

OPERATOR'S MANUAL

POINT-TO-POINT VERSATRAN

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## I. INTRODUCTION

### A. General Information

This manual contains information pertaining to the installation and operation of the Point-To-Point Versatran. It is intended as an aid and reference for qualified personnel who have been instructed by AMF representatives in proper methods of application and operation of the Versatran system. It is important that all maintenance and adjustment procedures beyond the scope of this manual be referred to technicians expressly trained for these jobs.

### B. System Description

The Point-To-Point Versatran is a manually programmable automatic transfer system that is electronically controlled and hydraulically actuated. This system is designed to move a manipulator assembly through a sequence of up to 12 points in three-dimensional space. In addition, the manipulator is controlled to achieve motion through three degrees of freedom. The manipulator can cause a set of "fingers" to: (a) open and close, (b) swing in a horizontal plane and, (c) rotate in a vertical plane. For other applications the manipulator may consist of a simple mounting platform on which an electric drill, spray gun, or other such device may be located.

Control of the Point-To-Point Versatran is achieved through an electronic memory which is stored in a set of potentiometers located in the control console. Control signals are stored in the control console by a programmer who can TEACH the Versatran by leading it through a sequence of points in space. At each spatial point the programmer "teaches" the machine by adjusting a set of potentiometer knobs until a set of lamps indicate that the position of this point is stored. At each of these spatial points the programmer also inserts pins into a plugboard to program the manipulator and synchronization functions to be used in the transfer application.

In the OPERATE mode, the Point-To-Point Versatran is controlled by the information stored in the electronic potentiometers and plugboard. This "memory" system causes the machine to repeat continuously the sequence of spatial points, associated operations, and synchronizations taught to it by the programmer.

C. Specifications

Program Duration:	Unlimited
Maximum Number of Discrete Points:	Twelve
Power Requirements:	
Versatran machine	440 VAC, $\pm$ 10%, 15 amps, 3-phase, 60 cycle 220 VAC, $\pm$ 10%, 30 amp unit optional
Hydraulic Supply (Internal):	7.5 hp, 7.5 gpm at 1000 psi to 1200 psi
Weight:	
Versatran machine	1,300 pounds
Control Console	300 pounds
Floor Space Required:	
Versatran machine	45 x 27 inches
Control Console	26 x 26 inches
Maximum Height:	
Versatran machine	73 inches
Control Console	48 inches
Arm Velocities with 40-pound Payload:	
Horizontal	36 inches per second, maximum
Vertical	36 inches per second, maximum
Swing	90° per second, maximum
Movements:	
<u>ARM</u>	
Vertical Travel	30 inches, maximum
Horizontal Travel	30 inches, maximum
Swing	0° to 240°

C. Specifications (continued)

Standard Manipulator\*

Swing	0° to 180°, left or right
Rotation	0° to 180°, CW or CCW
Open and Close	(dictated by design)
Maximum Transfers per Hour:	More than 1100, depending on number of points, magnitude of displacements, and payload.
Repeatability:	Better than $\pm 1/8$ inch in all axes, under all conditions, with arm in any position.

\*With a 20 lb. maximum load no more than 6" from centerline of manipulator. Larger payloads can be handled at less than maximum velocities.

## II. DESCRIPTION OF POINT-TO-POINT VERSATRAN CONTROL CONSOLE

### A. Operator Controls

The following primary operating controls are located in a protected area on the front of the Point-To-Point control console. They are accessible at all times because they are used in controlling operation as well as in programming.

<u>MARKING</u>	<u>DESCRIPTION</u>	<u>FUNCTION</u>
POWER/READY	Push button, momentary contact, illuminated amber/green.	Turns power on, lights amber; when system is ready to operate, lights green. Machine automatically in teach mode and TEACH lamp is lit.
SET AT POINT "1"	Push button, momentary contact, illuminated white.	Actuation of SET AT POINT "1" causes the transfer arm to move to the first command point by most direct path. If push button is released, arm stops immediately. Active only when machine in teach mode. Illuminated only when transfer arm is at Point 1 and when arm position corresponds to position programmed for it.
OPERATE/STANDBY	Push button, momentary contact, illuminated green/white.	When machine is in standby mode, STANDBY section of push button is illuminated white. Depressing OPERATE/STANDBY, when STANDBY is illuminated, sets machine into operation and OPERATE section lights green.

A. Operator Controls (continued)

<u>MARKING</u>	<u>DESCRIPTION</u>	<u>FUNCTION</u>
		<p>Machine goes back into standby after any of the following:</p> <ol style="list-style-type: none"> <li>1. LAST CYCLE was depressed, cycle is over, and arm is stopped.</li> <li>2. STOP AT NEXT POINT was depressed and arm has stopped.</li> <li>3. When SET AT POINT 1 was depressed, lit, and OPERATE/STANDBY depressed once.</li> </ol>
STOP AT NEXT POINT	Push button, momentary contact, no light.	When machine is in operate mode, actuation of STOP AT NEXT POINT causes machine to stop at the next point, and STANDBY lights. Operation can be resumed by actuating OPERATE/STANDBY push button.
LAST CYCLE	Push button, momentary contact, illuminated white.	Illuminated when actuated, machine will stop at the end of the program and STANDBY will be lit. When the machine has stopped, LAST CYCLE light goes out.
STOP	Push button, momentary contact, mushroom, illuminated red.	Actuation removes all power. To restart machine, POWER/READY must be depressed.



## B. Programmer Controls

The console components described below are used primarily to control the positions, motions, and operating speeds of the Versatran arm. After programming has been completed, these controls are covered and the production cycle is controlled by the push buttons described in Section II A.

<u>MARKING</u>	<u>DESCRIPTION</u>	<u>FUNCTION</u>
"1" "2" ... "12"	Pilot lights, green, across top of console.	Identify to which of the 12 point: commands are being given.
POSITION CONTROL POTENTIOMETERS, LOCKING, 10-POSITION	One per each command point (12) for the horizontal, vertical, and swing axes. (Total 36).	Determine position of transfer arm within the sector (see below) to which it will be sent.
SECTOR SWITCHES, 28 POSITION	One per point (12) for swing axis only. (Total 12).	Determine which of 28 sectors in swing axis transfer arm will be sent. (28 equal sectors in a total $240^{\circ}$ swing).
SECTOR SWITCHES, 4 POSITION	One per point (12) for horizontal and vertical axes only. (Total 24).	Determine which of four sectors transfer arm will be sent. (4 areas of $7\frac{1}{4}$ " each, within the 30" of travel available in both horizontal and vertical axes).

In programming, the transfer arm is led under Joystick control to each of the desired command points. Then, rotation of the console sector switches and potentiometers in each axis associated with each command point, cause the amber position-indicator lamps to go on and off. When perfect balance has been achieved, both lights go out, indicating that the command point has been identified, programmed, and can be relocated exactly in the actual transfer cycle.

B. Programmer Controls (continued)

<u>MARKING</u>	<u>DESCRIPTION</u>	<u>FUNCTION</u>
CW CCW IN OUT UP DWN	Pilot lights, amber. 2 per each axis. (Total 6).	Each pair shows direction in which arm must be moved to agree with commanded position. Only one of the two lamps lights at a time. Both lamps go out when arm is moved by the position control potentiometers so that actual arm position and command arm position agree.
CREEP	Potentiometer, locking, one per axis. (Total 3).	Controls arm "creep" speed (arm speed in each axis, as machine nears commanded position).
MAX.	Potentiometer, locking, one per axis. (Total 3).	Controls maximum speed of transfer arm in travel between points, in each axis. When close to command point, "creep" control takes over.

The nameplates on the rocker switch and push buttons located in the area of the console marked TEACH are self-explanatory. Used in programming, these controls permit the individual transfer motions to be repeated, in the desired sequence, so that the best possible cycle may be programmed. Exact control of the transfer arm may be accomplished using either the console switches and potentiometers, or by use of the joystick.

<u>MARKING</u>	<u>DESCRIPTION</u>	<u>FUNCTION</u>
ADV. STEP BACK STEP	Rocker switch, momentary contact.	Controls commands given to machine by switching from point-to-point, advancing or backing,

B. Programmer Controls (continued)

<u>MARKING</u>	<u>DESCRIPTION</u>	<u>FUNCTION</u>
TRY	Push button, momentary contact.	"1" "2" ... "12" lights change accordingly. Works only in teach mode.  When actuated, causes machine to go from point-to-point at normal speed until TRY switch is released, or until a point is met which has no OK pin inserted in plugboard. Releasing TRY stops machine immediately. Works only in teach mode.
PANEL/JOYSTICK	Push button, momentary contact, illuminated amber/white.	When actuated and PANEL illuminated amber, arm can be moved by sector switches and potentiometers. When actuated and white JOYSTICK light is illuminated, potentiometers have no effect and arm can be moved only with joystick control. Works only in teach mode. When machine first turned on, JOYSTICK is illuminated.
TEACH	Push button, momentary contact, green.	When illuminated, machine is in teach mode. When machine is in standby mode, actuating TEACH puts machine in teach mode.

B. Programmer Controls (continued)

In the HAND CONTROL area of the console, nameplates again make plain the functions of the rocker switches. In programming, the switches are used to actuate the manipulator attached to the transfer arm. The switch controlling clockwise and counterclockwise motions of the manipulator wrist is marked CW and CCW.

<u>MARKING</u>	<u>DESCRIPTION</u>	<u>FUNCTION</u>
OPEN CLOSE	Rocker switch, momentary contact.	Opens and closes hand when machine in teach mode.
LEFT RIGHT	Rocker switch, momentary contact.	Moves hand left or right when machine in teach mode.
CW CCW	Rocker switch, momentary contact.	Moves hand clockwise (CW) or counterclockwise (CCW) when machine in teach mode.

The two potentiometers controlling hand and arm delay times are vital in programming the majority of transfer operations. After determining the proper duration of delay, the potentiometers are locked so that the same delay times occur during the actual transfer cycle.

<u>MARKING</u>	<u>DESCRIPTION</u>	<u>FUNCTION</u>
HAND DELAY	Potentiometer, locking	Determines time allotted for hand to perform its function(s). Works only if HAND DELAY pin is in plugboard. (1 - 6 seconds delay).
ARM DELAY	Potentiometer, locking	Determines time delay before moving to next point, after arm has reached a commanded point. Works only if ARM DELAY pin IN plugboard, and GUIDE POINT pin is NOT in plugboard. (1 - 6 seconds delay).

B. Programmer Controls (continued)

The simplicity of the Versatran plugboard is the major reason why transfer operations can be programmed so quickly. Insertion of pins in the appropriately marked positions assure that the steps will be performed as marked. Plugboard markings also allow quick visual check of the overall sequence of transfer motions to be performed.

<u>MARKING</u>	<u>DESCRIPTION</u>	<u>FUNCTION</u>
(Two boards, columns "1" ... "6" and "7" ... "12".)	Plugboards	Insertion of pins (from pin storage tray), in column corresponding to a point, commands the action identified by the label on each row.
GUIDE POINT	1st row	Pin here, arm will pass within about 3" of the guide point and continue to next point without stopping.
EXT. STEP	2nd row	Pin here, machine will not move from this point until relay closure received from external source.
EXT. MACH.	3rd row	Pin here, and contact closures will be produced at the EXT. MACH. COMMON terminals on the rear panel. Duration of these closures adjustable.
ARM DELAY	4th row	Pin here, arm will wait at this point for a time determined by ARM DELAY potentiometer.
HAND OPEN/CLOSE	5th and 6th rows	A pin in either, but not both, determines hand operation at this point.

B. Programmer Controls (continued)

<u>MARKING</u>	<u>DESCRIPTION</u>	<u>FUNCTION</u>
HAND LEFT/RIGHT	7th and 8th rows	A pin in either, but not both, determines hand operation at this point.
HAND CW/CCW	9th and 10th rows	A pin in either, but not both, determines hand operation at this point.
HAND DELAY	11th row	Pin here, hand will have time for its operation as determined by HAND DELAY potentiometer.
HAND EXT. OPER.	12th row	Pin here, hand actions will occur only when relay closure received from external source.
SKIP THIS POINT	13th row	Pin here, command points in this column will be skipped and control transferred to next point.
OK	14th row	Pin here and machine will come to the predetermined command point. If in teach mode, and no pin in OK for next point, machine stops at this point. If in operate mode, and no pin in OK for next point, machine goes to Point 1 after this point, then recycles.

The Joystick is an auxiliary programming-control device which is plugged into the console. The programmer leads the arm from point-to-point in the transfer cycle by a type of power steering, utilizing 3 of the 4 control switches on the Joystick. In this manner, maximum operator visibility is obtained, and command points in the transfer cycle can be located with

B. Programmer Controls (continued)

great precision. Speed of arm motion is controlled by a 4th switch on the Joystick. This two-position switch permits the arm to be moved at either creep or medium speed.

<u>MARKING</u>	<u>DESCRIPTION</u>	<u>FUNCTION</u>
JOYSTICK	3-axis control switches and one speed control switch.	When in teach mode and JOYSTICK is illuminated, arm can be moved by Joystick control switches. Arm will go at creep or medium speed depending on position of speed switch.

C. Fuses

These fuses serve to protect the system's internal electronics and are located at the bottom front of the control console.

<u>MARKING</u>	<u>DESCRIPTION</u>	<u>FUNCTION</u>
F101	4 amp. fuse	Protects 115 VAC input transformer primary.
F102	2 amp. SLO-BLO fuse	Protects + 10 VDC regulated output.
F103	2 amp. SLO-BLO fuse	Protects - 10 VDC regulated output.
F104	1 amp. SLO-BLO fuse	Protects AC input to regulated + 30 VDC supply.
F105	5 amp. SLO-BLO fuse	Protects AC input to unregulated + 30 VDC supply.
F106	2 amp. SLO-BLO fuse	Protects AC input to unregulated + 24 VDC supply.
F107	$\frac{1}{2}$ amp. SLO-BLO fuse	Protects + 30 VDC regulated output.

C. Fuses (continued)

MARKING

F108

DESCRIPTION

3 amp. fuse

FUNCTION

Protects 115 VAC input transformer secondary.

D. Console Rear Panel

MARKING

EXT. STEP PT. 1  
... 12, TB115  
and TB117

DESCRIPTION

Twelve terminal board inputs,  
one for each command point.

FUNCTION

To use this input, a pin must be in EXT. STEP on plugboard. When external contacts are wired to the terminals for that point, the machine will not go to the next point until the external contacts are closed.\*

EXT. STEP COMMON,  
TB115 and TB117

One terminal board input.

This input is used with only one external step command. When external contacts are wired to these terminals, the machine will not go to the next point until the external contacts are closed. This command will be effective only at those points which have a pin in EXT. STEP on the plugboard.\*

HAND-EXT. OPER.  
1 ... 12, TB116 and  
TB118

Twelve terminal board inputs,  
one for each point.

To use this input, a pin must be in HAND EXT. OPER. on plugboard. When external contacts are wired to the terminals for that point, the machine will delay operation of the hand until

\*See Section IV D.



D. Console Rear Panel (continued)

<u>MARKING</u>	<u>DESCRIPTION</u>	<u>FUNCTION</u>
HAND EXT. OPER. COMMON, TB116 and TB118	One terminal board input.	the external contacts are closed.*  Used with only one external hand operate command. When external contacts are wired to these terminals the machine will not perform hand commands until the external contacts are closed. This command will be effective only at those points which have a pin in HAND EXT. OPER. on plugboard.*
CONTROLS FOR EXT. MACH., TB111	Twelve terminal board outputs.	Up to five relays can be connected to any of the twelve outputs to control the operation of external machines. The outputs correspond to the twelve points. The outputs will energize a relay for about 4/100 second when all three axes are at the commanded positions for that point and any wrist commands have been performed. If no wrist commands are present, the output occurs when the arm is at the commanded position. The EXT. MACH. row on the plugboard has no effect on this function.*

\*See Section IV D.

D. Console Rear Panel (continued)

<u>MARKING</u>	<u>DESCRIPTION</u>	<u>FUNCTION</u>
EXT. MACH. COMMON, TB112	One terminal board input.	This input is used where only one external machine circuit is to be controlled. Contact closures of adjustable duration will be produced at these terminals when all three axes are at the commanded positions and wrist commands completed, for any point for which a pin has been inserted in the EXT. MACH. row in the plugboard. Thus, one external machine can be controlled from 1 to 12 points.*
TIE POINTS - TB114	12 tie points.	For wiring interconnections as required by application.*
AUX. RELAYS K101 thru K110	10 4PDT Relay sockets.	For relays to be used as required. The contacts of these relays are wired to TB101 thru TB110 respectively. For example, see CONTROLS FOR EXT. MACH.*
J1001, J1002	Connectors	Accept cables which interconnect machine and control console.
J1003	Connector	Accepts cable from Joystick.
F109	$\frac{1}{2}$ amp. fuse	Protects + 24 VDC supply to interlocks.
PUMP ON S101	Toggle Switch.	Controls power to hydraulic pump motor.

\*See Section IV D.

D. Console Rear Panel (continued)

<u>MARKING</u>	<u>DESCRIPTION</u>	<u>FUNCTION</u>
HAND-INITIAL SET UP — S102, S103, S104	Toggle Switches	Control initial position of HAND (manipulator) at point 1 during 1st cycle only. S102 - Open/Close, S103 - Left/Right, S104 - CW/CCW.
EXT. MACH. COM- MON, TIME	Potentiometer	Allows adjustment of EXT. MACH. COMMON signal. Duration adjustable from 5/100 to 1 second.

### III. DESCRIPTION OF VERSATRAN MACHINE CONTROLS

<u>MARKING</u>	<u>DESCRIPTION</u>	<u>FUNCTION</u>
PILOT LIGHTS	Two pilot lamps, one green and one red, located on machine-base.	Lamps indicate condition of oil system filter. Green lamp on — filter good, red lamp on — notify qualified personnel to replace filter.
F1	5 amp. fuse, located on bottom of machine-base electrical panel.	Protects high-voltage primary of step-down transformer feeding control console.
F2	15 amp. fuse located on top of machine-base electrical panel.	Protects 115 VAC secondary of step-down transformer feeding control console.
J101, J102	2 connectors, located in center of machine-base electrical panel.	Accept cables which interconnect Versatran machine and control console.
J103	4-terminal connector located on bottom of machine-base electrical panel.	Accept cable which provides 3-phase primary power.

## IV. INSTALLATION

### A. Unpacking and Inspection

The Versatran system normally is shipped as three pieces consisting of the Versatran machine, the console, and a box containing the remaining items and such accessories as may have been specified by the order. Do not pierce the carton with sharp tools or implements when opening. When items are unpacked, check them against the shipping list to make certain that all equipment is accounted for.

Immediately upon unpacking, visually inspect the equipment for any damage which may have incurred in shipment and note such damage at once. Following are specific items which should be inspected:

1. Versatran arm for bent or battered condition.
2. All hoses for cuts or loose connections.
3. Housing covers for dents or scratches.
4. Attaching hardware for tightness.
5. Exposed wiring for cuts or loose connections.
6. Hydraulic fluid level in reservoir.
7. Indications of oil leakage.

### B. Locating the Versatran

Dimensions critical to the physical location of the Versatran are provided in the floor plan drawing presented herein. In addition, careful calculations and proper application drawings should be prepared in advance of the actual installation. It should be noted that the recommended maximum cable length between Versatran and console is 25 feet. Floor level is not critical as long as oil can be drawn from the oil reservoir. However, the installation of the three floor adapters in which the Versatran rests (AMF Part No. 9-2349) is critical and requires the use of AMF locating fixture TF-1063. The precise dimensions are shown in the Versatran plan drawing. Installation procedure is as follows:

1. Using fixture TF-1063 as a guide, punch mark the floor to locate the centers for the three floor adapters.

B. Locating the Versatran (continued)

2. Drill three 2-inch diameter holes in the floor,  $2\frac{1}{2}$  inches deep. Clean all chips and dust from the holes.
3. Attach the three floor adapters to the locating fixture, and position the fixture so that each adapter is centered in its hole. If necessary, block up the fixture until the top of each adapter is flush with the surface of the floor.
4. Pour epoxy compound, or its equivalent, into the holes around the adapters. Take care not to get the compound into the adapter holes themselves. Let the compound set until it is hard.
5. When the epoxy compound has hardened, remove the fixture from the adapters and set the Versatran in place.

If desired, an optional method of locating the Versatran machine is to drill 3 holes in a sturdy steel plate (dimensions per drawings TF-1063 and 9-2349) and lag this plate to the floor.

C. Connecting Cables and Wiring

1. System Power. - The 3-phase electrical power (nominally 440V) is to be connected, thru a disconnect, to the 4-blade electrical connector (J103) on the Versatran machine-base. The connecting cables must be large enough to supply the current requirements of the system (see specifications). In the event the pump motor runs backward, reverse any two leads (except the green) at the cable connector.

NOTE: A manually reset overload relay to protect the 3-phase power is located in the machine-base electrical chassis.

2. Interconnecting Wiring. - A large diameter cable, W102, and small diameter cable, W103, are used to interconnect the Versatran machine and console. These two cables are connected from their respective connectors (J101 & J102) on the machine-base electrical chassis to the connectors located at the bottom rear of the console (J1001 & J1002).

C. Connecting Cables and Wiring (continued)

WARNING: Never connect or disconnect these cables while the system power is on. See interconnections wiring diagram. When primary power is applied to the machine and the control console is OFF, 115 VAC exists at many points in the system. Do not work on the machine unless primary power (normally 440 VAC) is removed.

D. External Interlock

The interlock circuits perform two related functions. The first is to synchronize external machines to the Versatran - that is; to have the Versatran control the operation of other machines. The second function is to synchronize the Versatran to some external machines - that is; to have the Versatran operation controlled by external devices. Before proceeding further please reread carefully sections II B and II D.

1. Synchronization of External Machines. - Operation of external machines may be achieved in two fashions.

(a) External Machine Common.

To control one machine at any or all of the 12 points, wire the external machine to the two sets of form C contacts brought out to TB112, terminals 1 thru 6. See Interlock Diagram and Description in Section II D.

(b) Controls for External Machines.

To control up to 5 machines from any 5 of the 12 points, connect jumper wiring from any terminal of TB111 to any of five terminals on TB114 (terminals 1 thru 5). The jumper wiring then continues from one of the 5 corresponding terminals of TB112 (terminals 7 thru 12). At these terminals of TB112, a ground will be seen when the Versatran is at the corresponding point, and when the manipulator functions are completed. This switched ground is jumper wired to drive up to five of 10 available relays (K101 thru K110). See Interlock Diagram and Section II D.

D. External Interlock (continued)

EXAMPLE: To operate an external machine at point 3, the following jumper wiring would be used:

First jumper from TB111, terminal 3 (TB111-3) to TB113, terminal 1 (TB113-1)

Second jumper from TB112-7 to TB101-11

Third jumper from TB101-12 to TB113-6 (+ 24 VDC supply)

The external machine is now wired to any of the three sets of form C contacts available at terminals 2 thru 10 of TB101.

2. Synchronization of Versatran

(a) Arm Motion (External Step).

If arm motion is not to be synchronized, do not insert pins in the EXT. STEP row of the front panel plugboard.

If arm motion is to be synchronized by one common switch, connect the one common, normally open switch or relay contact from TB115-1 to TB117-1. Connect jumpers from TB115-1 to all the other TB115 terminals. The switch must be closed for the Versatran to leave all points for which a pin is in EXT. STEP.

If arm motion leaving any one point is to be synchronized by a separate switch, connect this separate normally open switch between the terminals listed below. Remove all common wiring and jumpers described in previous paragraph. A pin must be in EXT. STEP for points to be synchronized.

<u>SYNC POINT</u>	<u>CONNECT SWITCH</u>	
	<u>FROM</u>	<u>TO</u>
1	TB115-2	TB117-2
2	TB115-3	TB117-3
3	TB115-4	TB117-4
4	TB115-5	TB117-5
5	TB115-6	TB117-6
6	TB115-7	TB117-7



D. External Interlock (continued)

SYNC POINT	CONNECT SWITCH	
	FROM	TO
7	TB115-8	TB117-8
8	TB115-9	TB117-9
9	TB115-10	TB117-10
10	TB115-11	TB117-11
11	TB115-12	TB117-12
12	TB115-13	TB117-13

NOTE: Up to 12 separate switches, one for each command point, may be used.

See Section II B for all applicable programming data that must be followed with regard to the console plugboard. Also see the Interlock Diagram.

(b) Manipulator Motion (Hand External Operation).

If manipulator (hand) motion is not to be synchronized, insert no pins in the HAND EXT. OPER. row of the front panel plugboard.

If manipulator operation at all points is to be synchronized on one common switch, connect the one common, normally-open switch or relay contact from TB116-14 to TB118-14. Wire jumpers from TB116-14 to all the other TB116 terminals. The switch must be closed for the Versatran to operate the hand at all points for which a pin is inserted.

If manipulator operation at any one point is to be synchronized by a separate switch, connect this separate, normally open switch between the terminals listed below. Remove all the common wiring and jumpers described in the previous paragraph. A pin must be in EXT. HAND OPER. for the hand to be synchronized.

SYNC POINT	CONNECT SWITCH	
	FROM	TO
1	TB116-2	TB118-2
2	TB116-3	TB118-3
3	TB116-4	TB118-4

D. External Interlock (continued)

SYNC POINT	CONNECT SWITCH	
	FROM	TO
4	TB116-5	TB118-5
5	TB116-6	TB118-6
6	TB116-7	TB118-7
7	TB116-8	TB118-8
8	TB116-9	TB118-9
9	TB116-10	TB118-10
10	TB116-11	TB118-11
11	TB116-12	TB118-12
12	TB116-13	TB118-13

NOTE: Up to 12 separate switches may be used.

See Section II B for all applicable programming data that must be followed with regard to the console plugboard. Also see the Interlock Diagram.

(c) Emergency Stop.

Normally closed switches or relay contacts may be used so as to remove primary power to the control console in an emergency situation. To connect these devices: First remove the jumper between terminals 19 and 21 of TB119 (located at extreme bottom rear of console). Then replace jumper with a series string of stop switches and/or relay contacts.

WARNING: This circuit is in the 115 VAC input line for the console, so primary system-power (normally 440 VAC) must be disconnected when wiring.

E. Manipulator Stop & Speed Adjustments

There are five stop-adjustments on the standard Model D Versatran manipulator. The purpose of these adjustments is; (1) to limit the amount of manipulator clockwise rotation; (2) to limit the amount of manipulator counterclockwise rotation; (3) to limit the amount of manipulator left swing; (4) to limit the amount of manipulator right swing; and (5) to limit the amount of

## E. Manipulator Stop & Speed Adjustments (continued)

"jaw open" travel of the gripper cylinder. Manipulator adjustment points and locking devices are indicated on an accompanying illustration.

### 1. Manipulator Swing Adjustments

The two manipulator swing stops can be adjusted to limit swing motion to any desired arc sector up to a maximum of 180 degrees. To adjust the swing arc, first loosen the swing adjustment locks. Change the two swing stop positions by adjusting worm gears S1 (for the right swing stop) and S2 (for the left swing stop). Then tighten the adjustment locks securely. Worm gears S1 and S2 are identified by markings on the manipulator casting. A swing scale ( $0^{\circ}$  to  $\pm 180^{\circ}$ ) and an index mark are incorporated on the manipulator to facilitate fixture resetting. It also is possible to control manipulator speeds through needle valves which are normally located on the manipulator manifold at the top of the column. The needle valve-type and placement may vary from application to application.

### 2. Manipulator Rotate Adjustments

The two manipulator rotate stops can be adjusted to limit manipulator rotate motion to any desired arc sector, up to a maximum of 180 degrees. To adjust the rotate arc, first loosen the rotate adjustment locks. Adjust the rotate stop positions to the required settings (R1 worm gear adjusts the CW rotate stop and R2 worm gear adjusts the CCW rotate stop). Then tighten the adjustment locks securely. Worm gears R1 and R2 are identified by markings on the manipulator casting. A rotate scale ( $0^{\circ}$  to  $\pm 180^{\circ}$ ) and index mark are incorporated on the casting to facilitate fixture resetting. Normally a needle valve also is available on the manipulator manifold to control rotate speed.

### 3. Gripper "Jaw Open" Adjustment

One gripper adjustment is provided which can be set so as to prevent the jaws from opening to their extreme limit. This adjustment is achieved through the use of a socket head cap screw, the length of which is determined by the particular application. Needle valves may be supplied to control gripper speeds.

E. Manipulator Stop & Speed Adjustments (continued)

4. Manipulator Function Speeds

Set the manipulator function speeds by adjusting the appropriate needle valves located at the top of the machine column. On some applications the needle valves may be electrically controlled by the Versatran.

## V. OPERATING PROCEDURES

### A. To Program (Teach Mode)

1. Open top panel covers.
2. Depress POWER/READY push button.
3. Check that the following lamps are illuminated:

POWER/READY, amber then green

TEACH, green

1, green (upper left of console)

JOYSTICK, white

NOTE: If machine has been shut down for any length of time, check and adjust system pressure at the machine.

4. Obtain joystick and plug into connector J1003 at bottom rear of console.
5. Unlock all axis potentiometers to be used and set approximately to center positions.
6. Operate joystick to move arm to desired position at first point.
7. Set axis switches for Point 1 by rotating them until lights UP, DWN, IN, OUT, CW, and CCW jump from one to the other, (i.e., UP is lit, turn sector switch until DWN lights and UP goes off, leave switch in that position.
8. Rotate potentiometers until both lights go out for each axis. Lock potentiometers, as they are now set to command the present position of the arm. If desired, potentiometers can be used to control the arm by depressing PANEL, as described later (17.).
9. Set manipulator as desired, trying out by use of controls OPEN/CLOSE, LEFT/RIGHT, and CW/CCW. Refer to Section IV E, on mechanical adjustments of manipulator.
10. Put pins in plugboard to call for the manipulator positions desired at Point 1. Also, put pin in OK for Point 1.
11. Using ADV STEP/BACK STEP, set pilot lights for points to "2" (i.e., press ADV/STEP side once).

A. To Program (Teach Mode continued)

12. Set arm to desired position with joystick, and set potentiometers, switches, hand, and plugboard as before.
13. Put pin in plugboard position OK, at Point 2. The motion from Point 1 to 2 has now been set up may be checked as indicated in steps 14 thru 16.
14. Using ADV STEP/BACK STEP, set pilot lights for points to "1." Use SET AT POINT 1 or joystick to return arm to Point 1.
15. Depress and hold TRY button and machine will go from Point 1 to Point 2. Release of TRY immediately stops machine.
16. Repeat these procedures until all desired points have been set. If only 5 points are used, OK will be pinned only up to Point 5, and in operation, the machine will return to Point 1 from Point 5.
17. If it is more convenient to finalize the position of the arm at a point using the potentiometers rather than the joystick, control of the arm is passed to the potentiometers when PANEL is illuminated. To do this, depress PANEL/JOYSTICK and PANEL will be illuminated. To return to joystick control, depress PANEL/JOYSTICK again, and JOYSTICK will light and the joystick has control.

B. Programming Details

1. Guide Points

- (a) In many applications, it is necessary to establish a point which the arm approaches, but at which it does not stop on its way to the following point. For example, a direct path between two points might cause the arm to collide with another piece of machinery. To control the path of the arm so that it avoids collision, a guide point is set between these two points, in the usual manner. The machine will approach this point in its travel, bypass it and proceed to the next point.
- (b) The arm is prevented from stopping at this guide point by inserting a pin in GUIDE POINT of the plugboard.

## B. Programming Details (continued)

### 2. Arm & Hand Delays

- (a) There may be points at which it is desired to perform a hand function at reduced speed (such as rotating a part during a finishing operation), or where the nature of the load causes the hand operation to take longer than the normal time (such as when working against a force). In this case, a pin is put into the HAND DELAY hole of the plugboard at this point, and the machine will wait for a time determined by the HAND DELAY potentiometer before moving on to the next point, thereby allowing sufficient time for the hand to perform its function. The HAND DELAY potentiometer is set and locked during the teach mode.
- (b) Where the arm is to stay at a given point for a fixed period of time before moving to the next point, as might occur when a part is being held and heated, a pin is placed in the ARM DELAY position of the plugboard for that point. The ARM DELAY potentiometer is used to set the length of this delay.
- (c) Note that HAND DELAY is effective only where a hand operation actually takes place and a pin is inserted in HAND DELAY for that point. The arm delay is always effective where a pin is inserted in ARM DELAY for that point.

### 3. Position Editing

- (a) Depress LAST CYCLE or, STOP AT NEXT POINT, whichever will take the machine closest to point(s) to be edited. (Machine will go into standby mode, STANDBY will be illuminated white.)
- (b) Depress TEACH, which will then be illuminated green.
- (c) Proceed as in V A., using ADV STEP/BACK STEP to select point, TRY to review, and JOYSTICK to set arm position. If joystick control is inconvenient, proceed as follows:
- (d) Depress PANEL CONTROL, which will light amber. The arm can be moved using the potentiometers and switches on the control console.
- (e) When arm is at desired position, lock potentiometers and depress PANEL CONTROL which will no longer be illuminated.

## B. Programming Details (continued)

### 4. Speed Adjustment

- (a) To operate the machine at the maximum rate, to obtain control of the path taken by the arm, or to obtain a controlled velocity for an operational requirement (feeding a workpiece, painting), it is necessary to control the maximum speed in each axis. This can be done by locking and setting the MAX. speed control associated with each axis. This control determines the maximum velocity for all motions in its associated axis.
- (b) To check the speed adjustment, the TRY control can be used as previously described, or the machine can be cycled using the OPERATE button (see Section V C.) and depressing either the STOP AT NEXT POINT or LAST CYCLE push buttons, as desired.
- (c) As the arm approaches a point, it is automatically slowed to a low maximum speed, called "creep" velocity. Adjustment of this velocity is made with the CREEP speed control associated with each axis. In general, to obtain the minimum time for a program, this speed should be set as high as consistent with smooth operation. The correct setting can be determined by trial, using the TRY button and ADV STEP/BACK STEP or other means for trying programs, as described earlier. It is important to have the machine carrying the normal load in the hand, since this setting is, to a considerable extent, determined by the weight and weight distribution of the load. When the program is fully set up, the machine should be cycled to determine that these settings are giving the performance desired.

### 5. Co-ordination with External Machines and Limit Switches.

- (a) During operation it is often necessary to have the machine stop and delay performance of a hand function at a particular point until a relay or switch closure is given by another machine or limit switch. Examples of this are: the Versatran is not to place a part in a die until it is determined by limit switch that clearance exists, or where shutdown of a press must stop the Versatran. See Sections II B. and IV D. for details.



### C. Operate Procedures (Playback)

1. Depress POWER/READY push button: POWER section will light amber. When machine is warm, READY section will light green.
2. If SET AT POINT 1 is lit, depress OPERATE-STANDBY which will light STANDBY white.
3. Depress OPERATE-STANDBY again and the machine will carry out the program, and OPERATE will light green.
4. If SET AT POINT 1 is not lit, depress SET AT POINT 1. The arm will start to return to Point 1.
5. If the moving arm is likely to hit something, release SET AT POINT 1, and the arm will immediately stop. Then, the joystick can be used to guide the arm close to Point 1. When the arm is near Point 1, SET AT POINT 1 is used for final setting.
6. When the arm is at Point 1, SET AT POINT 1 will be illuminated and OPERATE-STANDBY may be depressed once, illuminating STANDBY.
7. Then, depress OPERATE-STANDBY again, and the machine will carry out the program, and OPERATE will light green.

### D. Shutdown Procedures

1. To Stop at a Point During Operation
  - (a) Depress STOP AT NEXT POINT. The machine will stop at the next point and STANDBY will light white.
  - (b) To resume operation from this point, depress OPERATE-STANDBY or;
  - (c) To shutdown at this point depress STOP.
2. To Stop at the End of Current Cycle.
  - (a) Depress LAST CYCLE. Machine will complete cycle and return to Point 1. LAST CYCLE will be illuminated white after it has been depressed until cycle is complete, when STANDBY will light.

D. Shutdown Procedures (continued)

- (b) To resume operation, depress OPERATE-STANDBY or;
- (c) To shut down, depress STOP.

3. Emergency Stop

- (a) Depress STOP, machine will stop immediately. To restart refer to Operate Procedures given previously.

## VI. MAINTENANCE AND TROUBLESHOOTING FOR 12-POINT VERSATRAN

### A. Preventive Maintenance

It is important that a regular and systematic routine of preventive maintenance service be instituted to insure that the Versatran is always at peak operating efficiency. Since most plants already have established machine maintenance schedules, it is suggested that the following recommended maintenance procedures be coordinated with existing routines.

The following preventive maintenance procedures will be supplemented from time-to-time by AMF Sales Department instructions.

When replacement of any part or material is necessary, only AMF supplied or approved material must be used. This requirement is particularly important when replacing such parts as resolvers, valves, transistors, filters, pumps, hydraulic packing, and hydraulic oil. Use extreme care when working on hydraulic components to prevent any dirt entering the hydraulic system.

### B. Beginning of Shift (8 Hour) Maintenance\* — (To be Performed by Machine Operator)

1. Inspect all exposed hydraulic components for oil leaks. (machine pressure must be set @ 1000 psi,  $\pm$  5% .)
2. Clean machine exterior and operating area.
3. Manually operate and check grippers for function and alignment.
4. Check horizontal arm and vertical bearing surfaces (if exposed) for signs of wear. Check arm, carriage, and column for looseness.
5. Check condition of system oil filter (see indicator lamps on machine base).

### C. 100 - 120 Hour Maintenance\*

1. Perform usual 8-hour checks.
2. Vacuum interior of console to remove dust or dirt. Check and clean air filter in console base.
3. Remove machine covers and check for oil leaks, especially around servo valves, cylinders, manipulator, and the accumulator. Leave cover off for checks C-4 through C-9.

\*Hourly intervals noted are hours of actual operation, as read from elapsed time meter on machine base.

C. 100 - 120 Hour Maintenance\* (continued)

4. Clean and inspect machine. Use low pressure air hose to blow out dust and dirt, especially in radiator. Check air filter in machine grill. Wipe off the horizontal arm and column.
5. Check oil pressure and oil level. Oil pressure should lie between 950 - 1050 psi. With the pump off, oil should cover 3/4 of the sight glass. Fill the reservoir with prefiltered oil only, using absolutely clean funnels, cans, etc. Wipe the filler pipe opening clean before removing the strainer cup.
6. Check accumulator pressure (800 - 850 psi). Accumulator pressure is system pressure observed just before abrupt drop to zero psi after pump is shut off.
7. Inspect resolver racks and gears for condition of teeth.
8. Check radiator fan-motor operation. Proper operation is as follows:
  - (a) Fan motor off when machine is cold.
  - (b) Motor operates at approximately 46°F. and remains on whenever the temperature is above this value.
  - (c) Fan motor may fluctuate on and off when the machine is first turned on.

D. 480 - 500 Hour Maintenance\*

1. Perform procedures outlined in Paragraphs VI B and VI C.
2. Change oil filters in servo valves.\*\* Use extreme care to prevent contaminating foreign material from entering the hydraulic system.
3. Inspect air filter on oil reservoir filler pipe and replace if dirty.
4. Check all fittings, bolts, and screws for tightness.
5. Inspect and oil the fan shaft bearing and the manipulator fixture. Check lubricant at horizontal drive gear and rack.

\*Hourly intervals noted are hours of actual operation, as read from elapsed time meter on machine base.

\*\*To be done by qualified personnel only.

E. 2000 Hour Maintenance\*

1. Perform procedures outlined in Paragraphs VI B thru VI D.
2. Versatran lubrication points are indicated on the accompanying illustration. Where oil is required, use Mobile SAE #30 or equal; where grease is required, use Lubriplate. Be sure to remove all old lubricant before applying new grease or oil. Inspect and grease the following items:
  - (a) Horizontal drive gear and rack.
  - (b) Vertical drive gears.
  - (c) Resolver rack.
  - (d) Manipulator fixture (if required)

F. Troubleshooting Instructions

The following chart lists some of the common troubles which can be corrected by an in-plant (first echelon) maintenance man.

WARNING: Turn power off before removing modules.

<u>TROUBLE</u>	<u>PROBABLE CAUSE</u>	<u>REMEDY</u>
Erratic or no Versatran motion in one or two axes.	Defective safety valve in affected axis.	Replace valve
	Defective servo valve in affected axis.	Replace servo valve.
	Defective module.	Replace module(s) for particular axes: Horizontal - #700466 (ESU-109) Vertical - #700466 (ESU-108)

\*Hourly intervals noted are hours of actual operation, as read from elapsed time meter on machine base.

F. Troubleshooting Instructions (continued)

<u>TROUBLE</u>	<u>PROBABLE CAUSE</u>	<u>REMEDY</u>
		Swing - #700466 (ESU-105) #700470 (ESU-106)
		NOTE: All modules numbered 700466 are identical in design and may be interchanged (for test purposes only) to see if fault is repeated in other axis.
Erratic Versatran motion in <u>all</u> axes.	Low Hydraulic pressure due to: 1. Low oil level. 2. Oil leak in system. 3. Relief valve stuck.  4. Relief valve improperly set.  Defective Module.	1. Refill reservoir. 2. Find and repair leak. 3. Lightly tap valve body. Check for dirty hydraulic oil. 4. Reset relief valve. Tighten lock nut.  1. Replace module 700473 (Oscillator). 2. Replace module 700470 (Swing Auxiliary).
Erratic synchronization between Versatran and external machines.	Defective interlock wiring.	Inspect interlock and limit switch wiring for damage or disconnected leads.

F. Troubleshooting Instructions (continued)

<u>TROUBLE</u>	<u>PROBABLE CAUSE</u>	<u>REMEDY</u>
	Defective module.	Replace module 700471 (Interlock Logic).
	Defective Relay	Replace relays K101 thru K110.
Erratic or incorrect manipulator (hand) motion.	Incorrect manipulator settings.	Check manipulator stops and speed adjustments.
	Faulty SCR card.	Replace
	Faulty directional valve.	Replace
	Defective module.	Replace module 700472 (Wrist Logic).
No Versatran motion in <u>all</u> axes, (if oil pressure correct and pump running).	No 115 VAC power to console	Check main cable connections and machine-base fuses. Check for low line voltage.
	Loss of internal DC voltages.	Check all fuses; replace as needed. Never use larger fuse than specified.
	Defective synchronization system.	See "Erratic synchronization" trouble.
	Defective module.	Replace module 700469 (Power Supply).
		Replace module 700468 (Control Logic).

F. Troubleshooting Instructions (continued)

<u>TROUBLE</u>	<u>PROBABLE CAUSE</u>	<u>REMEDY</u>
		Replace module 700473 (Oscillator).
		Replace module 700467 (Shift Logic).
		Replace module 700470 (Swing Auxiliary).
		Replace module 700471 (Interlock Logic).
	Pilot pressure directional valve malfunction:	
	1. Faulty SCR card.	Replace
	2. Faulty directional valve.	Replace
No Versatran motion in <u>all</u> axes.	440V/220V power off.	Check power cable connections, fuses, circuit breakers and disconnect switches.
	Motor overload tripped.	Reset motor start relay in machine-base. Check line voltages.
	Pump Inoperative.	1. Three phase power to pump motor reversed. Switch leads to reverse motor direction.
		2. Air leak in pump intake line. Tighten fittings.
		3. Motor-pump shaft coupling broken. Replace.



F. Troubleshooting Instructions (continued)

<u>TROUBLE</u>	<u>PROBABLE CAUSE</u>	<u>REMEDY</u>
Ready Light does not illuminate.	Hydraulic oil not up to temperature.	Run pump until oil heats up (not longer than 20 minutes in most environments).
	Defective thermostatic oil temperature switch.	Check and replace if necessary.
	Defective module.	Replace module 700473 (Oscillator).
Oil filter lights go from green to red.	Oil filter dirty.	Replace filter with Pall replacement cartridge. Return dirty filter in sealed plastic bag to AMF.
No green or red light with power on.	Defective bulb or bulbs.	Replace.

APPENDIX A

ILLUSTRATIONS

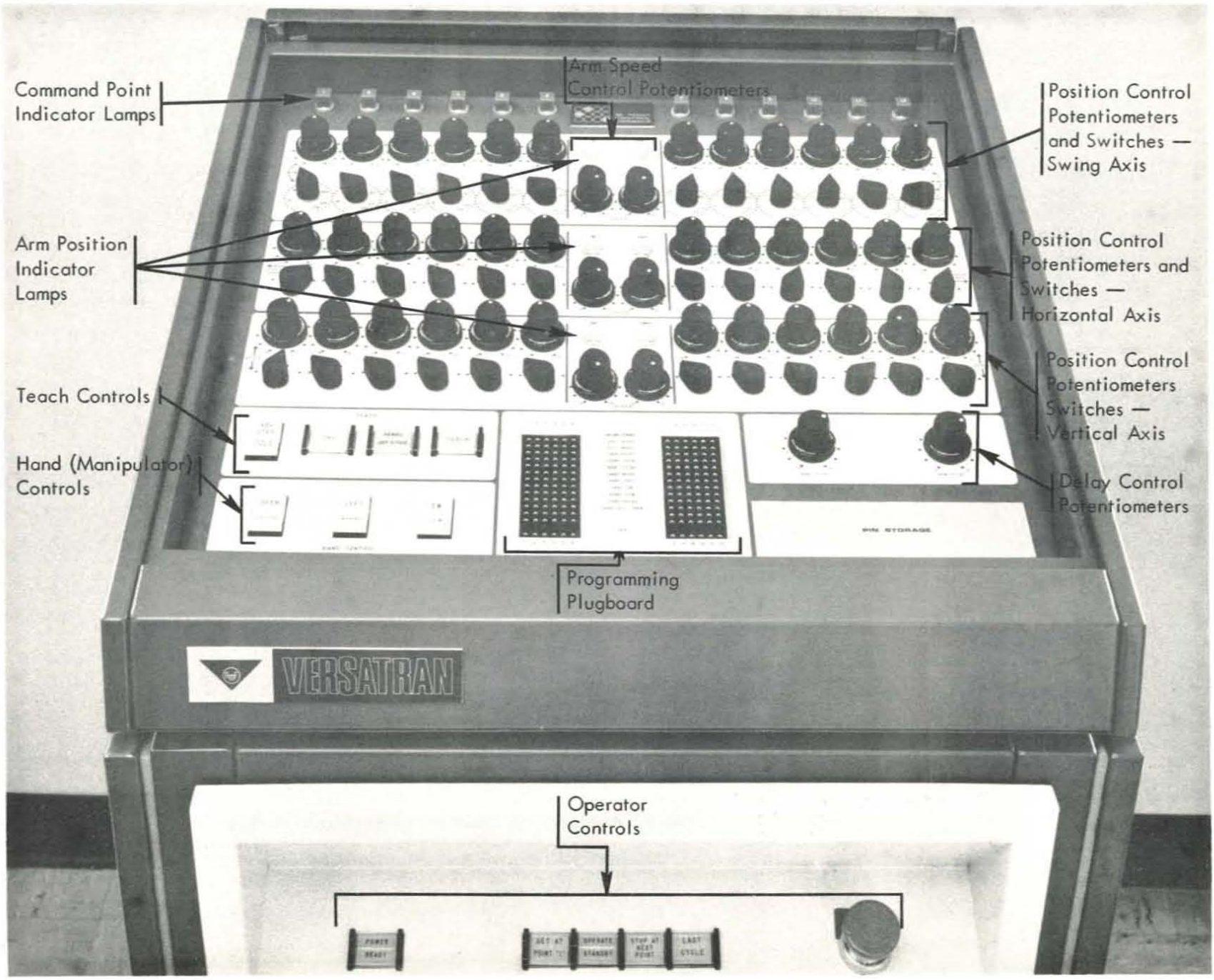


FIGURE 1. IDENTIFICATION OF PANEL COMPONENTS — POINT-TO-POINT CONTROL CONSOLE

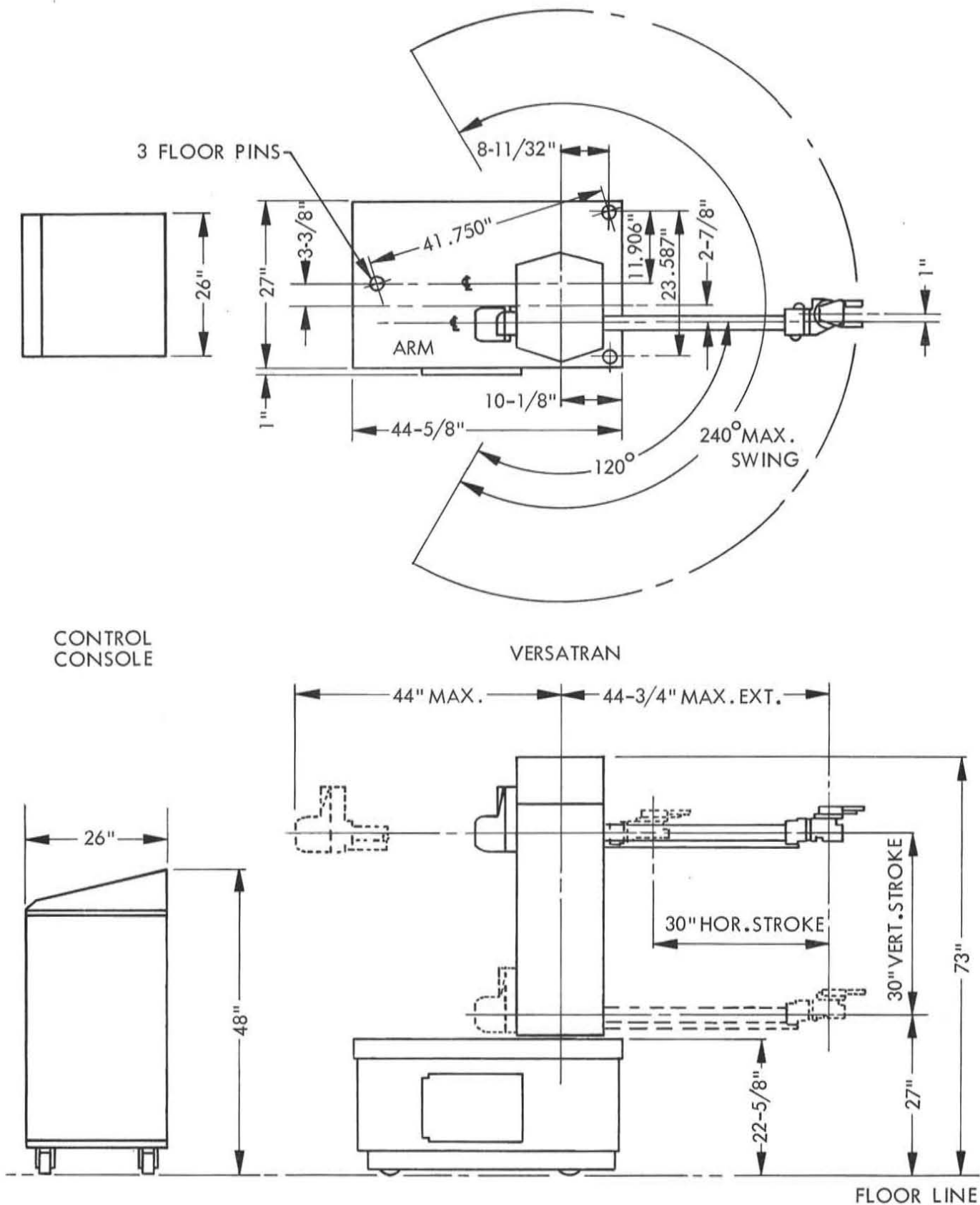


FIGURE 2. FLOOR PLAN — VERSATRAN AND CONTROL CONSOLE

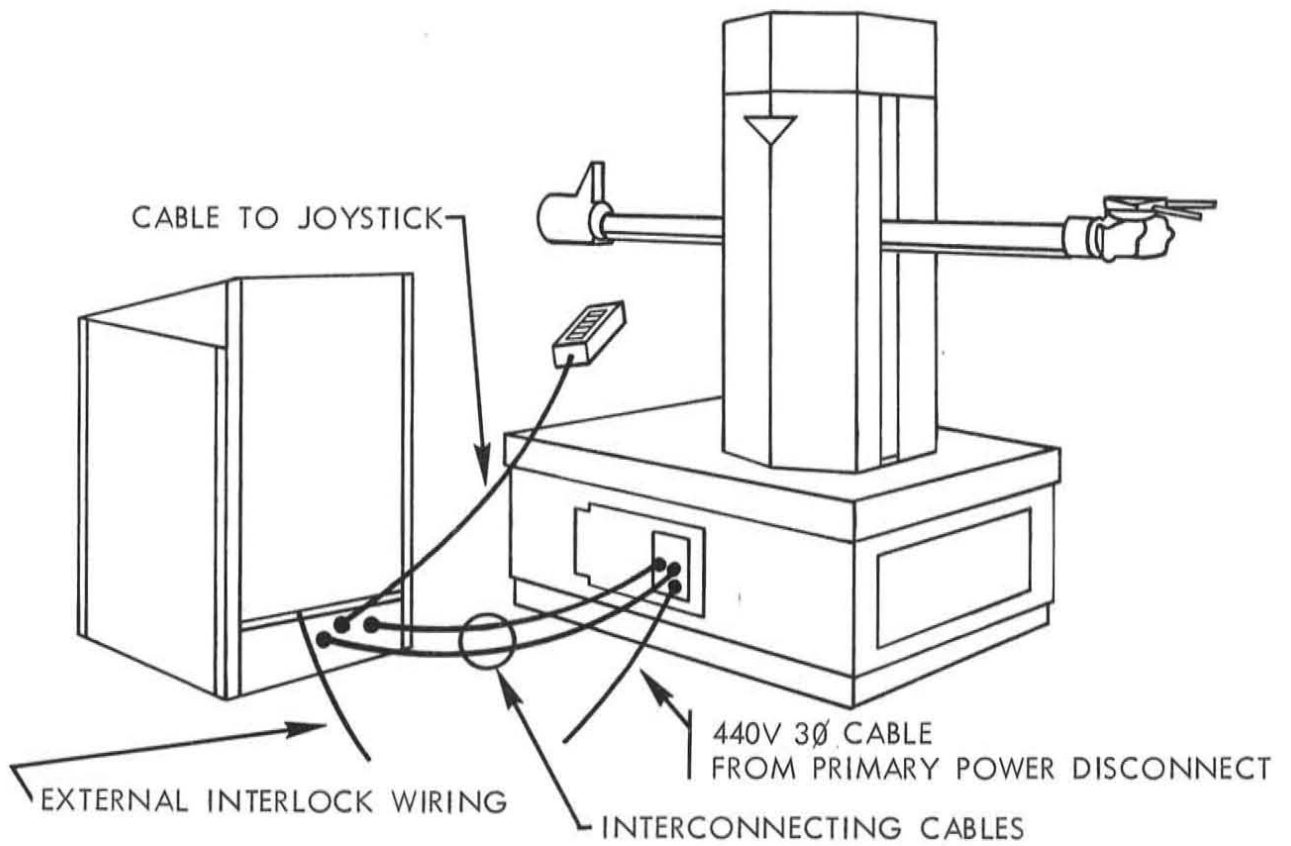


FIGURE 3. EXTERNAL WIRING AND CABLE CONNECTIONS

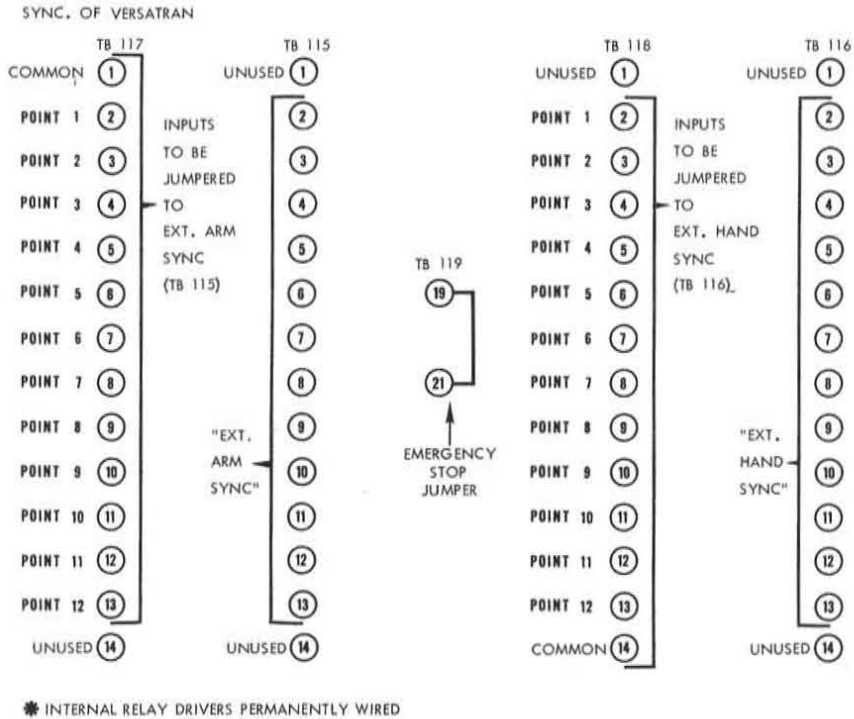
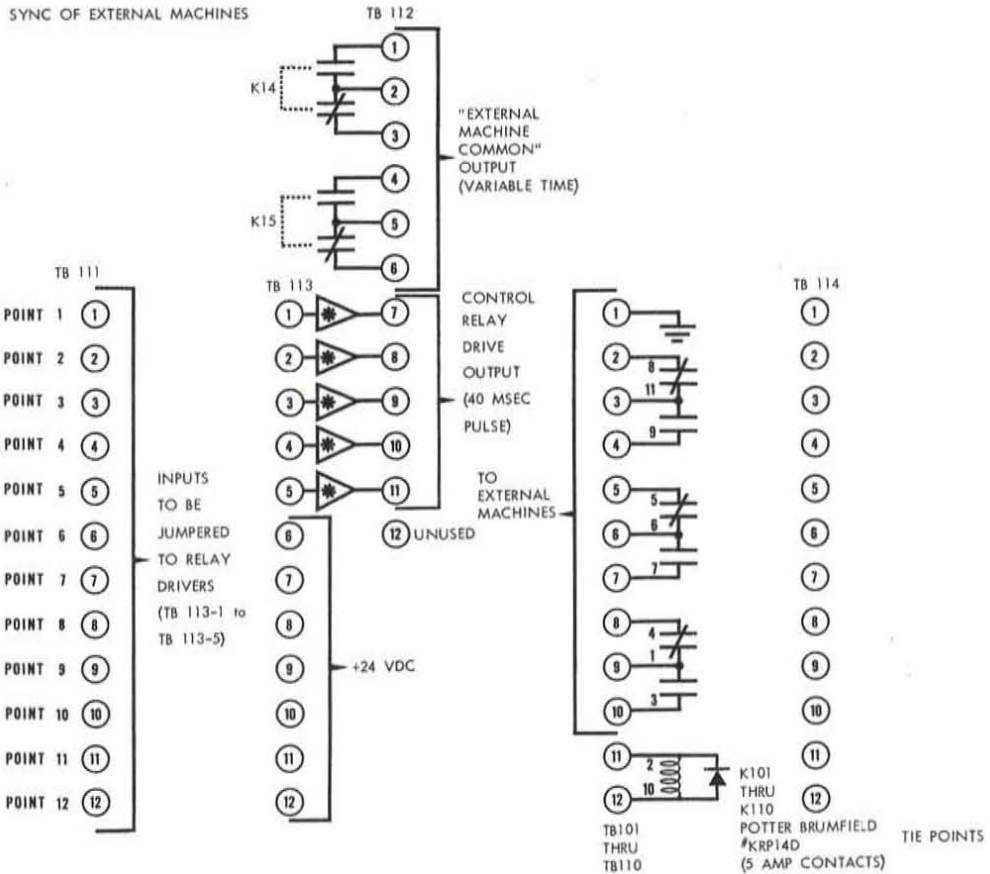


FIGURE 4. DIAGRAM OF CONTROL SYSTEM INTERLOCK TERMINAL BOARDS AND BASIC SYSTEM INTERLOCK WIRING

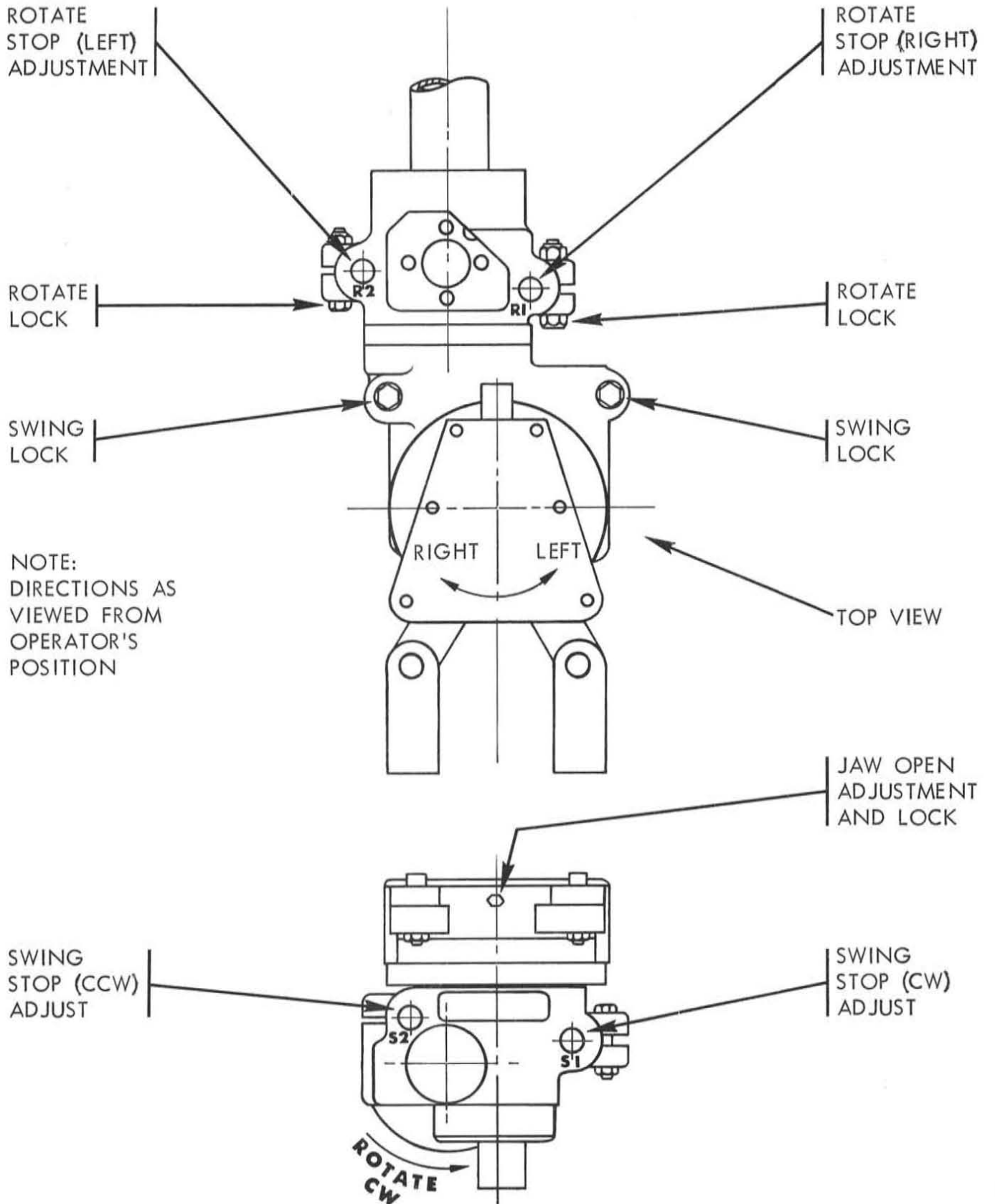


FIGURE 5. MANIPULATOR STOP ADJUSTMENTS

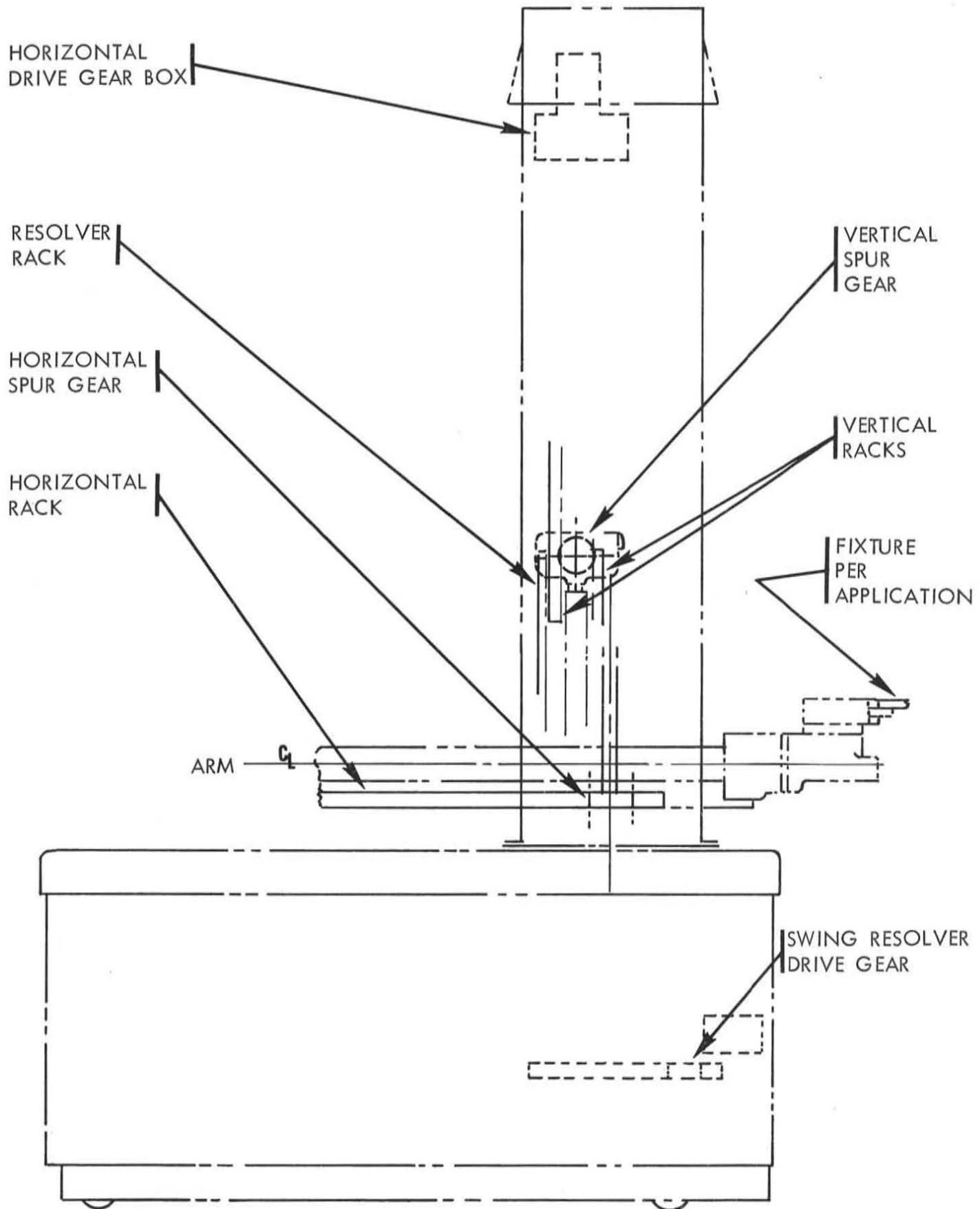


FIGURE 6. VERSATRAN LUBRICATION POINTS



ESU 101 MODULE 700468 INTERNAL LOGIC	ESU 102 MODULE 700473 OSCILLATOR	ESU 103 MODULE 700467 SHIFT LOGIC
ESU 104 MODULE 700472 MANIPULATOR LOGIC	ESU 105 MODULE 700466 SERVO AMPLIFIER SWING AXIS	ESU 106 MODULE 700470 SWING AUXILIARY SWING AXIS
ESU 107 MODULE 700471 INTERLOCK LOGIC	ESU 108 MODULE 700466 SERVO AMPLIFIER VERTICAL AXIS	ESU 109 MODULE 700466 SERVO AMPLIFIER HORIZONTAL AXIS
ESU 110 MODULE 700469 POWER SUPPLY		

FIGURE 7. MODULE LOCATIONS, POINT-TO-POINT CONTROL CONSOLE

Operators Manual Point to Point Versatran  
Autom die Equipment Dept