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DESCRIPTION OF A
C-SCAN DRIVE SYSTEM
FOR AN
UNDER SODIUM SCANNER

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INTRODUCTION

A C-scan type drive system has been designed which could be applied to an in-sodium transducer manipulator of the type shown, in concept version, in APDA-220*, and which is compatible with the C-scan recorder furnished to PNC by APDA in August 1972 under PNC/APDA Contract, December 24, 1971. The manipulator concept was described in some detail in Chapter V of APDA-220, and the functional requirements it was intended to fulfill are outlined in Chapter IV of that report. The concept at that stage of development did not define the drive and control system which would be required for operating in the C-scan mode; that equipment is the subject of this report. Although a drive system is proposed herein for a specific manipulator concept, it undoubtedly could be adapted to other types of C-scan manipulators.

DRIVE AND CONTROL EQUIPMENT

Equipment Required

The C-scan drive system (APDA drawings 6XN-8871 and 6XN-8893) consists of two stepping motors which are connected by drive chains to the tape driving assembly of the manipulator, a two-channel preset indexer, and a specially designed control panel containing various relays which interconnect the preset indexer channels to provide the proper scan sequencing of the drive motors. Also connected to the preset indexer are the two stepping motors that drive the Alden recorder which provides a picture of the field scanned. These two motors are synchronized with the manipulator drive motors.

Description of Manipulator Motors

The motors selected to drive the C-scan movements of the transducer manipulator are Type X250-1003 bifilar Slo-Syn synchronous/stepping motors manufactured by Superior Electric Company. These motors have a shaft rotation of 1.8 degrees per step and operate on 4.6 volts, 3.1 amperes per winding from power supplied by the preset indexer. The motors are fitted with planetary gear reducers mounted on their shaft end to provide the desired shaft speed range and torque. The sideways (horizontal) fanning drive has a Superior Electric Company Type P2 reducer, having a 21 2/3:1 reduction and a 2000 inch-ounce torque output. The slope (vertical) fanning drive motor has a Superior Electric Company Type P3 reducer, having a 108 1/3:1 reduction and a 2000 inch-ounce torque output.

* "A Proposed Program for the Design and Demonstration of a Prototype Under-Sodium Ultrasonic Scanner," J. Matte, February 1968, Atomic Power Development Associates, Inc. (APDA-220).

Description of Recorder Motors

The drive motors for the Alden recorder, as already furnished by APDA to PNC, are Superior Electric Company Slo-Syn Type SS25-1001 stepping motors, having a shaft rotation of 1.8 degrees per step. The motor for the recording helix is equipped with a reduction furnished by Alden to give a full span recorder trace in approximately 537 steps of the motor. The motor for the paper feed is equipped with a reduction furnished by Alden to provide $10\frac{1}{2}$ inches of paper travel in approximately 2670 steps of the motor.

Description of the Preset Indexer

The preset indexer, used for providing a predetermined number of power pulses to the C-scan drive motors on the manipulator and the Alden recorder, and also for automatic initiation of the next scanning motion, is a two-channel Type 2SP1800-4 Preset Indexer, manufactured by Superior Electric Company. One channel controls the sideways or horizontal scanning motor and the other channel controls the slope or vertical scanning motor. Both channels have speed adjustment from 3 steps per second to 500 steps per second; the number of steps that can be set on the decade counter controls can range from 1 step to 9999 steps.

The block diagram in Figure 1 shows the basic elements which comprise one channel of the preset indexer circuit. These include an adjustable frequency oscillator, control gates, decade counters, and a pulse-to-step translator logic circuit. Depending on the angular movement desired, the correct count is preset on the decade counter controls. A command signal in the form of a switch closure causes the gate circuits to pass pulses from the oscillator to the decade counters and the translator logic circuit. The translator logic circuit converts the pulses into the switching sequence needed to advance the motor shaft in steps. When the preset count is completed, the control gate turns off the pulse gate and actuates a relay which controls any external apparatus being operated in conjunction with the preset indexer.

Description of the Control Panel

The control panel, shown schematically on drawing 6XN-8893, is a specially designed unit containing six (6) control relays, a counter (such as a Veeder-Root Series 7102 counter), a 6-pole double throw switch, and four (4) pilot lights. These components would be interconnected as shown on the schematic, and connected to a power supply and to the preset indexer. The control panel is also connected to four (4) limit switches which would be mounted on the upper end of the manipulator for the purpose of limiting sweep travel to somewhat less than the mechanical limits of the transducer motion.

FIGURE 1

C-SCAN OPERATION

Types of Scan Movements

Two types of transducer scan movements are possible with this system. One type is the zig-zag scan (Figure 2) and the other is the rectilinear scan (Figure 3). Each type of scan is determined by the operational mode of the vertical drive motor. For rectilinear scan, the vertical drive motor runs only during a pause of the horizontal scan movement. For a zig-zag scan, the vertical drive motor steps continuously during the horizontal scanning movements. The selection of the scan mode is determined by the position of a 6-pole double-throw switch in the control circuit.

The scan control system permits easy adjustment of the angle of scan in either direction, so that the scan can be concentrated on the area of interest. The spacing between scan lines (line density) can also be readily controlled, in either zig-zag or rectilinear movements.

Operation

The horizontal angle of the scan of the transducer can be established by setting the decade counter controls of the horizontal channel of the indexer to the number of steps required for the angle of scan. Each step from the indexer will rotate the transducer through a horizontal angle of 2.80×10^{-2} degrees. Therefore, if a horizontal scan angle of 15 degrees is desired for the transducer, the number of steps from the indexer must be:

$$\frac{15^{\circ} \text{ (scan angle)}}{2.80^{\circ} \times 10^{-2} / \text{step}} = 537 \text{ steps.}$$

The horizontal speed of the scan, in degrees per second, can be varied by adjusting the oscillator frequency control on the horizontal channel of the indexer. The range of this control can be varied from 3 steps per second to a maximum of 500 steps per second. This will allow varying the scanning speed from 0.08 degrees per second to 13.9 degrees per second in the horizontal direction.

The vertical angle of scan can be established by setting the decade counter controls of the indexer vertical channel to the number of steps required for the angle of scan. Each step from the indexer rotates the transducer through a vertical angle of 5.62×10^{-3} degrees. Therefore, if a vertical scan of 15 degrees is desired for the transducer, the number of steps from the indexer must be:

$$\frac{15^{\circ} \text{ (scan angle)}}{5.62^{\circ} \times 10^{-3} / \text{step}} = 2670 \text{ steps.}$$

FIGURE 2

FIGURE 3

The vertical scan speed can also be varied, by adjusting the oscillator frequency control on the vertical channel of the indexer. The range of this control can be varied from 3 steps per second to a maximum of 500 steps per second, similar to the horizontal channel. This will allow varying the vertical scanning speed from 0.0017 degrees per second to 2.8 degrees per second. These scan speeds are slower than the horizontal scan speeds because the vertical drive motor has a higher ratio gear reducer.

Zig-Zag Scanning

Zig-zag scanning is selected by throwing the 6-pole double throw switch into the zig-zag scanning position "Z." The angle of horizontal and vertical scan is determined by the setting of the decade counter controls. For example, it takes 537 steps for a horizontal scan angle of 15 degrees and 2670 steps for a vertical scan of 15 degrees. The C-scan mechanical equipment is positioned by using the remote jog switches and then the index switch is actuated. The horizontal channel will then drive the horizontal motor back and forth 15 degrees while the vertical drive motor slowly drives the transducer back and forth 15 degrees in the vertical direction.

Rectilinear Scanning

Rectilinear scanning is selected by throwing the 6-pole double throw switch into the rectilinear scanning position "R." The angle of horizontal scan is again determined by the number of steps selected on the decade counter controls. The vertical scan angle will be controlled by the number of steps of the vertical drive motor in each vertical movement, together with the number of these vertical movements preset on the counter. When the number of vertical movements counted reaches the preset number, the control will reverse the vertical drive motor for another set of vertical movements in the opposite direction.

Overtravel Limits

Adjustable limit switches are indicated to stop the scanning drive motors and recorder drive motors if the sweep travel approaches the mechanical limits of transducer rotation. These switches are arranged so the control panel remains energized, thus preserving the pilot light indicating the fault and also simplifying the restarting procedure.

LIST FOR DRAWING No 6XN-8871				
ITEM No.	SHOWN ON DWG No.	QTY	DESCRIPTION	USED ON DWG No.

SUPERIOR ELECTRIC COMPANY
BIFILAR SLO SYN SYNCHRONOUS/STEPPING
MOTOR - TYPE X250-1003, 4 & VOLTS, 3.1
AMPERES PER WINDING WITH TYPE P3
PLANETARY GEAR ASSEMBLY (100% GEAR RATIO -
TORQUE OUTPUT 2000 IN. OZ.)

SUPERIOR ELECTRIC COMPANY BIFILAR
SLO-SYN SYNCHRONOUS/STEPPING
MOTOR - TYPE X250-1003, 4 & VOLTS
3.1 AMPERES PER WINDING WITH TYPE
P2 PLANETARY GEAR ASSEMBLY (21 2/3 GEAR
RATIO - TORQUE OUTPUT 2000 IN. OZ.)

PROPOSED TAPE DRIVE ASSEMBLY
(SEE DRAWING NO 6XN-719)

VIEW "AA"

SIDEWAYS FANNING
DRIVE

SLOPE FANNING DRIVE

FRONT ELEVATION

SLOPE FANNING DRIVE

SIDE ELEVATION

NOTE
THIS DRAWING AND ELECTRICAL Schematic 6XN-8892 SHOW
PROPOSED DRIVE MOTOR AND CONTROL APPLIED TO A PROTOTYPE
UNDER SODIUM "BRASS" PER MANIPULATOR AS SHOWN ON 6XN-7200,
6XN-7107, 6XN-7108, 6XN-7155 AND 2. THESE THREE MOTORS AND
CONTROL ARE FULLY COMPATIBLE WITH THE PER PAPER DRIVE MOTORS
ON THE ALUMINUM "I" REGULATOR FURNISHED UNDER DUC/APOR
CONTRACT, DECEMBER 24, 1971.
DRAWING NO 6XN-8871 SHOWS A SUGGESTED ARRANGEMENT FOR
INCORPORATING THE TYPE SYN 5855 UNIDIRECTIONAL IN THE PROPOSED
TRANSDUCER MANIPULATOR

DATE	NAME	CHANGE	MADE BY	CHK'D	DATE	APP'D	DATE

TITLE UNDER SODIUM SCANNER FOR PNC
SUGGESTED TAPE DRIVE MOTORS FOR
A TRANSDUCER MANIPULATOR
ATOMIC POWER DEVELOPMENT ASSOCIATES INC.
PROJECT NO. 295-01-03
SCALE FULL
DATE 7-31-73
DRAWING NUMBER 6XN-8871
USE DIMENSIONS ONLY

[illegible]

CONTROL CIRCUIT

WIRING DIAGRAM

SYNTHETIC

ZIG ZAG SCAN
TIMING DIAGRAM

RECTILINEAR SCAN
TIMING DIAGRAM

LTR ZONE		CHANGE		MADE BY	CH KD	DATE	APP D	DATE
NAME	DATE	TITLE						
MADE BY	BRADLEY	8-3-72	UNDER SODIUM SCANNER FOR PNC					
RECEIVED BY	W L TOTH	8-4-72	WIRING DIAGRAM FOR TAPE DRIVE					
RECEIVED BY			MOTORS FOR TRANSDUCER MANIPULATOR					
APPROVED BY	<i>Shute</i>	8-16-72	ATOMIC POWER DEVELOPMENT ASSOCIATES INC					
SCALE	PROJECT NO.		DRAWING NUMBER					
	235-01-03		6XN-8893					
USE DIMENSIONS ONLY								