APRIL 20, 1964

REMOTE PROGRAMMABLE POSITION CONTROLLER

NAS 8-5346

May 1963 to February 1964

FINAL REPORT

Prepared for

George C. Marshall Space Center

Huntsville, Alabama

Prepared by: Mark Gitlin

Mark Gitlin

Approved by: H. Scheithauer

H. Scheithauer

THE BENDIX CORPORATION

ECLIPSE-PIONEER DIVISION

TETERBORO, NEW JERSEY

TABLE OF CONTENTS

1.0 INTRODUCTION

The Remote Programmable Position Controller (X-1837470-1) was produced for the National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Alabama.

The system was designed and manufactured in accordance with Proposal 7511-62-R17. The contract number was NAS-8-5346.

2.0 GENERAL

The Remote Programmable Position Controller consists of two panels; a Tape Reader and a Mode Panel. The Tape Reader feeds the information "read" on the programmed tape into the Mode Panel which converts this information into error signals which are fed into the electronics of the Servoed Three-Axis Test Stand, (X-1822716-1), thereby positioning the gimbals. In addition, the Mode Panel houses the Modulators and Level Detectors used when the Three-Axis Test Stand is to be operated in the Guidance Signal Processor Mode. The control for switching between the Tape and G. S. P. Mode is located on the Mode Panel and is so arranged that when switched either into the Tape or G. S. P. positions the Normal Slewing Mode is disconnected.

3.0 CONCLUSION

The Remote Programmable Position Controller was installed at NASA, Marshall Space Flight Center, Huntsville, Alabama. The system is operating satisfactorily and meets all the original specifications and design requirements.

4.0 DESIGN

The Remote Programmable Position Controller receives signals from a programmed punched tape and, in turn, transmits information corresponding to angular movements to the associated circuitry thereby positioning the gimbals of the Servoed Three-Axis Test Stand.

The electronics for the R. P. P. C. is housed in a standard 19 inch rack mounted panel 8-3/4 inches high by 20 inches deep. The associated tape reader is a Tally Model Number 424 rack mounted in a standard 19 inch panel.

The electronics in the Mode Control Panel are mounted on twelve plug-in cards.

The function of each of these cards will now be described.

4.1 Frequency Divider and Tape Driver Card

The purpose of this card is to convert 115 volts, 60 cycles to 24 volts, 15 cycles. This 15 cycle square wave is used to drive the read head of the tape reader. The -9 volts d. c. power supply needed for biasing purposes is also housed on this card.

4.2 Stepping Motor Drive Cards

These cards convert the signals received from the Tape Reader into information used to position each of the gimbals. There are six identical cards in the system; two for each gimbal; one for clockwise rotation and one for counter-clockwise rotation.

4.3 Tape Direction Control Card

This card controls the direction that the Tape Reader drives. The circuitry is designed so that signals received from the tape "read" head can cause a reversal in the direction of tape travel. The card can also be activated manually.

4.4 Stop Card

This card contains the circuitry to inhibit the operation of the Frequency Divider card thereby stopping the Tape Reader. This operation may be performed either manually or as a result of signals received from the tape "read" head.

4.5 Lamp Driver Card

This card contains all of the circuitry necessary for operating the illuminated labels on the front of the panel associated with the particular action of the system.

4.6 Modulator Card

This card is used only when the system is in the G. S. P. mode. This card receives d. c. signals from either the G. S. P. simulator or the flight G. S. P. ; converts these signals to proportional 400 cycle signals and feeds them to the resolvers in the Three-Axis Test Stand. The outputs of each of these resolvers are in turn fed to the test stand amplifiers and associated circuitry thereby positioning each of the gimbals.

4.7 Level Detector Card

This card is used only when the system is in the G. S. P. mode. The circuitry is connected to the control transmitter on the Roll Axis Gimbal of the test stand. The function of the card is to provide a warning signal when the Roll Axis Gimbal is rotated 50^{o} from its 0^{o} position. If the gimbal is further rotated another 10^{o} an interlock is activated which removes power to the Roll Axis Power Amplifier.

5.0 POWER REQUIREMENTS

The power requirements of the R. P. P. C. are as follows:

28 volts d. c., 5 amperes

115 volts, 60 cps, 1 phase - 2 amperes

115 volts, 400 cps, 3 phase - 3 amperes/phase.

6.0 OPERATION

Appendix I, MT-8103, Operating Instructions for Remote Programmable Position Controller covers, in detail, the procedures for operation.

NASA personnel have also been instructed in the operation.

7.0 APPENDIX I

MT-8103 -- Operating Instructions for Remote Programmable Position Controller (X-1837470-1).

To: Engineering File MT-8103

Issue: Original

From: Mr. Richard Mc Crea

Date: 1/8/64

Operating Instructions for Remote Programmable Position Controller

Prepared by: Richard McCrea
Richard Mc Crea

TABLE OF CONTENTS

1.0 INTRODUCTION

The purpose of this report is to state the procedure for operating the Servoed Three Axis Test Stand in the Tape and Guidance Signal Processor modes.

When operated in the tape mode the test stand is connected to a tape reader, which feeds a pre-selected program to each Control panel through the Mode panel thereby automatically positioning or slewing each of the gimbals.

In the G.S.P. mode, the Mode panel employs the signal from the Guidance Signal Processor or its simulator to slew the gimbals by using the resolvers in the pivots of the gimbals to transform from command signals to test stand gimbal error signals.

In addition, a safety interlock has been provided which functions when in the GSP mode. The function of this device will also be described.

2.0 Power Requirements:

28 ± 1 volt, 8 AMPS

1115 volts 60 ± 1%, 60 cycles, 1 phase - 2 AMP

115 volts ± 2 volt, 400 ± .004 cycles, 3 phase - 3 AMP/ϕ

3.0 General Description:

Two panels have been added to the existing system X1822716-1 which has been previously described by MT-1166. These are the Mode panel (see Figure 1) and the Tape reader (see Figure 2).

Since the tape reader can transmit 8 channels of information, two channels are allocated for each of the three gimbals to provide a clockwise or counter clockwise movement of the gimbal. The remaining two channels are for automatically reversing the drive direction of the reader or for stopping it.

The Mode panel contains the switches which controls the functions of the tape reader when the MODE SELECTOR switch is in TAPE. In this mode, the signal which is a function of the hole in the coded tape in the Reader enters the Mode panel. It is amplified and directed to one of the three Control panels X1811600. The particular panel that it enters is a function of the channel in which the hole is punched in the tape. In the Control panel, a stepping motor is stepped each time a pulse is received from the tape. The stepping motor rotates the slewing control transformer's rotor and in this manner rotates the gimbal. Each step of the motor rotates the gimbal .01 degrees.

If the MODE SELECTOR is placed into the GSP position, the D. C. command signal from the GSP enters the Mode panel where it is modulated by a 400 cps reference voltage and is directed to the proper Control panel. The signal is then transmitted to the appropriate Power panel to drive the gimbal. Relays are utilized in the Control panel for conveying the signal and are energized by the position of the MODE SELECTOR switch on the Mode panel.

In the GSP mode, due to torque and stability considerations the roll axis should not be driven greater than 60^{o}.

To ensure awareness of this on the part of an operator, a warning light and buzzer has been instituted which will both become activated when the roll axis gimbal has rotated 50 degrees. If the gimbals is still rotated another 10^{o} an interlock cuts off the signal to the power amplifiers whereby the middle gimbal can not be slewed.

In addition, the Mode panel contains the switches controlling the power to the Tape reader and to its own electronic cards.

A further description of the switches and lights on the Mode panel will follow.

4.0 DESCRIPTION OF PANEL CONTROLS:

4.1 28 VDC Switch

In the "ON" position this voltage is used as bias voltage for all of the cards in the MODE Panel. It is also used to drive the tape reader and the stepping motors located in each of the control panels.

4.2 115 V 400 cps Switch

In the "ON" position voltage is made available to the Switching Transformers used in the modulator card.

4.3 115 V 60 cps Switch

In the "ON" position voltage is made available to the Tape Reader motor and to the transformers driving the frequency divider and the -7 volt DC power supply.

4.4 Mode Selector Switch

This switch selects either the tape mode of operation or the GSP mode of operation. For either GSP or TAPE mode of operation switches S4 on the control panel must be in the REMOTE POSITION. When the switch is in the GSP position the CX-CT misalignment interlock is cut-out and the output of the modulator is connected to the power amplifiers in the power panel.

The GSP light in the MODE PANEL should become illuminated.

When the switch is in the TAPE position excitation is provided to energize the tape reader. In addition the slewing motor in the control panel is disengaged and the stepping motor is engaged by clutches. The Tape light in the MODE PANEL will become illuminated.

For Normal operation as described in MT-1166, switch S4 on the control panels should be in the internal position and the MODE SELECTOR SWITCH on the Mode Panel should be in the "OFF" position.

4.5 Program Forward switch:

Operates tape reader in the forward direction ; i.e. tape advancing from left reel to right reel. FORWARD light will become illuminated.

4.6 Program Reverse switch:

Operates tape reader in the reverse direction; i.e. tape advancing from right reel to left reel. REVERSE light will become illuminated.

4.7 Stop switch:

Stops Tape Reader. STOP light will become illuminated.

4.8 Single Step Forward:

Advances tape one step in the forward direction.

4.9 Single Step Reverse:

Advances tape one step in the reverse direction.

4.10 Tape-Fast Traverse Forward:

Provides rapid travel in the forward direction.

4.11 Tape-Fast Traverse Reverse:

Provides rapid travel in the reverse direction.

4.12 Roll Axis Warning:

Indicates that the Roll Axis gimbal has been rotated 50^{o}. If this situation occurs a WARNING light and buzzer will begin to operate.

When a warning signal is indicated the GSP controls should be turned so that the roll axis gimbal is rotated in a direction to decrease the angle.

4.13 Roll Axis Interlock light:

Indicates that the Roll Axis gimbal has been rotated 60^{o}.

The interlock can be activated only in the GSP mode. When the INTERLOCK light is illuminated the GSP signal to the Roll Axis Power Amplifier are cut off and the input to the amplifier is short circuited.

The WARNING light and buzzer will shut off.

5.0 OPERATING INSTRUCTIONS IN TAPE MODE

5.1 Threading tape reader :

To thread a tape through the read head, raise the lift lever handle. This raises the read head so the capstan is clear. Lay the tape across the capstan so that the pins project through the sprocket holes. While holding the tape in position on the capstan, push the lift lever down until the lever locks. Further information concerning the Reader is contained in the Tally Reader manual Model 424 D-1066.

5.2 On the three control panels place S4 in the REMOTE position.

5.3 On the MODE PANEL place the MODE SELECTOR switch in the TAPE position.

5.4 Turn all power switches to their "ON" position.

5.5 The program is started by pressing the PROGRAM FORWARD switch.

5.6 The tape reader may be reversed at any time by pressing the PROGRAM REVERSE button.

5.7 The Single Step or the RAPID TRAVERSE operations can be utilized only when the reader is in the STOP condition. i.e. RED STOP light must be lit.

5.8 The tape reader may be programmed so that the unit will automatically reverse. This is done by punching a hole in channel 7 on the tape.

The reader may also be programmed to automatically stop. This is done by punching holes in both channel 7 and 8.

5.9 Figure 3 indicates the numbering of the channel as referenced by the sprocket holes:

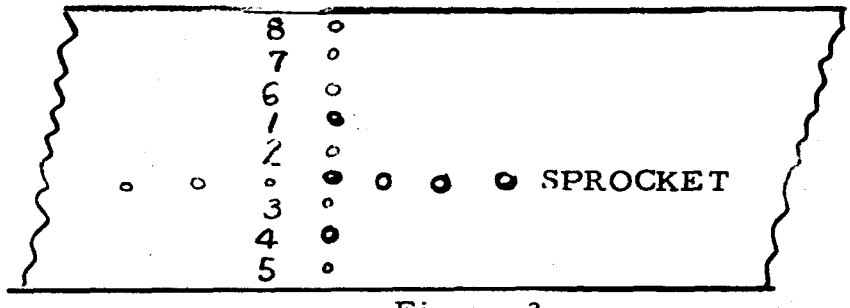

Figure 3

Channel	Description
5	Drives inner gimbal CCW
4	Drives inner gimbal CW
3	Drives middle gimbal CCW
2	Drives middle gimbal CW
1	Drives outer gimbal CCW
6	Drives outer gimbal CW
7	Tape drive reverses direction
8	When punched simultaneously with #7, stops.

6.0 OPERATING INSTRUCTIONS IN THE GSP MODE

6.1 The following instructions apply whether the Guidance Signal Processor or the G.S.P. simulator is used. Only the correct cable must be connected to the Mode panel as directed by X1837978.

6.2 Switches S4 (INTERNAL - REMOTE) on the Control panels shall be placed in the REMOTE position.

All the power switches on the three axis Test Stand console shall placed in the "ON" position.

6.3 The power switches on the Mode should be in "ON" position.

6.4 Throw the MODE SELECTOR to GSP. The system is now prepared to react to the command signals of the GSP.

6.5 If the Roll axis is driven into interlock while in the GSP mode, throw the MODE-SELECTOR switch to OFF. After throwing the REMOTE-INTERNAL switches on the Control panels to INTERNAL, bring the gimbals out of interlock by the method outlined in MT-1166 and drive the gimbals back to the zero position. The GSP simulator should be brought to zero and the GSP program be started again if it is desired to continue in the GSP mode.

7.0 Shut down procedure for both Modes.

7.1 Throw MODE SELECTOR switch to "OFF".

7.2 Throw all power switches on Mode Panel to OFF.

7.3 Throw all REMOTE-INTERNAL switches on the Control panels to INTERNAL.

7.4 All power switches on the Power panels and Service. Panel placed in the OFF position.

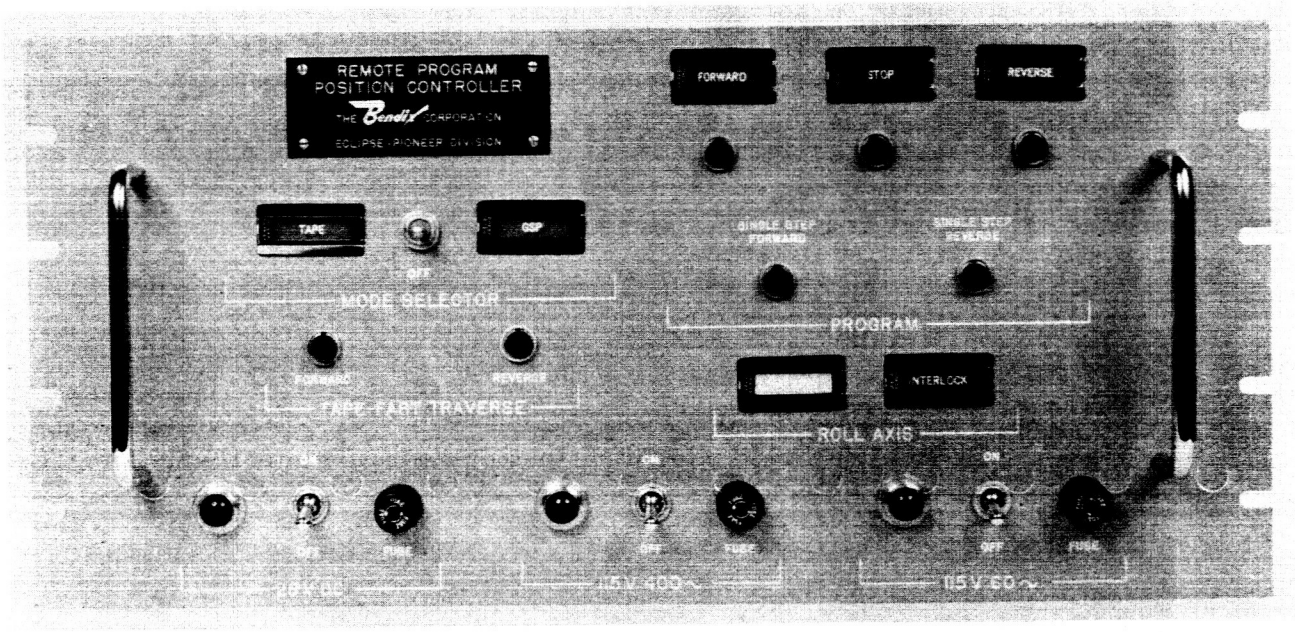
REMOTE PROGRAM
POSITION CONTROLLER
THE Bendix CORPORATION
ECLIPSE-PIONEER DIVISION
FORWARD
STOP
REVERSE
TAPE
GSP
OFF
MODE SELECTOR
SINGLE STEP FORWARD
SINGLE STEP REVERSE
PROGRAM
FORWARD
REVERSE
TAPE-FART TRAVERSE
INTERLOCK
ROLL AXIS
ON
OFF
FUSE
115 V 400 ~
115 V 60 ~

FIGURE 1

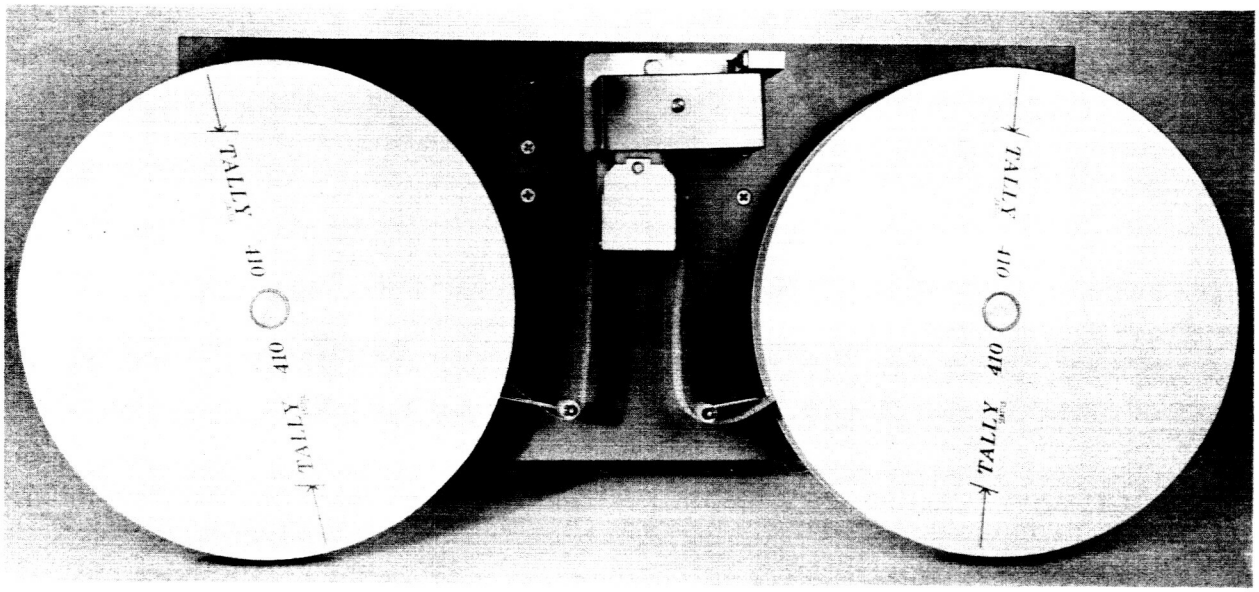

FIGURE 2