Jan. 26, 1960 H. A. PANISSIDI ET AL 2,922,399

HYDRAULIC DRIVE AND CONTROL THEREFOR

Filed Jan. 24, 1957 3 Sheets-Sheet 1

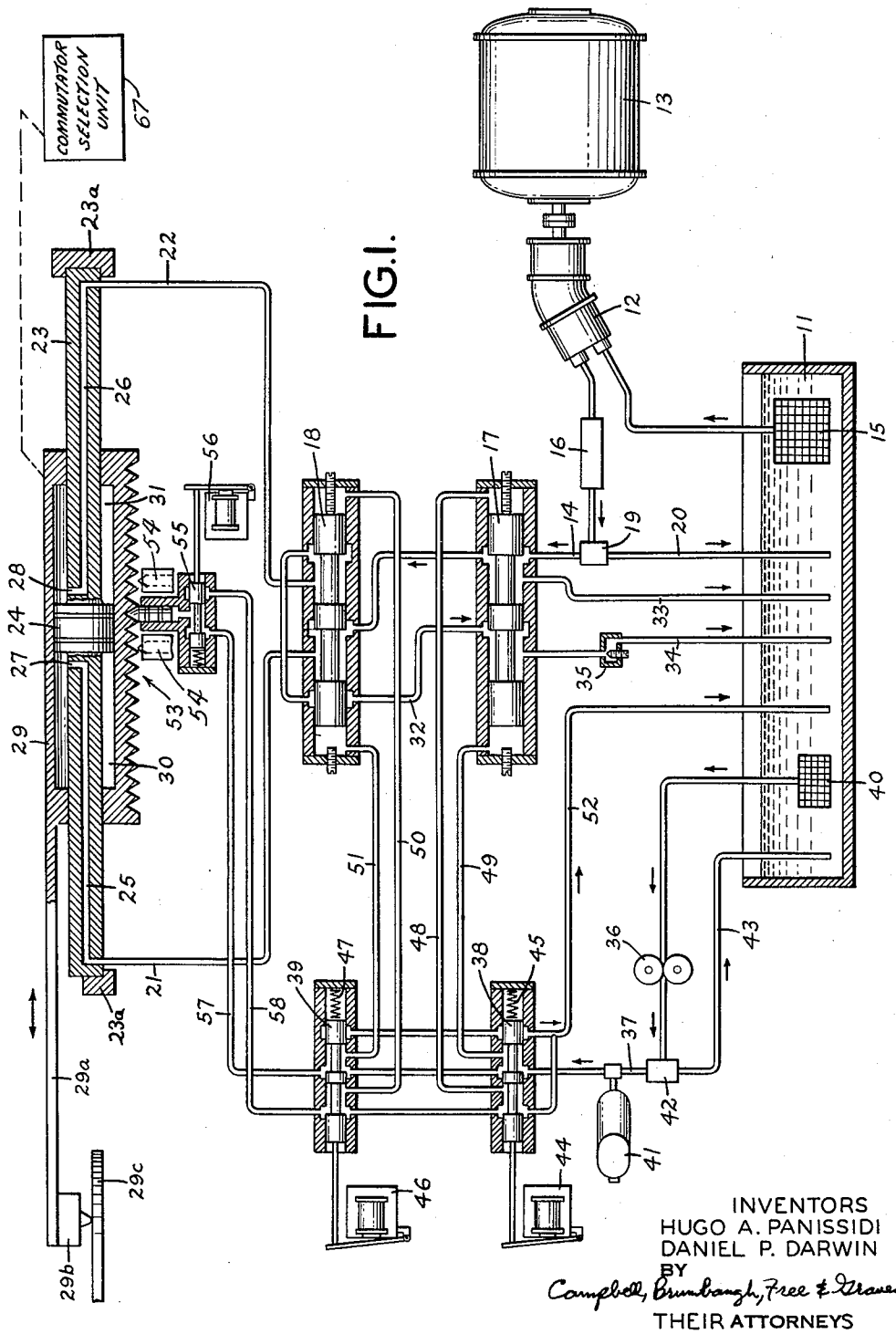


FIG. I.

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HYDRAULIC DRIVE AND CONTROL THEREFOR

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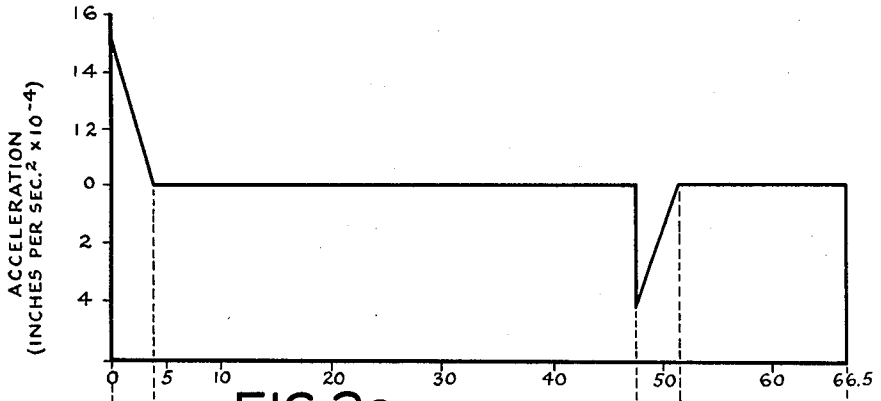


FIG.2a.

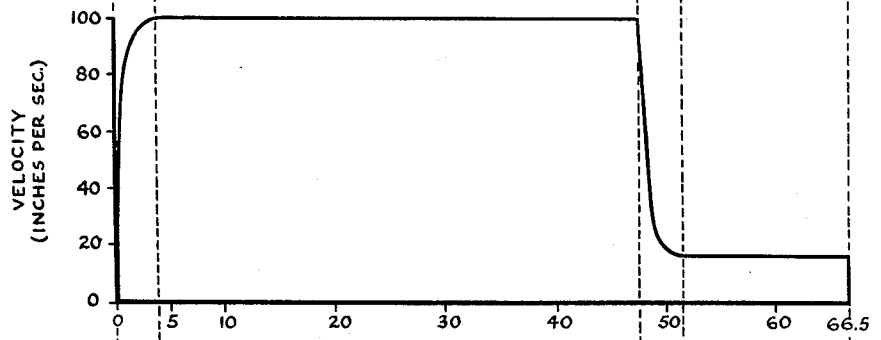


FIG.2b.

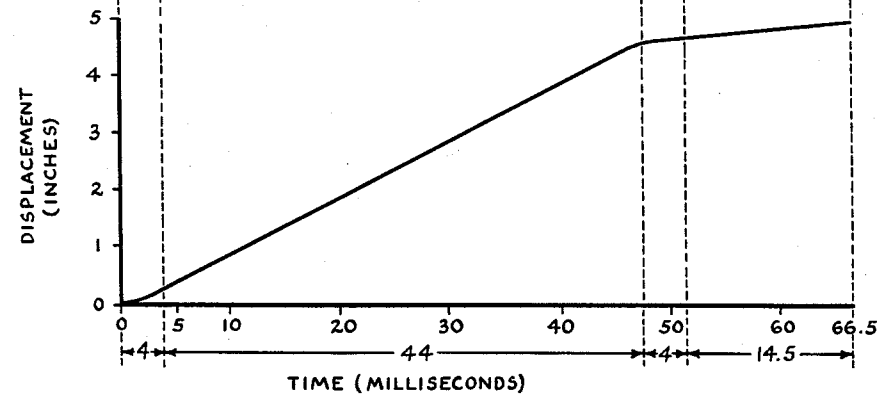


FIG.2c.

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Filed Jan. 24, 1957 3 Sheets-Sheet 3

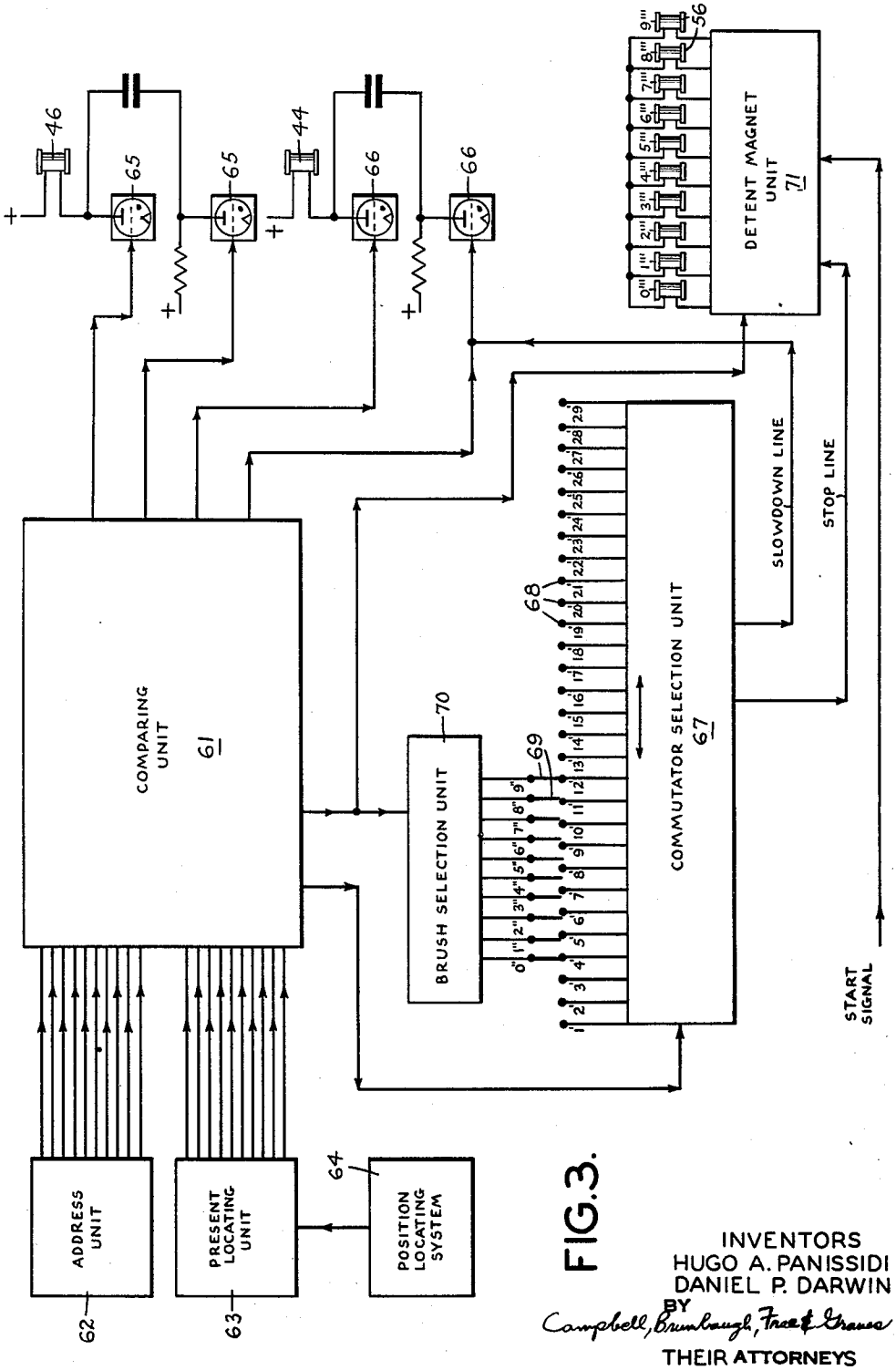


FIG. 3.

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2,922,399

HYDRAULIC DRIVE AND CONTROL THEREFOR

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Application January 24, 1957, Serial No. 636,119

5 Claims. (Cl. 121—40)

This invention relates to hydraulic drive systems and, more particularly, to a new and improved hydraulic drive system adapted to drive a member such as a carriage to any one of a series of predetermined positions at random within a fixed maximum time.

In computing devices and the like, data storage or memory units are frequently utilized to store information for varying periods of time during the computing operation. For example, a carriage supporting a magnetic transducer may be so mounted that the transducer is accessible to any of a series of closely spaced magnetic tracks for recording or reading information thereon as desired. It is essential to the efficient operation of such devices that the transducer be capable of moving from any track to any other track within a maximum fixed time of short duration, particularly when information is to be recorded or read from the various tracks at random.

Accordingly, it is an object of this invention to provide a new and improved drive system for computing devices and the like whereby a carriage may be moved from one position to any other position within a maximum fixed time of short duration.

Another object of the invention is to provide a drive system of the above character having high acceleration rates and smooth and efficient operation.

A further object of the invention is to provide a new and improved drive system for imparting motion to a carriage at selected velocities, according to the distance to be traversed.

Still another object of the invention is to provide novel hydraulic carriage drive means whereby a movable carriage may be locked in position at any desired location rapidly and accurately.

These and other objects of the invention are attained by providing carriage means adapted to be driven to any desired position by hydraulic fluid under pressure. More particularly, the carriage is driven by piston and cylinder means powered by a hydraulic circuit and its motion is governed by direction control and speed control valves. These valves are operated by a lower pressure hydraulic circuit under the control of magnet-actuated pilot valves, the speed control valve being positioned according to the distance to be traversed by the carriage. Utilization of a lower pressure hydraulic circuit to control the valves of the carriage drive circuit combines the high torque advantages of high pressure systems with the low control power and minimum actuation time required by low pressure systems, thus affording smooth and highly efficient operation.

Further objects and advantages of the invention will be apparent to those skilled in the art from a reading of the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a schematic illustration of a typical embodiment of the hydraulic drive system of the invention;

Figs. 2*a*, 2*b* and 2*c* illustrate graphically the acceleration, velocity, and displacement characteristics of the drive system shown in Fig. 1; and

Fig. 3 is a schematic illustration of a suitable circuit for controlling the hydraulic drive system shown in Fig. 1.

The typical hydraulic circuit illustrated in Fig. 1 comprises a fluid reservoir **11** from which hydraulic fluid is withdrawn by a pump **12**, powered by an electric motor **13**, and applied to an input line **14**. A pump capable of supplying 11.5 gallons of hydraulic fluid per minute at a pressure of 1500 pounds per square inch has been found satisfactory for this purpose. If desired, a strainer **15** and a filter **16** may be interposed in the system to remove impurities from the fluid withdrawn from the reservoir **11**.

Hydraulic fluid passes from the input line **14** through a speed control spool valve **17** to a direction control spool valve **18**, a relief valve **19** being provided to divert excess fluid to the reservoir **11** through a return line **20**. Two supply lines **21** and **22** lead from the direction control valve **18** to opposite ends of a stationary shaft **23** held in position by supports **23***a*, the shaft carrying a fixed piston **24**. In order to convey fluid from the lines **21** and **22** through the shaft **23**, two internal ducts **25** and **26** are provided and these terminate in outlet ports **27** and **28** adjacent the piston **24**.

A movable cylinder **29** is slidably mounted on the piston **24** and the shaft **23**, and the two outlet ports **27** and **28** communicate with two chambers **30** and **31** formed by the piston and the cylinder. The cylinder **29** carries an arm **29***a* upon which a magnetic transducer **29***b* is mounted, a rotatable record disc **29***c* having record tracks at regular radial intervals, for example, one-fortieth of an inch, being supported adjacent the head.

In order to remove fluid displaced by the motion of the cylinder **29**, a return line **32** leads from the direction control valve **18** to the speed control valve **17**. The displaced fluid is then directed to the reservoir **11** either through an open line **33** or through a restricted line **34** according to the position of the valve **17**, an adjustable needle valve **35** being interposed in the line **34** to control the fluid flow therein.

The operation of the valves **17** and **18** is controlled by a low pressure (e.g. 500 p.s.i. at ½ g.p.m.) hydraulic circuit comprising a pump **36** which supplies hydraulic fluid through an input line **37** to a speed control pilot valve **38** and a direction control pilot valve **39**. A strainer **40** may be included in this circuit to remove impurities, if desired. In order to maintain uniform fluid pressure, an accumulator **41** and a pressure regulator **42**, connected to the reservoir through a return line **43**, are interposed between the pump **36** and the valve **38**.

The pilot valve **38** is actuated by a magnet **44**, a return spring **45** being provided within the valve casing, and the valve **39** is similarly actuated by a magnet **46** and a spring **47**. Two lines **48** and **49** direct fluid from the pilot valve **38** to either end of the speed control valve **17** according to the pilot valve position and the direction control pilot valve **39** is likewise connected to actuate the direction control valve **18** through two lines **50** and **51**. The operation of the valves **17** and **18** in this manner displaces fluid in the low pressure circuit which is directed to the reservoir through a return line **52**.

In order to locate the magnetic transducer **29***b* accurately at any desired position, regularly spaced detent teeth **53** provided on the cylinder **29** are engaged selectively by one of a series of regularly spaced pawls **54**, shown in Fig. 1. Hydraulic actuation of each detent pawl **54** is controlled by a valve **55** connected to a magnet **56**,

fluid from the low pressure circuit being supplied to the valve 55 through two lines 57 and 58.

The spacing of the teeth 53 differs from that of the pawls 54 so that a vernier relation between the two is established. For example, the teeth may have a one-quarter inch separation while the pawl interval is nineteen-fortieths of an inch, thereby permitting the carriage to be locked in a series of positions spaced by one-fourtieth of an inch corresponding to the track locations on the record disc 29c.

In a typical electric circuit for controlling the hydraulic drive system, illustrated in Fig. 3, a conventional comparing unit 61 compares the present location of the carriage with the "address" or desired location. Position information is supplied to the comparing unit in numerical form by an address unit 62 and a present location unit 63, carriage location data being transmitted to the latter by a position locating system 64. The comparing unit 61 determines the difference between the present and the desired locations and actuates the direction control magnet 46 through a pair of thyratrons 65 accordingly. Similarly, the speed control magnet 44 is actuated through a pair of thyratrons 66 by the comparing unit according to whether the distance to be traversed is greater or less than one inch (forty magnetic tracks).

In order to position the carriage at the desired location, a commutator selection unit 67 moves with the cylinder 29 and carries a row of commutator contacts 68, which are individually indentified in Fig. 3 by a series of primed reference numbers. A series of brushes 69, individually designated by double-primed reference numbers, is mounted on a stationary brush selection unit 70 in a position to engage the contacts. The spacing of the commutator contacts 68 and the brushes 69 is arranged to provide a vernier relation between the two in the same manner as that between the detent teeth 53 and the pawls 54 described above, each contact 68 corresponding to one of the teeth 53 and each brush 69 corresponding to a pawl 54. The commutator selection unit 67 is arranged to actuate the speed control magnet 44, slowing down the carriage when it approaches the desired location, and to signal the detent magnet unit 71 to energize the proper detent magnet 56, as determined by the comparing unit 61, when the carriage has reached the new address.

In operation, the comparing unit 61 actuates the speed and direction control valves 17 and 18 through the magnets 44 and 46 according to the motion to be imparted to the cylinder 29. For example, if the distance to be scanned is greater than one inch (forty magnetic tracks) the speed control valve 17 is first moved to the left to allow fluid from the cylinder 29 to pass freely to reservoir 11 through the open line 33, the direction control valve 18 being positioned according to the difference between the present location and the desired location.

The numerical "address" information supplied to the comparing unit determines which brush 69 and commutator contact 68 will be connected when the transducer is at the desired location. For example, the address "114" indicates the location at which the contact marked 15' and the brush marked 4'' are connected, the field address "11" and the unit address "4" being added to obtain the correct contact number. Two contacts four positions away, 11' and 19', are selected to send a slow-down pulse to the speed control valve 17 when contacted by the brush 4''. Also, the detent magnet marked 4''' is selected for actuation on signal by the comparing unit.

After the above functions have been carried out by the comparing unit 61, a start signal applied to the detent magnet unit 71 releases the engaged pawl 54 allowing the carriage to be driven at high speed toward the desired location. When the cylinder reaches a point about one-quarter inch from the desired location, the brush 4'' engages the contact 11', deenergized the magnet 44 and shifting the valve 17 to the right. This changes the system to a low speed condition by directing the return fluid from the cylinder through the restricted line 34 and diverting a portion of the fluid from the input line 13 to the reservoir 11 through the line 33. Adjustment of the needle valve 35 varies the velocity of the cylinder 29 in the low speed condition and this may be set at any desired value.

The cylinder is positioned and retained at the desired location when the brush 4'' engages the contact 15', energizing the magnet 4''' to engage a selected pawl 54 in the row of teeth 53. The speed and force with which the hydraulic pressure drives the pawl 54 into the detent tooth stops the carriage motion rapidly, and accurately positions the transducer 29b within a thousandth of an inch of the desired location. If the distance to be traversed by the transducer is small, for example 40 tracks or less, the comparing unit 61 retains the valve 17 to the right in the low speed condition throughout the cycle of operation.

The unique and highly efficient performance of the novel hydraulic drive is illustrated graphically in Figs. 2a, 2b and 2c. The curves there shown represent the acceleration, velocity, and displacement characteristics of the system during one cycle of operation when driving a ten pound carriage. It will be observed that the high acceleration provided by the hydraulic system enables the carriage to traverse a five inch distance within a maximum time of sixty-six and one-half milliseconds. During the first forty-eight milliseconds, the carriage is driven four and three-quarter inches at a maximum velocity of one hundred inches per second, including an acceleration time of less than four milliseconds. Thereafter the speed is reduced to twenty inches per second to allow accurate positioning and a minimum of impact when the carriage is stopped by the detent pawl 54.

It will be apparent from the above that the invention provides novel means for driving a carriage from one position to any other position at random within a fixed maximum time, smoothly and efficiently.

It will be understood that the embodiment described above is illustrative rather than restrictive of the invention. Various modifications and changes will occur to those skilled in the art which do not exceed the intended scope of the invention as defined in the following claims.

We claim:

1. Hydraulic apparatus for driving a member from one position to another comprising piston and cylinder means to which said member is connected forming two chambers, detent means including a plurality of detents and a plurality of cooperating pawls arranged in vernier relation for positioning the piston and cylinder means in any of a plurality of predetermined relative positions, a plurality of valves for supplying hydraulic fluid to each of the plurality of pawls, a plurality of magnets each connected to operate a selected one of the valves to engage the corresponding pawl with a selected detent when the member reaches the desired location, a first hydraulic circuit for supplying hydraulic fluid to either of the two chambers selectively to impart relative motion to the piston and cylinder means, valve means to control the flow of fluid in the first hydraulic circuit, and a second hydraulic circuit to actuate said valve means and said detent means according to the location of the member.

2. Hydraulic apparatus for driving a member from one position to another position comprising piston and cylinder means connected to said member forming two chambers, detent means for positioning the piston and cylinder means in any of a plurality of predetermined relative positions comprising a plurality of detents and a plurality of pawls arranged in vernier relation to each other, a plurality of valves each supplying hydraulic fluid to operate one of said pawls, a plurality of magnets each connected to operate a selected one of the valves to engage the corresponding pawl with a selected detent when the member reaches the desired location, a first hydraulic circuit for supplying hydraulic fluid under pressure to either of the two chambers selectively to impart relative motion

to the piston and cylinder means, a speed control valve to adjust the rate of flow of fluid in said first circuit to either of two predetermined values, a direction control valve in said first circuit to control the direction of motion of the cylinder, and a second lower pressure circuit having a magnet-actuated speed control pilot valve to supply hydraulic fluid to said speed control valve to actuate it according to the location of the member, a magnet-actuated direction control pilot valve to supply hydraulic fluid to the direction control valve to actuate it according to the location of the member, and circuit means supplying hydraulic fluid to said plurality of pawl valves.

3. Apparatus for driving a member to a selected one of a plurality of locations comprising hydraulic drive means connected to the member, circuit means supplying fluid under pressure to the drive means according to the location of the member, means for positioning the member at the selected one of the plurality of locations including a plurality of detents and a plurality of pawls spaced in vernier relation thereto for selective engagement therewith, and means responsive to the location of the member for actuating a selected pawl to engage a selected detent when the member reaches the selected location.

4. Apparatus according to claim 3 including valve means in the circuit means controlling the velocity of the drive means, and means responsive to the position of the member for actuating the valve means to reduce the velocity of the member at a predetermined distance from the selected position.

5. Apparatus according to claim 4 wherein the valve means is arranged to interpose a restricted passage in the hydraulic circuit means decreasing the flow of fluid in the circuit to reduce the velocity.

References Cited in the file of this patent

UNITED STATES PATENTS

1,683,175	Falcke et al.	Sept. 4, 1928
1,766,510	Gregory	June 24, 1930
1,943,061	Douglas	Jan. 9, 1934
2,118,021	Curtis	May 17, 1938
2,157,707	Keel	May 9, 1939
2,251,961	Snader	Aug. 12, 1941
2,435,026	Barnes	Jan. 27, 1948
2,765,808	Tydeman	Oct. 9, 1956
2,821,172	Randall	Jan. 28, 1958
2,855,752	Le Brusque	Oct. 14, 1958
2,860,751	Seigle	Nov. 18, 1958