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INSTRUMENTATION FOR THE CORIOLIS ACCELERATION PLATFORM

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SUMMARY PAGE

THE PROBLEM

To provide the basic communication, measurement, test, and recording capabilities required to implement the experimental programs planned for the Coriolis Acceleration Platform, a new motion device recently installed at the vestibular research facilities of this activity.

FINDINGS

The development and installation of a general-purpose instrumentation system for the Coriolis Acceleration Platform which provides the basic transducers, signal-conditioning circuitry, and recording equipment for the acquisition, display, and storage of a wide variety of commonly collected biological and bioenvironmental measurement data.

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INTRODUCTION

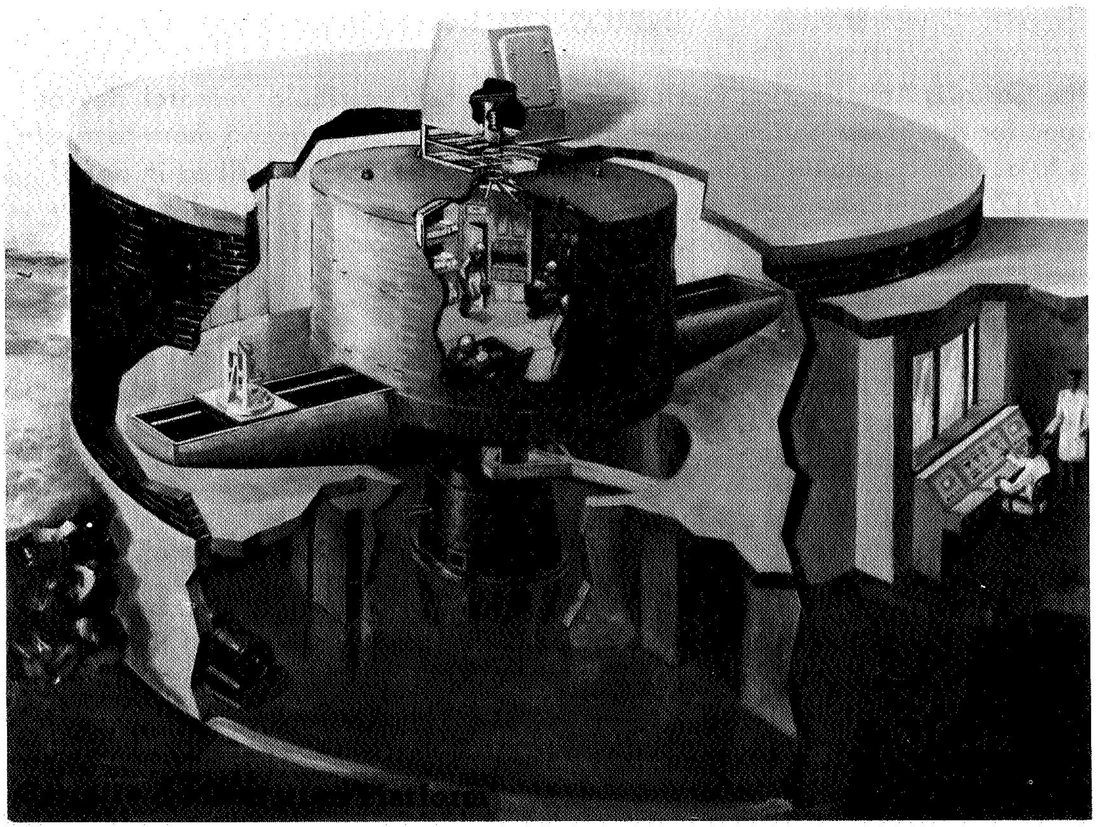
The Coriolis Acceleration Platform (CAP) is a new vestibular research device developed for the investigation of the biological effects of long-and short-term exposures to aerospace acceleration environments. The device, described in detail elsewhere (2), can produce two precisely controlled forms of motion: rotation about an Earth-vertical axis and translation along an Earth-horizontal axis. By means of two independent drive systems, these motions can be programmed to occur either singly or in combination. As a result of this capability, the device affords a direct experimental approach to the study of the separate and joint contributions of the linear acceleration and angular acceleration components of a force environment to an observed biological response. The subject of this report is an instrumentation system developed to provide the basic measurement and recording capabilities required to initiate such studies.

GENERAL DESCRIPTION

The physical configuration of CAP is illustrated by the artist's sketch of the overall installation presented at the top in Figure 1. The motion element of the device is a large, rotating superstructure installed centrally in a circular, two-level building. The superstructure, composed of a 20-foot diameter capsule and a 40-foot long track turret which passes radially through the center of the capsule, is bearing supported on a pedestal assembly mounted in the lower level of the building. A dome atop the building houses an instrumentation slip-ring bank which electrically interconnects the capsule and an adjacent control room. The device can be used to present linear and/or angular motion stimuli to a single subject seated on a track platform as shown in shaded detail at the left of the capsule in Figure 1, or angular motion stimuli to a large number of subjects located within the capsule.

The form of the motions produced by CAP is illustrated in the plan view of the device and control room presented at the bottom in Figure 1. The rotation capability is derived from a direct-coupled DC torque motor installed in the pedestal which turns the entire device, track turret as well as capsule, about an Earth-vertical axis. Precise control of the angular motion parameters is established by operation of the torque motor as a velocity mode servomechanism. The Earth-horizontal linear displacement capability is derived from a second drive motor installed within the superstructure immediately above the pedestal. This motor is wire-rope coupled to the base of the track platform which is wheel-supported on two "Vee" rails extending the full length of the turret. Operation of this motor as a position mode servomechanism results in programmed control of the instantaneous displacement of the track platform. Unrestricted passage of the platform through the center of the device is provided by removable wall and floor panels installed in the capsule structure.

It is evident that, through programmed control of the level, magnitude-time profile, and duration of the two forms of motion, a wide variety of stimuli conditions can be produced. As a result, the instrumentation demands of each research program are usually unique. There are, however, certain requirements which are common to each program.



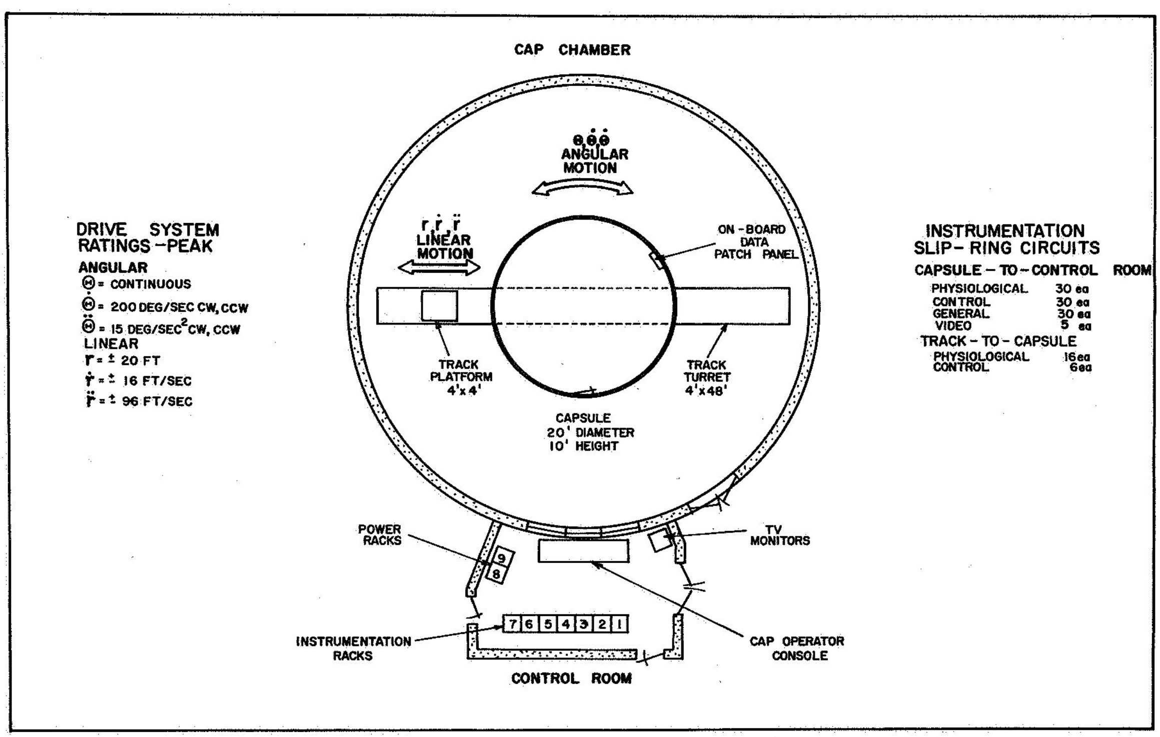


Figure 1

Artist's sketch (top) and plan view (bottom) of the Coriolis Acceleration Platform (CAP)

These include the need for transducers and signal-conditioning equipment for measurement of the motion parameters of CAP, similar facilities for measurement of physiological and psychological responses, recording devices to display and store such data, audio and visual equipment to monitor subject status, and ancillary test devices for system checkout.

A block diagram of the system developed to meet these requirements with minimal interface complications is presented in Figure 2. In this diagram the components shown above the horizontal dashed line are installed aboard the device; those shown below are installed off-board, chiefly in the CAP control room. The central element in the device area is a shielded-cell patch panel with a removable program board. This element, identified as the On-Board Data Patch Panel, terminates all instrumentation devices and circuits located aboard the device. A similar unit, identified as the Control Room Data Patch Panel, serves an identical function for the off-board components of the system. Data transmission between the two areas is provided by four sets of slip rings mounted above the capsule which directly interconnect the On-Board and Control Room Data Patch Panels. A second slip-ring assembly, coupled to the shaft of the track drive motor, interconnects the track platform to the On-Board Data Patch Panel.

For the acquisition of physiological data within the capsule, the system provides a 12-channel Biosignal Conditioner Module which can be used for the measurement of such parameters as the standard lead ECG, Frank lead VCG, heart rate, respiration rate, EEG, horizontal and vertical nystagmus, body temperature, and GSR. The unit also includes carrier and chopper-stabilized DC amplifiers for operation of resistive strain gage, variable reluctance, and similar bridge-type transducers. Signal-conditioning operations in the control room are provided by a 16-channel data amplifier assembly used to drive the system recording equipments. These include an 8-channel direct-writing recorder and a 16-channel light-beam galvanometer recorder for data display, a 7-channel magnetic tape recorder for data storage, and a 30-channel event recorder for display of sequential on-off response data.

Multipath voice communication between on-board and off-board personnel is provided by a 4-channel audio-amplifier system. The input and output circuitry of this system and related audio recording and acoustic test instruments are terminated in the control room at a third patch panel, identified as the Audio Patch Panel. Closed-circuit television coverage of a given experiment is provided by two vidicon cameras which can be installed either within the capsule or on the track platform. Two television monitors installed in the control room allow off-board observations; a third monitor can be installed within the capsule whenever capsule personnel are required to monitor the status of a subject positioned on the track platform.

Transducers available to record the motion parameters of the device include an indicator tachometer and an angular accelerometer to measure the instantaneous angular velocity and acceleration of the superstructure, two linear accelerometers to measure the instantaneous linear acceleration of the track platform in the radial and tangential directions, and a track position potentiometer to measure the linear displacement of the

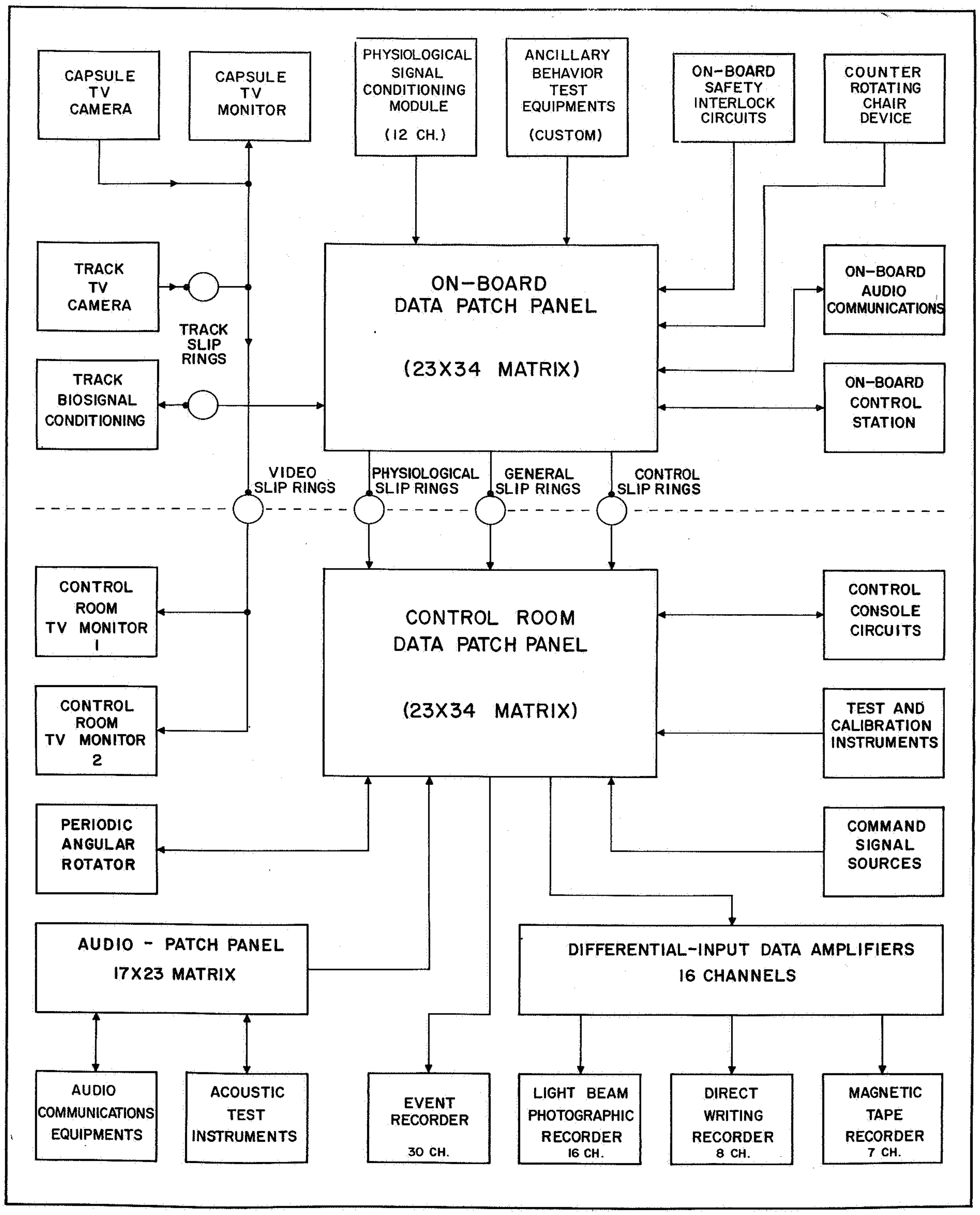


Figure 2

Block diagram of CAP instrumentation system

track platform from the center of the device. Command signal sources are furnished to allow the drive systems to be programmed to produce ramp, sinusoidal, triangular, and square wave motion profiles.

Ancillary terminations at the On-Board Data Patch Panel include access receptacles for connection of specialized instrumentation equipment supplied by an investigator to meet his individual experimental requirements, slip-ring circuitry associated with a counterrotating device (3) which can be installed on the track platform, and miscellaneous safety interlock and control circuits required for operation of the device. Similar terminations at the Control Room Data Patch Panel include the input/output circuitry of various test instruments used to set up and calibrate the system; the output of several general purpose, voltage-regulated DC power supplies; and interconnecting lines to a similar patch panel installed in the instrumentation system of an adjoining vestibular research device, the Periodic Angular Rotator (1). These lines permit the ready interchange of instrumentation capabilities between the two systems.

The majority of the off-board elements of the system are housed in seven forced-air ventilated racks installed in the CAP control room, an over-all view of which is shown at the top in Figure 3. These racks may be seen at the left directly across from the operator console; the two racks at the rear house DC power supplies used to energize various instrumentation and control circuits. A front-view photograph of the seven instrumentation racks, identified as Rack 1 through Rack 7 as viewed from left to right, is shown at the bottom in Figure 3. The recording system components are housed in Racks 1 and 2; the Control Room Data Patch Panel in Rack 3; the system test and calibration instruments, as well as certain CAP command signal sources, in Rack 4; the Audio Patch Panel in Rack 5; and the audio communication elements of the system in Racks 6 and 7.

APPLICATION DETAILS

INSTRUMENTATION SLIP RINGS

Data transmission between the Control Room and On-Board Data Patch Panel stations is provided by the upper slip-ring assembly that is mounted above the ceiling of the capsule to achieve maximal physical separation from the power circuitry located in the pedestal. This assembly, in which coin-silver rings and silver-graphite (75%-25%) brushes are used, provides 90 instrumentation circuits and 5 video lines. A simplified schematic drawing of the instrumentation circuits is shown at the top in Figure 4 in which each slip ring is drawn as a circle with the related brush contact denoted by an intersecting dot. The numerals seen within the circle represent the manufacturer's circuit identification for the slip ring; the alpha-numeric symbol shown at the side of a given slip-ring circuit denotes the specific patch-panel cell to which the slip ring is wired.

The 90 instrumentation circuits are subdivided into three groups of 30 rings and the groups identified as the Control Slip Rings UV, the General Purpose Slip Rings RS, and the Physiological Slip Rings AB-FG. The alphabetical suffix denotes the patch-panel

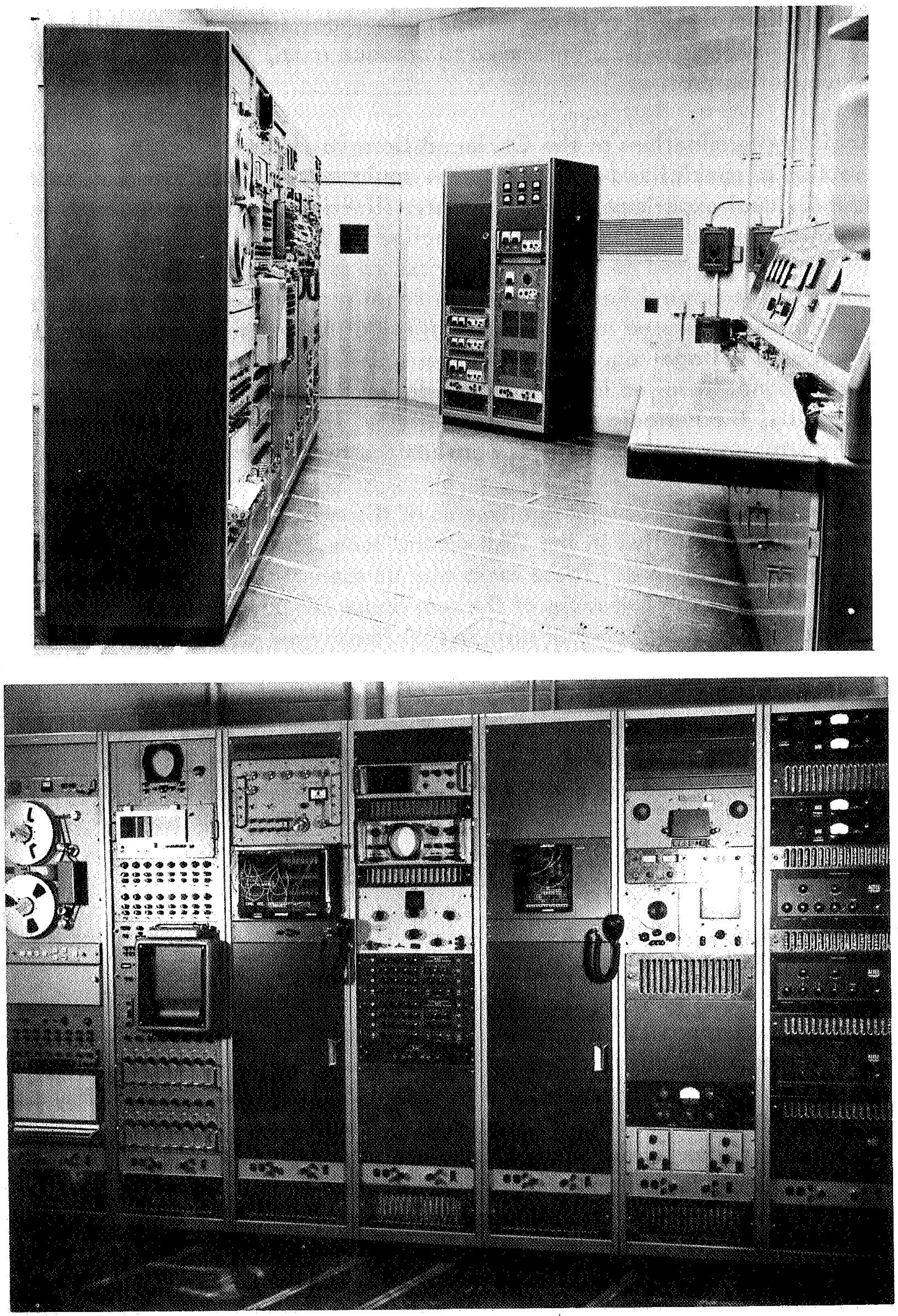


Figure 3

Over-all view of the CAP control room showing the control console at the right, the bioinstrumentation racks at the left, and the power supply racks in the background (top). Front view of the bioinstrumentation racks (bottom).

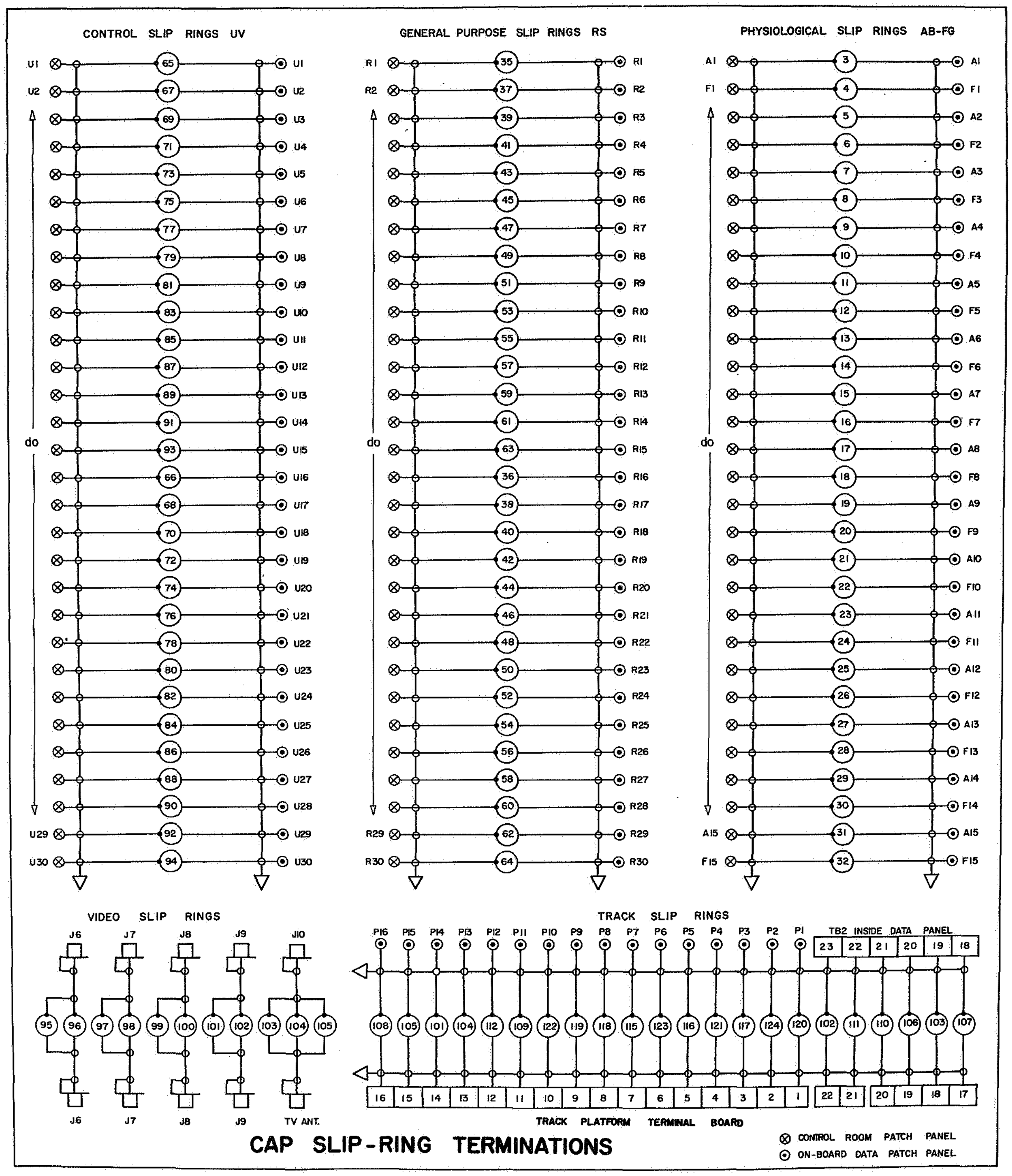


Figure 4

Simplified schematic of CAP instrumentation slip-ring circuitry row at which the related group of slip rings is terminated. Each ring in the control and general purpose groups is application rated at 115 VDC and 2 amperes into a resistive load. Those in the physiological group are rated at 28 VDC and 0.1 ampere into a resistive load and have a maximum noise output of less than 5.0 microvolts rms across 500 ohms over the 0-100-cps spectrum at 30 rpm. Interconnection between each slip-ring assembly and the two patch panels is provided by 90, type RG174U, coaxial cables. To minimize ground-loop difficulties, the shields of these cables are physically isolated from each other at the slip-ring assembly proper and electrically interconnected at a single bonding point within each data patch panel. The two bonding points are electrically linked by four slip rings (not shown in Figure 4) and returned to a high-quality ground-rod system installed beneath the control room floor.

The five video slip-ring circuits shown at the lower left in Figure 4 use separate slip rings for the center conductor and shield of each interconnecting coaxial cable. Access to these circuits from within the capsule is provided by five BNC receptacles installed at the On-Board Data Patch Panel. Four of these circuits are made available in the control room at a termination panel installed at the rear of Rack 3; the fifth circuit is directly connected to an outside antenna/booster amplifier combination used to provide entertainment TV to personnel living aboard CAP during long-duration rotation studies.

The circuitry associated with a second slip-ring assembly which interconnects the moving track platform and the On-Board Data Patch Panel is shown at the lower right in Figure 4. Of the 22 circuits provided, 16 are made available on the patch panel proper for low-level instrumentation purposes and 6 are wired to an internal terminal board for power service to the track platform. The patch-panel circuits are application rated for resistive loads at 28 VDC and 0.1 ampere and the terminal board circuits at 115 VDC and 2.0 amperes.

DATA RECORDING SYSTEM

The data recording system was developed from standard commercially available equipment (Sanborn Company) and includes two 8-channel data amplifier modules (Model 860-4000P) which provide the voltage amplification and impedance transformation characteristics necessary to drive the system recorders; a CRT oscilloscope (Model 569A) with input switching circuitry to monitor the output of each data amplifier; an 8-channel direct-writing recorder (Model 358) for display of data in the 0-100-cps spectrum; a 16-channel light-beam galvanometer recorder (Model 650-900) for display of data in the 0-500-cps spectrum; a 7-channel magnetic tape instrumentation recorder/reproducer (Model 2000) for data storage purposes; and a 30-channel event recorder (Model 361).

The 16-data amplifiers are differential-input, single-ended output units which feature precision control of gain, high common-mode rejection, and low DC drift. Each amplifier is equipped with a fixed-gain selector switch to provide voltage amplifications of 5, 10, 20, 50, and 100, and a vernier gain control to preselect intermediate values. Since many CAP experiments would involve recording data from high-output transducers, such as the capsule tachometer, as well as low-level data derived from on-board equipment, a custom attenuator panel was developed for each amplifier module. This panel provides a separate six-position attenuator switch for each amplifier to allow gain reduction in decade steps. Pertinent manufacturer's performance specifications include a full-scale output of ±5 volts at ±100 milliamperes, an input impedance of 150,000 ohms, a linearity of ±0.1 per cent of full scale at DC, and a drift temperature coefficient of less than ±1.0 microvolt per degree C referred to the input.

Rectilinear display of low-frequency data on thermal-sensitive chart paper is provided by the 8-channel direct-writing recorder. Each channel of the recorder is set up to have a recording sensitivity of ±1 volt to produce a galvanometer deflection of ±10 minor chart divisions. This sensitivity, which serves as reference for the entire recording system, is such that ±2.5 volts produces full galvanometer excursion over the 50-minor chart division width (approximately 4 centimeters) of the recording paper. Individual gain controls, installed on a panel located immediately above the recorder proper, permit the sensitivity of each channel to be precisely trimmed to this level. Individual position controls on the same panel allow each galvanometer to be centered on the chart paper with a zero input signal level relative to ground serving as adjustment reference. The recorder also includes a combination time and marker stylus which can be activated at the recorder proper or at a master control station common to all of the recorders.

The light-beam galvanometer recorder utilizes an ultraviolet light source and is equipped with an external latensification unit for relatively rapid visual display of the recorded data on 8-inch photographic paper. Sixteen of the galvanometers, each with a 0-500-cps response, are driven by the data amplifiers; a 17th galvanometer is driven by a master 1.0-second clock pulse generator. The basic deflection sensitivity of each channel is preset by means of a vernier gain control to ±1-volt input per ±2.5-centimeter deflection. Ancillary controls include attenuator switches to reduce this sensitivity by a factor of 1, 2, or 5; potentiometers to position each galvanometer trace at any point on the recording paper; and toggle switches to reverse the polarity of the galvanometer deflection.

The 7-channel magnetic tape recorder/reproducer is an IRIG compatible, standard-bandwidth instrument using 1/2-inch tape. The unit is equipped with FM record and FM reproduce electronics for operation at a tape speed of 7 1/2 ips, resulting in a data storage bandwidth of 0-1250 cps. When voice annotation is required, direct type electronics can be substituted for one of the FM channels. The recording sensitivity of each of the FM channels is calibrated so that a ±2.5 volt signal produces full ±40-per cent modulation deviation. This modulation sensitivity was selected to achieve maximal compatibility between the tape recorder proper and the 8-channel direct-writing recorder usually used to monitor the record level of the input data. Since the latter recorder requires a ±2.5-volt signal for full utilization of its galvanometer deflection capability, any signal displayed within the boundaries of the chart paper will be stored by the tape recorder without overload distortion.

The 30-channel event recorder utilizes electrically sensitive chart paper to record the time of occurrence and duration of on-off electrical responses. One channel is used to display the 1.0-second timing pulses generated by the master clock. A response is recorded in the form of a darkened line whenever the single wire input to a given channel is connected to a signal return line which is common to all 30 channels.

CONTROL ROOM DATA PATCH PANEL

The pictorial layout of the Control Room Data Patch Panel shown in Figure 5 serves to detail the specific circuit terminations of the instrumentation slip rings, the data recording equipment, and the majority of the ancillary devices and circuits installed in the proximity of the CAP control room. The patch-panel assembly (AMP Inc. Model 695109-2) is a removable program board unit that contains 782 individually shielded and color-coded nylon cells with gold-plated contact inserts. The cells, arranged in a 23x34 matrix, can be interconnected from the front by RG174 coaxial cable patchcords that are available in a variety of single and multiconductor combinations. Permanent wiring is attached to the rear of the panel by means of a 0.053-inch taper pin receptacle located at the center of each cell insert.

The physical location of each cell in the matrix is identified in standard alphanumeric code as derived from the row and column symbols shown on the sides of the panel in Figure 5. On this drawing, a filled circle on a line dividing two adjacent cells denotes that these cells have been electrically connected by means of rear panel jumpers. These cell junctions or commoning points are provided for the on-line checkout of system operation without circuit interruption due to patchcord removal. The shields surrounding each cell are electrically interconnected and terminated at cell A17 which is wired directly to a high-quality Earth ground-rod system installed in a cabling trench located immediately beneath the control room instrumentation racks. Access to the ground system is provided by rear panel jumpers which interconnect all the cells in the patch-panel row bounded by D1 and D17 and the column bounded by A17 and Q17.

As indicated in Figure 5, the 30 Control Slip Rings are wired to cells U1-U30 and V1-V30 with 2 cells provided for each slip ring. Those safety interlock circuits and DC power services which are patched routinely through the Control Slip Rings to the capsule are permanently wired to cells W1-W30. The 30 General Purpose Slip Rings are similarly terminated at R1-R30 and S1-S30. The 30 Physiological Slip Rings are subdivided into two sets to facilitate patching operations involved in the setup of the differential-input data amplifiers and recording system; 15 slip rings are wired to cells A1-A15 and B1-B15 with the remaining terminated at cells F1-F15 and G1-G15. Access to the input/output circuitry of the 16 data amplifiers is as follows: The positive and negative differential-input terminals of Amplifier 1 (located in Rack 2 at the extreme left in the top data amplifier module) are wired to cells C1 and E1, respectively; the signal return path of the amplifier is brought to ground potential at D1; and the single-ended output signal is made available at H1 which is wired in parallel with I1. The remaining 15 data amplifiers are similarly terminated in columns 2 through 16.

Access to the single-ended input stages of the 16-channel light-beam galvanometer recorder is provided by cells J1-J16 and K1-K16; the 8-channel direct-writing recorder

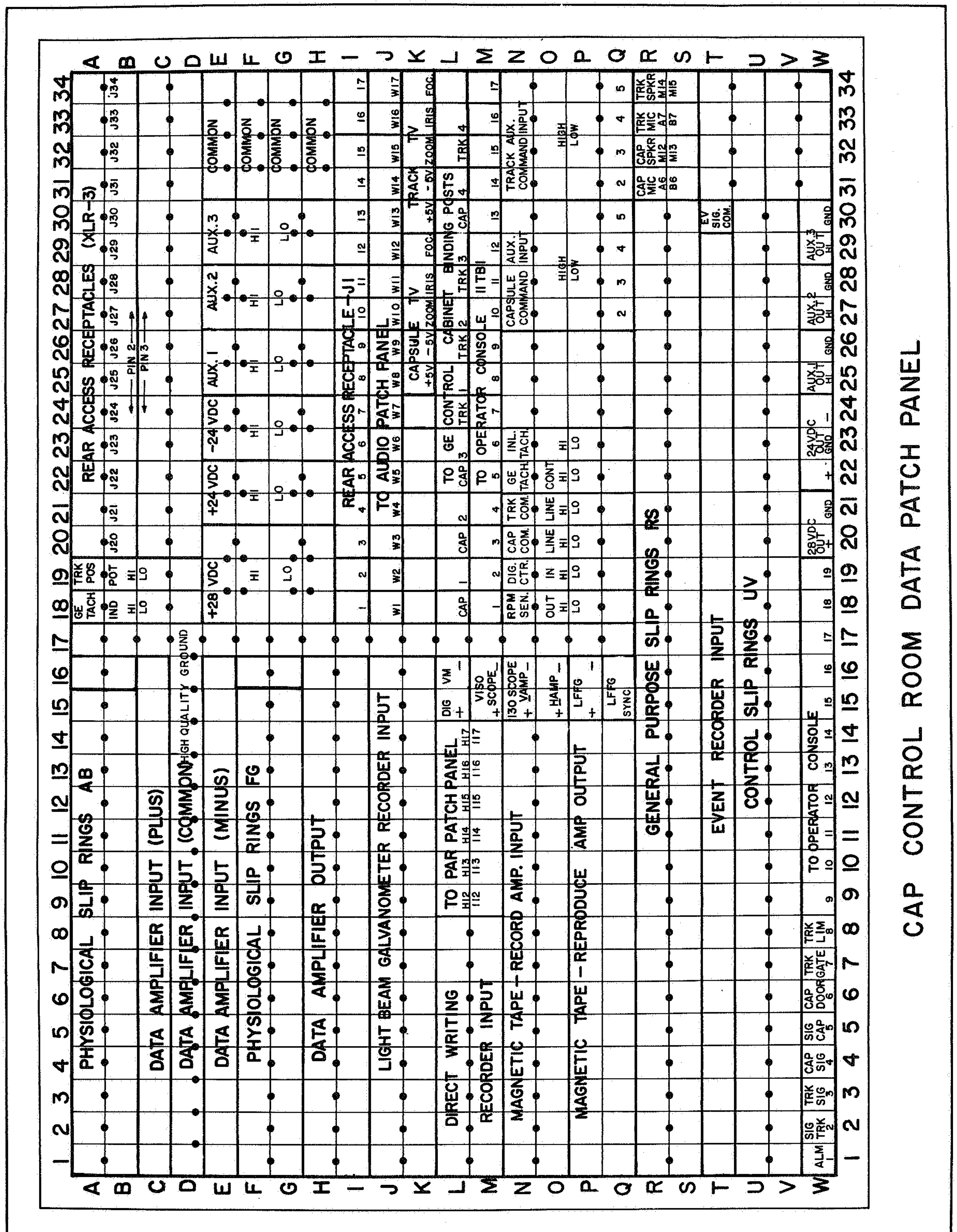


Figure 5

Layout drawing of the Data Patch Panel installed in the CAP control room listing the circuits terminated at each patch-panel cell. A dot shown on a line separating two adjacent cells denotes that the cells are electrically interconnected at the rear of the patch panel.

at L1-L8 and M1-M8; and the 7-channel magnetic tape recorder at N1-N7 and 01-07. The signal and signal return output lines of the tape reproduce amplifiers are separately terminated at cells P1-P7 and Q1-Q7. Seven extra cell columns provide for later conversion of the tape system to a 14-channel capability. All signal return or ground path wiring associated with the output of each data amplifier and with the input of each recording channel is made internal to the patch panel to reduce patching operations to the transfer of only a single circuit line.

The input circuitry to the event recorder is terminated in cell row T1-T30. To activate any of the 29 record channels, the associated channel input lead must be connected to terminal T30. The connection must be of hard wire form, i.e., a relay or switch contact, and be isolated from ground.

The circuitry associated with the test equipment supplied for setup and calibration of the system is made available in the cell group bounded by L15, L16, Q15, and Q16. The floating input of a digital voltmeter (Non Linear Systems Inc. Model 484A) is terminated at L15 and L16. This unit provides a visual 4-digit decimal readout of voltage with automatic ranging and polarity identification from 0.000 to 999.9 volts. When the input selector switch of the oscilloscope used to monitor the output of the data amplifiers is placed in the "off" position, access to its vertical amplifier input is gained at cells M15 and M16. The input terminals of the horizontal and vertical amplifiers of a general purpose oscilloscope (Hewlett Packard Corp, Model 130C) are available at N15-N16 and O15-O16, respectively. The output of a low-frequency function generator (Hewlett Packard Corp., Model 202B) used for system test and command signal source functions is terminated at P15 and P16. The sync output of this unit is at Q15.

The cell group bounded by E18, E30, H18, and H30 are used to terminate various power supplies installed in the system for general purpose application. The output of a regulated 28-VDC (NJE Corp. Model CR-36-20) supply can be patched through the Control Slip Rings to the capsule and used to energize power or control type circuits involving relays, motors, electromechanical timers, etc. that an investigator may furnish for a given experiment. A dual 24 VDC (NJE Corp., Model QR-36-4) is available for solid-state circuitry applications. For maintenance purposes, the high and low sides of these isolated power supplies are routed directly to the patch panel without any connection to ground. The ground return path is then established by a patching operation.

When it is desired to terminate additional equipment temporarily at the Control Room Data Patch Panel, electrical access may be obtained through a series of receptacles mounted on a panel installed at the rear of Rack 3. These include a multicontact receptacle identified as J1 which is wired to I18-I34; and 15 three-contact receptacles, identified as J20 through J34, which are terminated in the cell group bounded by A20, A34, D20, and D34. The third contact of each of these receptacles is used for termination of the shield of the related input cable and returned to high-quality ground. Ancillary terminations include: a set of commoning cells in the E31, E34, H31, and H34 group which are used to parallel two or more circuits during system checkout; the output of the previously described capsule tachometer at cell column A18-D18; the output of a position potentiometer at A19-D19 which measures the instantaneous displacement of the CAP track platform; and interconnecting lines to a similar patch panel installed in the instrumentation system of the adjacent Periodic Angular Rotator (cell rows L9-L14 and M9-M14); the CAP drive system control cabinets (cell row L18-L34); the CAP operator console (cell row M18-M34); and the Audio Patch Panel (cell row J18-J34). The on-board microphone and loudspeaker circuitry is routed through the Control Slip Rings and patched directly to the Audio Patch Panel by means of cell rows R31-R34 and S31-S34. The circuitry associated with remote control of the track and capsule TV cameras is routed through the Control Slip Rings and terminated in cell row K25-K34.

The circuits terminated in the N18, N34, Q18, and Q34 cell group are concerned primarily with maintenance and program control of the two CAP drive systems. The output of two auxiliary command signal sources, a low-frequency function generator (Servomex Controls Ltd. Model LF-51) and an operational-amplifier ramp-generator (Philbrick Co. Model K5-U), are also terminated in this group.

Audio Equipment

A block diagram of the CAP audio communications system is presented in Figure 6. The operational function of the system is to provide a multipath voice transmission link between the control room, capsule, and radial track platform. For maintenance purposes these areas are also linked to the device chamber, upper dome assembly, motor-generator room, drive pedestal room, and the basement control-panel station. The system utilizes standard commercially available equipment (Altec-Lansing Corp.) and consists of four 35-watt power amplifiers (Model 342B), four compression type microphone preamplifiers (Model 438A), and one siren tone-generator (Model 357A) for emergency alarm purposes.

Five series-connected, low-impedance, dynamic microphones with press-to-talk switches are installed in the control room and wired to the input of Preamplifier A. Three of these units are installed on the console for use by personnel responsible for operation of the device. The remaining two units, installed on Racks 3 and 5, are used by personnel responsible for direction of the instrumentation phase of each test. Inside the capsule four microphones attached to the inner walls of the device are similarly series connected and routed to the input of Preamplifier B via the upper slip-ring assembly. A single microphone installed on the radial track platform is directed to Preamplifier C through the series-connected track and capsule slip rings. The microphones installed in the maintenance area are connected to the input of Preamplifier D.

For reception of voice information in the control room, two parallel-connected loudspeakers are installed in the ceiling immediately above the console. These speakers are driven by Power Amplifier A which has four independent input channels. The amplifier is equipped with a single master gain control and four mixer potentiometers for independent gain control of each input channel. For Power Amplifier A, mixer channels 1, 2, and 3 are connected to Microphone Preamplifiers B, C, and D, respectively. Channel 4 is connected to the Siren Tone Generator. By adjusting the associated mixer

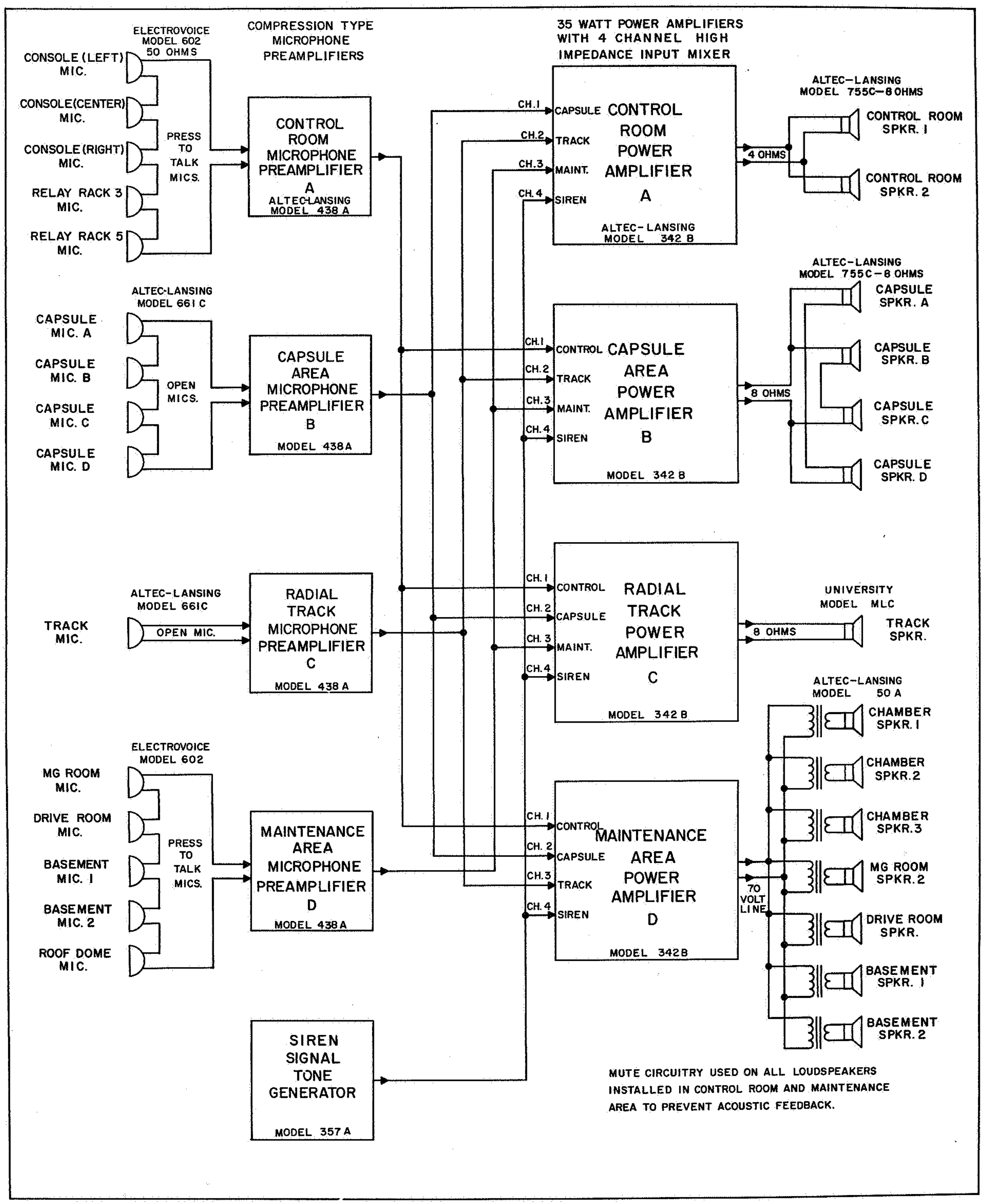


Figure 6

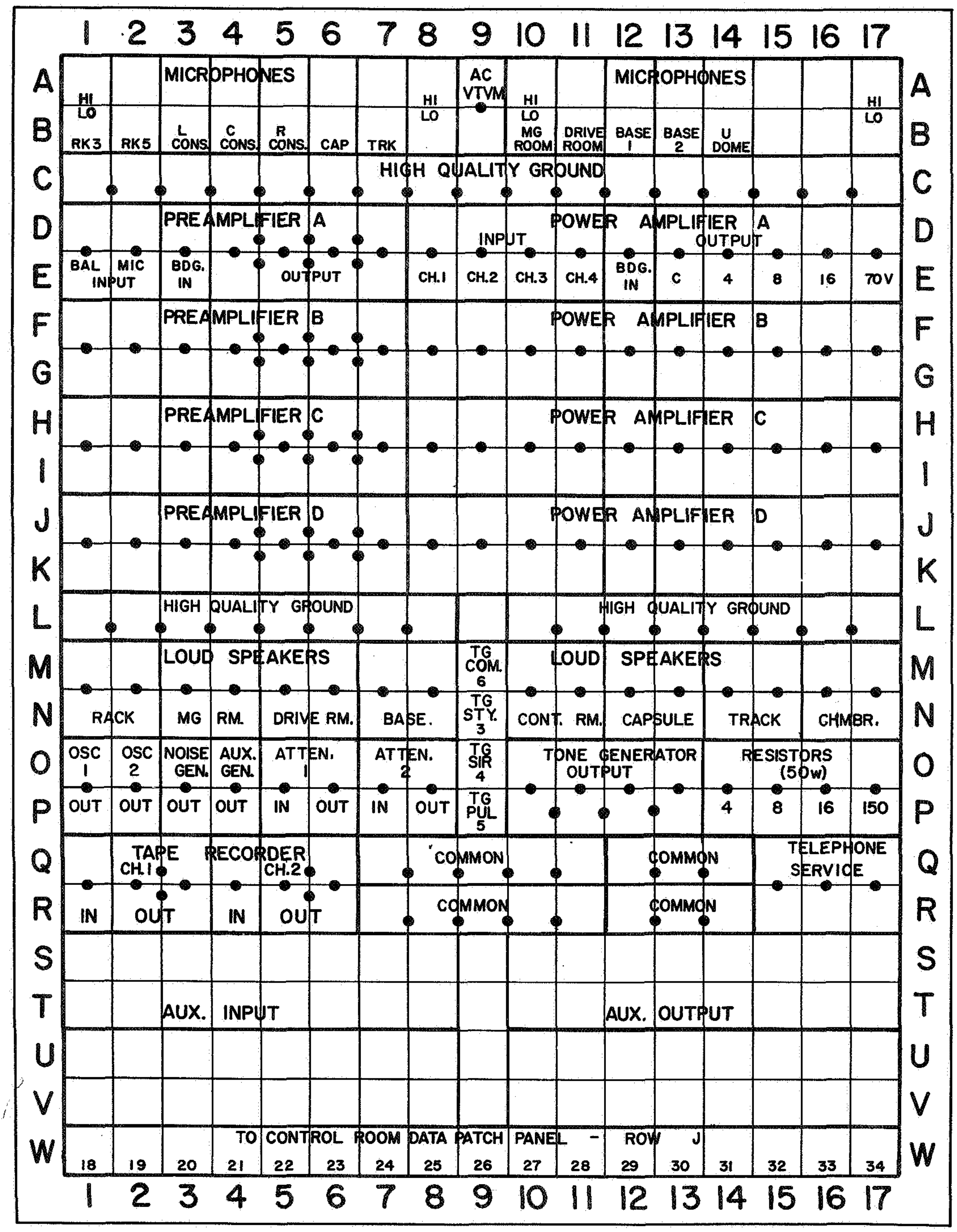
Block diagram of audio communications system gain controls, the control room personnel may simultaneously monitor voice signals originating in the capsule, aboard the track platform, or in any of the maintenance areas. The capsule and track microphones are operated in an open or live state so that the control room personnel can continuously monitor all on-board originated conversations. To prevent acoustic feedback during control room transmission to the device, a separate set of contacts on the press-to-talk switch of each control room microphone is used to relay transfer the output of Power Amplifier A from the loudspeakers to a matching dummy load resistor. Similar muting action is used in the maintenance area.

The termination of these microphones, loudspeakers, amplifiers, and related equipments at the Audio Patch Panel (AMP Inc. Model 695061-2) is illustrated in Figure 7 which is a front panel layout of the 17x23-cell matrix. Rows O and P are used to terminate ancillary audio equipment including a 5-cps to 600-kcs audio oscillator (Hewlett Packard Corp., Model 200 CD) at column O1-P1; a white noise generator (General Radio Company, Model 1390-B) at O3-P3; and two 5-watt, 55-volt, 600-ohm, 100-db attenuators (Hewlett Packard Corp. Model 350-D) at cell group O5, O8, P5, and P8. The input to an audio voltmeter (Hewlett Packard Model 400 H) is available at A9-B9. Rows Q and R terminate a two-channel audio tape recorder, incoming telephone lines used by on-board personnel during long-term test runs, and commoning cells for multipoint circuit junctions. Interconnection to the Control Room Data Patch Panel is established by the cells in row W.

ON-BOARD DATA PATCH PANEL

A photograph of the On-Board Data Patch Panel station used to give electrical access to the slip-ring circuitry and related instrumentation equipment is shown in Figure 8. The electrical layout of the patch panel proper, a 23 x 34-matrix unit similar to that installed in the control room, is presented in Figure 9. The circuit function and patch panel terminations of the column of five connectors seen at the lower left in Figure 8 are as follows: Receptacle J1, located at the top of the column, is used to terminate the output of the Biosignal-Conditioner Module at cell rows C1-C12 and E1-E12; J2 is used to transfer data routed through the patch panel to the input stages of an on-board recorder that may be provided by an investigator and is terminated at cell rows H1-H15 and J1-J15 where the number of the receptacle contact wired to a given cell is shown within the cell boundary; J3 is provided as an auxiliary input for general purpose applications and is wired to cell row L1-L30 which is column paralleled with row M1-M30; J4 is used to terminate the slip rings of a counterrotating device and is wired to cell rows N1-N30 and O1-O30; and J5 is used to terminate the on-board circuitry associated with operation of the event recorder installed in the control room and is wired to cell row T1-T30.

The three columns of receptacles seen to the right of J1-J5 in Figure 8, identified in sequence from top to bottom and from left to right as J20 through J34, are terminated in cell rows bounded by A20, A34, D20, and D34. These receptacles provide shielded-pair access to the panel for general purpose applications. Multicircuit access is provided by the column of five receptacles seen at the extreme right in Figure 8 which are identified as J11-J15 and terminated in cell row K1-K34. The BNC receptacles seen at the left of J11-J15 terminate the video slip rings. The column of SPDT toggle switches installed



CAP AUDIO PATCH PANEL

Figure 7

Cell terminations of the Audio Patch Panel installed in the CAP control room

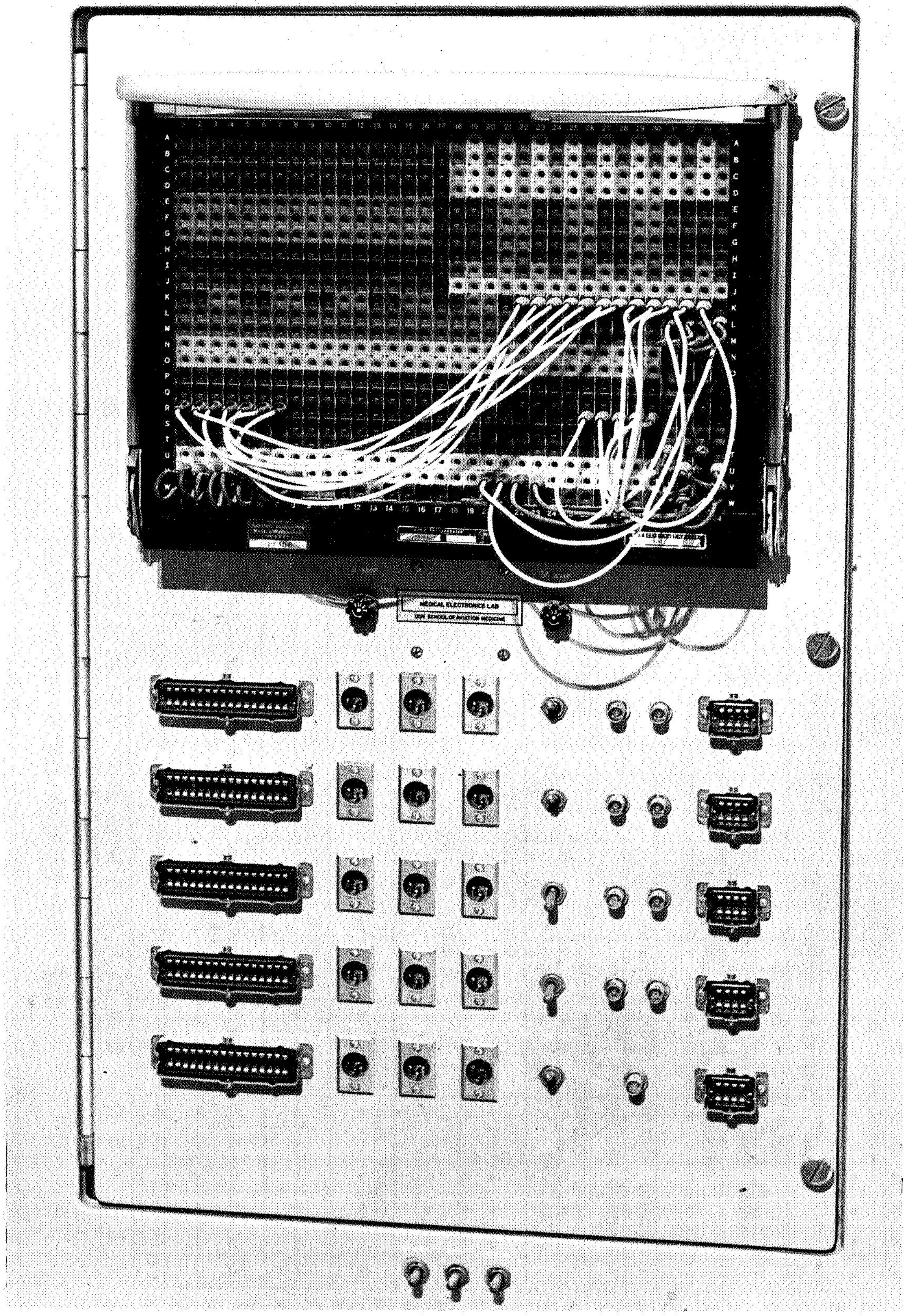
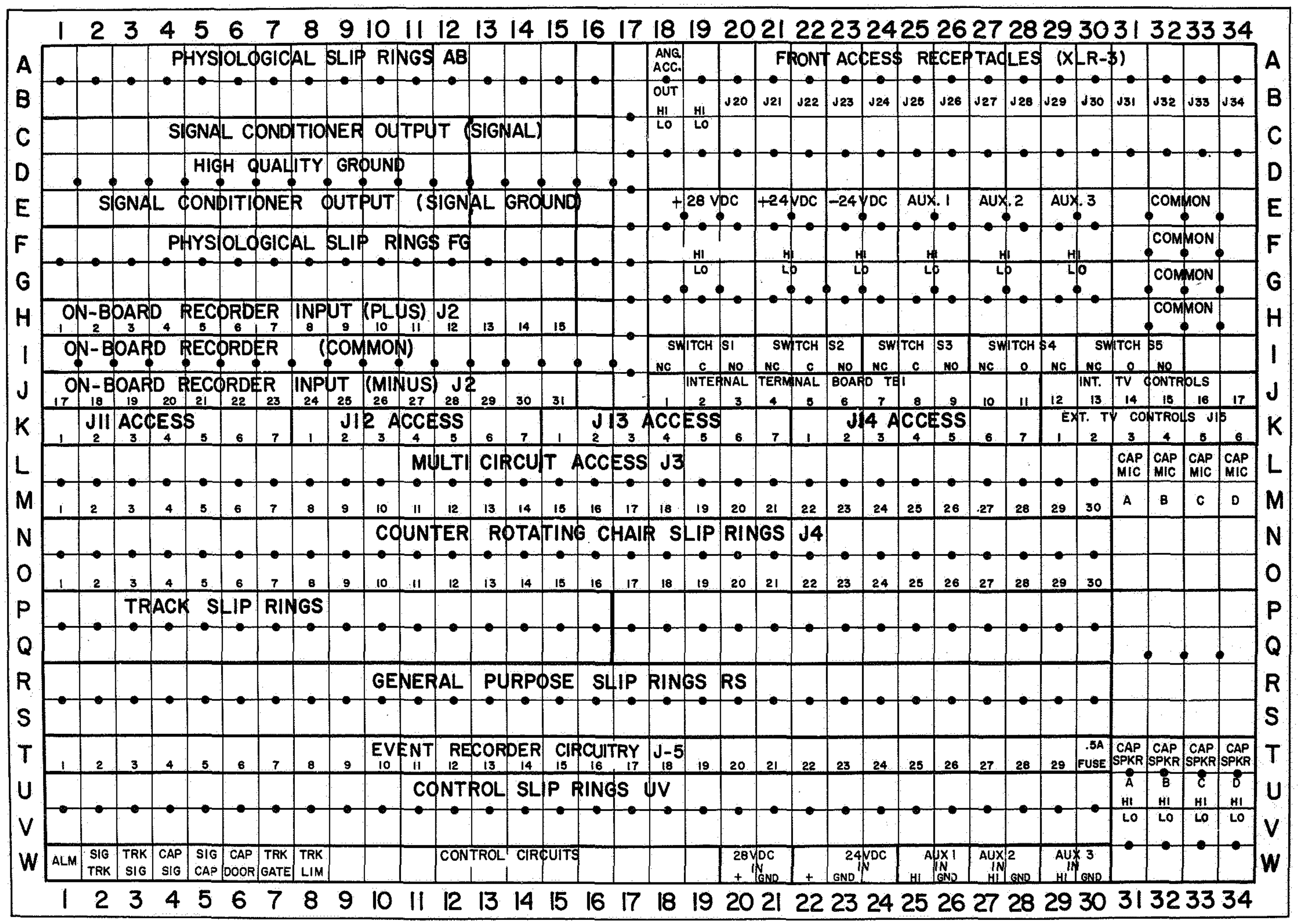


Figure 8

Photograph of the On-Board Data Patch Panel Station located inside the capsule of the Coriolis Acceleration Platform



CAP ON-BOARD DATA PATCH PANEL

Figure 9

Cell terminations of the Data Patch Panel installed inside the CAP capsule near the center of the panel are provided as ancillary switching aids and wired to cell row I18-I32.

The three switches at the bottom of Figure 8 are used for remote adjustment of the zoom, focus, and iris controls of an F/2, 17-mm to 70-mm zoom lens (Zoomar Inc. Mark IV) attached to the closed-circuit television camera installed on the track platform. The camera proper (General Electric Corp. Model 4TE9B3) is a vidicon unit with automatic light compensation and can be operated from either 28 VDC or 115 VAC, 50-400 cps. An identical camera-zoom-lens combination is available for installation in the capsule area.

The cell assignments of the upper slip-ring assembly joining the capsule to the control room are identical to those of the Control Room Data Patch Panel, as may be observed by comparing Figures 5 and 9. The Track Slip Rings which interconnect the capsule to the track platform are available in cell rows P1-P16 and Q1-Q16. In all cases two rows of cells are provided for each set of slip rings, with cells in the same column electrically jumpered at the rear of the patch panel.

Other circuits permanently wired into the system at the rear of the patch panel include the capsule microphones which are available in cell group L31, L34, M31, and M34; the capsule loudspeakers in cell group T31, T34, W31, and W34; the capsule angular accelerometer at cell column A18-D18; and various control, safety, and signalling circuits associated with the CAP drive system at W1 through W30.

For distribution of the various DC supply voltages brought aboard the device, groups of paralleled cells have been made available for each supply potential. The output of the 28-VDC supply is available at cell group E18, E20, H18, and H20; the dual 24-VDC instrumentation supply at cell group E21, E24, H21, and H24. Distribution points defined by the E25, E30, H25, and H30 cell group are made available for up to three auxiliary power supplies that may be required for a given experiment.

A photograph of the Biosignal Conditioner Module (Sanborn Co.) developed for on-board preamplification of physiological data is shown in Figure 10. The unit utilizes 12 standard plug-in preamplifiers (Series 760) that are rated to produce a full scale output of at least 1 volt. These preamplifiers, housed in two 6-channel panels, may be seen at the top of the vertical surface of the console; the meter at the right in each panel is used to monitor the DC output level of each preamplifier. The termination panel at the bottom of the console provides front-panel access to the basic input and output circuitry of the preamplifiers. On-board checkout and calibration of the preamplifiers is afforded by a single-channel, direct-writing recorder installed at the top which, in conjunction with an input selector switch, can be used to monitor the output of each channel.

The signal and signal-return lines from each of the 12 preamplifiers are individually routed to the receptacle seen at the lower right on the termination panel which is connected to the On-Board Data Patch Panel at receptacle J1. The connectors seen at the lower left, and the switch immediately above, allow the selection of either a

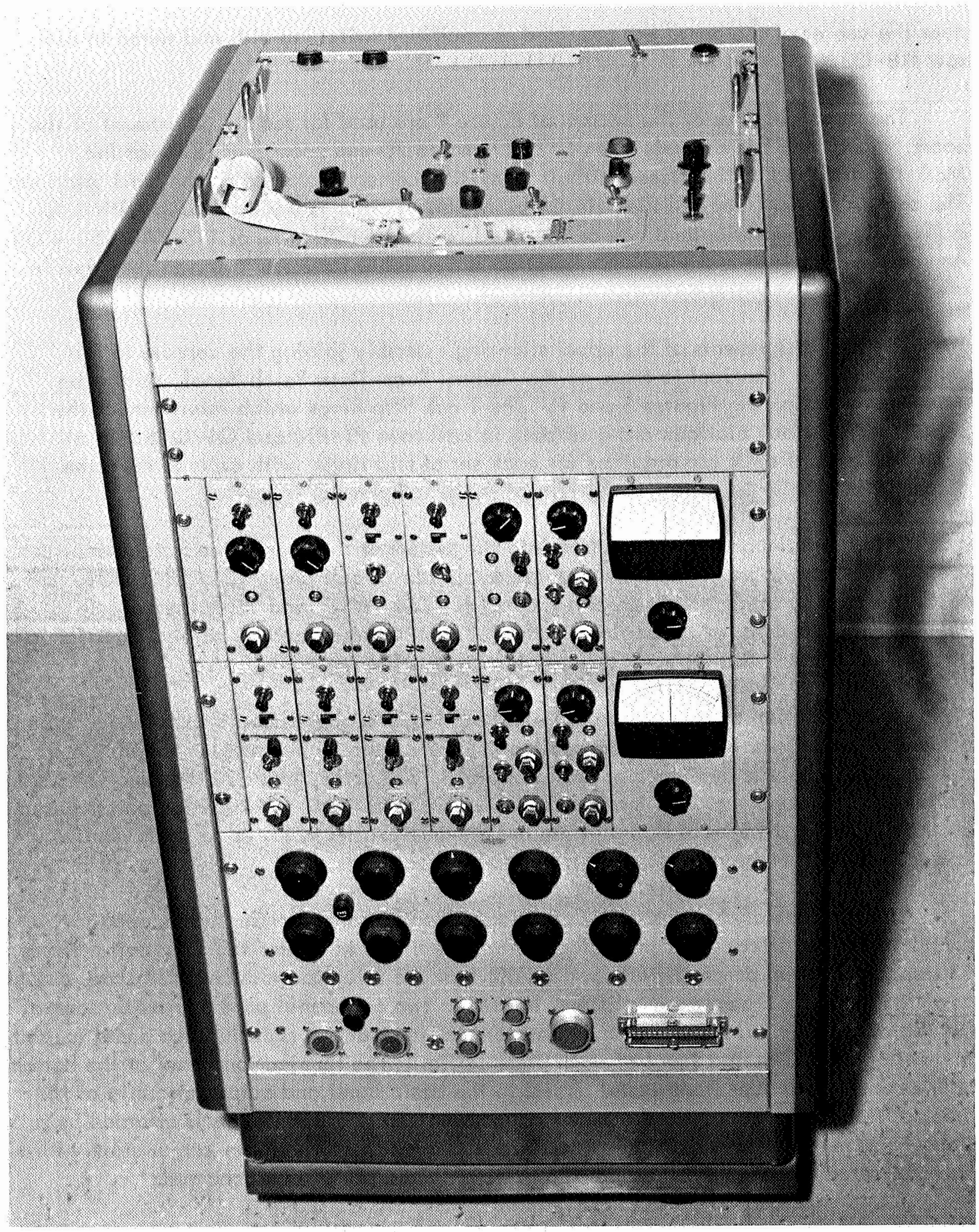


Figure 10

View of Biosignal Conditioner Module

conventional ECG or Frank VCG patient cable/electrode configuration. When the conventional configuration is used, the two columns of switches seen at the upper left can each be used to select one of the standard I, II, III, AVR, AVL, AVF, V, and CF electrocardiographic leads to be amplified on channels 1 through 4 of the console. The remaining columns of switches at the upper right are used to select EEG lead combinations that can be recorded on channels 7 through 10 with the EEG patient cable terminated at the receptacle located immediately beneath the described selector switches. Access to the input of Channels 5, 6, 11, and 12 is provided by the remaining connectors.

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13. ABSTRACT

The report describes a general-purpose instrumentation system developed for use in conjunction with the Coriolis Acceleration Platform, a combined linear and angular motion device recently installed at the vestibular research facilities of this activity. The system, based on the use of standard commercially available equipment, provides the basic transducers,signal-conditioning circuitry, and recording instruments required for the acquisition, display, and storage of a wide variety of commonly collected biological and bioenvironmental measurement data.

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