

SECTION 7

DESCRIPTION OF ASSEMBLIES

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7.1 LEFT HAND TABLE RACK ASSEMBLIES

Figure 3 is a close-up view of the LEFT HAND table rack in the PRIMARY huts with the equipment mounted. Starting at the bottom, the following units are mounted in this rack:

LOCAL AUDIO PANEL
CHANNEL A RECEIVER (R-390A/URR)
CHANNEL D RECEIVER (R-390A/URR) (In some cases this may be a R-391/URR Receiver)
TIME CODE GENERATOR (Astrodata)
INTERCOMMUNICATION UNIT (Talk-a-Phone)

Figure 4 is a close-up view of the LEFT HAND table rack in the SECONDARY huts with the equipment mounted. It will be noted that the equipment provided is identical with that in the PRIMARY hut except that a REMOTE TIME DISPLAY unit is provided in lieu of the TIME CODE GENERATOR.

7.2 RIGHT HAND TABLE RACK ASSEMBLIES

Figure 5 is a close-up view of the RIGHT HAND table rack in the PRIMARY huts with the equipment mounted. Starting at the bottom, the following units are mounted in this rack:

LOCAL AUDIO PANEL
CHANNEL B RECEIVER (R-390A/URR)
CHANNEL C RECEIVER (R-390A/URR)
CATHODE RAY OSCILLOSCOPE
SIGNAL PANEL

Figure 6 is a close-up view of the RIGHT HAND table rack in the SECONDARY huts with the equipment mounted. At first glance this might appear to be a duplicate of Figure 5 but closer

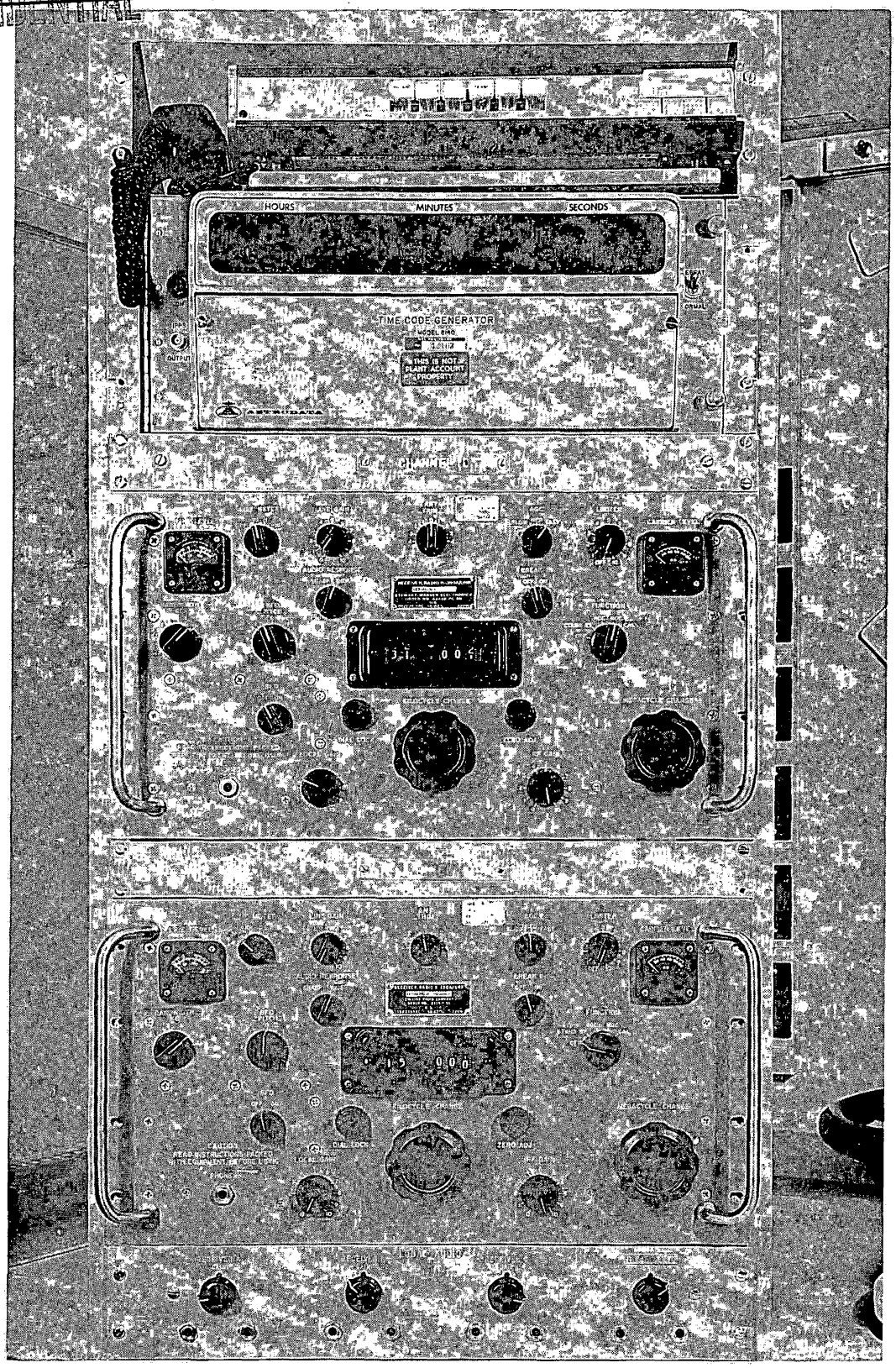

Fig. 3 - Left Hand Table Rack Assembly – Primary Hut

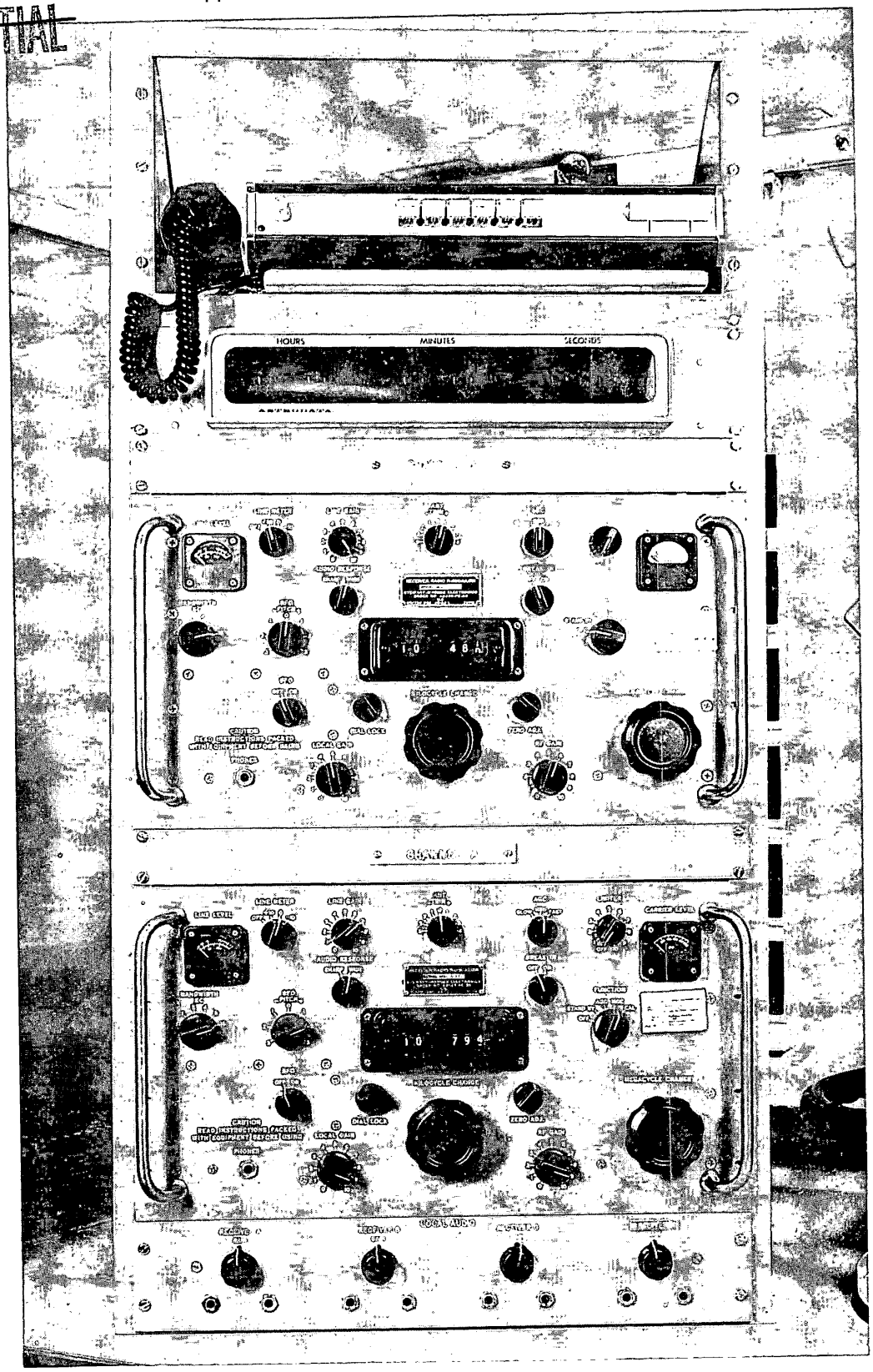

Fig. 4 - Left Hand Table Rack Assembly – Secondary Hut

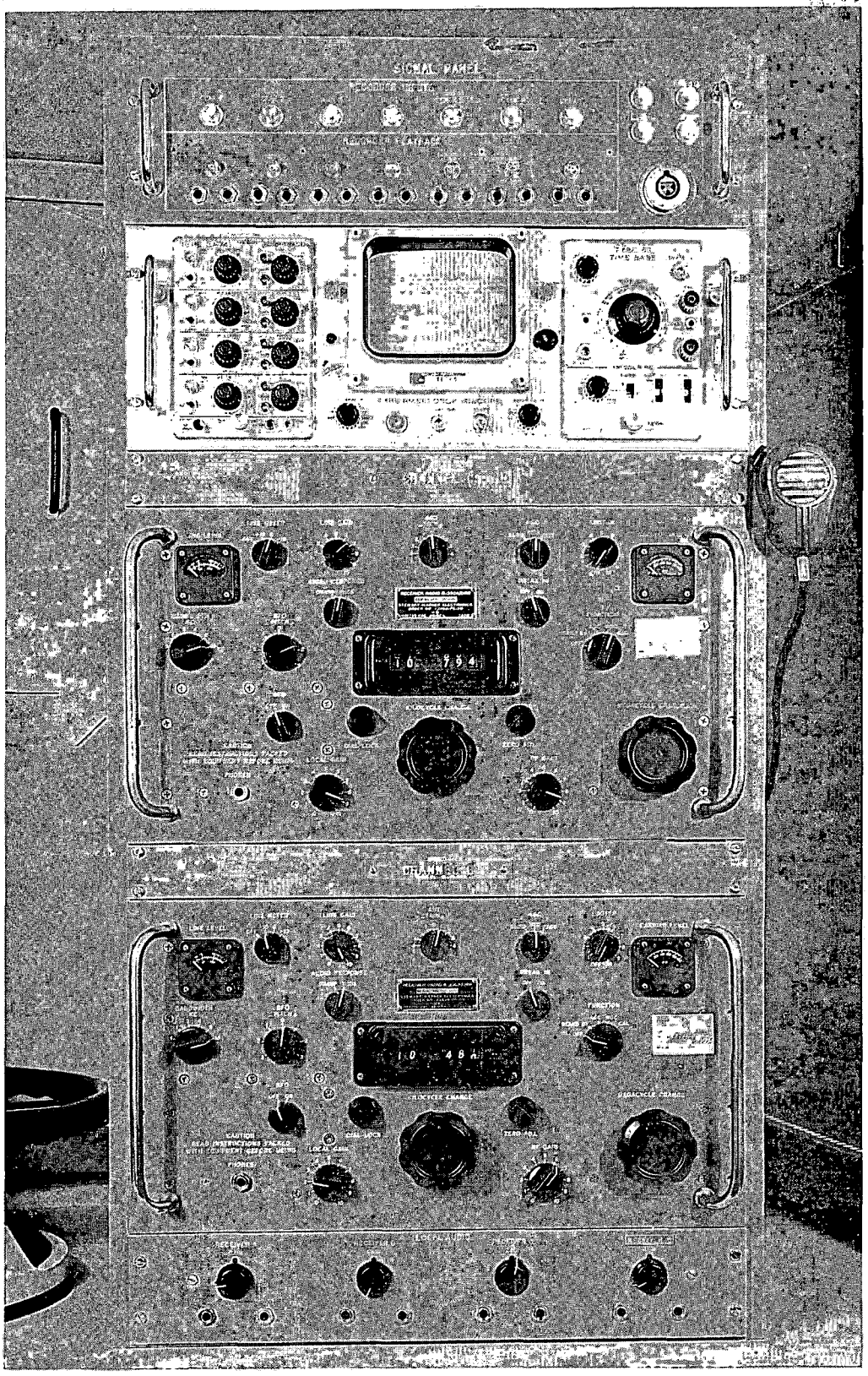

Fig. 5 - Right Hand Table Rack Assembly – Primary Hut

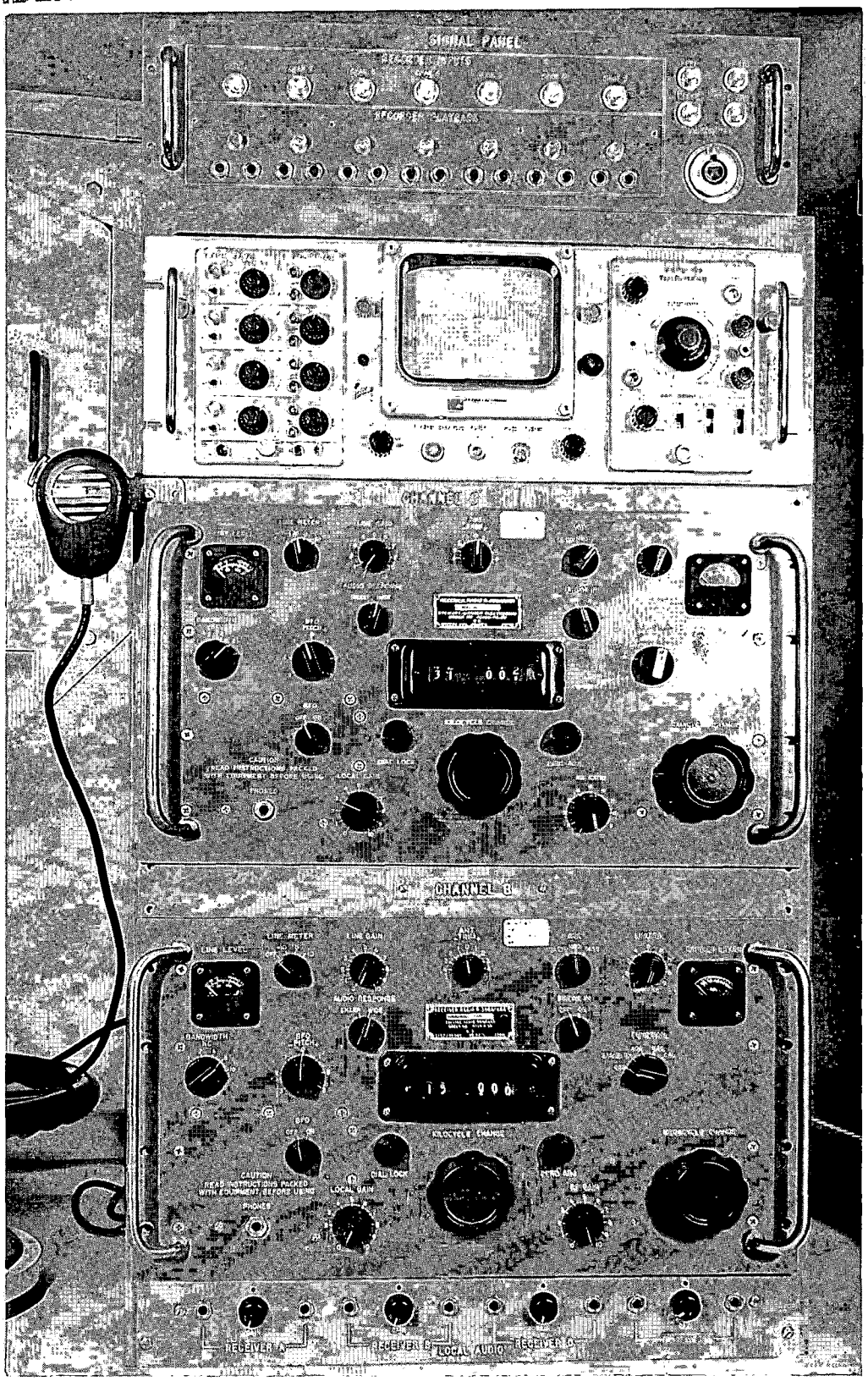

Fig. 6 - Right Hand Table Rack Assembly – Secondary Hut

inspection will show that the LOCAL AUDIO panel is different from that in the PRIMARY huts, being slightly smaller with the controls and jacks differently arranged. This resulted from the fact that, as mentioned in paragraph 6.2, the RIGHT HAND racks employed in the SECONDARY huts are the original racks and slightly smaller in the vertical dimension, thereby allowing less room for the LOCAL AUDIO panels. (In the case of the one secondary hut which is 12 feet long, the right hand rack is as shown in Figure 5.)

7.3 CONVERTER RACK ASSEMBLY

Figure 7 is a close-up view of the CONVERTER rack in the PRIMARY huts with the equipment mounted. Starting from the bottom, the following units are mounted in these racks:

BATTERY POWER UNIT for the Astrodata Time Code Generator
FAN UNIT
TAPETONE CONVERTERS
CONVERTER CONTROL UNIT
LINE DRIVER-DETECTOR UNIT
PATCH PANEL

The CONVERTER racks in the SECONDARY huts are identical with those in the PRIMARY huts as shown in Figure 7 except that the BATTERY POWER unit is omitted, there being no TIME CODE GENERATOR in these huts, a blank panel being substituted in its place.

Similarly it will be noted that in the racks in both huts a spare compartment has been provided at the top above the PATCH PANEL. This blanked off compartment has been provided to permit future expansion of facilities.

The availability of panel space in this compartment to permit expansion from four to eight converters per hut was mentioned in paragraph 6.3.

It might also be mentioned that in operation it is unnecessary to open the protective door of the CONVERTER compartment inasmuch as ON-OFF switches are provided on the CONVERTER CONTROL UNIT to control the power to the individual CONVERTERS.

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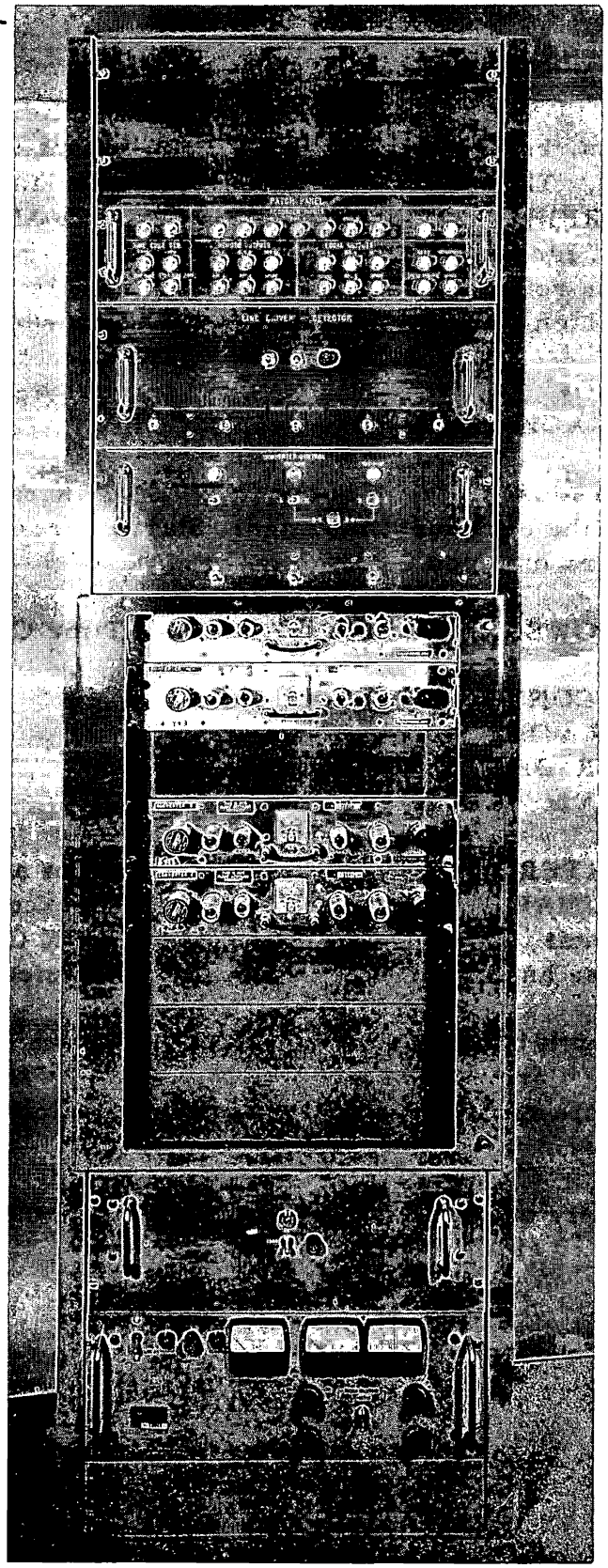

Fig. 7 - Converter Rack Assembly - Primary Hut

7.4 TAPE RECORDER ASSEMBLY

Figure 8 is a close-up view of the front of the GR-2800 tape recorder with the upper tape reel removed. The lowest section, behind the grille work houses all the power equipment with the power controls immediately above it. The five blank panels are for future expansion, except that behind one is located all the transistorized amplifying equipment.

The Operating Control panel is readily identified by the five large and four small white control buttons.

The upper half of the assembly is occupied by the Tape Transport unit. This unit is hinged to open sideways to facilitate maintenance and is normally covered by a transparent Plexiglas door.

Figure 9 is a close-up of the rear of the GR-2800 tape recorder with its protective metal door removed.

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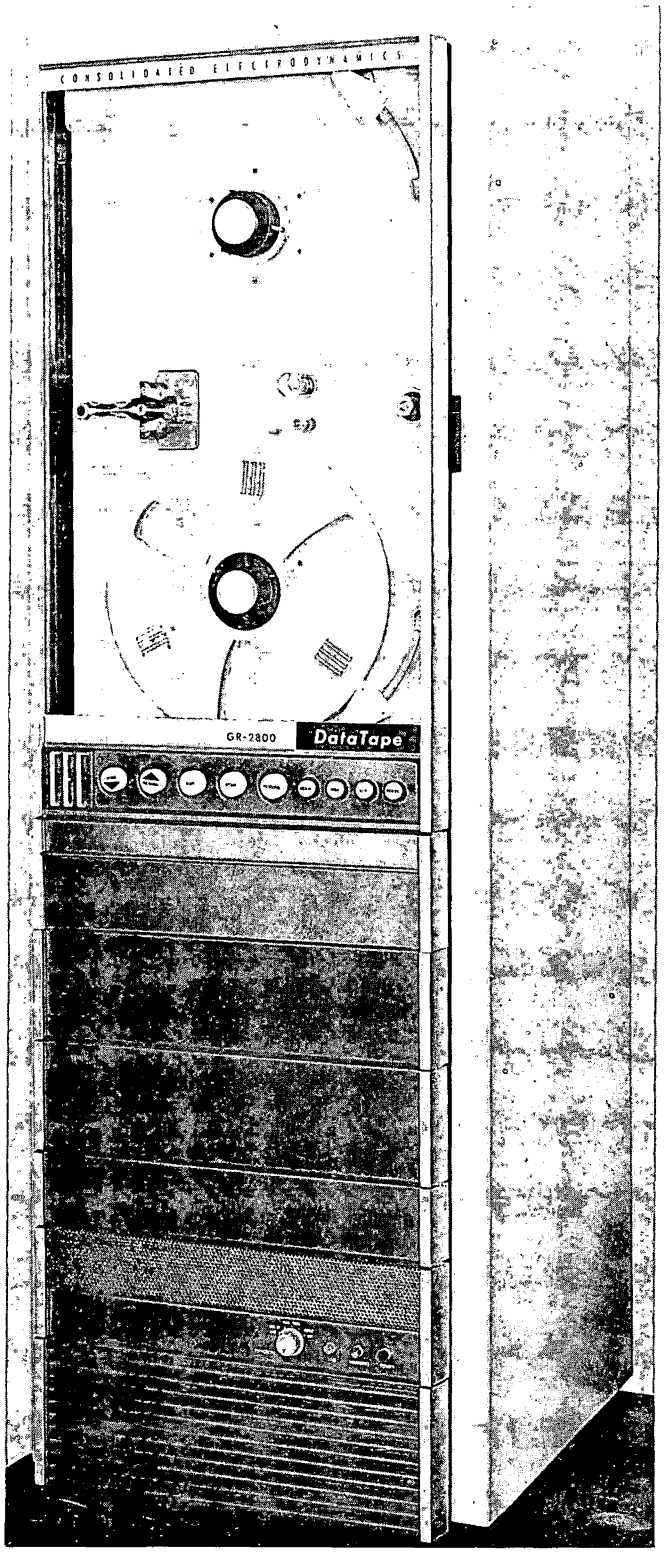

Fig. 8 - GR-2800 Tape Recorder - Front View

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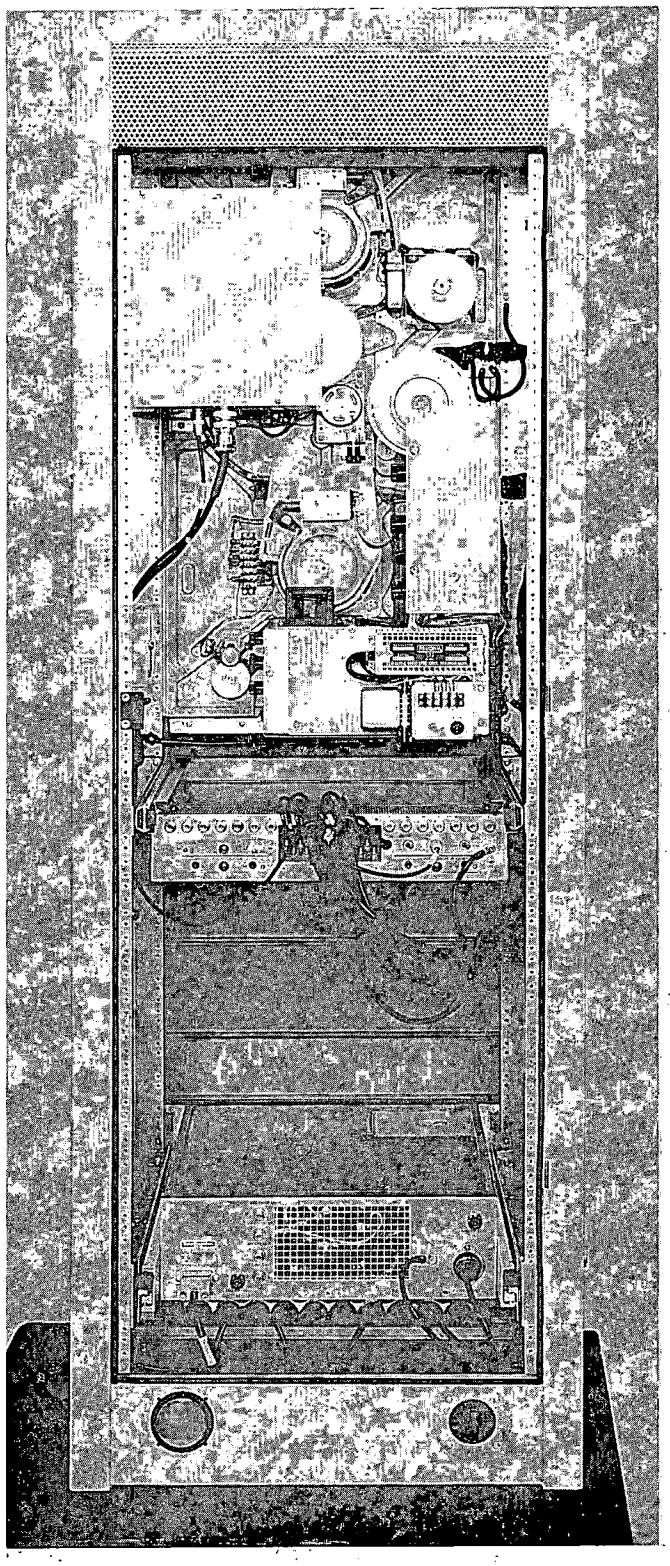


Fig. 9 - GR-2800 Tape Recorder – Rear View – Door Removed

SECTION 8

MOUNTING OF ASSEMBLIES

-0-

8.1 THE PRIMARY HUT

Figure 10 shows the arrangement of the equipment as installed in a PRIMARY hut as viewed from the doorway.

It should be mentioned that both time and photographic limitations were encountered in attempting to obtain photographs of both the PRIMARY and SECONDARY huts so that the results are not as complete and accurate in all details as might be desired. Because of time limitations it was necessary to employ mock-up techniques so that certain minor and unimportant details of the actual huts are not shown. Similarly, because of the relatively small size of the huts and the doorways even the widest angle lens could not photograph all the details of the huts, particularly toward the door. For this reason it was necessary to omit the GR-2800 tape recorders in Figures 10 and 11 to avoid blocking a view of the operating table.

Under the above mentioned limitations, Figure 10 shows quite clearly the appearance of the interior of a PRIMARY hut. A few explanatory comments might be helpful in completing this picture.

a. The GR-2800 RECORDER is installed close to the right bulkhead next to the chair with its operating panel facing the operating table.

b. The CONVERTER rack (obliquely visible to the left on the figure) fits between the work table and the operating table.

c. The (auxiliary) EECO Time Code Generator and its power unit are installed beneath the work table and are not shown in the figure.

d. The air conditioner (installed on the outside of the hut) and its grille are located between the two table racks behind the antenna shaft.

e. The small terminal board appearing beneath the table under the left hand rack is for receiving the coaxial cables interconnecting the huts.

f. The small object hanging below and to the right of the oscilloscope is a hand microphone for making voice comments on the tape recorder.

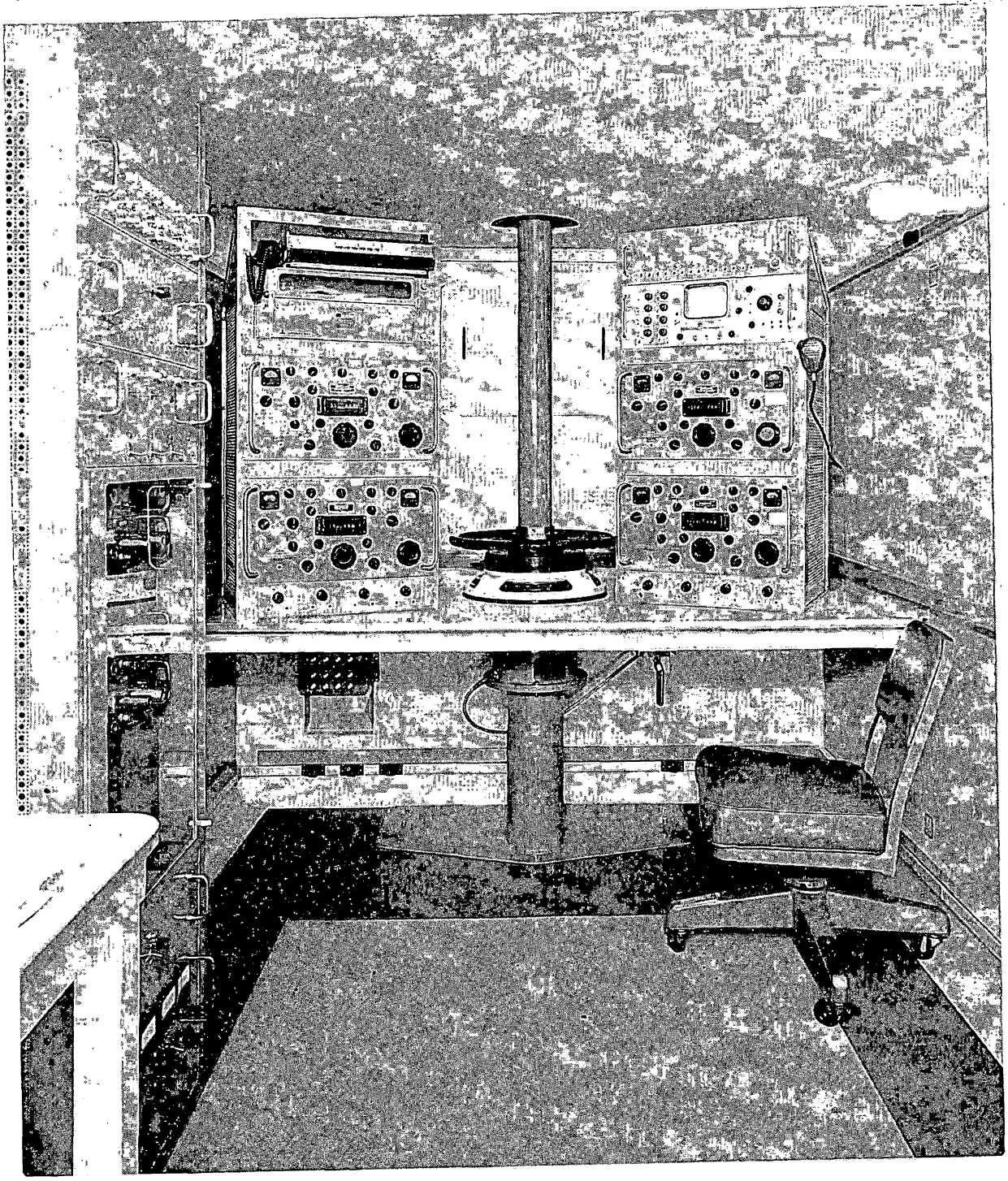


Fig. 10 - Interior of Primary Hut

8.2 THE SECONDARY HUT

Figure 11 is a mock-up view showing the general appearance of a SECONDARY hut. It will be noted that the arrangement of the assemblies in this hut is identical to that in a PRIMARY hut excepting that the (auxiliary) ECO TIME CODE GENERATOR is omitted. In fact, at first glance, Figures 10 and 11 look like duplicates, but it will be noted that in the SECONDARY hut the Astrodata TIME CODE GENERATOR is replaced with a REMOTE TIME DISPLAY UNIT in the left hand table rack and the hand microphone is on the left side of the right hand rack.

Finally, it is necessary to make mention of an error in Figure 11. This, having been made from a mock-up, employed the same CONVERTER rack as in Figure 10 and unfortunately the BATTERY POWER UNIT was left in place in its lower compartment. In a SECONDARY hut this is obviously not required (there being no TIME CODE GENERATOR) and in an actual installation this compartment is blanked off.

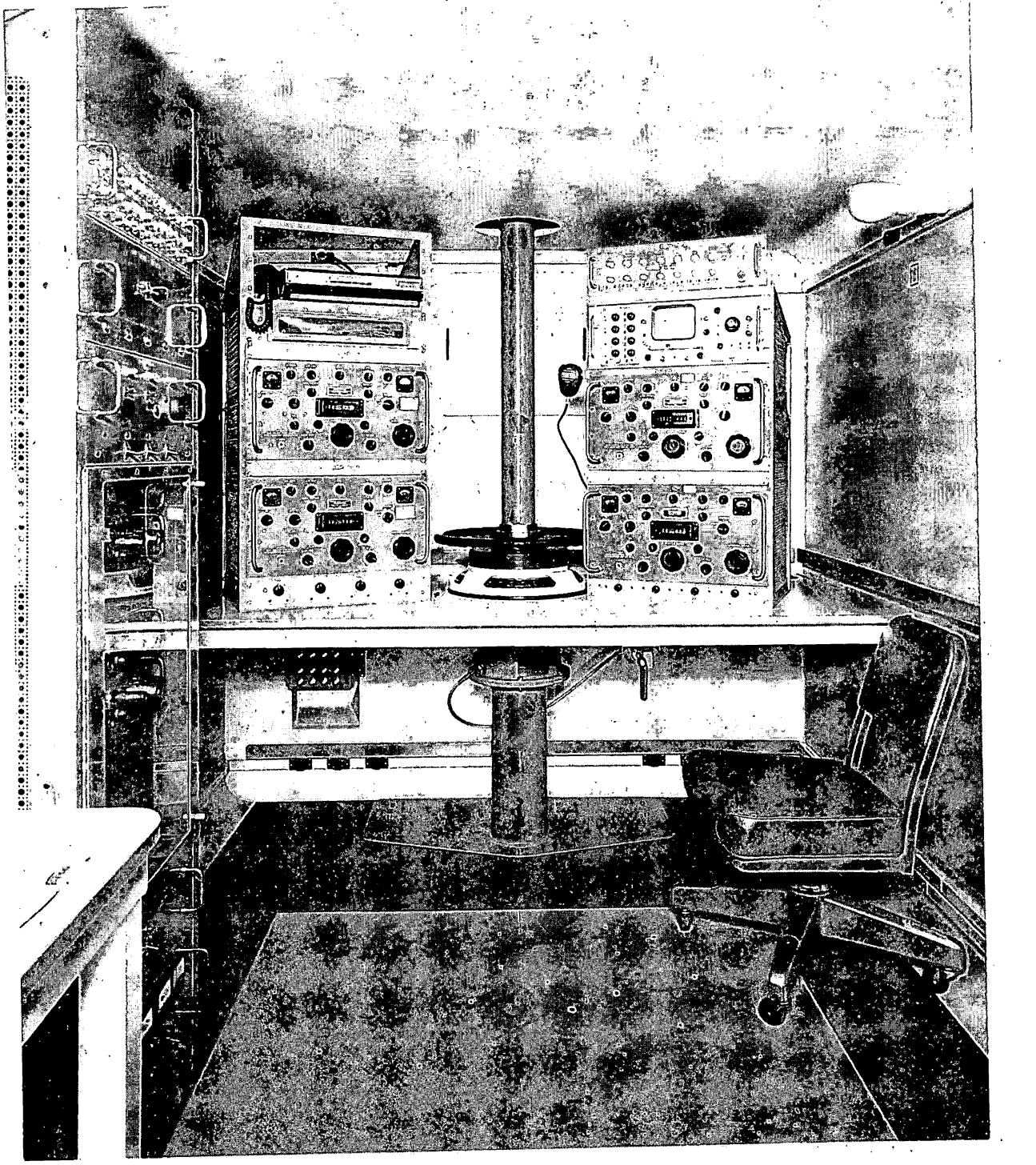


Fig. 11 - Interior of Secondary Hut

SECTION 9

DESCRIPTION OF INDIVIDUAL UNITS

-0-

9.1 THE CONVERTER CONTROL UNIT

Associated with each receiving channel are two amplifier/converter units employed to convert the respective VHF signals to high frequencies for instroduction to the radio receivers. Two similar converters are employed for each channel in order to provide an active spare, always warmed up and ready for immediate service in the event of a failure of the converter in use. Means must be provided to accomplish this switching, which is the primary function of this unit. In addition, however, it is necessary to provide means whereby the output of a VHF Signal Generator may be introduced into the converter input circuits to permit the testing of the over-all receiving channels. This is accomplished by interposing a Directional Coupler having 70 db attenuation looking toward the Signal Generator input, between the antenna and converter input for each channel. These couplers are contained in the units in question. The CONVERTER CONTROL UNITS also serve an additional function, that of a power distribution and control medium for the various converters.

Figure 12 is a panel view of one of the CONVERTER CONTROL UNITS. The three BNC receptacles at the top of the panel (marked "Test Point") are for receiving the Signal Generator output for introduction to the respective directional couplers.

Each of the two toggle switches in the center of the panel (labeled 1, 2, 3 and 4) controls two electrically operated SPDT coax switches that transfer both the antenna inputs (through the directional couplers) to either of the converters of a set and at the same time transfer their output to the receivers.

The three toggle switches at the bottom of the panel (one is a spare) control the line power to each set of two converters.

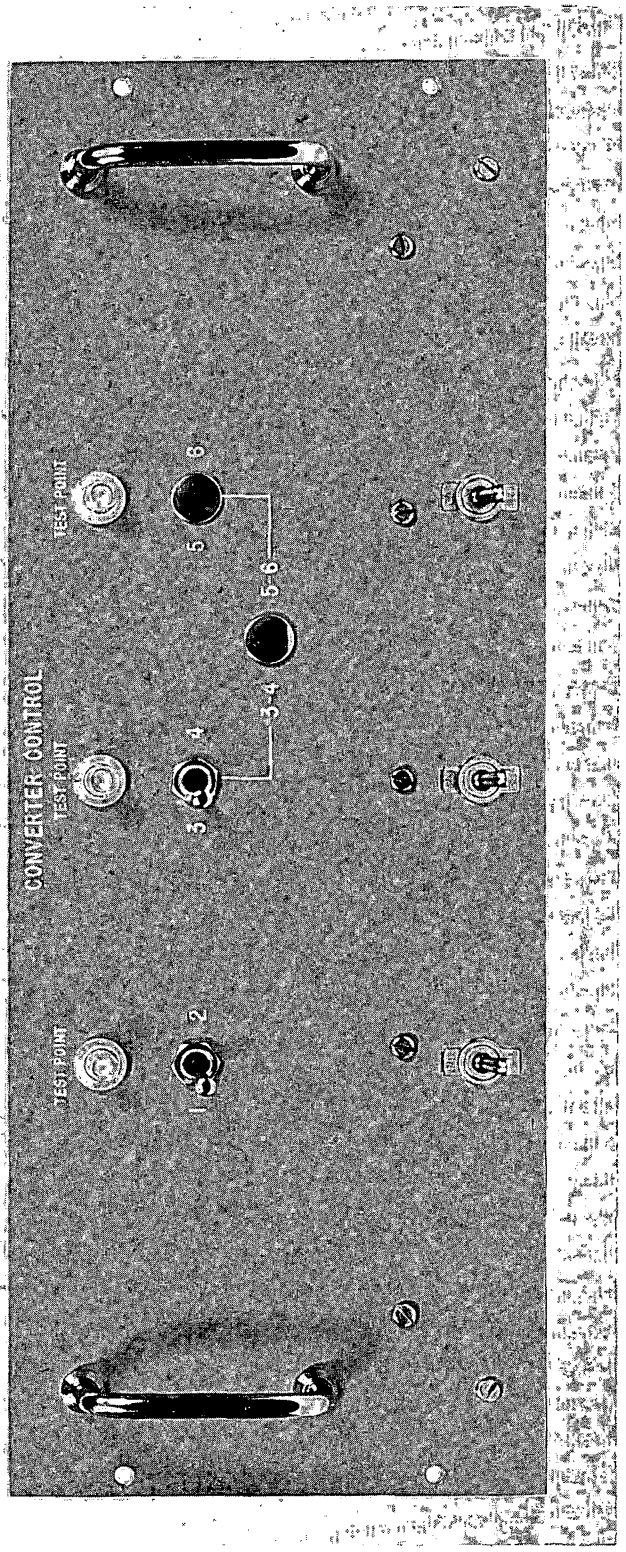


Fig. 12 - Converter Control Unit - Panel View

Figure 13 is an interior view of the units with the coax cabling removed for better visibility. It will be noted that while a spare BNC fitting and power switch have been provided, only two sets of rf switches and directional couplers have actually been installed.

On the rear of the chassis may be seen six female power receptacles for plugging in the power cords from the converters and one male receptacle for receiving line power from the converter rack.

No pilot lights are provided as these are a part of the converters themselves.

9.2 THE CONVERTERS

9.21 Function of the Units - These units are actually Amplifier-Converters but in the interest of simplicity will be referred to herein merely as converters. Their function is primarily to convert the received VHF signals to high frequency signals for injection into the R-390A/URR (or R-391/URR) radio receivers at a fixed frequency in the 14-15 megacycle band. The converters serve the additional function of improving the Noise Figure of each receiving system by virtue of their low input noise level and rf gain, while the tuning of the R-390A/URR (or R-391/URR) receivers serves as an i-f frequency vernier.

9.22 Types and Styles of Units - The converters, while all having essentially the same external appearance, are of two different types and styles. The two types involve the VHF at which they are designed to operate while the two different styles involve certain mechanical differences, mainly in the design of the internal shielding. They may be differentiated as to type by noting the numbers near the right end of the panel. For ready identification, the eight converters at a site have been labeled (with adhesive embossing tape placed near the power switch) with a distinguishing mark such as PRI converter 1. Those carrying numbers 1 and 2 are the highest VHF type while those carrying numbers 3 and 4 are of the lower frequency type. The styles

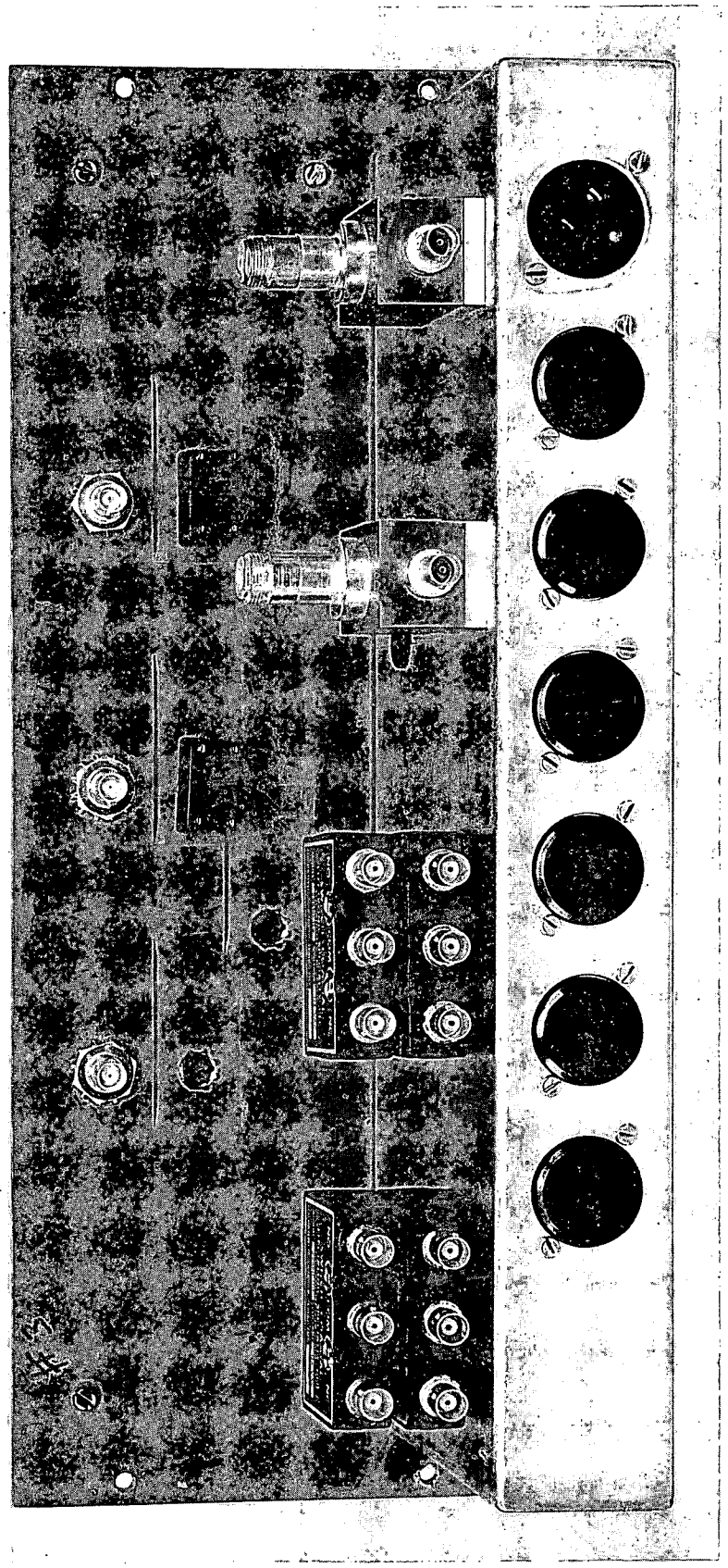


Fig. 13 - Converter Control Unit - Interior View

may be differentiated in two ways, being arbitrarily designated herein as styles 1 and 2. Style 1 units have two Pin Jacks on the power unit panel, a red one marked "GND" and a yellow one marked 150 volts. They also have a row of six countersunk Phillipshead screws along the bottom of the front panel. On the style 2 units these features are omitted.

The converters were manufactured by the Tapetone Electronics Laboratories, Inc. of West Newton, Mass. and are all designated as their Model 100 series.

9.23 Physical Construction - The Model 100 converters (of both types) consist essentially of two distinct units, secured together into a common assembly. This assembly is designed for mounting in a standard 19" rack and is 3 1/2" high x 3 3/4" deep, panel to panel. The part of the assembly that secures to the rack is the converter proper, while secured to it is the power unit. Accordingly the electron tubes and other converter panel appurtenances face toward the front of the rack while the power unit tubes, power transformer, etc. face toward the rear of the rack and are reached from behind. Figure 14 shows the appearance of one of the assemblies as viewed from the front and back.

9.24 Fundamental Electrical Design

9.241 The Converter Units - The converters consist essentially of the following basic components:

(a) A cascaded three-stage rf amplifier operating at the incoming very high frequency. The first stage employs a low-noise-level vacuum tube operated as a grounded grid amplifier with the cathode input matched for a 50-ohm coaxial line. The second and third stages employ a dual triode vacuum tube, the second stage being operated as a conventional grounded cathode amplifier while the third stage is operated with grounded grid.

(b) A combined mixer and i-f output stage. This stage operates with grounded cathode with grid current biasing.

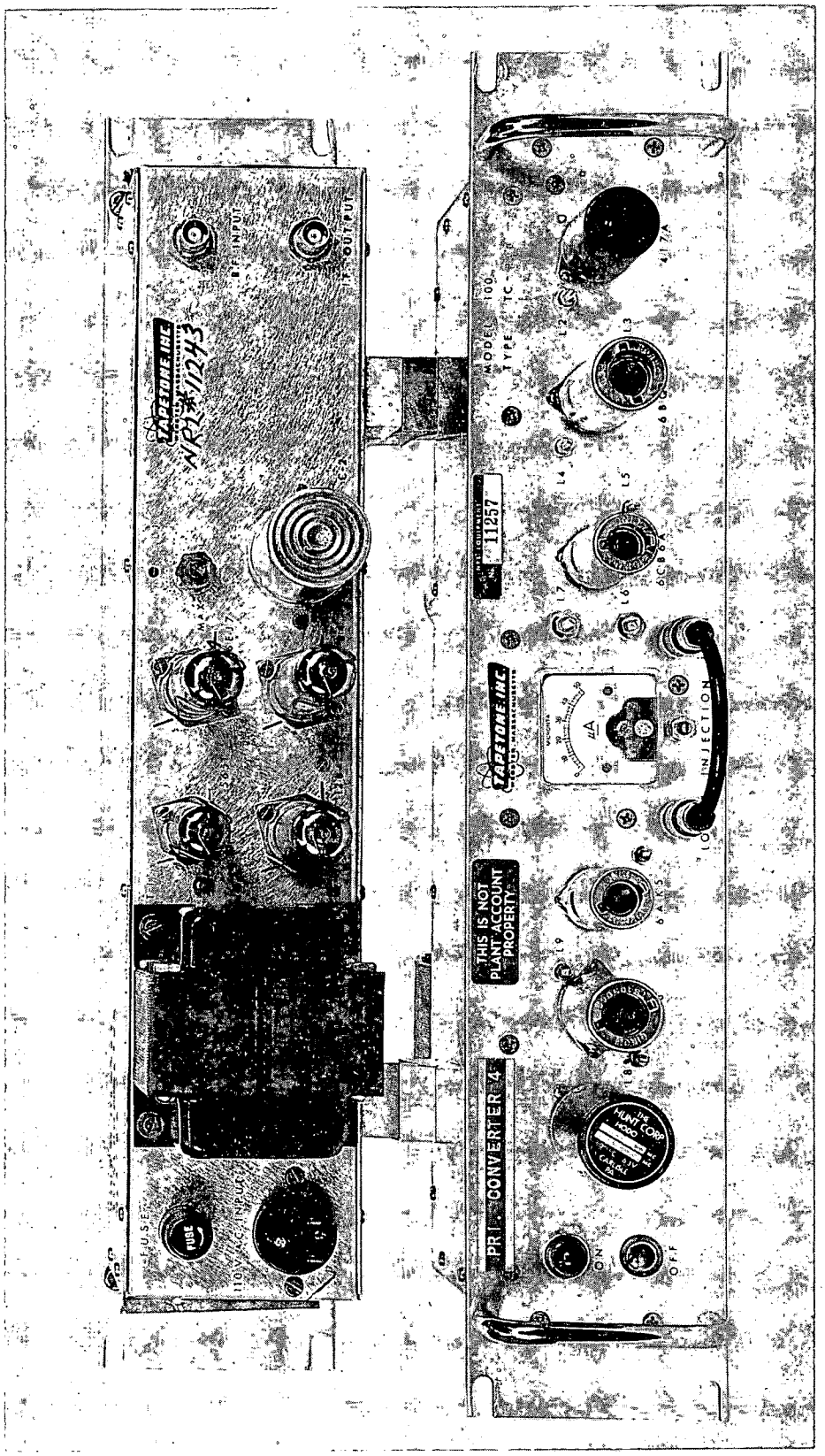


Fig. 14 - Converter Unit - Front and Rear View

Both the rf signal and oscillator injection voltage are applied to the control grid. A microameter is provided in the grid resistor circuit to indicate the strength of the injection voltage. The i-f output is taken from the plate through a circuit matched to a 50-ohm coaxial line.

(c) A crystal controlled Pierce oscillator, operating at one third the injection frequency. The crystal is contained in a small plug-in type oven which holds the temperature to approximately 85° C, if used. (AS SUPPLIED, THE OVENS HAVE BEEN DISCONNECTED.)

(d) A conventional frequency tripling stage.

(e) An injection voltage buffer amplifier stage. Means are provided to vary the screen grid voltage of this tube to control the level of the injection voltage.

9.242 The Power Units - The Power Units supply all voltages required for operation of their associated converters, namely 6.3 volts for cathode heating of the electron tubes and heating of the crystal ovens and 150 volts for the plate and screen supplies.

The 150-volt source is electronically regulated to maintain a high order of stability over wide variations of line voltage.

Crystal diodes are employed as rectifiers, operated in a full-wave circuit.

9.243 Converter Panel Arrangement - The rf section starts on the right hand end of the panel. The crystal oven, oscillator, multiplier, and buffer stages start on the left side and proceed toward the center of the panel. The L.O. injection level meter is centrally located with the L.O. buffer tube on the left and the mixer and i-f output circuits on the right.

Output from the L.O. is brought to the front panel through a BNC connector on the left of the meter and is fed into the mixer through a five-inch patch cable to another BNC connector located to the right of the meter. The L.O. level adjustment is just below the meter.

Off-on switch and pilot light are located on the extreme left end of the front panel.

9.25 Details of the Electrical Circuitry

Figure 15 is a Schematic Wiring Diagram of both the converters proper and the power units, while Table 1 shows the electrical characteristics of the various components versus Symbol Numbers.

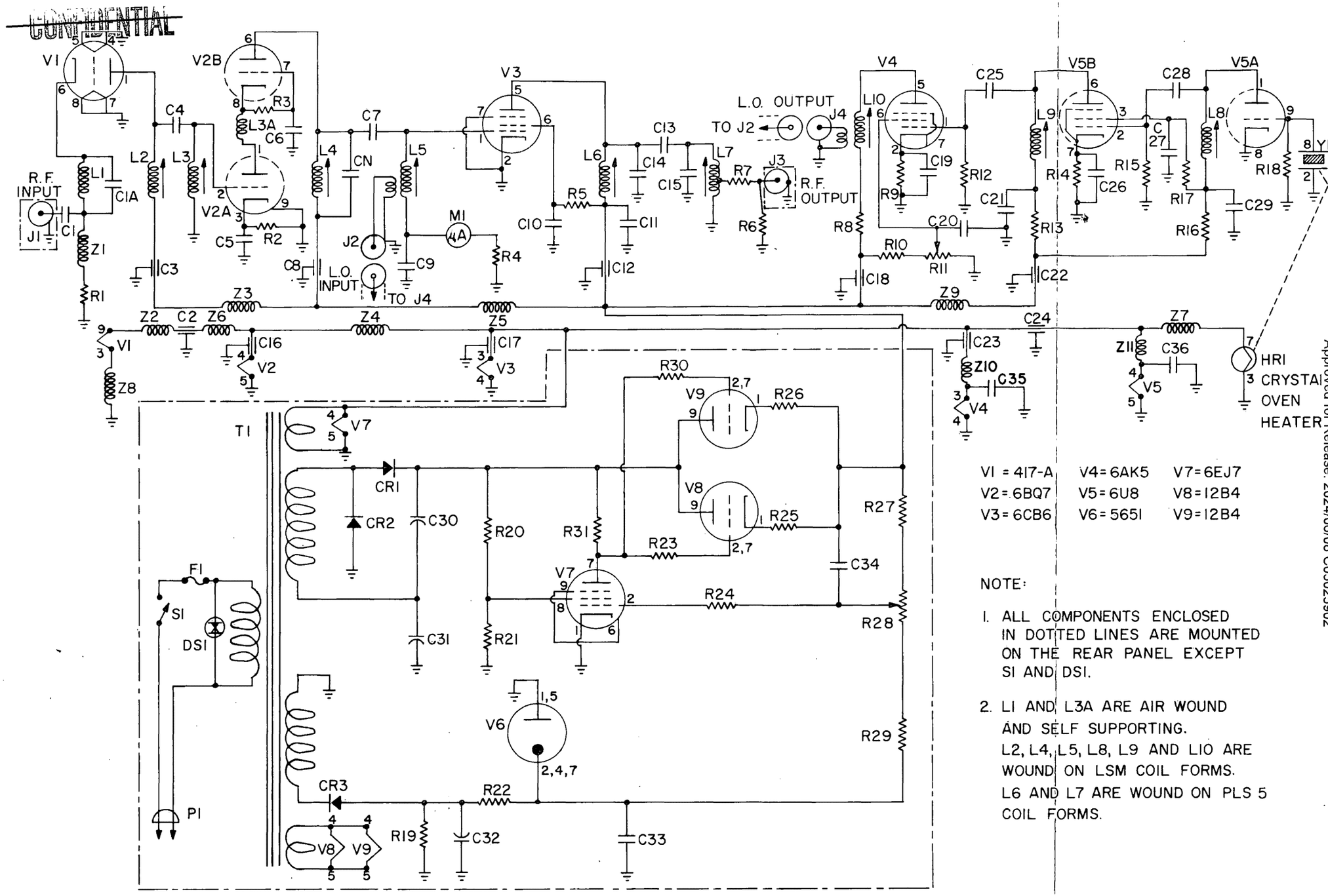
First RF Amplifier

The first stage of a properly designed frequency converter determines the overall noise figure of the system. High first stage gain is desirable in order to override the noise contributions of the succeeding stages.

A 417-A (V1) is used as a grounded grid rf amplifier. The signal is applied through blocking capacitor C1 to the input circuit which consists of impedance L1C1A in series with impedance Z1 and resistance R1. The total impedance is designed to match the cathode impedance of V1, while the impedance of Z1R1 matches the 50-ohm impedance of the antenna transmission line to which it connects through capacitor C1. The plate is resonated at the signal frequency by means of L2 and the signal is then coupled to the next grid which acts as a shield between the cathode and the plate, reducing the plate-to-cathode capacitance to a very low value. This insures stable operation free from the type of feedback that causes oscillation.

Second RF Amplifier

The second rf stage uses one section of a 6BQ7 dual triode (V2) arranged in a stable cascode circuit. The signal is coupled from the first rf amplifier through coupling capacitor (C4) to the tuned grid of the first triode (V2A). This tuned grid circuit in conjunction with the tuned plate circuit of the first rf amplifier comprise a double tuned circuit which establishes the rf bandwidth. The first triode (V2A) is connected for grounded cathode operation.



V1 = 417-A V4 = 6AK5 V7 = 6EJ7
V2 = 6BQ7 V5 = 6U8 V8 = 12B4
V3 = 6CB6 V6 = 5651 V9 = 12B4

NOTE:

1. ALL COMPONENTS ENCLOSED IN DOTTED LINES ARE MOUNTED ON THE REAR PANEL EXCEPT S1 AND DS1.
2. L1 AND L3A ARE AIR WOUND AND SELF SUPPORTING. L2, L4, L5, L8, L9 AND L10 ARE WOUND ON LSM COIL FORMS. L6 AND L7 ARE WOUND ON PLS 5 COIL FORMS.

Fig. 15 - Converter – Schematic Wiring Diagram

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Third RF Amplifier

The output from the plate of V2A is coupled directly to the cathode of the second triode section (V2B) which is operated as a grounded grid type amplifier. The plate of V2B is tuned with L4 and the signal is coupled to the following stage through C7.

Mixer

The mixer circuit employs a 6CB6 electron tube (V3) in a standard pentode circuit. The signal is coupled to the grid through C7. The local oscillator input from J2 is also connected to a link on the grid coil L5. The grid coil L5 and the plate coil of the previous stage comprise another double tuned circuit which increases the skirt selectivity of the rf bandpass. A high "Q" tuned circuit (L6) at the plate of the mixer is resonant at the i-f frequency. This circuit offers a high impedance to i-f voltage and a low impedance to signal and local oscillator voltages. Because of this impedance only the i-f signal is passed through the coupling capacitor C13 to L7. L7 is an impedance matching coil. The network of resistors from the tap on L7 is a pad giving an output impedance which properly terminates a 50-ohm line. The two coils L6 and L7 comprise another double tuned circuit to insure a uniform frequency response at the intermediate frequency.

Oscillator Multiplier

The local oscillator V5A is a conventional Pierce circuit. This circuit was chosen to provide maximum stability and trouble-free operation. The oscillator uses a third overtone crystal. The oscillator plate coil L8 is parallel tuned to the crystal frequency. The rf output is capacity coupled to the multiplier V5B. The multiplier plate is resonant at the injection frequency and its output is capacity coupled to the grid of the buffer output tube V4 by means of C25. The output level from V4 is controlled by means of R11 which varies the screen potential and thus adjusts the rf output level of this tube. The rf output is link coupled from L10 to the output jack J4.

Power Supply

115-vac, 60-cycle-power is applied to the primary of T1 and magnetically coupled to two high-voltage secondary windings of this transformer. One secondary winding is coupled to the full-wave rectifier circuit consisting of CR1 and CR2. The rectified output from the full-wave rectifier circuit is filtered adequately by capacitors C30 and C31 and is then applied to load resistors R20 and R21. The output of the filter provides plate voltage for the differential amplifier tubes V8 and V9, plate voltage for the dc error amplifier tube V7 through resistor R31 and is also applied to the grids of the amplifier V8 and V9 through resistors R31, R30 and R23. The cathodes of V8 and V9 provide the +150 vdc regulated output.

The output load of the power supply consists of adjustable resistor R28 and fixed resistors R27 and R29. Variable resistor R28 controls the dc potential at the control grid of the dc error amplifier tube V7 which in turn controls the dc potential applied to the grids of the differential amplifier V8 and V9 and therefore, the +150 vdc output at its cathodes. The reference voltage on the error tube V7 grid is held at -87 volts by the regulator tube V6.

A third secondary winding on T1 delivers 6.3 vac to the converter and local oscillator section for a filament supply.

The components employed in the converter and its power supply are listed in Table 1.

TABLE 1

CONVERTER PARTS LIST

Symbol	Item	Description
C1	Capacitor,	470 pf Ceramic
C1A	"	470 pf Ceramic.
C2	"	1000 pf feed-through
C3	"	1000 pf feed-through
C4	"	1.0 pf Jeffers
C5	"	470 pf Ceramic
C6	"	470 pf Ceramic
C7	"	1.0 pf Jeffers
C8	"	1000 pf feed-through
C9	"	51 pf Ceramic
C10	"	470 pf Ceramic
C11	"	0.01 mf Ceramic
C12	"	1000 pf feed-through
C13	"	5 pf Ceramic
C14	"	8.2 pf Jeffers
C15	"	10 pf Ceramic
C16	"	1000 pf feed-through
C17	"	1000 pf feed-through
C18	"	1000 pf feed-through
C19	"	1000 pf Ceramic
C20	"	1000 pf Ceramic
C21	"	1000 pf Ceramic
C22	"	1000 pf feed-through
C23	"	1000 pf feed-through
C24	"	1000 pf feed-through
C25	"	1000 pf Ceramic
C26	"	1000 pf Ceramic
C27	"	1000 pf Ceramic
C28	"	1000 pf Ceramic
C29	"	1000 pf Ceramic

TABLE 1 (Continued)

Symbol	Item	Description
C30	Capacitor	100 mf 250 V. Electrolytic. Aerovox PRS - 1595 or equal.
C31	"	100 mf 300 V. Electrolytic. Aerovox AFHS, 1-36-05 or equal.
C32	"	20 mf 250 V. Electrolytic. Aerovox PRS - 1570 or equal.
C33	"	0.03 mf 200 V. Aerovox P88 or equal.
C34	"	0.03 mf 200 V. Aerovox P88 or equal.
CN	"	Value selected at factory to resonate L4 at input frequency.
C35	"	1500 pf
C36	"	1500 pf
CR1	Rectifier	Silicon. Type 1N1491
CR2	"	Silicon. Type 1N1491
CR3	"	Sarkes Tarzian Model 50 [redacted] or equal.
DS1		Lamp, pilot, neon. Industrial Devices, Model 50 or equal.
F1		Fuse, 1/2 amp, 250 V. slow blow, 1/4" diameter x 1 1/4". Bussmann Fuseetron or equal.
HR1		Oven, crystal. Hunt Corp. Model Hodo, 6.3 V., 85°C.
M1		Meter, dc, 0-50 microamps. Hoyt Model 661; Beede Model 5 or equal.
R1	Resistor	47 ohms, 1/2 w 10%
R2	"	47 " " "
R3	"	470K " " "
R4	"	100K " " "
R5	"	15K " " "

TABLE 1 (Continued)

Symbol	Item	Description
R6	Resistor,	47 ohms, 1/2 w, 10%
R7	"	47 " " "
R8	"	1K " " "
R9	"	100 " " "
R10	"	22K " " "
R11	Potentiometer,	5K " " "
R12	Resistor,	6.8K " " "
R13	"	1K " " "
R14	"	470 " " "
R15	"	47K " " "
R16	"	1K " " "
R17	"	1K " " "
R18	"	1M " " "
R19	"	470K " " "
R20	"	56K " 2 w, "
R21	"	47K " 1 w, "
R22	"	27K " 1/2 w, "
R23	"	470K " " "
R24	"	33 " " "
R25	"	62 " " "
R26	"	62 " " "
R27	"	820K " " 1%
R28	Potentiometer,	50K " 2 w, Allen-Bradley type JA or equal.
R29	Resistor,	430K ohms, 1/2 w, 1%
R30	"	470 " " "
R31	"	68K " " "
S1	Switch, toggle, SPST, 6a., 125 V. Carling Electric No. 2FA63; Cutler - Hammer No. 7580L or equal.	
T1	Transformer, power. Tapetone Electronics Labs. No. 8801 or equal.	

TABLE 1 (Continued)

Symbol	Type	Description
V1	Vacuum tube	type 417-A
V2	" "	" 6BQ7
V3	" "	" 6CB6
V4	" "	" 6AK5
V5	" "	" 6U8
V6	" "	" 5651
V7	" "	" 6EJ7
V8	" "	" 12B4
V9	" "	" 12B4
Y1	Crystal Unit, quartz, CR 32/U in HC-6/U holder, for 85°C operation. In requesting replacement, specify type number of converter, also installation number on panel, such as Converter 1.	
Z1	Choke, rf, 3.3 microhenrys.	
Z2	" 0.68 "	
Z3	" 3.3 "	
Z4	" 0.68 "	
Z5	" 3.3 "	
Z6	" 0.68 "	
Z7	" 0.68 "	
Z8	" 0.68 "	
Z9	" 3.3 "	
Z10	" 0.68 "	
Z11	" 0.68 "	

9.26 Alignment Procedure

The alignment of this unit should be done in the following sequence: (1) Local Oscillator, (2) RF Section, (3) I-F Section.

9.261 Local Oscillator Section

With the power on, the injection level control R11 at maximum, and the connecting cable from J4 to J2 installed, tune coils L8, L9 and L10 respectively for maximum indication on the injection level meter. If no deflection can be seen, place a high impedance voltmeter on the grid (pin 2) of V5B. Then tune L8 for maximum on this voltmeter. Repeat this procedure on the buffer output tube. Place the high impedance voltmeter on the grid (pin 1) of V4 and peak L9 for maximum. Be sure the cable from J4 to J2 is connected. Peak L10 for maximum deflection on a meter connected across C9; this should be at least 1.5 vdc.

9.262 RF Alignment

Connect a sweep generator to the rf input jack J1. Connect an oscilloscope through a 47K resistor to the junction of L5 and C9. Tune the sweep generator to the proper frequency, and put a marker at the desired frequency. Tune L2, L3, L4 and L5 for maximum gain and desired bandwidth.

9.263 I-F Alignment

Connect a sweep generator as in Section 9.262. Connect an oscilloscope through a 50-ohm detector to the rf output jack J3. Tune L6 and L7 for maximum gain and the desired bandwidth.

9.27 Trouble Shooting.

If your Model 100 frequency converter fails to perform in accordance with specifications you may find the following paragraphs helpful.

9.271 High Noise Figure (Low Sensitivity):

A problem with noise figure in a Model 100 Converter can usually be traced to the first rf amplifier (V1-417A). The simplest method for determining the condition of this tube is to check the overall converter noise figure with several different 417A's.

9.272 Low Gain:

If the converter gain is low there are two possible areas where the trouble could be, either misalignment or a defective component. If the trouble is misalignment the rf alignment procedure previously outlined should be followed. The next probable point to be checked is the L. O. output level. If injection level is low it will not only cause a decrease in gain but it will also deteriorate the dynamic range. The injection level meter should not read more than 25 micro-amps. A check of this meter can be made by placing a VTVM across C9. Voltage should be at least 1.5 vdc.

9.273 Completely Inoperative:

If the converter is completely inoperative the first check should be at the power supply. Place a VTVM from the junction of R26 and R27 to the ground. This voltage should be 150 vdc. If it is not, adjust the output voltage control R28. If the proper voltage cannot be obtained or if there is no voltage output, a check of the power supply tubes (V6, V7, V8 and V9) will usually reveal the trouble.

If the proper voltage is obtained the next check should be made in the local oscillator section. This is accomplished by checking the voltage across C9. This should be at least 1.5 vdc. If no voltage is evidenced here a check of the cable connecting J2 to J4 should be made. If the cable is connected and in good condition the oscillator can be checked by using a grid dip meter as an absorbtion wave meter, tuning it to the crystal frequency and coupling it to the oscillator plate coil. If power is evidenced, move on to the multiplier plate coil L9 and follow the same procedure except tune the grid dip meter to the injection frequency. If power output is also evidenced here check the buffer stage plate coil L10 in the same manner, also tuning the grid dip meter to the injection frequency.

If the local oscillator is not at fault, a stage by stage check of the converter section can be made by following the alignment procedure in paragraph 9.26.

9.28 Check for Instability

While both types of the Model 100 converters are designed to be inherently stable in operation, it has been found that certain of the units possess a degree of regeneration in the rf amplifier section. Normally this is sufficiently small so as to be innocuous so as to merely result in somewhat higher GAIN than normal. However, should this over-all regeneration increase excessively, such as might occur with unusually high Gm tubes in the rf stages, there is a hazard that the entire rf amplifier may go into a condition of over-all oscillations resulting in the BLOCKING of the converters, rendering them inoperative. This will manifest itself in two ways:

(a) The channel in which it has occurred will become unusually quiet.

(b) The INJECTION LEVEL meter on the panel of the converter involved will read hard off scale.

It should be realized that oscillations occur in an amplifier when the feed-back gain exceeds the load losses and that the input termination represents an amplifier load; oscillations (for a given degree of feed-back) are more likely to occur with the input unterminated, i.e. with no antenna connected, but may be entirely stable and useable for normal operation with its antenna connected.

Therefore, ANY TIME A CHANNEL APPEARS TO BE UNUSUALLY QUIET UNDER NORMAL OPERATING CONDITIONS CHECK FOR OSCILLATIONS IN ITS ASSOCIATED CONVERTER AS FOLLOWS:

(a) Observe the INJECTION LEVEL meter. IF IT IS HARD OFF SCALE, oscillations are suspected.

(b) To confirm this suspicion, open one end of the short patch cord in the center of the Converter panel. (This removes the Injection oscillator voltage from the Mixer tube.) If the meter remains hard off scale, the rf amplifier is definitely oscillating.

(c) Assure that, in some manner, the antenna has not become disconnected. If a BNC connector with a 50-ohm resistor across it is available, substitute this for the antenna connector. Should this reduce the meter reading to approximately zero (less than 6 microamps) the antenna circuit is a suspect.

To clarify the nature of the above tests, it might be helpful to understand that oscillator injection is accomplished into the grid circuit of the mixer tube in parallel with the output of the rf amplifier through a grid blocking capacitor; the Injection Meter is in series with the 100K grid leak, hence it reads grid current which is proportional to the rf drive. Under normal operation the injection level is adjusted so that the grid current does not exceed approximately 25 microamps. However, should

the rf amplifier go into oscillations, an excessive drive is introduced to the grid of the mixer tube, making its grid current quite excessive.

SERVICING

9.29 Separating Converter and Power Units.

As has previously been described, the Model 100 converter assemblies consist of two units, namely the converters proper and their power units. These are secured together to form a complete entity for mounting in their rack. The converters and power units are secured back to back with their respective panels on which the tubes and other appurtenances are mounted facing outboard. This results in the innermost sections of the two chasses facing each other with little spacing between them. It therefore is difficult to do any point-to-point or other testing, let alone effecting removal and replacement of any components, without separating the two chasses. At the same time it is desirable to maintain intact the interconnecting leads between the two chasses, which are soldered in place, in order to keep power on both units. A suggested procedure to be followed in separating the power units and converters proper for these two styles of units is detailed below.

9.291 Separating the Style 1 Units

(a) Remove the unit from its rack and place on a suitable work bench.

(b) Two shield plates will be found on the top and bottom of the complete unit. These are approximately 3 1/2" wide x 15 3/4" long and are secured by eight (8) self-tapping screws along three of their edges. Remove these 16 screws and take off the two plates.

(c) Remove the two nickel plated handles by unscrewing their four securing screws.

(d) Place the unit bottom up on the work bench, i.e., with the power transformer and crystal oven to the right as one faces the converter panel.

(e) Remove the four flat Phillips head machine screws that hold the side sections of the power unit chassis to the converter panel (two on each side), being careful to retain the nuts and lock washers.

(f) Remove the six flat Phillips head machine screws from the bottom of the converter panel, being careful to retain the nuts and washers. Then remove the 10 slotted-head machine screws (arranged in pairs) from the top of the shield. This will free the "L" shaped bottom and rear shield from the converter, but do not attempt to remove it as yet.

(g) Carefully lift the loosened assembly by holding the two units together at both ends and place it with the converter panel up and its bottom toward you on the bench, allowing it to rest on the power transformer and vacuum tube tips. It will be noted that the wires connecting the two units together at the top of the converter are away from you.

(h) Now grasp the converter panel with the hands at either end, holding the "L" shaped shield in place with the two thumbs and carefully fold over away from you, placing it on the bench behind the power unit, resting on the tips of the vacuum tubes. During this operation the wiring will serve as a fulcrum.

(i) Lift off the "L" shaped shield from the converter unit and all the components of both units will be exposed for ready point-to-point testing or other servicing operations with power still maintained on both units. It should be understood, however, that for satisfactory

rf operation of the converter it will be necessary to temporarily replace the shield as its removal changes the electrical characteristics of the various rf circuits.

(j) Figure 16 shows the two units as separated for servicing operations.

(k) Reassembly after servicing should obviously be accomplished in the reverse order as described above.

9.292 Separating the Style 2 Units

(a) Remove the unit from its rack and place on a suitable work bench.

(b) Remove the two (top and bottom) shield plates by taking out the 16 self-tapping screws along three of their edges.

(c) Remove the two nickel plated handles by unscrewing their four securing screws.

(d) Place the unit bottom up with the power unit facing you.

(e) With a 5/8" end wrench, remove the securing nut from the rf input BNC connector, pushing the connector into its compartment.

(f) With the same wrench loosen the hexagonal locking nut on the Power ON-OFF switch and remove the outside knurled nut with the fingers. Push the switch into its compartment.

(g) With a small soldering iron unsolder the pilot light leads. These may be more readily reached from the other side (top) of the unit.

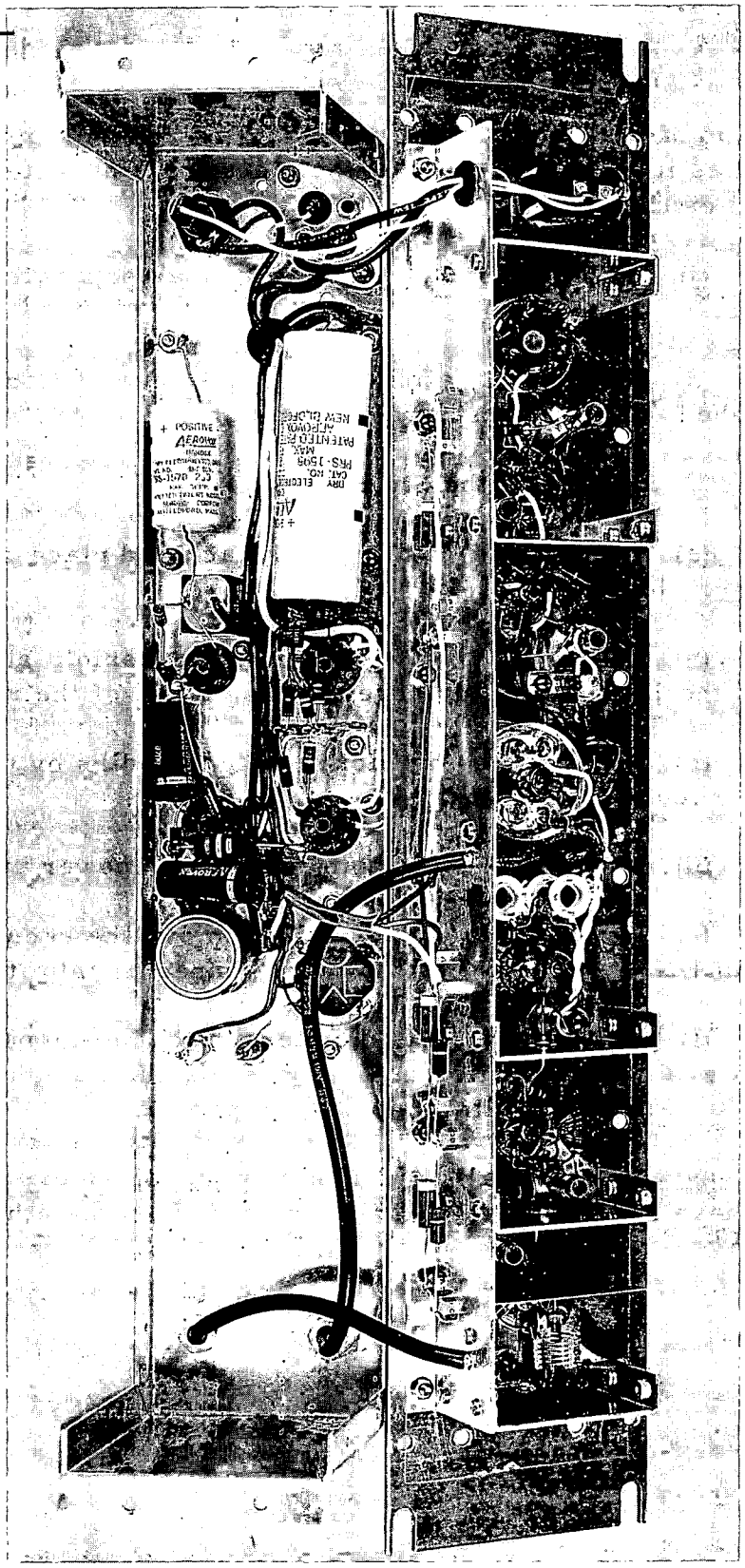

Fig. 16 - Converter - Style 1 Disassembled

(h) Stand the unit on the transformer and tubes of the power unit with the Converter panel up and the bottom facing you.

(i) Remove the four flat Phillips-head machine screws holding the two units together, (in line with the handle-mounting holes), being careful to retain the nuts and lock washers.

(j) Grasping the Converter panel at its two ends, carefully fold back the panel and rest it on its vacuum tubes behind the power unit.

(k) Both units are now readily accessible for testing and the replacement of components.

(l) Figure 17 shows the two units as separated for servicing operations.

9.3 CONVERTER RACK FAN UNIT

This unit is intended to provide a circulation of air from the bottom to top of the Converter Rack to assist in the cooling of the various pieces of equipment contained therein but primarily to provide cooling of the Converter units themselves. Being mounted in the rack immediately below the line of Converters it will provide for the maximum circulation of air around these units.

Figures 18 and 19 show a panel and an interior view of the Fan Unit, respectively.

It will be noted that the elements of the unit are all supported from a standard 7" rack panel which contains the ON-OFF switch, a pilot light and a line fuse. The 9" chassis mounts two fans provided with dust filters. The fans are staggered with respect to depth in order that one blast of air will flow over the electron tubes mounted on the front panel of the Converter units and a second over the power unit tubes mounted on the rear panel of the Converter units.

The fans are manufactured by the Rotron Manufacturing Company of Woodstock, New York and are designated as their Gold Seal Muffin type, Series #2093. Each is rated as 75 CFM (for zero static pressure) with an electrical rating of 105/125 volts, 50/60 cycles and 14 watts.

These fans have self-lubricating bearings designed for continuous operation over a period of three to five years, depending on temperature; the higher the temperature the shorter the life.

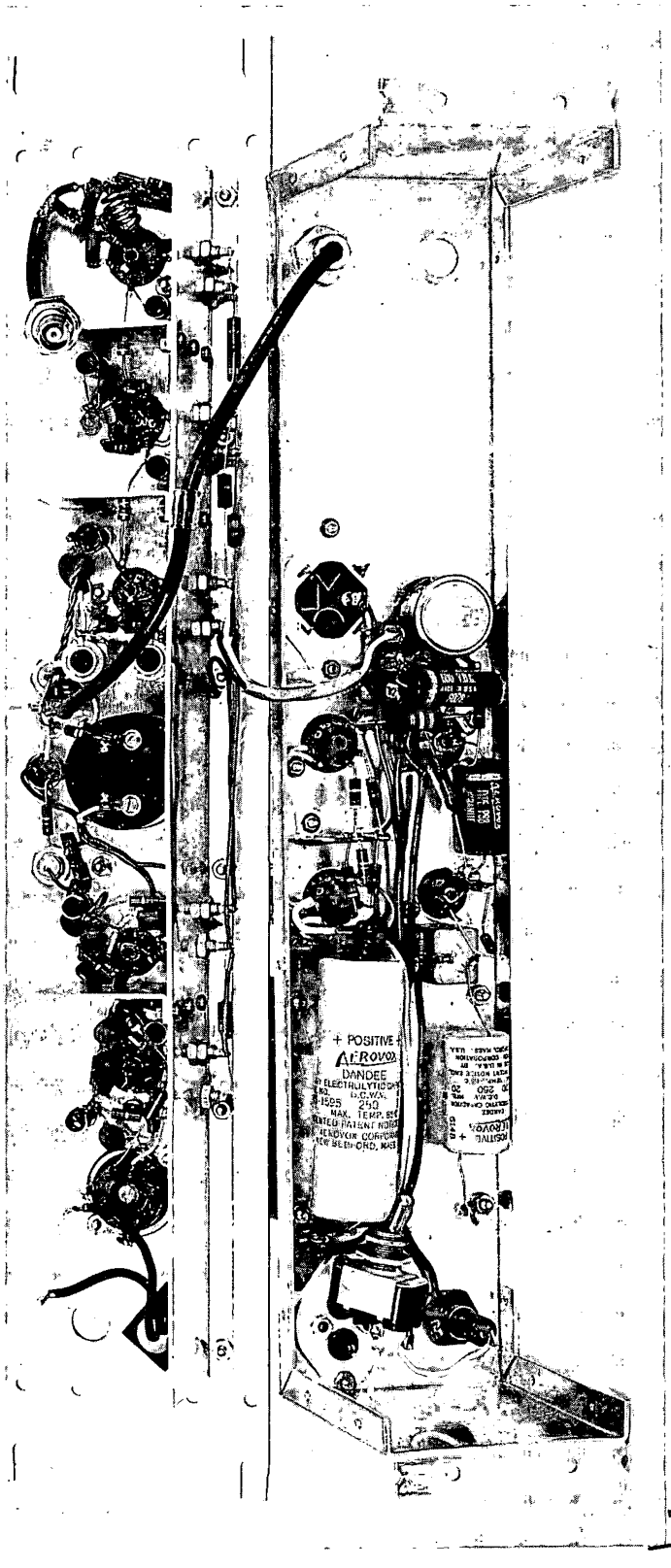

Fig. 17 - Converter - Style 2 Disassembled

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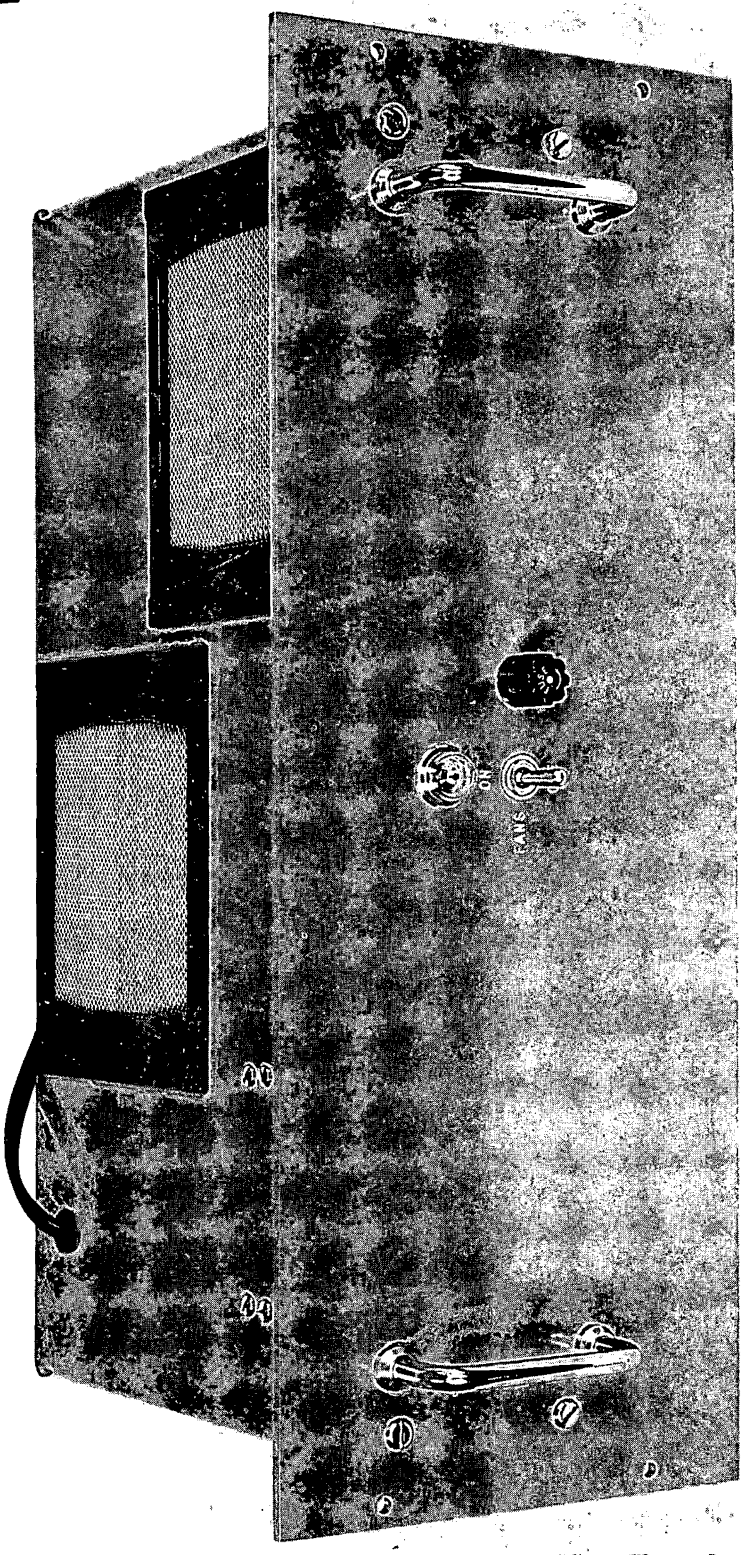

Fig. 18 - Converter Rack Fan Unit - Panel View

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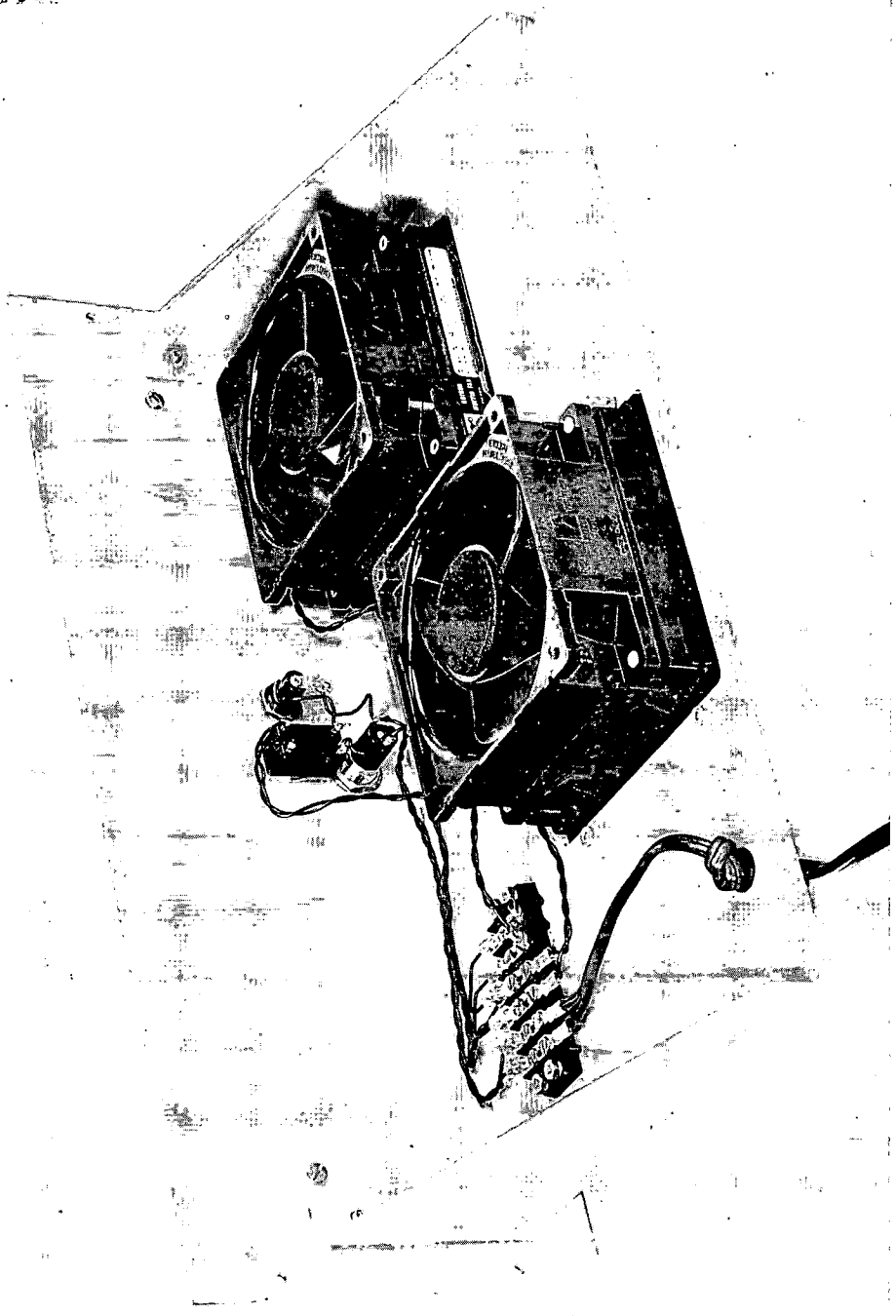

Fig. 19 - Converter Rack Fan Unit - Interior View

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9.4 THE RADIO RECEIVERS

The eight R-390 A/URR high-frequency receivers provided for each facility (four installed in each hut) are all standard Army/Navy type equipments, well known to the Services. (In a few SECONDARY huts, R-391/URR receivers may be installed in Channel D in lieu of R-390A/URR equipments).

Not only because these receivers are so familiar to the Services, but because they are all covered by complete, detailed and voluminous instruction manuals which are available at all sites and contain not only a description but complete and detailed operating and maintenance instructions, no attempt will be made to duplicate such information in this Manual.

Mention should be made, however, of a small additional unit that is installed on the receivers upon installation. It is necessary to carry three output lines from each receiver, namely a detector, a line audio and paralleled local audio. These all are obtained from one of the screw-type terminal boards on the rear of the receivers and are all carried in coaxial cables. In addition, it is necessary to provide a terminating resistor and a dc blocking capacitor in the detector line. Coax cables do not lend themselves very well to connection to screw terminals, so that, in the past, these connections, as well as the location of the resistor and capacitor, were, of necessity, accomplished in a "hay wire" manner.

The small additional unit mentioned above, and shown in Figure 20 is designed to mount over the terminal board and contains not only the detector resistor and capacitor, but four BNC receptacles to permit the easy connection of the four coax lines required. The termination of these receptacles is clearly marked, as shown in the figure, but it might be desirable to explain that the two receptacles marked LOCAL are in parallel (cables from these points running to the respective LOCAL AUDIO units) and were so placed to avoid using a Tee for this purpose.

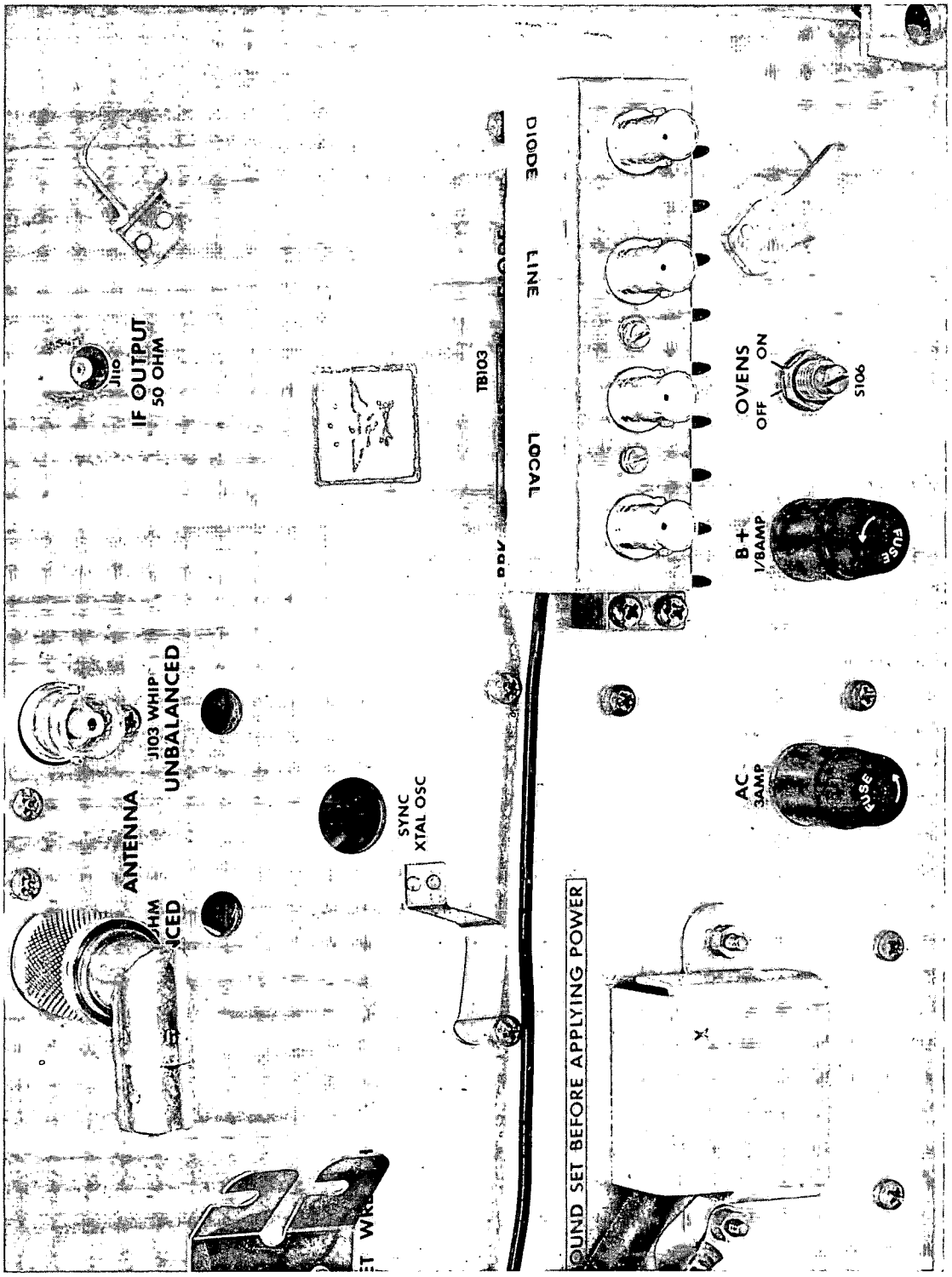


Fig. 20 - Audio Output Terminal Modification to R-390A/URR Receivers

9.5 LOCAL AUDIO PANELS

Each operating position is provided with a small strip panel, designated as a LOCAL AUDIO PANEL. These are located at the bottom of each table rack. These panels contain four pairs of standard telephone jacks. Between each pair is mounted a "tapered" 1,000-ohm potentiometer with knob control. The combination of two jacks and their potentiometers is marked RECEIVER A, RECEIVER B, RECEIVER C and RECEIVER D, respectively while the knobs of the potentiometers are marked GAIN.

As installed, each potentiometer is connected between ground and the Local Audio output of each receiver through individual 8.2K isolating resistors. The jacks connect to the arms of the pots. In operation, the Local Audio Gain of all receivers is maintained well advanced, all headphones are plugged into the Local Audio jacks and the headphone levels adjusted by the Gain controls on this unit.

The purpose of these units is to permit either operator to monitor the output of any receiver without disturbing the other operator or to permit one operator, by the use of "split phones", to monitor two receivers simultaneously.

Figure 21 shows a panel and rear view of the LOCAL AUDIO panels as used for all racks other than the RIGHT HAND rack in the SECONDARY huts. These panels, while electrically the same as those described above, are slightly smaller and have a slightly different arrangement of jacks and controls. (See par. 7.2 for more details on this difference).

9.6 THE LINE DRIVER - DETECTOR UNIT

In the installation of the Facilities at the various sites, the two huts will be separated by 200 wire feet and possibly 100 or more geographic feet. It would be physically difficult if not impossible to insulate the two ends of the system to permit grounding all parts at a common point. Experience has indicated that in many cases where two ends of high-gain

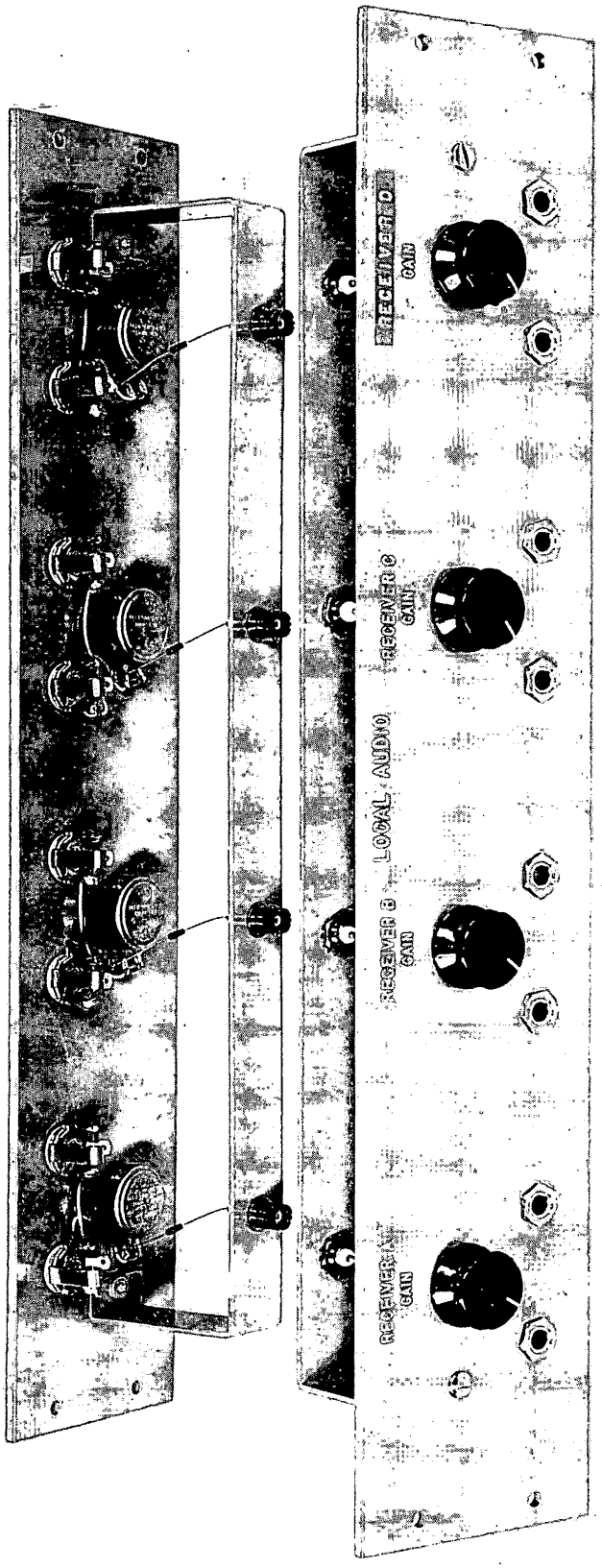


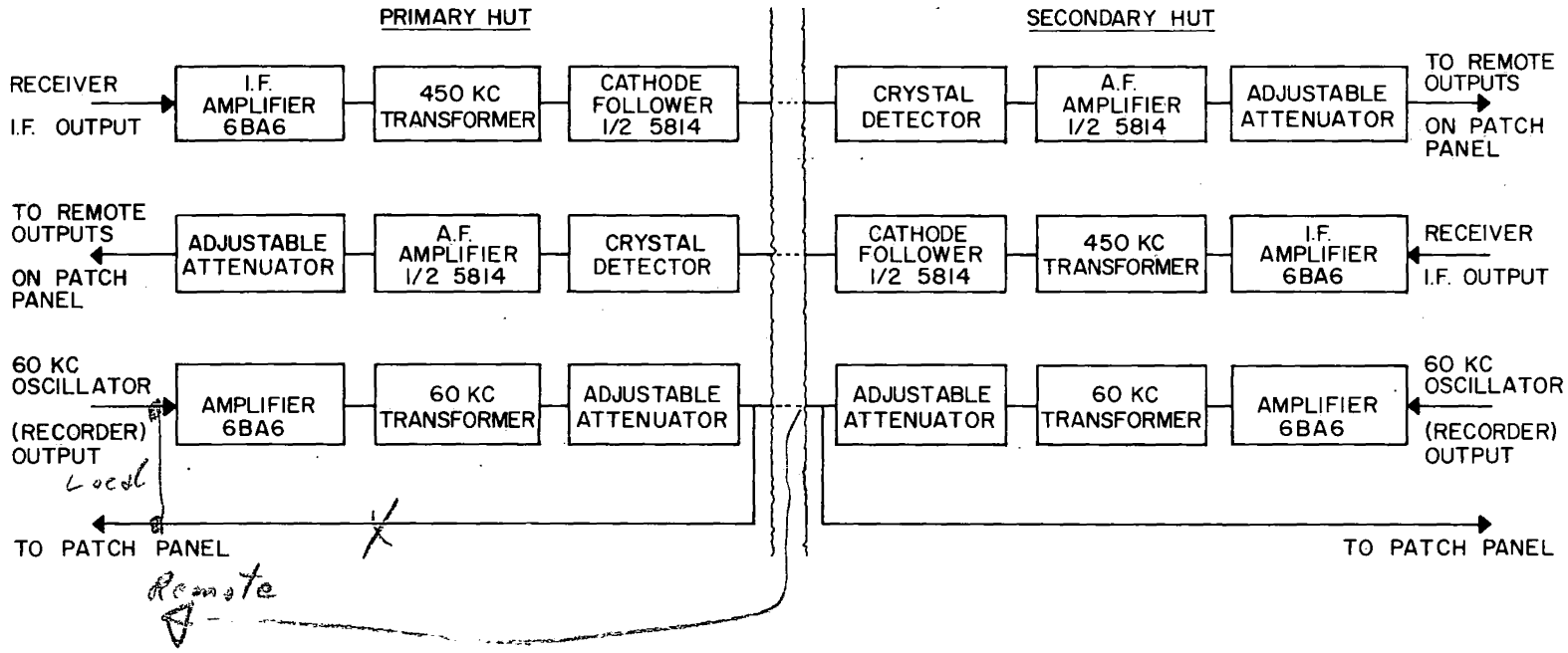
Fig. 21 - Local Audio Panel - Front and Rear View

audio devices are grounded at two isolated points, "hum" trouble is likely to be encountered. The obvious, and in fact the only practical, solution to this condition is to maintain the level of the signals during their passage through the interconnecting cables at such a level as to render any hum or stray pickup innocuous. This is the function of the LINE DRIVER-DETECTOR unit. The unit provided contains five identical sub-units to provide correction of five transfer lines between huts, four being immediately required with receivers A to D, the fifth being provided as a spare or for future expansion.

While the operating principles are quite simple, Figure 22 shows, in block diagram form, the operation of one of the sub-units. Assume that it is desired to record the output of one of the receiving channels in the PRIMARY hut on the Recorder in the SECONDARY hut. The IF output of the receiver passes through a broad-band (50 kc) amplifier where its level is raised approximately 20 db, thence through a cathode follower where the impedance is reduced to 50 ohms to match the coax line between the huts. In the LINE DRIVER-DETECTOR unit in the SECONDARY hut, the 455 kc signal is demodulated by a crystal diode detector, passed through an amplifier, thence to an adjustable pad to set the output level and then to the desired Recorder channel (see Figure 22(a)). Obviously, the reverse process occurs if it is desired to record a signal received in the SECONDARY hut on the Recorder in the PRIMARY hut (see Figure 22(b)).

Another sub-unit is provided in these units in addition to the five mentioned above. This is an amplifier to raise the level of the 60-kc timing signals generated in the Recorders to permit their recording on the recorder in either hut (Figure 22(c)). These signals are straight ac and are recorded as 60 kc, requiring no demodulation. Hence, no detector circuits are required.

Each LINE DRIVER-DETECTOR unit is provided with its own rectifier power unit which is electronically regulated to maintain constant "B" potentials and therefore constant preadjusted gain (excepting gain changes resulting from tube aging).



NOTE 1 (a) AND (b) EACH REPRESENTS ONE OF FIVE CIRCUITS (A TO E) FOR FEEDING RECEIVER OUTPUTS IN ONE HUT TO THE RECORDER IN THE OTHER HUT.

NOTE 2 IN CIRCUITS B AND C OF THE LINE DRIVER-DETECTOR, TUBE 5814 IS REPLACED BY TUBE 12BH7.

Fig. 22 - Line Driver-Detector Unit – Block Diagram of Operations

Figure 23 shows the schematic wiring diagram of the amplifier and detector circuitry while Figure 24 shows a schematic of the regulated power supply. The circuitry involved is so straightforward and orthodox as to require no detailed explanation.

Figures 25, 26 and 27 show the panel, top of chassis and bottom of chassis views respectively. From Figure 25 it is apparent that there are no panel controls involved other than a power ON/OFF switch and the five screw-driver adjustable controls for setting the output levels of the five channels to meet the recorder requirements.

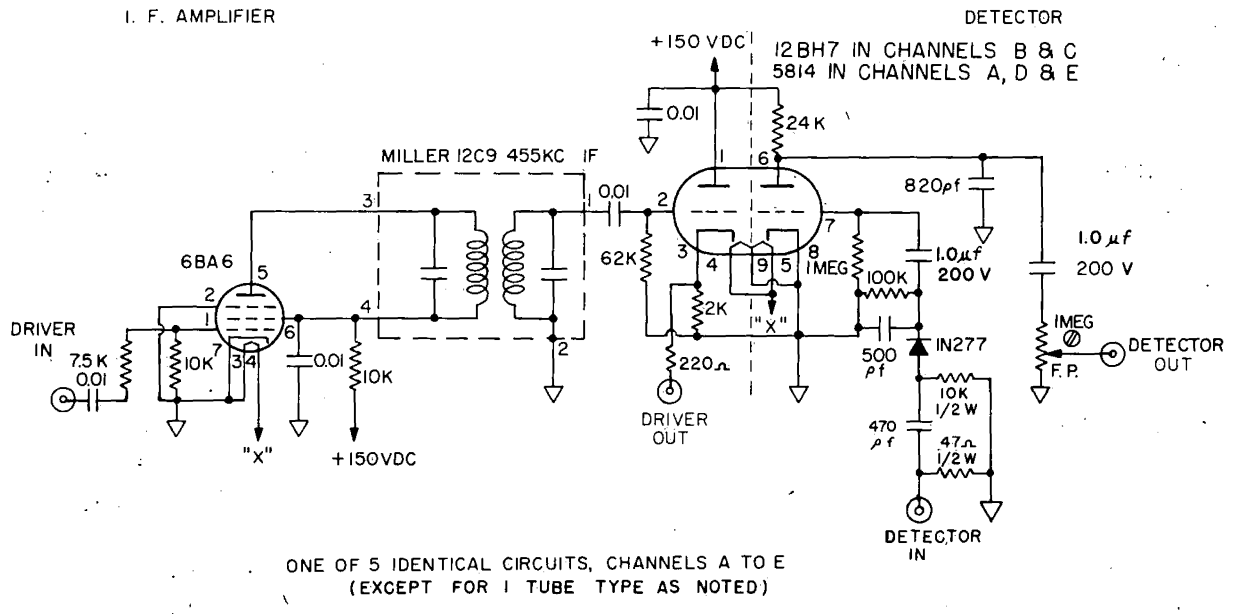
Referring to Figure 26, the electronically regulated power supply is on the right of the chassis immediately behind the panel. Along the rear of the chassis are the five amplifier-detector channels, each involving an IF transformer flanked by its two electron tubes, a 6BA6 pentode amplifier and a 5814 dual triode employed as an amplifier and cathode follower. To the left on the chassis behind the panel is the 60 kc amplifier employing a 6BA6 pentode driving a small untuned iron-core plate/line transformer (mounted beneath the chassis).

Figure 27, showing the underside of the chassis, requires no explanation and has been included merely to illustrate the clean and accessible manner in which all components are mounted and the wiring accomplished.

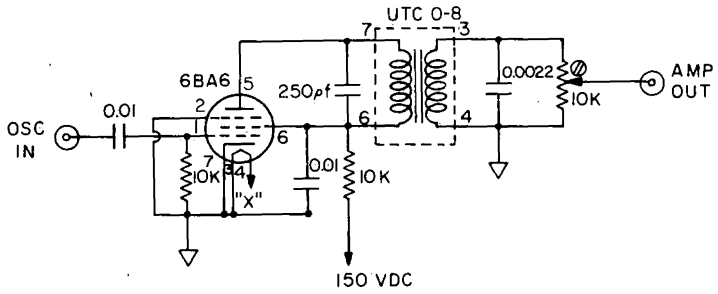
9.7 THE PATCH PANEL

The Patch Panel is fundamentally a distribution medium for the seven inputs of the Recorder by which any receiver output may be patched to any recorder input. Before describing this unit it is necessary to emphasize the flexibility that is being provided in the overall recording capabilities of the Facilities.

In the installation the two huts are electrically cross connected with respect to both the output of the various receiving channels and the inputs of the two recorders. Thus, the outputs of the receiving channels and the recorder input channels in the PRIMARY hut also appear in the SECONDARY hut and vice versa. The Patch Panel provides means whereby the signals received on any channel in either hut may be recorded on any channel of the recorder in either hut.

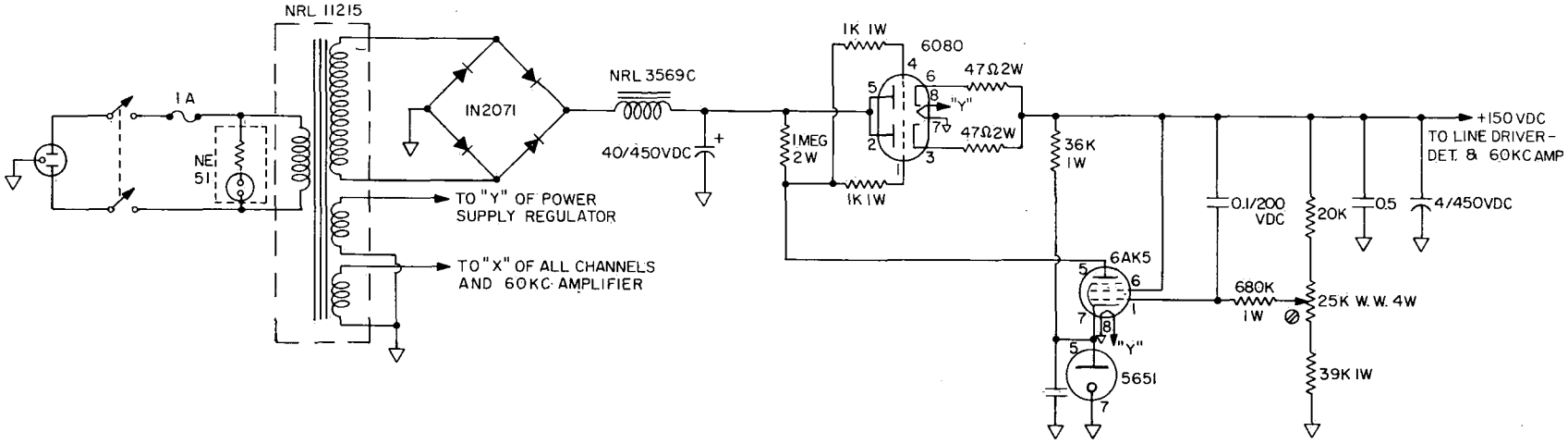


(a) I. F. AMPLIFIER AND DETECTOR



(b) 60 KC AMPLIFIER

Fig. 23 - Line Drive-Detector Unit – Schematic of Amplifier and Detector Circuits



NOTE: ALL CAPACITANCES ARE GIVEN IN MFDS. UNLESS OTHERWISE NOTED.

Fig. 24 - Line Driver-Detector Unit – Schematic of Regulated Power Supply

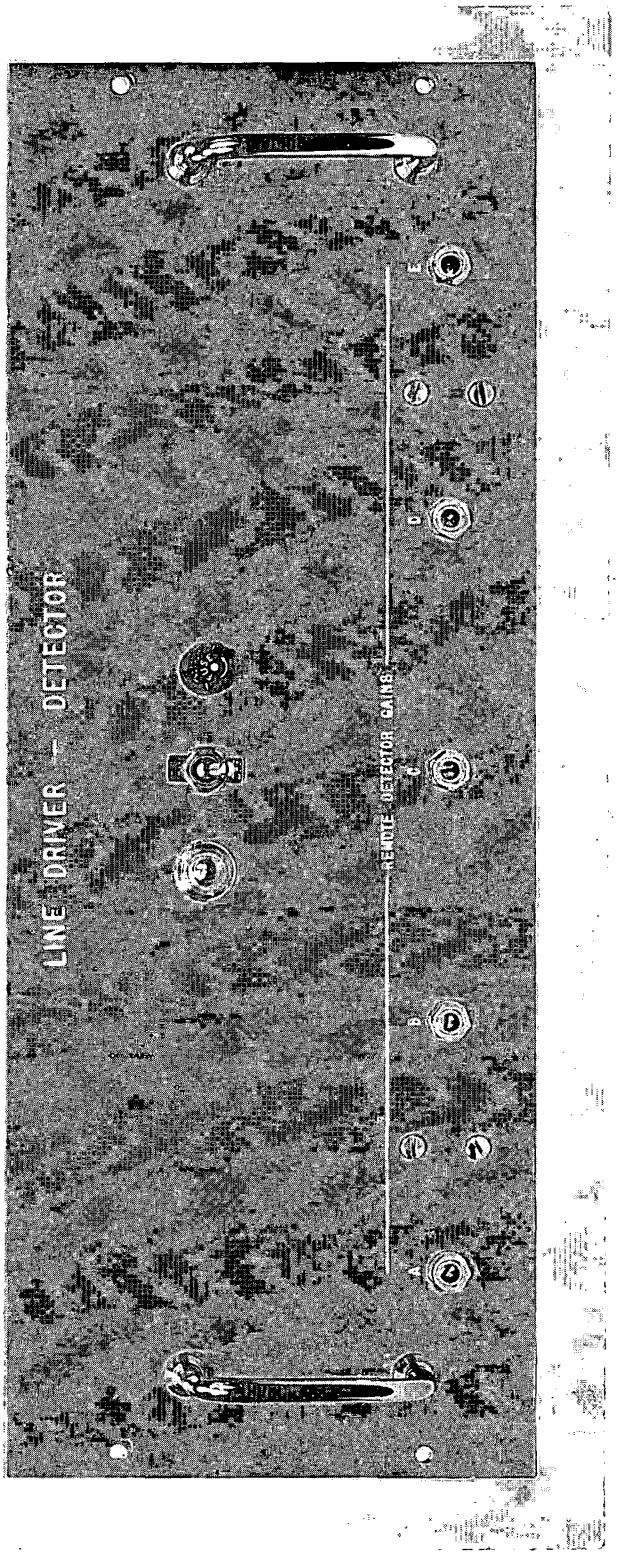


Fig. 25 - Line Driver-Detector Unit – Panel View

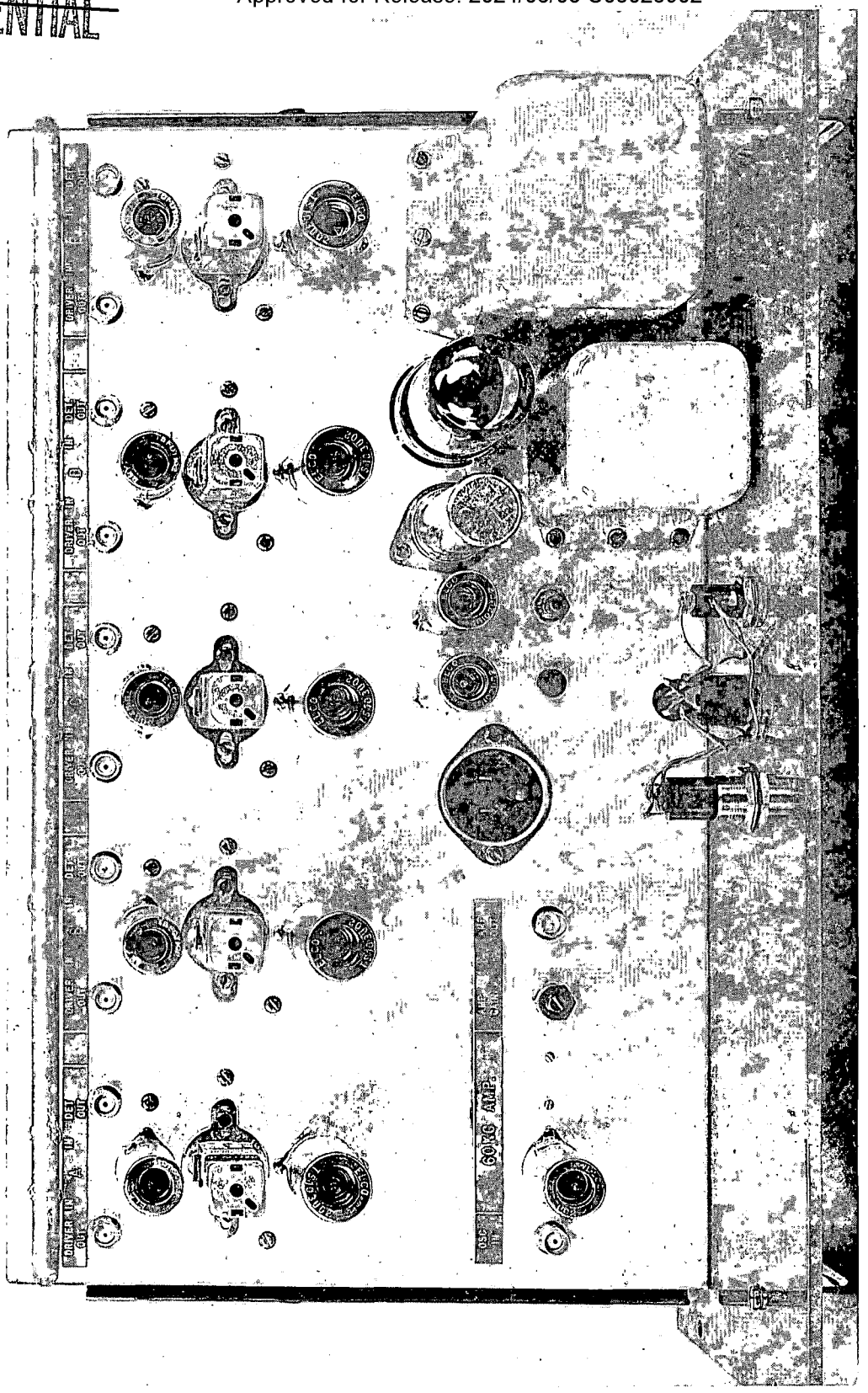


Fig. 26 - Line Driver-Detector Unit - Top View of Chassis

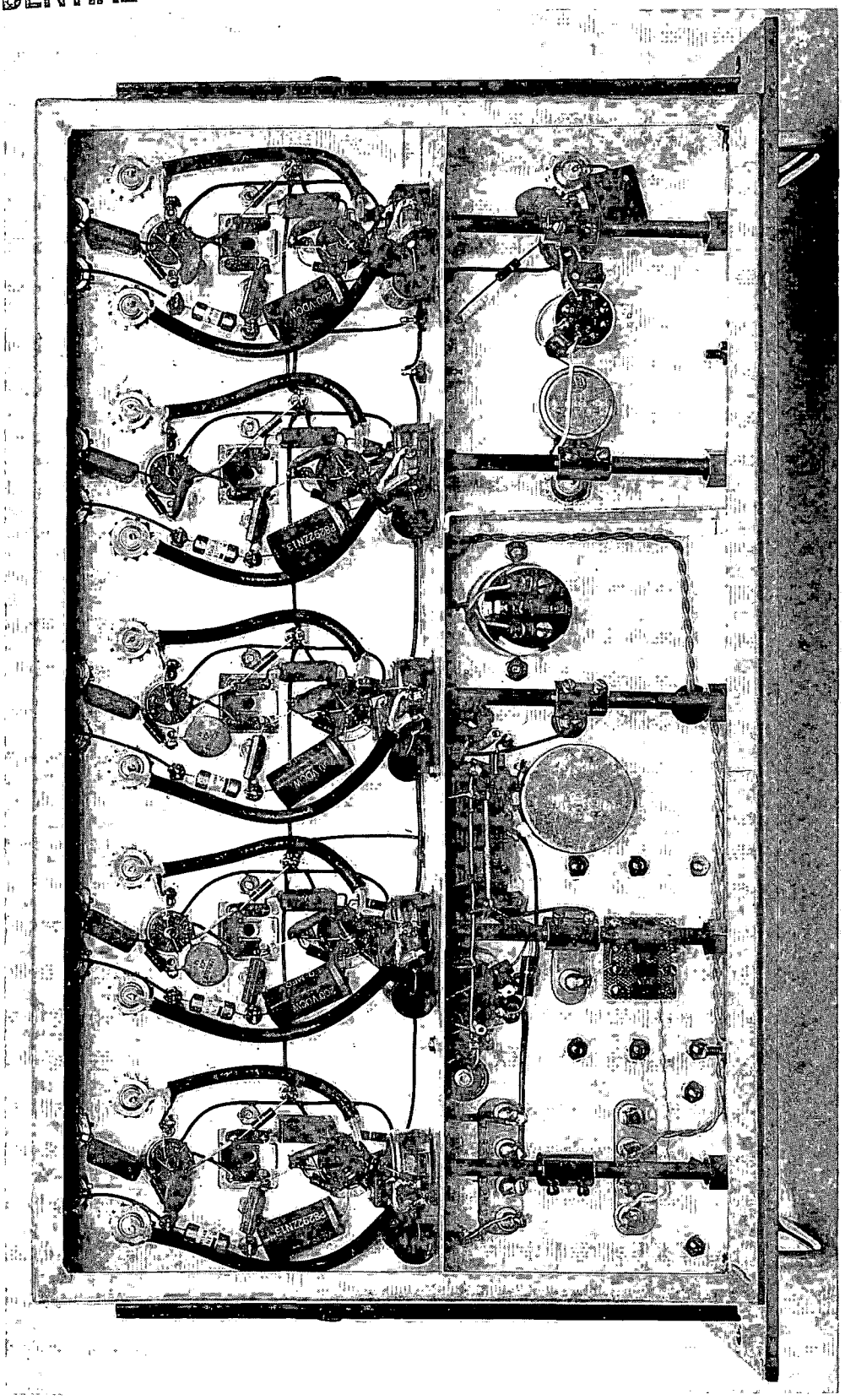


Fig. 27 - Line Driver-Detector Unit - Bottom View of Chassis

Referring to Figure 28 which shows a front view of the Panel, it is believed that the engraved designations for the various BNC receptacles are quite descriptive and self explanatory. Further explanation would be almost redundant.

The two features that might warrant a slight explanation are with respect to the terminals marked REMOTE OUTPUTS and LOCAL OUTPUTS. The terms REMOTE and LOCAL refer to the huts. Remote outputs are those coming from the receiving channels in the adjacent hut through the LINE DRIVER-DETECTOR unit, whereas those marked LOCAL come directly from the detectors in the four receivers in the same hut. It will also be noted that receptacles are provided in the REMOTE and LOCAL OUTPUT groups marked "REC. E". These were provided in anticipation of the possible future installation of an additional receiver and are not used in the present installation.

Mechanically the PATCH PANEL is merely a standard 19" rack-mounting panel 5 1/4" high with all the BNC receptacles being of the feed-through type so that the receptacles behind the panel serve as mechanical terminations for the various coax lines.

9.8 THE CATHODE-RAY OSCILLOSCOPE

The new oscilloscopes are of the latest design, produced by TEKTRONIX, employing five-inch instead of three-inch tubes as in the scopes previously installed in the field huts. Furthermore, they are extremely more versatile and flexible inasmuch as they employ plug-in units to permit functional changes to be made, as required, without rendering the entire instrument obsolete.

These scopes are basically designated as TEKTRONIX TYPE RM-561, and are equipped with four-channel plug-in heads. These heads contain all necessary amplifier and electronic switching gear to permit simultaneous four-channel operation. The many requirements for a multi-channel scope are so apparent to those familiar with the operation of the receiving facilities in question as not to require delineation in this Manual.

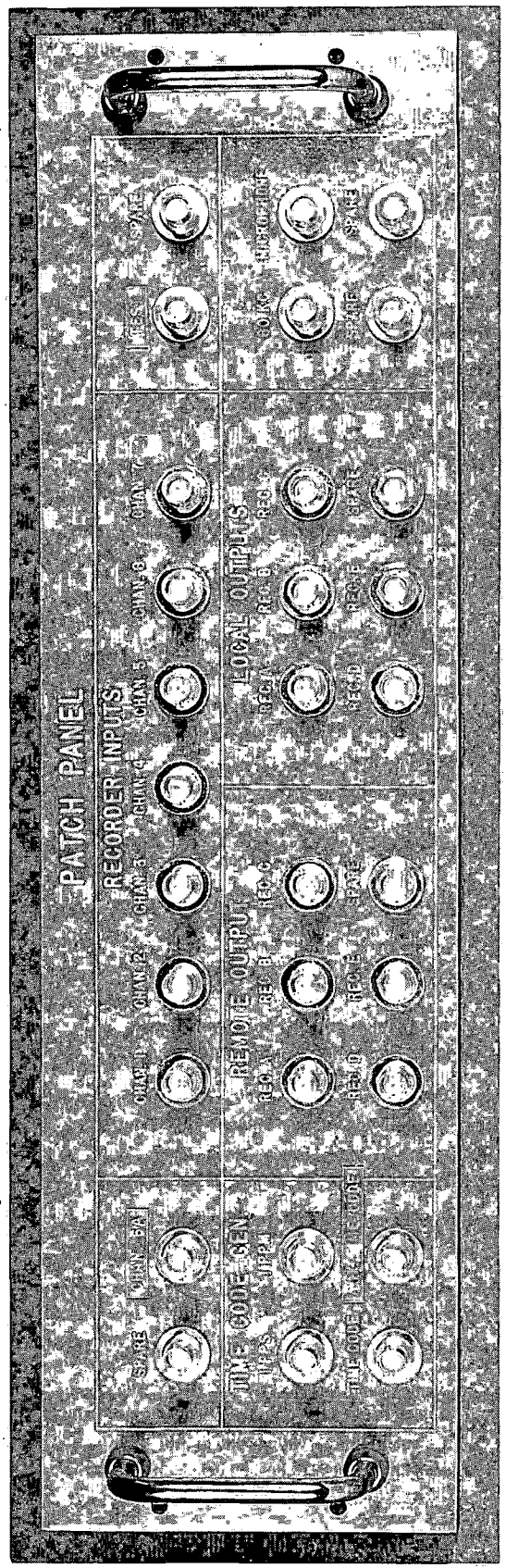


Fig. 28 - The Patch Panel - Front View

As is the case with those other standard commercial products furnished as part of the Facilities, the oscilloscopes are provided with instruction manuals prepared by the manufacturer which will be made available to all sites, so that the information contained therein need not be repeated here.

The appearance of the panel of these scopes may be gained from Figure 5 or 6.

9.9 THE SIGNAL PANEL

This unit (except for the convenient inclusion therein of a Microphone receptacle for plugging in the hand microphone) is in reality a Monitoring panel, primarily for use with the Cathode-Ray Oscilloscope.

Figure 29 shows the front panel arrangement of this unit. The seven BNC receptacles, marked Channel 1 to Channel 7 inclusive, connect to the Recording and Playback terminals of the seven-channel Recorder. The 14 'phone jacks along the bottom of the panel are in parallel, in pairs, with the BNC receptacles immediately above and are to permit aural monitoring of the playback from each channel. When no 'phones are plugged in, a sufficiently-high resistive load is provided for the playback amplifiers of the recorder.

The inputs of the oscilloscope may be plugged into any of the recording or playback receptacles for observation and/or monitoring.

The two upper BNC receptacles, designated "1 PPS" and TIME STD connect to the 1 PPS output of the Time Code Generator and the output of the Channel D (Time Signal) receiver and are to permit the resetting of the Time Code Generator, when required, by simultaneous observations of its 1 PPS output and standard time signals.

The MICROPHONE receptacle is for receiving the output of the hand microphone used for making voice comments on one of the recorder channels.

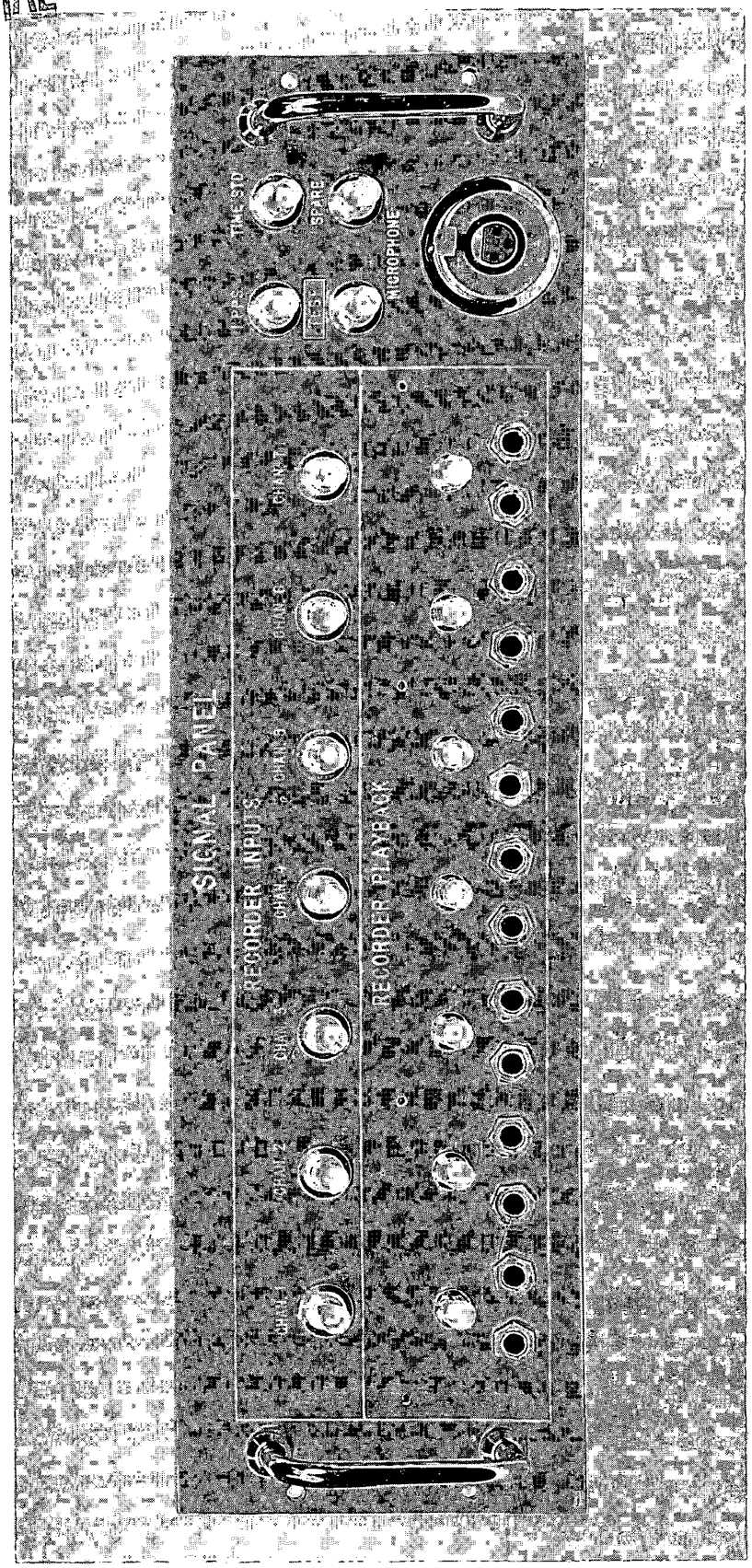


Fig. 29 - The Signal Panel - Front View

Figure 30 is a rear view of the Signal Panel with all cables removed for better viewing. It will be noted that the playback outlets are in a separately shielded compartment to isolate them from the Recorder input terminals.

It might be mentioned that, while not shown by the Figures, the BNC feed-through Recorder input terminals, are, when the equipment is installed, also used as branch circuit junction points between the Recorder and the circuits feeding its input, by the employment of Tee fittings.

9.10 THE TIME CODE GENERATING EQUIPMENT

All the time code generating equipment is installed in the PRIMARY hut although the time code itself is piped to, and is available in, the SECONDARY hut. This was necessary, not only for reasons of fiscal economy but primarily because the smaller SECONDARY huts would have been seriously overcrowded had an attempt been made to install any or all this equipment in the eight foot huts.

Two separate and distinct TIME CODE GENERATORS are provided, designated as the BASIC generator and the AUXILIARY generator. The AUXILIARY generator consists of the original EECO generator and power unit that were provided in the original installations and have been in use in the field ever since. These are described in NRL Instruction Book #25 and Addendum 1 thereto so that no additional description is necessary herein. It should be mentioned, however, that these have been reinstalled in the PRIMARY huts principally as a "back-up" for the BASIC generators for use in the event of an unexpected complete failure of the latter and not for normal use.

9.101 The BASIC Time Code Generator Equipment

This equipment consists of four separate and distinct units, namely:

(a) The Time Code Generator
(b) The Battery Power Unit
(c) The Battery Box with Batteries
(d) The Remote Time Display Unit

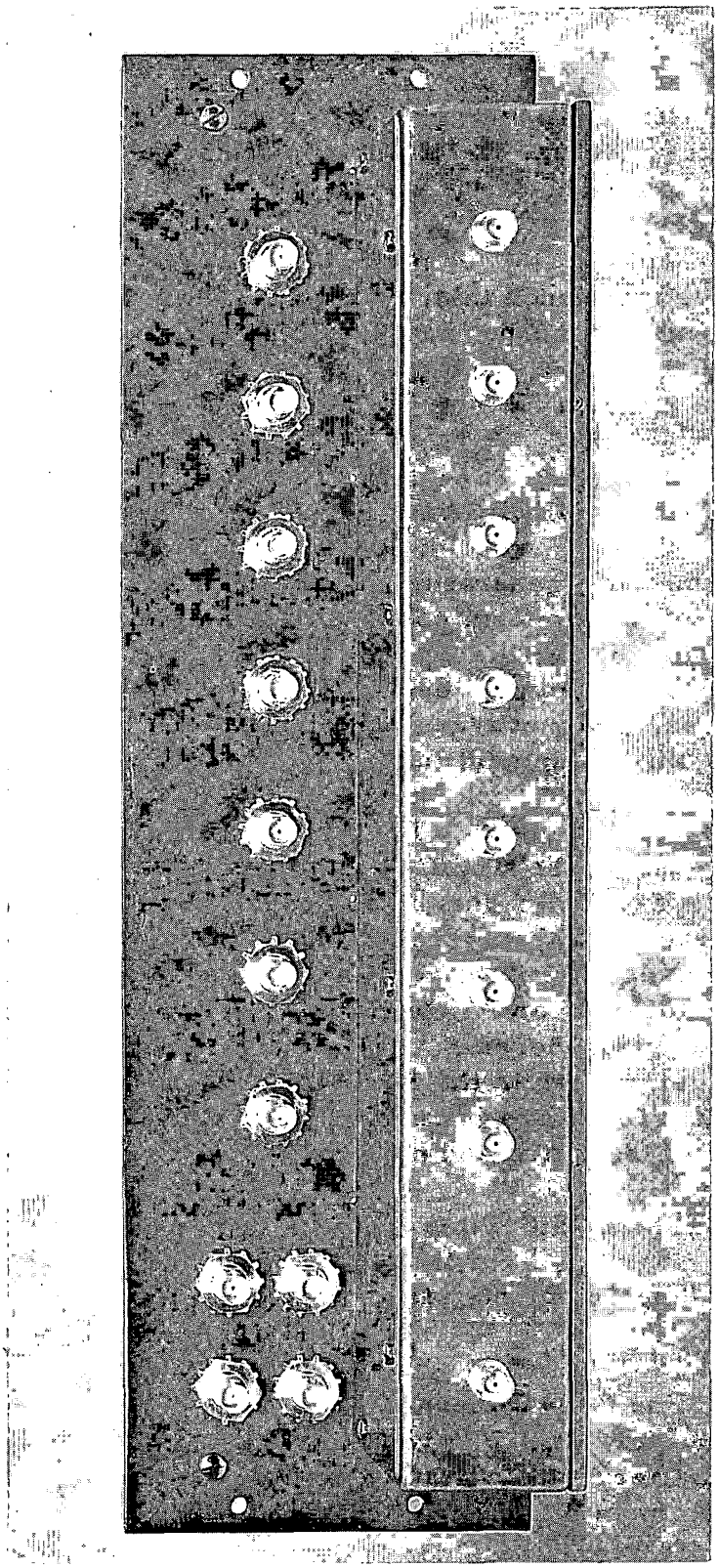


Fig. 30 - The Signal Panel - Rear View

It was supplied by ASTRODATA, INC. of Anaheim, California and is transistorized in its entirety, employing no electron tubes and accordingly operates on relatively low dc power voltages.

9.1011 The Generator Proper

The Time Code Generator (proper) is designated as Astrodata Model 6140-500, is a rack-mounting unit and is mounted in the LEFT HAND TABLE rack in the PRIMARY huts. Figure 31 shows a close-up of this unit. The lower door covers and protects all the adjustment and operating controls. Above it is the time read-out sub-unit. Time is indicated in hours, minutes and seconds by relatively large "Nixie" lamps which are readily read in a well lighted compartment at nearly all angles and distances.

Figure 32 shows this unit with the control hatch cover open. (The unit to its right is a Remote Time Display identical to the unit mounted on the panel of the Generator).

Most of the basic circuits are the "printed" type, carried on a multiplicity of cards which are plugged into the front of the unit, from behind the control panel and are carried on guides. This facilitates maintenance, inasmuch as, in the event of a failure of any circuit, a new card can readily be inserted. Figure 33 shows the method by which these cards may be replaced. It will be noted that the front section of the unit is hinged and opens to the left thereby exposing the edges of all the cards and permitting their replacement.

Figure 34 is a rear and top view of the unit (with the protective cover removed). This shows the top of the guides in which the circuit cards slide. The round grilled opening in the center is the exhaust for the air circulating fan contained in the unit.

The generators are designed for operation from a 115 volt, 50/62 cycle power source through self contained regulated power units, which supply the relatively low dc voltages for the transistors. However, no regulation, no matter how perfect, can protect against operating failures resulting from excessively low voltage or complete failure of

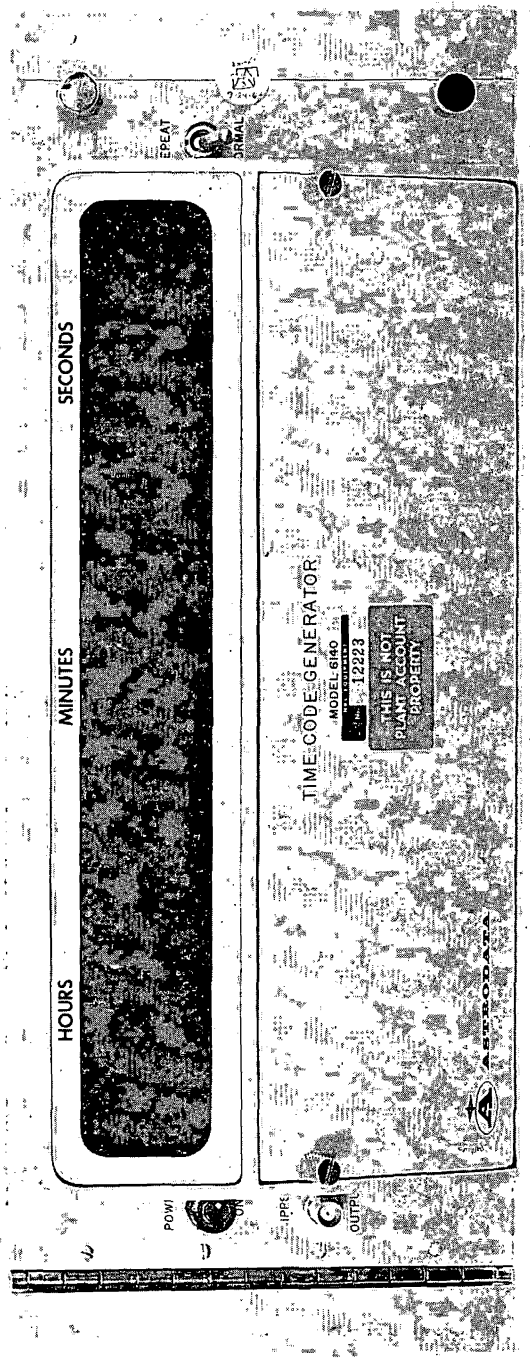


Fig. 31 - Basic Time Code Generator - Front View

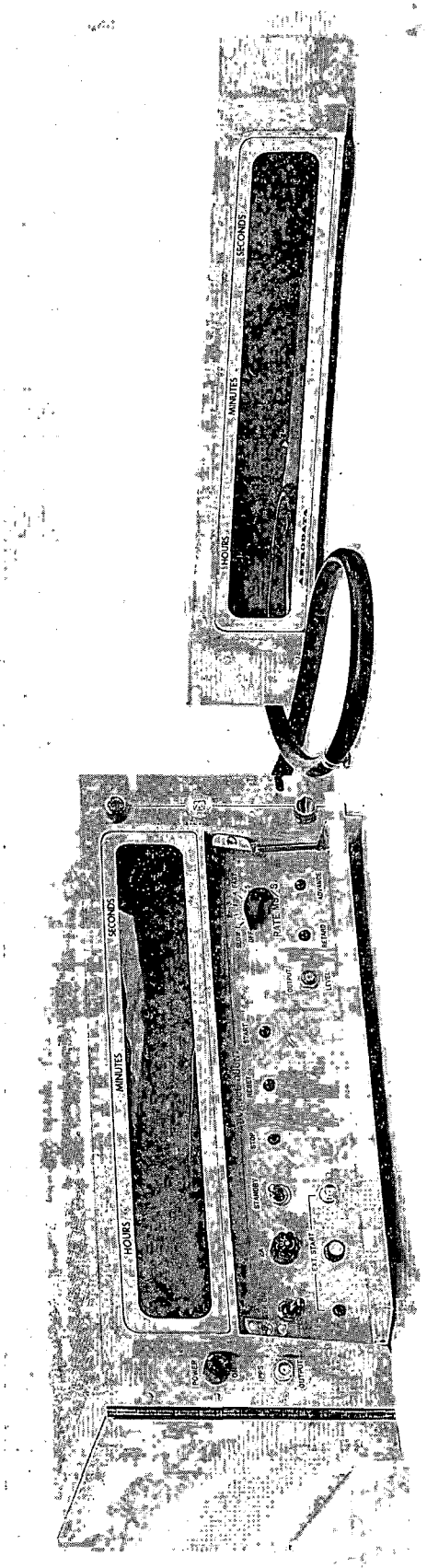


Fig. 32 - Basic Time Code Generator Showing Control Panel and Remote Display Unit

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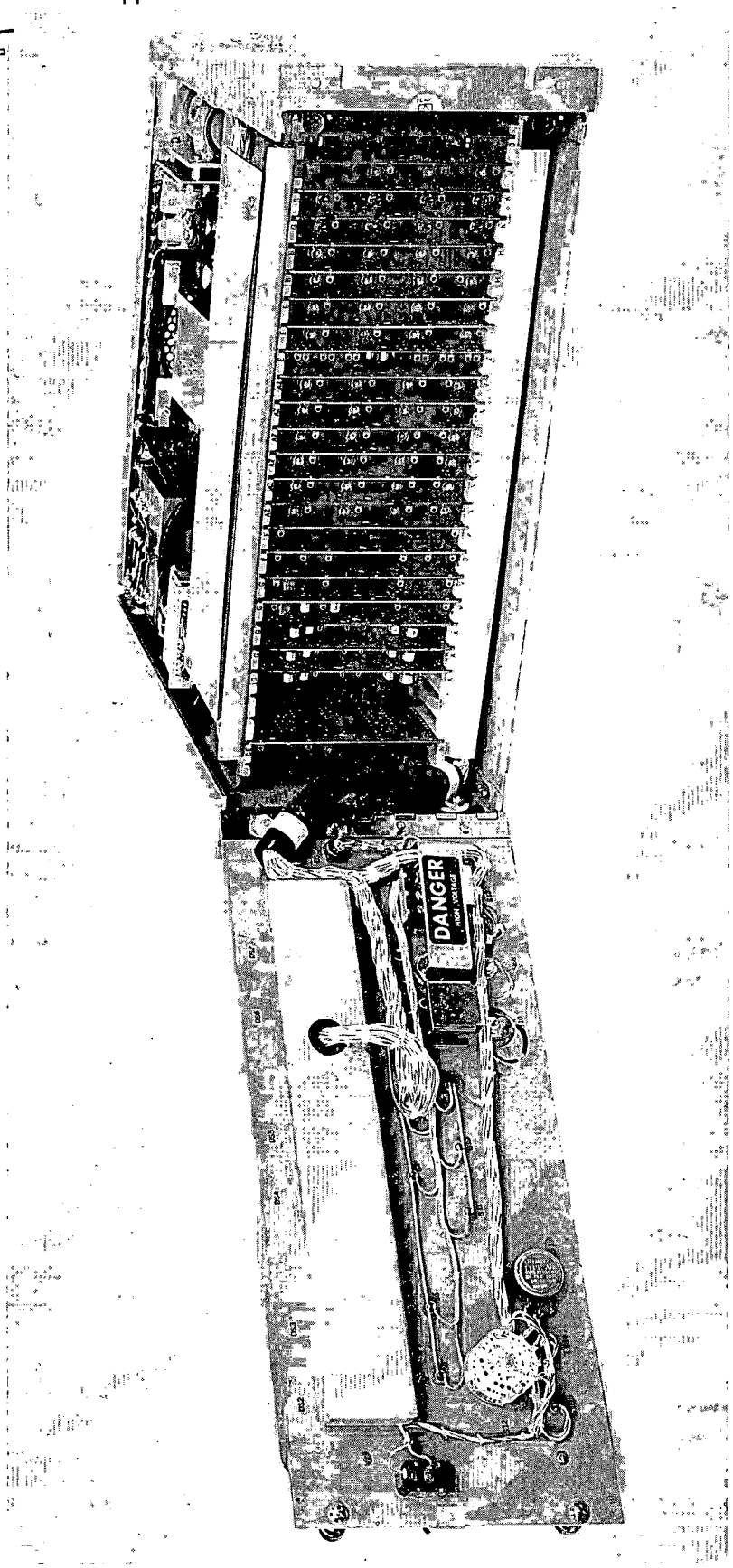

Fig. 33 - Basic Time Code Generator - Front Panel Open

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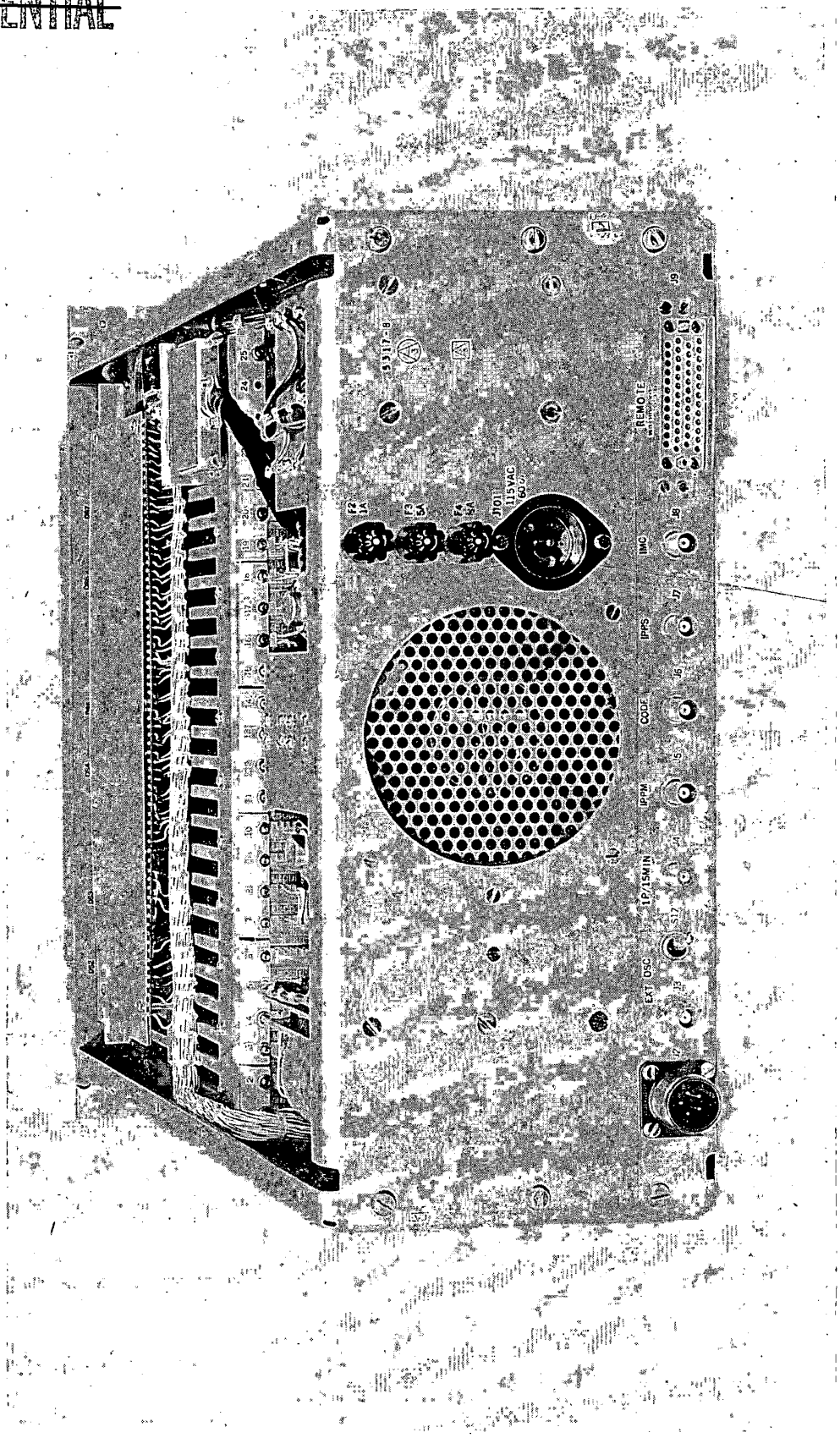

Fig. 34 - Basic Time Code Generator – Rear and Top View

the ac power. This was one of the difficulties experienced with the EECO generators. Accordingly, the BASIC generators, as installed, are also designed to operate from a set of nickel-cadmium batteries. This feature is described in 9.1012 and 9.1013 below.

9.1012 The Battery Power Unit

In order to minimize the size of the batteries required with the equipment (nickel-cadmium batteries being a relatively expensive item) the design incorporates a separate unit, designated as the Battery Power Unit, which is installed in the converter racks for convenience. Thie unit serves a dual purpose. With normal line voltage and regulation, it supplies all the dc power necessary to operate the generator with an excess to carry the batteries on "trickle" charge. Hence, under normal operating conditions, the batteries act primarily as a regulating device for the dc voltages. However, as the line voltage decreases, the batteries begin supplying a part of the power necessary to maintain proper dc operating voltages until, should the ac line voltage reach zero, i.e., the power fail completely, the batteries take over completely. With this method of operation it will be noted that there is never an even momentary interruption of dc power, such as would occur with switching methods which obviously cannot be tolerated.

It should be mentioned that with the Astrodata equipment, a high proportion of the dc power required is used to energize the Nixie time display lights. However, these lights can be disabled without in any way affecting the operation of the Time Code feature. Accordingly, in order to obtain the maximum length of operating time with the minimum battery size, a feature is provided that automatically disables the Time Displays when the ac line voltage reaches such a low level (or fails) that the batteries are carrying a major share of the load.

Assuming fully charged batteries at the time of a power failure, the batteries are of sufficient capacity to maintain the generator in accurate operation for a period of approximately six hours.

Figure 35 shows a close-up of the panel of the Battery Power Unit, It is believed that the detail in this photograph is sufficient to permit the various controls and meters to be identified without further explanation.

Figure 36 is a close-up of the rear of the unit showing the cooling fins for heat dissipation and the mounting of the various transistors on their heat sinks.

9.1013 The Battery Box

Figure 37 is a close-up of the battery box showing the batteries in place as well as the output receptacle for carrying the power to the Generator through a three-wire cable. This unit is installed in the PRIMARY huts on the deck beneath the operating table. It should be mentioned that one of the characteristics of nickel-cadmium batteries is their absence of gassing during either normal charge or discharge. Accordingly, there being no noxious gases involved, it is entirely permissible or even desirable to mount the batteries in the huts.

9.1014 The Remote Time Display Unit

This unit is identical to the unit mounted on the front panel of the Generator except that it is carried by a small individual rack mounting panel. One is shown in Figure 32, and as mounted in the LEFT HAND TABLE rack in the SECONDARY huts, in Figure 4. Internally, it contains merely the required number of NIXIE lamps for indicating the time in hours, minutes and seconds which connect in parallel with similar lamps in the Generator, being connected through 47 wires in a special cable connecting the two huts.

9.11 THE RECORDERS

In the modernization covered by this Manual two types of Recorders will be involved. Both are manufactured by the Consolidated Electrodynamics Corporation of Pasadena, California under the trade name DATATAPE. However, more specifically they are designated as types GR-2500 and GR-2800. The GR-2500 units are those that have been installed in the huts that have been in the field since June 1961, the general electrical and mechanical characteristics of which are described in Addendum 1 of NRL Instruction Book #25.

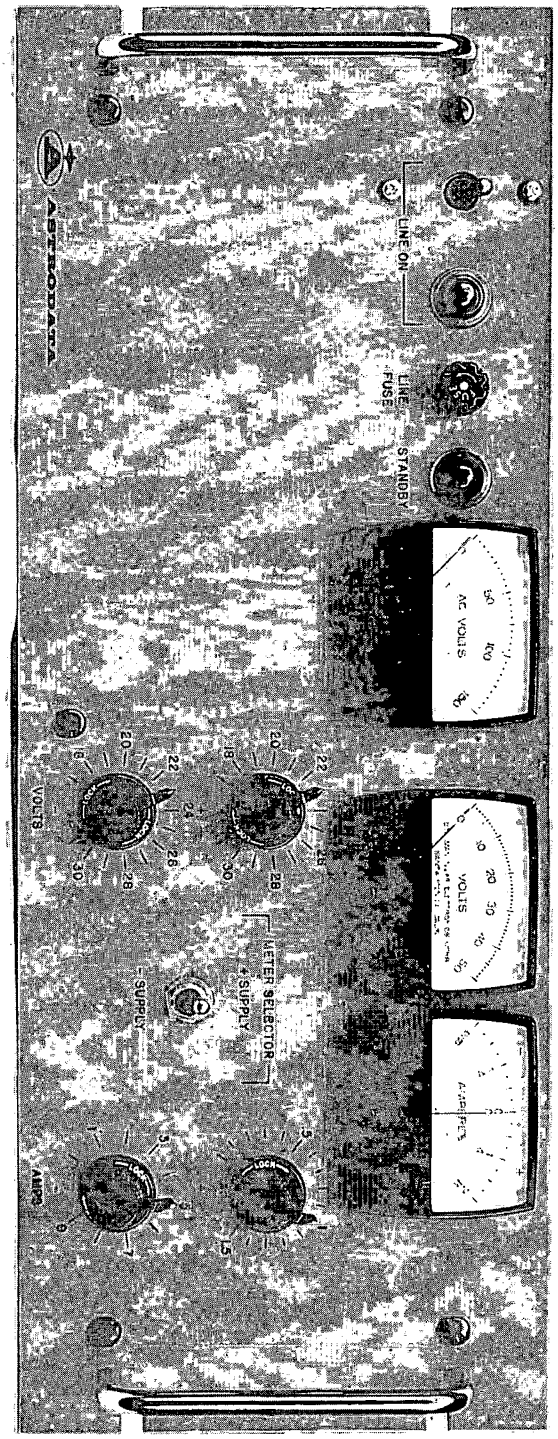

Fig. 35 - Basic Time Code Generator - Battery Power Unit - Front View

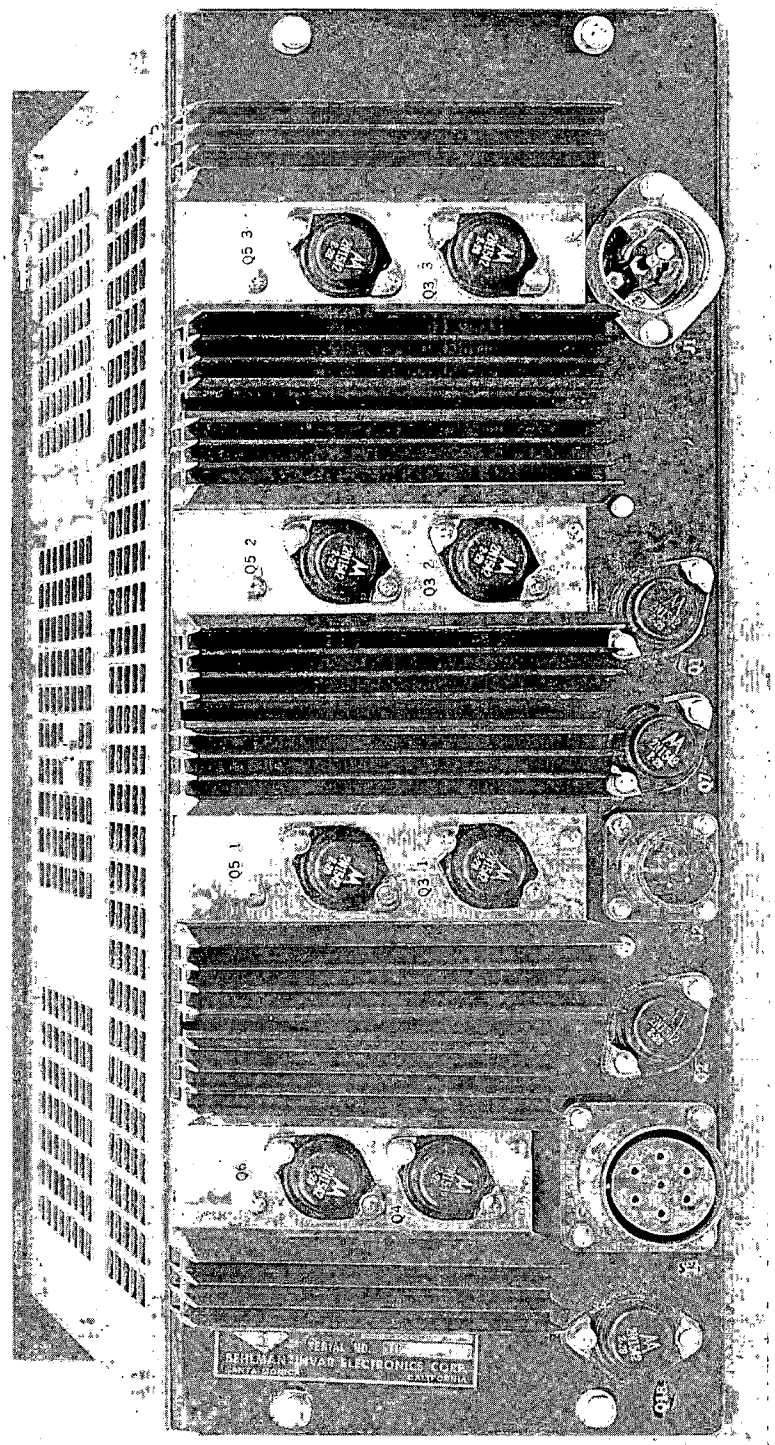

Fig. 36 - Basic Time Code Generator - Battery Power Unit - Rear View

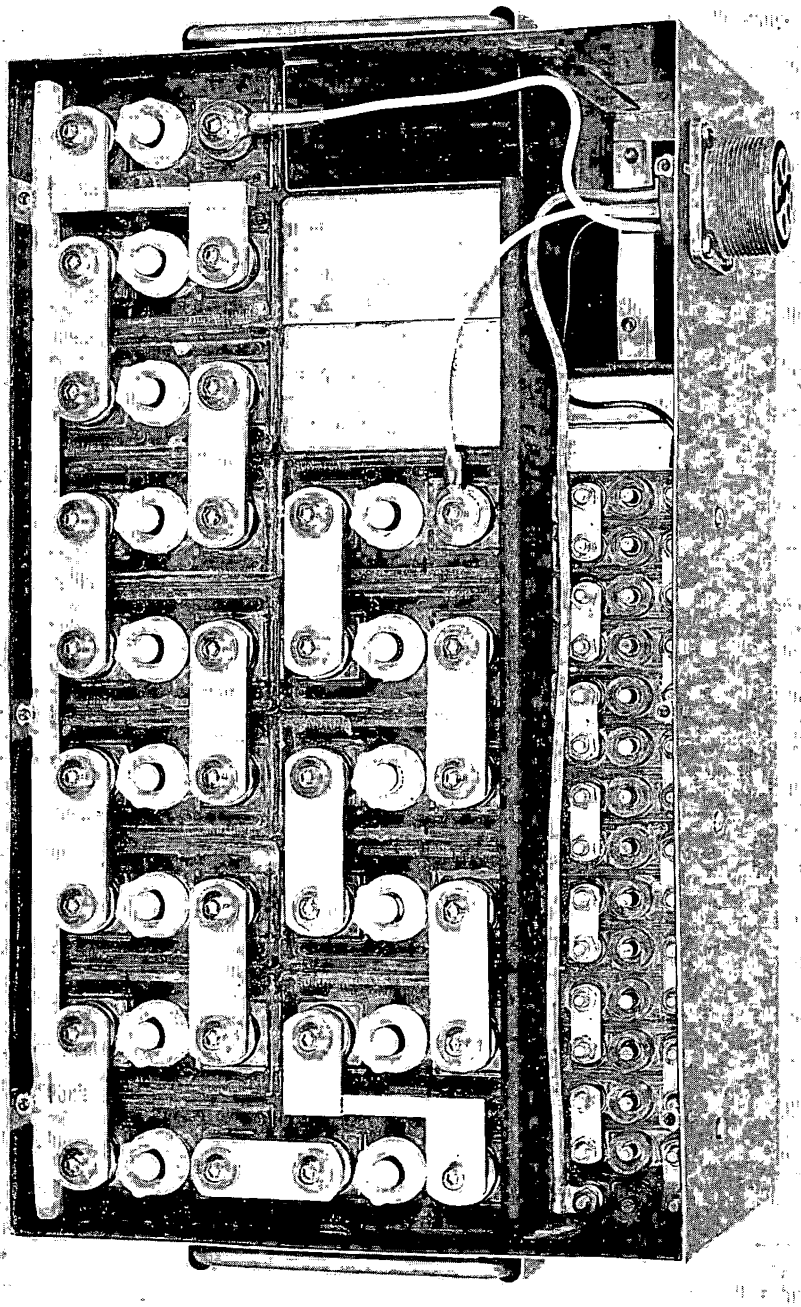

Fig. 37 - Basic Time Code Generator - Battery Unit Showing Batteries

The GR-2800, an improved version of the same recorder, is housed in a similar cabinet and employs substantially the same Tape Transport mechanism.

Electrically, the basic differences between the two types of recorders revolve around the fact that the GR-2800 is completely transistorized, employing no electron tubes, is provided with seven play-back amplifiers instead of only two as in the case of the GR-2500, and embodies 4 FM and 3 AM channels instead of 3 FM and 4 AM as in the GR-2500.

The GR-2500 recorders are no longer in production so that, aside from the superiority of the GR-2800 instruments, it proved impossible to equip all the field facilities with GR-2500's.

Accordingly, in order that no one site will have two different types of recorders that would obviously complicate maintenance, both huts at most of the sites will be equipped with GR-2800 units, while a few facilities will be provided with GR-2500's, the additional units being obtained by transfer from those sites receiving GR-2800's throughout.

It should be mentioned that the design of the GR-2800 Recorders is extremely flexible so that they can be supplied by the manufacturer, and adjusted to operate, under many different conditions, so that it is necessary to know the nature of the equipment installed in order to understand their operating potentialities.

BASIC DESIGN CHARACTERISTICS OF GR-2800 RECORDERS

POWER REQUIREMENTS:	105/125 volts, 50/62 cycle single phase ac, 210 watts for the Tape Transport plus 50 watts for each amplifier.
TYPE OF RECORDING:	AM, FM or PDM.
TYPE OF PLAYBACK:	AM, FM or PDM.
NUMBER OF CHANNELS:	Any number up to 14.
TAPE WIDTH:	1/2" or 1"
TAPE THICKNESS:	1.0 or 1.5 mil Mylar or 1.5 mil acetate.
TAPE REELS:	Up to 14" in diameter.
TAPE SPEED:	60, 30, 15, 7 1/2, 3 3/4 or 1 7/8 ips. Change of each pair of speeds requires a belt change, change within any pair is by panel control.

CHARACTERISTICS OF GR-2800 INSTALLED

POWER REQUIREMENTS:	105/125 volts, 50/62 cycles single phase ac, 1,000 watts (approximately). Equipment supplied with local oscillator power amplifier power source for capstan drive to make operation independent of line frequency fluctuations.
TYPE OR RECORDING:	3 AM channels, 4 FM channels.
TYPE OF PLAYBACK:	3 AM channels, 4 FM channels.
TAPE WIDTH:	1/2".
TAPE THICKNESS:	1.0 mil Mylar.
TAPE REELS:	10 1/2"
TAPE SPEED:	60 or 30 ips.

Figure 8 shows a front view of a GR-2800 Recorder. It will be noted that all operating controls are carried on a panel at the bottom of the Tape Transport unit which occupies the upper half of the cabinet. All controls are of the momentary contact, internally lighted type actuating lock-in relays that effect the actual functional operations.

The entire Tape Transport Assembly swings on heavy-duty pivot hinges and locks open for safety and convenience. It is mounted in a frame which, in turn, is mounted in the cabinet. A transparent dust cover closes on a continuous gasket to protect the tape and mechanical components from dust and dirt contamination.

Mechanical components of the Transport are fixed in precise alignment on a single-piece mounting base which serves as the reference plate for all mechanical subassemblies. A precision flat mounting plate holds the head stacks and vital tape drive and tape guidance components, maintaining precise head alignment and tape tracking.

A closed-loop capstan drive is used to control the tape speed in the Record and Playback modes. Pince rollers press the tape against the precision driven capstan and isolate the closed-loop of tape across the heads from disturbances outside the capstan drive. Uniform tape tension is maintained by magnetic amplifier control circuits which drive the reel

motors. The information for this control is obtained from "follower arms" (shown on the right side of the Transport in Figure 8) which rest on the tape on the reels and hence compensate for the variation in radius of the tape stack on the reels during operation.

The above is intended only as an abbreviated description of the Recorder as a matter of general information. The manufacturer of both the GR-2500 and GR-2800 units has issued complete and voluminous Instruction Manuals which are available at all sites. These Manuals contain a more complete description as well as complete instructions for operation and maintenance of the units.

SECTION 10

INTERCONNECTIONS

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10.1 INTERHUT CONNECTIONS

Sixty nine (69) wires are required for interconnection of the equipments in the two huts. Two hundred (200) wire feet of cable is provided for this purpose. These wires are carried in 18 cables, distributed as follows:

(a) 47 wires for connection between the Time Code Generator and the Remote Time Display unit. These are carried in a special 54 conductor neoprene covered cable, thus providing seven spares.

(b) 6 wires for connection between the Intercommunication units. These are carried in a special six-conductor low-capacity cable.

(c) 16 individual type RG-223U coaxial cables. 14 of these interconnect the Line Driver-Detector units in the two huts, one carries the hf antenna output between huts and one is a spare.

These cables pass through four weatherproof entrance tubes in the wall of the hut at the Entry Termination Panel (ETP) which is visible in Figure 2 at the lower right, and in Figure 10 under the operating table to the left of the antenna mast. The two multiconductor cables enter through two of the tubes while the coaxial cables use the other two tubes, eight through each tube.

10.2 INTRAHUT CONNECTIONS

So many cables are required within each hut for the interconnection of the various items of equipment that they cannot be meaningfully described by text. However, Figures 38 and 39 clearly show the many cable runs.

For identification purposes each cable has been assigned a "Cable Number" which is marked on both ends of the cables. All cables have been precut to the proper length and most end fittings are BNC and are interchangeable, end for end. To permit the various cables to be installed in an orderly fashion, plastic cable ducts have been installed between the respective racks. After installation, these ducts, then completely closed, not only give eye appeal to the installations but afford additional protection to the various cables. Aside from power cables, the cables within the huts are either RG-58/U or RG-223/U which are interchangeable both mechanically and electrically.

SECTION 11

OPERATIONAL COMMENTS

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11.1 GENERAL

As has been mentioned previously, this manual will make no attempt to delineate any details of the operation of the Facilities, for two reasons:

(1) The major units that are installed in the respective huts are all covered by their individual instruction manuals which, in each case, contain complete and comprehensive operating instructions. Any attempt at additional instructions herein would merely be repetitious.

(2) The operation of the Facilities, as a whole, varies markedly according to the particular mission involved at any specific time. Accordingly, additional manuals will be issued, as required, giving complete operating details. These will be designated as STANDARD OPERATING PROCEDURES, abbreviated SOP.

11.2 OPERATING CAPABILITIES

Fundamentally the design of the equipment in both huts and the provisions for their cross connection is such as to provide the maximum flexibility and the possibility of future expansion. For example, the two huts with their equipment provide facilities for a total of eight receiving channels and fourteen recording channels in such manner that any signals may be put on either recorder at the option of the operators.

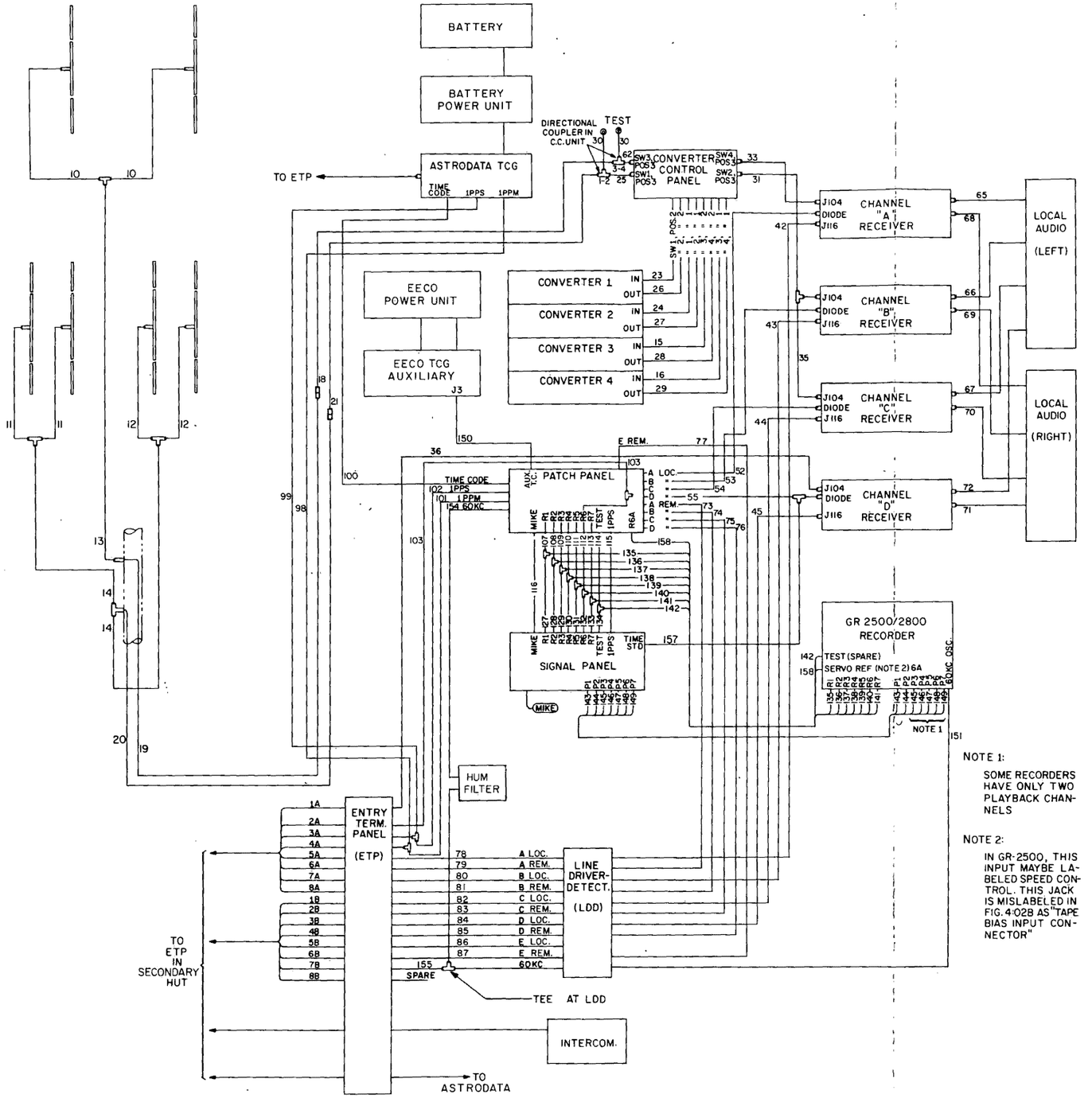
In this connection it should be repeated that the equipment and facilities in both huts are identical in all particulars, except for the Time Marking facilities, the PRIMARY hut only being equipped with a TIME CODE GENERATOR, the SECONDARY hut merely having a remote TIME DISPLAY unit. Accordingly an understanding of the operation of one hut will be equally applicable to the other.

It is believed that the block diagrams of the PRIMARY and SECONDARY huts (Figures 38 and 39) and the hut interconnection diagram (Figure 40) together with the front views of the PATCH and SIGNAL panels, shown in Figures 28 and 29 are sufficiently descriptive to permit a thorough understanding of the operational capabilities of the FACILITIES without a detailed exposition. However, there are a few points that might require some clarification. These will be enumerated below.

1. While it will be noted that but four receivers are provided in each hut, designated as Channels A to D inclusive, the PATCH PANEL and the LINE DRIVER - DETECTOR unit both carry items designated as Channel E. These were provided in anticipation of adding an additional special receiver to the complement in each hut at a later date. These features may be ignored in the description contained in this manual.

2. The SIGNAL PANEL is intended primarily as a means whereby the oscilloscope may be patched into any of the recording or playback channels on the recorder or at such other points that might merit scope inspection. Inasmuch as the scope is provided with a four channel head, inspection and/or comparisons may be made of any four circuits simultaneously.

3. The circuital connections of the 60-kc output from the two recorders may appear confusing without an explanation. A 60-kc signal is intended as a timing trace on the tape records of the two recorders which at times may be so cross-connected as to be receiving signals from either or both huts. Under such conditions it is essential that the 60-kc time markings on both tapes be exactly the same. But the oscillators in the recorders are not of extremely high precision. Therefore, in operation, it is necessary to use the 60-kc output from only one recorder to feed the tapes of both, at the same time keeping the oscillators of both recorders available for immediate use. To accomplish this, the amplified output from both recorders is connected together and to the respective PATCH panels in the two huts, but the 60 kc - OFF - 30 kc switch of one oscillator (which is accessible when the tape transport is extended) must be set on OFF and that of the other at 60 kc.



NOTE 1:

SOME RECORDERS HAVE ONLY TWO PLAYBACK CHANNELS

NOTE 2:

IN GR-2500, THIS INPUT MAYBE LABELED SPEED CONTROL. THIS JACK IS MISLABELED IN FIG. 4-028 AS "TAPE BIAS INPUT CONNECTOR"

Fig. 38 - Cabling Diagram - PRIMARY Huts

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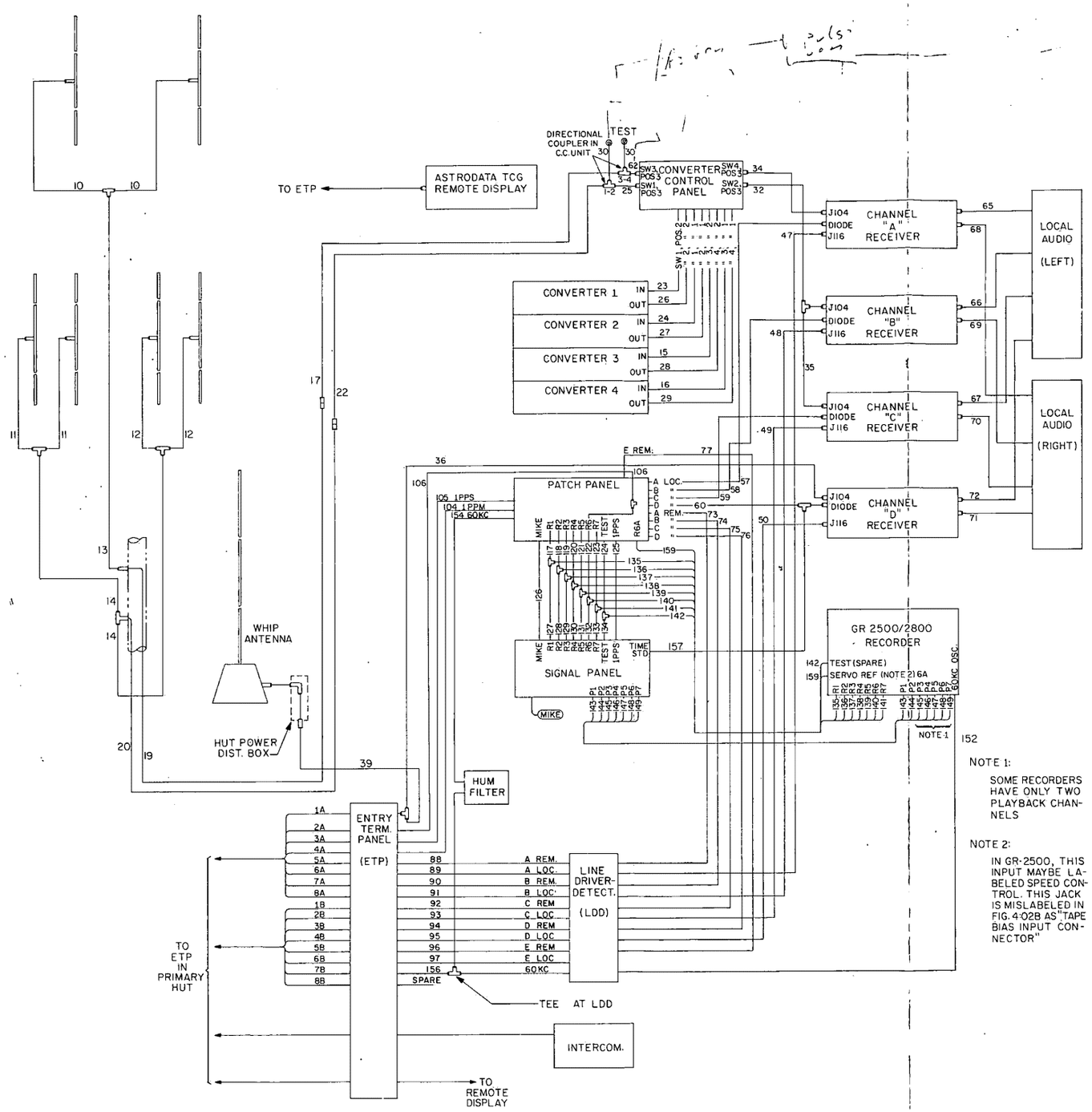

Fig. 39 - Cabling Diagram – SECONDARY Huts

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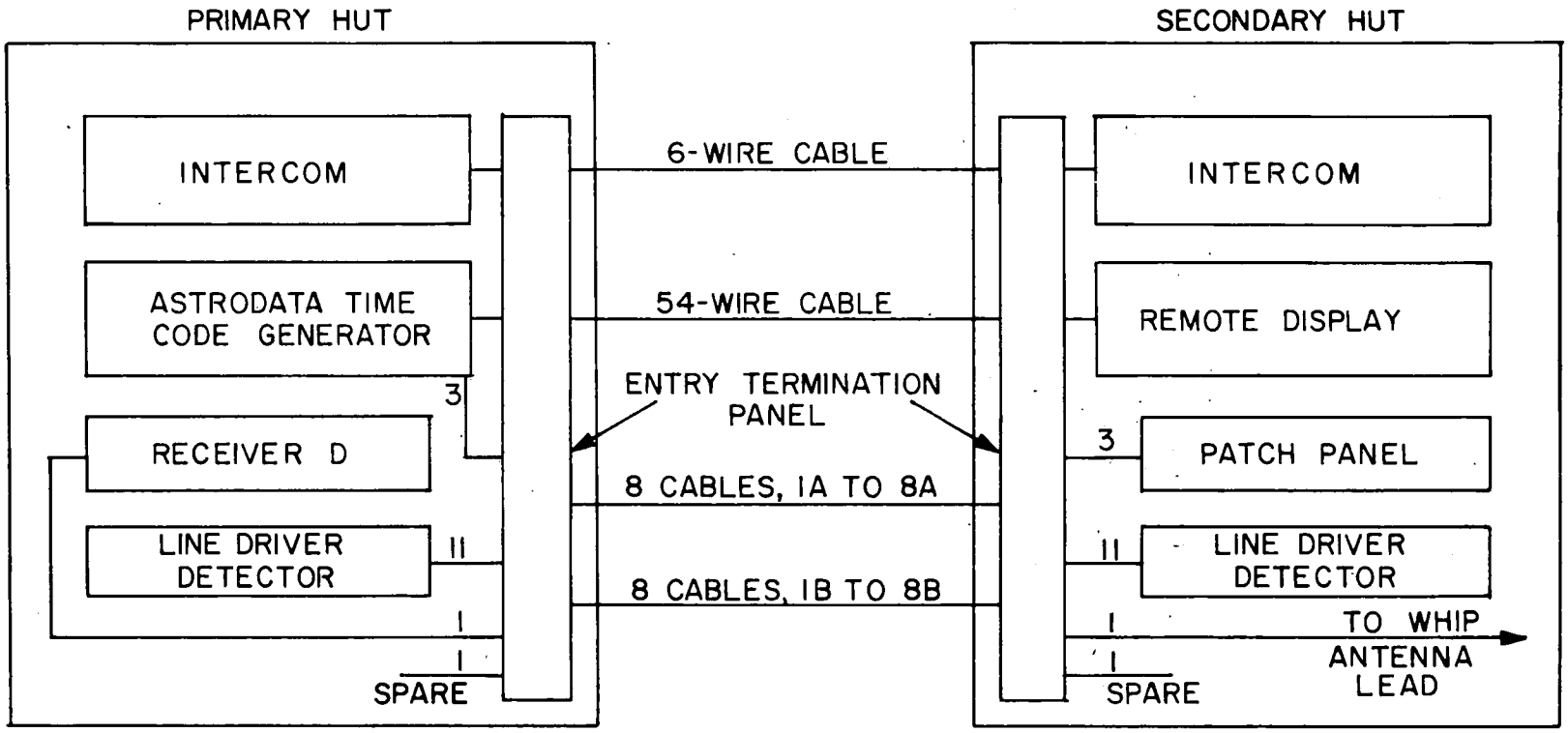

Fig. 40 - Interconnection of Huts – Block and Cabling Diagram

SECTION 12

MAINTENANCE

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As in the case of Operating Instructions, the various instruction manuals for all the major equipments installed in the Facilities contain complete and detailed maintenance instructions which require no supplementary instructions here. Certain of the minor units, such as the PATCH, SIGNAL and LOCAL AUDIO panels were designed and furnished by the Naval Research Laboratory as were the CONVERTER RACK FAN unit and the LINE DRIVER - DETECTOR units. The first four are primarily interconnection or patch panels and require no maintenance. The fifth, the LINE DRIVER - DETECTOR unit is of such electronic simplicity as to require little or no maintenance other than the periodic replacement of the electron tubes as required.

The ac power wiring of the 12-foot huts is shown in Figure 41.

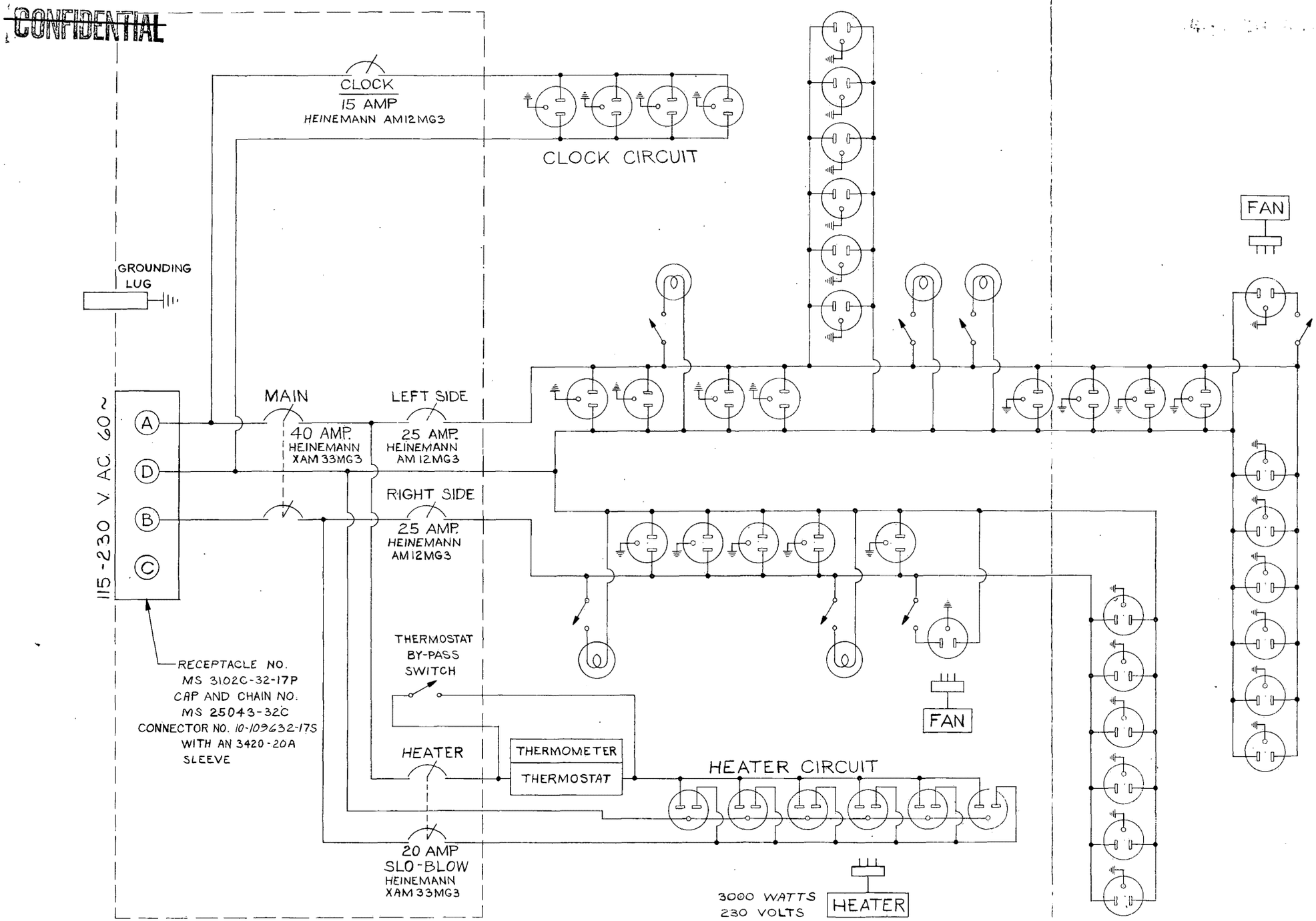

Fig. 41 - Circuits of 12-Foot Huts

SECTION 13

SPARE PARTS SUPPLIED

13.1 LIST OF SPARE PARTS

In addition to the duplication of facilities that has been provided (including two complete huts at each site, an installed spare converter for each frequency band in each hut, the retention of the EECO Time Code Generator as an emergency spare for the new Astrodata TCG, and means for rapidly connecting the output of any receiver to the recorder in either hut) a limited number of spare parts has been furnished each station as a part of this modernization. These spares are listed in Tables 2 to 5 below.

TABLE 2

SPARES FOR LINE DRIVER - DETECTOR

Item	Description	Quantity
Capacitor, Filter	40 mfds., 450 vdc.	1
Choke, Filter	NRL No. 3569C	1
Transformer, Power	NRL No. 11215	1

TABLE 3

SPARES FOR TIME CODE GENERATOR ASTRODATA MODEL 6140-500

Astrodata Part No.	Description	Quantity
11191	Circuit Card, 20 kc Preset Counter	2
11262	Circuit Card, Stop, Start, Arm, Advance, Retard Logic	1
11413	Circuit Card, 1 Mc Signal Shaper	1
11415	Circuit Card, 100 kc DCU	1
11873	Circuit Card, -6, -10, and +18 Voltage Regulator	1
12048	Circuit Card, Decoded Nixie Driver 0-9, 0-5	1
15042	Circuit Card, TCG Output Driver	1
15043	Circuit Card, 2 kc Sine Wave Shaper	1
15050	Circuit Card, 10 kc DCU	1
15051	Circuit Card, Dual 0-5 Decimal Decoder	1
15052	Circuit Card, 20 Bit Code Matrix	1
15053	Circuit Card, 20 Bit Code Output	1
15069	Circuit Card, 1 Mc Counter	1
1163-002	Power Supply, Time Code Generator	1

TABLE 4

SPARE TUBES AND SEMICONDUCTOR DEVICES

Tube Type	Equipment In Which Used	Tubes Per Site For Modernization #2	
		In Use	Spares Supplied
OA2	R-390A, EECO TCG PU	8	2
OG3	Scope	2	2
3TF7	R-390A, R-391	8	2
6AJ5	R-391	3	5
6AK5W/5654	R-390A, Converter, LD-D	24	5
6AK6	R-390A, R-391	24	6
6AL5	EECO TCG	2	5
6AU6	Scope	7	2
6BA6W/5749	R-390A, R-391, LD-D	56	10
6BC7	Scope	2	2
6BH6	R-391	1	5
6BJ6	R-391	7	5
6BL8	Scope	8	2
6BQ7A	Converter	8	2
6C4	R-390A, R-391	24	6
6CB6	Converter	8	2
6CL6	Scope	4	2
6CZ5	Scope	2	2
6DC6	R-390A	7	2
6DJ8	Scope	18	5
6EJ7	Converter	8	2
6J6	EECO TCG	1	5
6U8	Converter	8	2
12AT7	R-391	1	5
12AU7 (SEE 5814A)			
12AY7	EECO TCG PU	1	2

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TABLE 4 (Continued)

SPARE TUBES AND SEMICONDUCTOR DEVICES

Tube Type	Equipment In Which Used	Tubes Per Site For Modernization #2	
		In Use	Spares Supplied
12B4A	Converter	16	4
12BH7	Scope, LD-D	2	5
26Z5	R-390A, R-391	16	3
417A/5842	Converter	8	2
5642	Scope	1	2
5651	R-391, Converter, LD-D	12	3
5654 (SEE 6AK5W)			
5687	EECO TCG	1	2
5693	EECO TCG	1	2
5749(SEE 6BA6W)			
5814A/12AU7	R-390A, R-391, LD-D	6	16
5842 (SEE 417A)			
5963	EECO TCG	39	5
5965	EECO TCG	39	5
6080/6080WA	EECO TCG PU, LD-D, Scope	6	2
6082	R-391	2	5

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TABLE 4 (Continued)

SPARE TUBES AND SEMICONDUCTOR DEVICES

Tube Type	Equipment In Which Used	Tubes Per Site For Modernization #2	
		In Use	Spares Supplied
7233/Z-2300	Scope	2	2
7586	Scope	2	2
IN277	Astrodata TCG, LD-D		10
IN643	Astrodata TCG		10
IN658	Astrodata TCG		10
IN1491	Converter	16	10

NOTE 1: Tubes listed for "Scope" include those for plug-in units supplied with scope.

NOTE 2: No spare tubes are included for GR-2500 Recorder, only a few of which are in service. Spares for it were supplied with Modernization No. 1.

NOTE 3: Tubes of the following types (of which spares were previously furnished for the Magnecord Recorder and the original style of converter) are no longer needed as spares for the modernized huts: OA3, 5U4G, 5Y3, 6AQ5, 6SJ7, 6Y6 and 5879.

TABLE 5

SPARE FUSES

Fuse Rating Amps.	Volts	Description	For Use In	Quantity
1/8	250	3AG QA	R-390A Receiver	10
1/4	125	3AG SB	R-390A Receiver	10
3/8	125	3AG SB	R-391, Conv. Fan Unit	10
1/2	250	3AG QA	Astrodata TCG	10
1/2	125	3AG SB	Converter	15
1	250	3AG QA	Astrodata TCG, LD-D, GR-2800 Recorder (F202)	10
1	125	3AG SB	GR-2800 Recorder (F203)	10
1	250	8AG (1") QA	Talk-A-Phone	10
2	125	3AG SB	Astrodata TCG	10
3	250	3AG QA	Astrodata TCG PU	10
3	125	3AG SB	R-390A, R-391, GR-2800 (F2, F4, F207)	20
5	250	3AG QA	Astrodata TCG	10
5	125	3AG SB	EECO TCG PU, GR-2800	10
8	125	3AG QA	GR-2800	10
10	125	3AB ML	GR-2800, Astrodata TCG PU.	10
20	125	3AB ML	GR-2800	10

NOTE 1: Stations provided with GR-2500 Recorders are also supplied ten 15-Ampere 3AB-ML fuses.

NOTE 2: QA = quick acting; SB = slow blow; ML = medium lag.