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AND STOPPING OF A HYDRAULIC MOTOR

2,902,005

Filed May 23, 1957

3 Sheets-Sheet 1

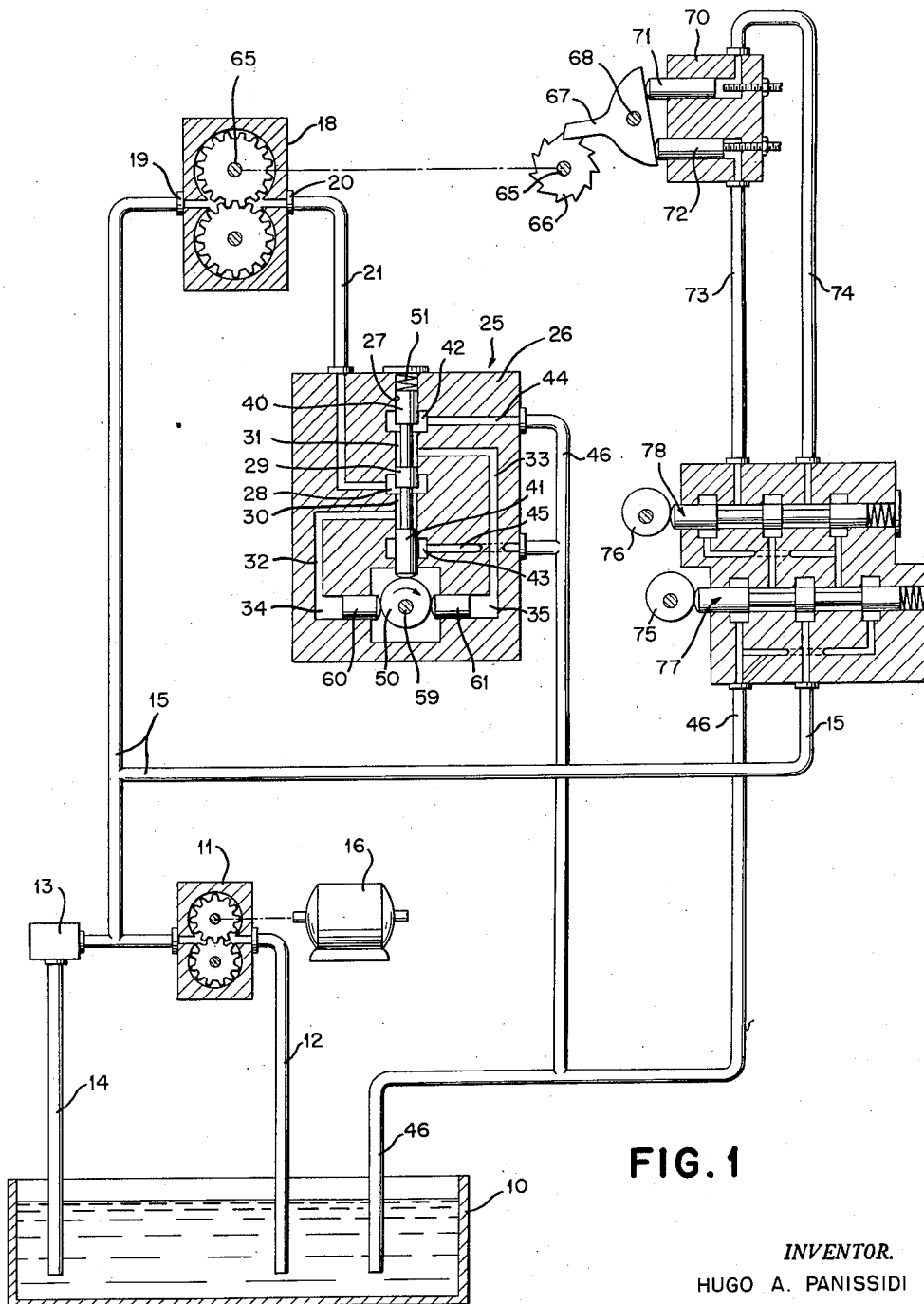


FIG. 1

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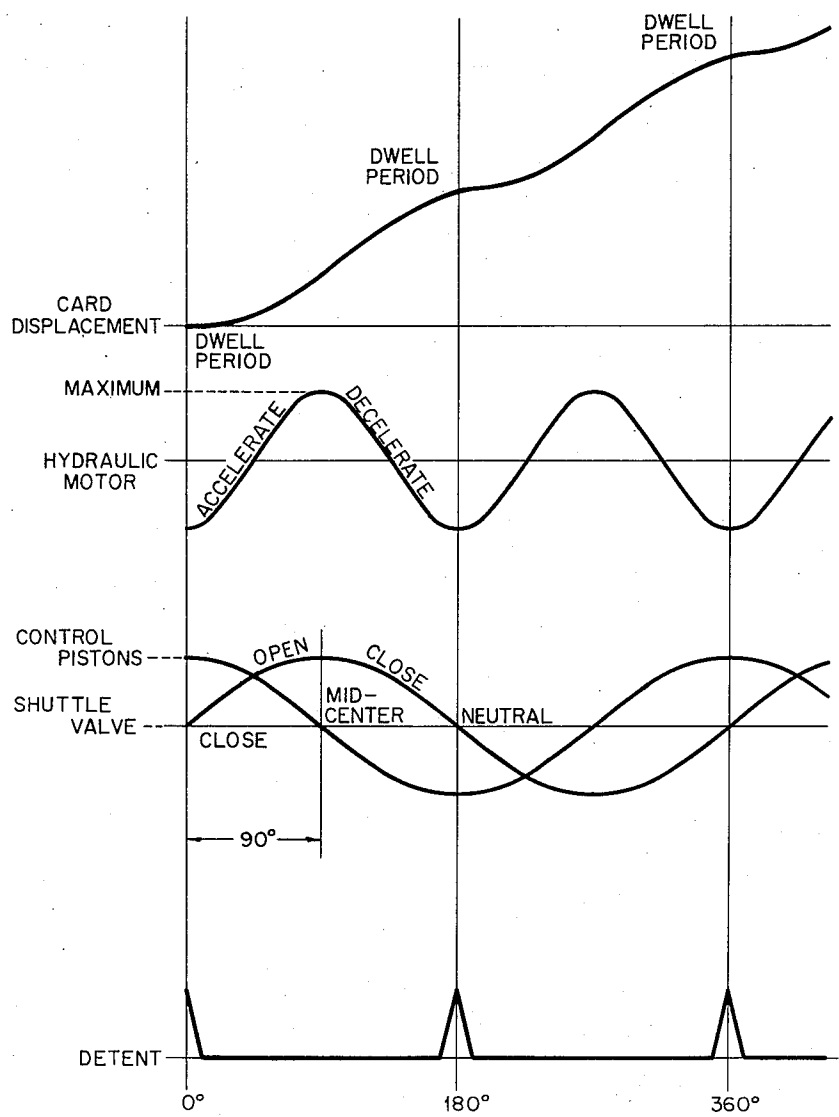


FIG.2

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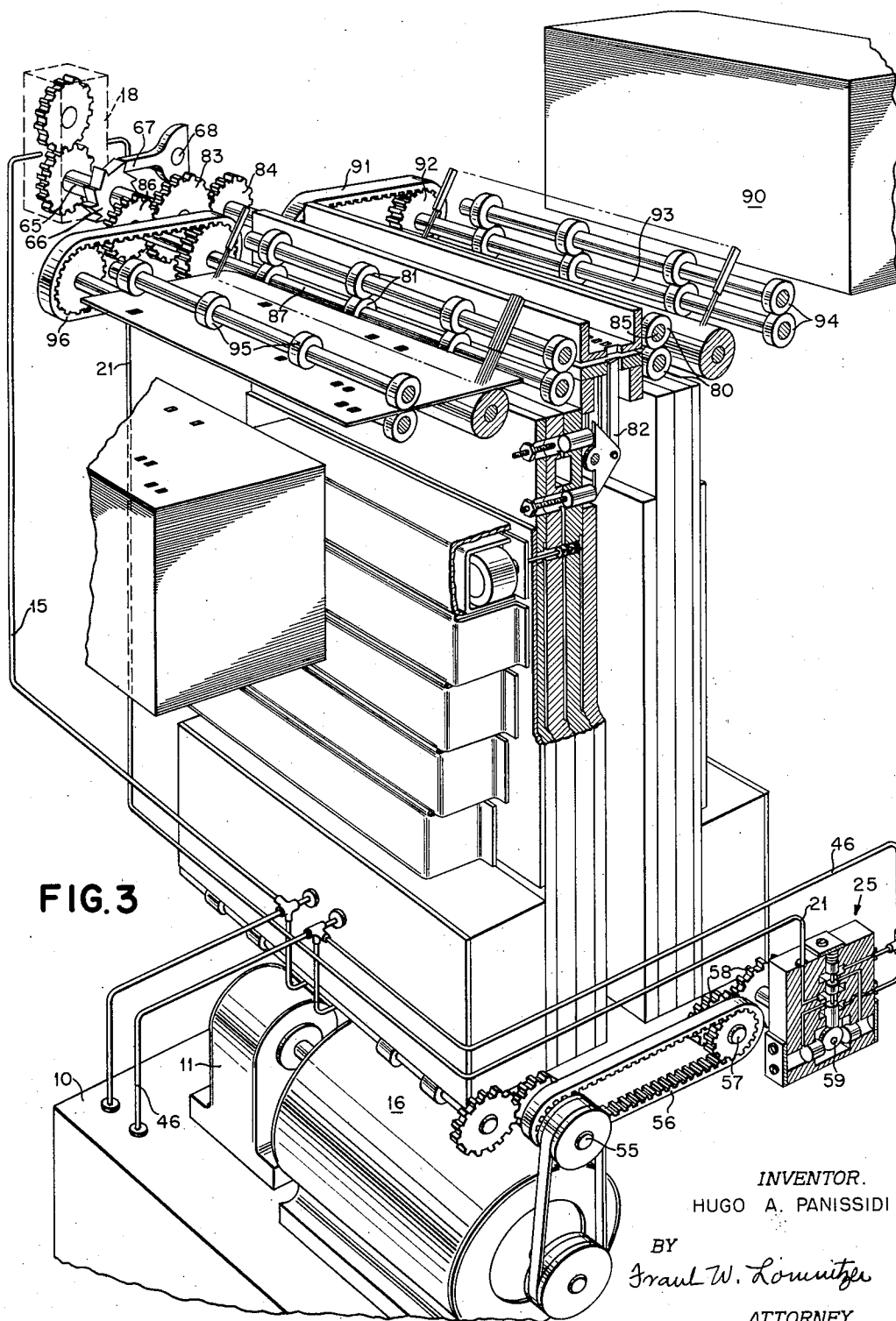
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HYDRAULIC CONTROL FOR INTERMITTENT STARTING AND STOPPING OF A HYDRAULIC MOTOR

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6 Claims. (Cl. 121—38)

This invention relates to hydraulic mechanisms and particularly to the type in which a control or regulator for the hydraulic motor causes the operation of a work device in a predetermined manner.

The broad object of the present invention is to provide a hydraulic motor with a novel form of control or regulator therefor to provide periods of non-rotation intermediate periods of rotation.

It is a requirement in one form of card punching machine shown herein that the card to be punched be fed past the card punches by a "step by step" operated card feed. Stated in other words, the card feed is driven to accelerate the movement of the card from rest, then the card feed is decelerated and interrupted for a short dwell to enable the passage of the punches through the card while the card is at rest, followed by an accelerated and decelerated card feed to coordinate the next position of the card to be punched with the punches.

In said form of card punching machine this mode of card feed operation has been attained by a mechanical Geneva type card feed drive which has been entirely satisfactory for card punching speeds in the range of 100–150 cards per minute. It is to comply with the desirability of doubling or tripling the card punching output that the present high speed hydraulic motor card feed drive has been devised and constructed in a novel manner which enables a mode of card feed operation which is the counterpart of the Geneva card feed drive of earlier card punching machines.

A broad object of the present invention is to devise a control or regulator for the hydraulic fluid output port of a hydraulic motor which regulates or determines the rotation of the hydraulic motor according to predetermined requirements.

A still further object of the present invention is to provide a control or regulator to intermittently control the rotation of a hydraulic motor and to terminate the rotation of said motor in such manner as to cause said motor to have an inactive dwell period of non-rotation accompanying each period of rotation.

A still further object of the invention is to control the intermittent starting and stopping of a hydraulic motor by intermittently opening and closing the output port of the hydraulic motor from which the hydraulic pressure fluid emanates.

Another object of the invention is to control or regulate the angular displacement or rotation of a hydraulic motor by alternately opening the output side of the motor to two piston metering chambers the pistons of which are cam operated to admit the hydraulic output fluid in expanding volume governed by the expanding volume of the metering chambers; to provide a cam operated shuttle valve to control the admission of the fluid alternately to the two chambers, and to cause said shuttle valve cam to open the output side of one chamber to a fluid return while the other cham-

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ber is opened to receive and meter exhaust fluid from the output side of the hydraulic motor.

A still further object of the invention is to devise the cam which operates said shuttle valve in such manner that as said cam effects the transition from one fluid receiving chamber to the other said cam completely closes the output side to cause the rotation of the hydraulic motor to be stopped during a predetermined period.

More specifically, according to the present invention, fluid under constant pressure is applied to the input side of a hydraulic motor adapted to operate a load, such as a card feed. The output side of the motor is connected to a shuttle or four-way valve which directs the fluid alternately to chambers in which freely float related control pistons. The cams which operate the shuttle valve and the control pistons effect a displacement of the shuttle valve and control pistons 90° out of phase. As said cam effects its maximum upward travel of the valve pistons, one of said pistons opens the output side of the hydraulic motor to a piston chamber, while another of said pistons connects the other piston chamber to the return to the fluid reservoir.

As the shuttle cam rotates, the first said piston chamber expands its volume to receive the output fluid from said hydraulic motor, and permits the motor to rotate at a rate equal to the piston displacement. When the valve piston cuts off the output port the motor stops, and in the transition of the connection of the output port to the other piston chamber, a dwell period ensues. During this time the hydraulic motor stops and a specific operation, such as punching a card hole may take place during the stopping of the motor.

After this dead center position of the cam and pistons, the other piston chamber is connected to the output port of the motor to permit further rotation of the motor, and the above operation is repeated. A single revolution of the cam of the shuttle valve effects two periods of rotation of the hydraulic motor with an intermittent stopping to effect a desired operation.

It is evident, of course, that there are other machines in which the present hydraulic motor and control apparatus could be employed, and its illustrative application for a card transport of the type of card punching machine shown should not be regarded as restrictive. It would be entirely feasible to utilize the period of non-rotation of the motor to a type of card punching machine in which punching of all holes in the card is effected simultaneously. Further, by suitably designing the shuttle valve operating cams the period of non-rotation of the motor can be regulated, to a smaller extent, or to a longer period, dependent upon the desired type of operation. Further, other forms of construction of the control or regulator could be employed within the principles of the invention as described above.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of example, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In said drawings:

Fig. 1 is a diagrammatic representation of the components of the present hydraulic apparatus comprising the novel control and speed regulator for the hydraulic motor.

Fig. 2 is a timing diagram.

Fig. 3 is a perspective view of a well known form of card punching machine showing by way of example the incorporation of the hydraulic motor with its control and regulator to drive the card transport for the punching machine in the desired manner.

Constant fluid pressure source

The hydraulic motor to be described is actuated by

fluid at a constant pressure derived from a hydraulic pump 11 (Figs. 1 and 3) of the gear type. A duct 12 is connected to the suction side of the gear pump 11 to draw fluid from a reservoir 10. An adjustable pressure regulator valve 13 which has an overflow pipe 14 in reservoir 10 insures fluid at a constant pressure level in a duct 15 which is connected to the pressure side of the gear pump 11. The hydraulic gear pump is continuously driven by an electric motor 16. It should be noted that motor 16 (see Fig. 3) is the mechanical drive to the punch cam shafts, and other parts of the punching machine.

The hydraulic motor 18 is of the fluid actuated type and the duct 15 is connected to the inlet side 19 of the hydraulic motor, whereby the pressure of the fluid in duct 15 rotates said motor as long as the fluid output port 20 is unblocked to permit free exit of the exhaust fluid at a lower pressure through a duct 21.

Shuttle valve

The closing or opening of the output side of the hydraulic motor 18 at output port 20 is controlled by a shuttle valve 25 so designed as to produce the desired rotational characteristics to the hydraulic motor 18.

Said shuttle valve comprises a block 26 suitably bored for cylinders and associated ports and fluid ducts. The shuttle valve comprises a cylindrical bore 27 in which fits a spool type valve. The output duct 21 is connected to the central input port 28 and is adapted to be completely closed by the central land or piston valve 29 of the shuttle valve or direct the output fluid to a chamber 30 when said piston valve 29 is in the elevated position shown. In a lowered position of said piston valve 29 fluid communication is made between input port 28 and a chamber 31. It will be seen that bores 32 and 33 connect their respective chambers 30 and 31 with related metering cylinders 34 and 35. Hence, it will be seen that piston valve 29 alternately directs the fluid output in duct 21 to metering cylinders 34 and 35 for a reason to be soon evident.

Said shuttle valve also carries upper and lower end lands or piston valves 40, 41, adapted to open or close their respective ports 42, 43, each of said ports having a respective fluid bore connection 44, 45 to the return conduit or duct 46 which returns fluid back to the reservoir 10.

The desired movements of the shuttle valve to effect the desired rotational characteristics of the hydraulic motor 18 are controlled by a profile cam 50 against which bears the piston valve 41, and a spring 51 causes said piston assembly to follow the profile of the cam 50 as the latter is rotated.

As shown in Fig. 3 the armature shaft of motor 16 drives a shaft 55 which drives the card punch shafts, etc. of the punching machine and the latter has a belt drive 56 to a shaft 57. Suitable gearing 58 between shaft 57 and a shaft 59 carrying cam 50 causes cam 50 to be rotated to operate the shuttle valve in synchronism with card punching operations.

Fitting within respective cylinders 34 and 35 (Fig. 1) are control pistons 60, 61 whose positions in the respective cylinders are controlled by the same cam 50. The successive displacements of the pistons of the shuttle valve and control pistons 60, 61 are 90° out of phase, as is evident in the timing diagram of Fig. 2.

Assuming that the hydraulic system starts with cam 50 in such position that piston valve 29 completely closes the port 28 it will be evident that the output duct 21 is closed and tight enough to prevent emergence of fluid from the output side 20 of the motor 18. Hence, hydraulic motor 18 is stopped, conforming to the zero acceleration and neutral position of the shuttle valve shown at 0° in the timing diagram of Fig. 2.

As said cam 50 rotates clockwise, the elevation of piston valve 29 opens port 28 with a gradual increase in opening as shown in Fig. 1, enabling a proportional

gradual increase in the volume of fluid in chamber 30 to be directed by bore 32 to metering cylinder 34. This enables, at the highest position of piston valve 29 shown in Fig. 1, the acceleration of hydraulic motor 18 to the maximum speed. (See Fig. 3.) Thereafter, the lowering of piston valve 29 of the shuttle valve begins to gradually close the port 28 and by reverse action the hydraulic motor is gradually decelerated, and piston valve 29 again completely closes port 28 at 180° to stop the hydraulic motor.

Due to the 90° out of phase relation of the shuttle valve and control pistons, the piston 60 is at the extreme left at 0° position of the shuttle valve. Said cam 50 permits movement of piston 60 to the extreme right to increase the cylinder volume to accommodate the increased volume of fluid directed through bore 32 to metering cylinder 34, as the piston valve 29 opens and then closes port 28.

Simultaneous with this operation the metering cylinder 35 which may have previously become filled with fluid from the output port 21 is exposed or opened to the fluid return duct 46. The agency of the piston 40 is to effect a communication between metering cylinder 35 through bore 33 to port 42, thus permitting hydraulic fluid to return by bore 44 to fluid return duct 46. Synchronously, the cam 50 causes the movement of control piston 61 to the right to decrease the volume in metering cylinder 35 as the fluid is exhausted from metering cylinder 35.

It is thus evident that two valve movements of the four-way valve to fill metering cylinder 34 and empty metering cylinder 35 are carried out during 180° rotation of cam 50, and the latter continues to rotate to carry out the remaining sequence of events which are a repetition of those just described except metering cylinder 34 is emptied and metering cylinder 35 filled with exhaust fluid as will soon be described.

While it may be desirable to continue with the uninterrupted rotation of the hydraulic motor when piston valve 29 passes from chamber 31 to chamber 30, it is desirable to provide a dead zone of the shuttle valve through its neutral position where there will be a short dwell period of the fluid during the top and bottom dead center stroke position of the control pistons. This will result in a temporary stopping of the hydraulic motor and is primarily effected by design of cam 50 which retains the duct 21 closed for the desired period. This is shown in Fig. 2 as "Dwell Period" at 180° and 360°. During this time the shuttle valve is neutral.

Further clockwise rotation of cam 50 from 180° to 360° causes piston valve 29 to open duct 21 and port 28 to the chamber 31 directing the fluid through bore 33 to metering cylinder 35. Simultaneously, piston valve 41 has opened chamber 30 to port 43, and fluid in metering cylinder 34 is now returned to the reservoir by bore 45 and duct 46. Thus, there will now ensue between 180°-360° an acceleration of the hydraulic motor and a following deceleration to a period of non-rotation. Thus, the hydraulic motor will intermittently advance twice for each single revolution of the cam 50 and such advancement will be equal to the displacement of the control pistons 60, 61, in their respective metering cylinders 34, 35, and each rotational advance of the hydraulic motor is preferably followed by a short period non-rotation.

Hydraulically actuated detent mechanism

While the above described shuttle valve will effect a complete blocking of the output duct 21 to completely stop the motor it is desirable to overcome momentum and coasting by providing a detent mechanism which is also hydraulically actuated to effectively and almost instantaneously stop the rotation of the motor during the non-rotation periods. This detent mechanism, as shown in the timing diagram, is actuated for each non-rotation period of the motor.

While various forms of detent mechanisms can be provided, it is desirable to employ the following described type: Secured to the load shaft 65 of the hydraulic motor is a detent wheel 66 with which a detent pawl 67 pivoted on a rod 68 may engage to thereby inhibit the clockwise rotation of shaft 65 (Fig. 1) at the desired intervals. A cylinder block 70 is provided with a pair of cylinders in which pistons 71 and 72 move. The hydraulic fluid pressure in a duct 73 is connected to the input side of the cylinder of piston 72 and said piston will rock the detent pawl 67 clockwise out of engagement with the detent wheel 66 to free the hydraulic motor 18 for rotation during the desired time. When said motor is to be stopped in its rotation, fluid pressure in a duct 74 which is connected to the input side of the cylinder of piston 71 will rock said detent pawl 67 counterclockwise, causing it to engage a tooth of the detent wheel 66 to effectively stop said motor and prevent a further rotation, due to inertia or momentum.

Any suitable hydraulic pulse generator may be provided to direct the hydraulic pulses in ducts 73 and 74 and connect the ducts 73 and 74 to the return duct 46 but is preferable to employ the differential valve of the type fully shown, described and claimed in the application of Hugo A. Panissidi, Serial No. 479,111, filed December 31, 1954, now patent No. 2,800,885, issued July 30, 1957.

In the preferred arrangement a pair of synchronous cams 75 and 76 provided with the proper phase angle difference individually operate control valves 77 and 78 in a predetermined manner to convert fluid at constant pressure level supplied by the duct 15 to hydraulic pulses applied alternately to conduits 73 and 74 to effect the operations just described.

Illustrative application of present hydraulic improvements

The present hydraulic improvements may be embodied with numerous advantages to drive the card feeding mechanism of a card punching machine of a well known type and disclosed in numerous patents, among which the patent to C. D. Lake, No. 2,032,805 may be referred to.

As is well known, cards to be punched are fed out from a hopper one at a time by a picker mechanism and are further fed past the punches by a first set of rollers 80 and by a second set of rollers 81. Said rollers are, in the machine described in the above patent, driven by a mechanical Geneva type card feed drive fully shown in the aforementioned patent so that feeding of the card is first accelerated and decelerated to a stopped position at which time a punch 82 is adapted to punch a hole in the respective card column. Said punch is operated by a shaft driven by motor drive shaft 55 (Fig. 3) in synchronism with the shuttle operating cam 59. (Fig. 1). After the punching operation feed rollers 80 and 81 are then accelerated and decelerated to correlate a second punching position with the punches 82. This required characteristic of card feed is satisfied by the present hydraulic motor and its accompanying speed regulator and control. The driven shaft 65 of said hydraulic motor carries an intermediate pinion 83 meshing with a pinion 84 secured to the feed roller shaft 85 of the feed rollers 80. Said pinion 83 also meshes with a pinion 86 secured to the feed roller shaft 87 of the feed rollers 81. This inter-gearing will cause the clockwise rotation of the two sets of feed rollers 80 and 81 to advance the record card to be punched step by step.

In order to feed other cards from the hopper 90 and the cards to be punched in a synchronous manner, said shaft 85 has secured thereto a gear which, through a rubber belt 91, rotates gear 92 secured to the feed roller shaft 93 of the first set of rollers 94 which feed the card to the card punching mechanism.

A similar drive for feed rollers 95 which feed the punched card to the stacker is provided, said rollers 95 being driven by a belt drive 96 in the same manner.

While there have been shown and described and pointed

out the fundamental novel features of the invention, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art, without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. In a hydraulic system, a rotary hydraulic fluid motor having inlet and outlet ports, means for supplying hydraulic pressure fluid to said inlet port to effect the rotation of said motor when exhaust fluid emerges from said outlet port, a plurality of metering cylinders each adapted to receive a predetermined volume of said exhaust fluid, a return duct for each of said metering cylinders, cam operated valve means having an inlet port connected to said outlet port and a plurality of pistons, one of said pistons blocking the connection of said outlet port to both of said metering cylinders to stop the rotation of said motor, and then opening said outlet port and connecting said outlet port to one or the other of said metering cylinders whereby a predetermined volume of exhaust fluid received by each of said metering cylinders causes the rotation of said hydraulic fluid motor by said hydraulic pressure fluid a predetermined amount, and said valve means having a plurality of pistons each adapted to connect the respective metering cylinder previously filled with exhaust fluid to said return duct for emptying said metering cylinder.

2. In a hydraulic system, a rotary hydraulic fluid motor having inlet and outlet ports, means for supplying hydraulic pressure fluid to said inlet port to effect the rotation of said motor when exhaust fluid emerges from said outlet port, a pair of cylinders for alternatively receiving exhaust fluid from said outlet port, a valve having an inlet connected to said outlet port, a piston in said valve for connecting said outlet port during one period of operation to one of said cylinders, and during the next period of operation to the other cylinder, whereby exhaust fluid received by each of said cylinders causes the rotation of said motor by said hydraulic pressure fluid to an extent according to the volume of said exhaust fluid directed to each of said cylinders, a return duct for said exhaust fluid, a plurality of pistons in said valve for connecting the return duct to one cylinder during each period of operation to empty the previously filled cylinder while the other cylinder receives the exhaust fluid, and means comprising a cam for simultaneously positioning said first named piston and said plurality of pistons, said cam adapted to position said first named piston during each period of operation of the valve to completely close said outlet port of the motor to stop said motor intermediate periods of rotation for an appreciable period.

3. In a hydraulic system, a unidirectional rotary hydraulic fluid motor having at least one rotatable element and inlet and outlet ports, means for supplying hydraulic pressure fluid to said inlet port to effect the continuous unidirectional rotation of said rotatable element as long as exhaust fluid emerges from said outlet port, a metering cylinder for receiving exhaust fluid from said outlet port, a valve between said cylinder and outlet port comprising a piston in said valve for effecting in one position of said piston a fluid connection between said outlet port and said metering cylinder and in another position of said piston for blocking said outlet port, and a cam for positioning said piston constructed and arranged to cause said piston to gradually effect a fluid connection between said outlet port and said cylinder to cause said metering cylinder to receive a predetermined volume of fluid exhausted from said motor and to cause said motor to be accelerated from rest, and to gradually close said outlet port to decelerate the rotation of said element to a stopped position, both during a period of rotation determined by the volume of said metering cylinder.

4. In a hydraulic system, a rotary hydraulic fluid

motor having inlet and outlet ports, means for supplying hydraulic pressure fluid to said inlet port to effect the rotation of said motor when exhaust fluid emerges from said outlet port, a plurality of metering cylinders each adapted to receive from said outlet port a predetermined volume of exhaust fluid from said motor to cause its rotation by said hydraulic pressure fluid, a plurality of control pistons, one in each of said metering cylinders and adapted by displacement therein to vary the metering cylinder volume, valve means having an inlet connected to said outlet port, and means comprising a cam for actuating said valve means for connecting said outlet port to said metering cylinders in succession and for displacing the piston in the metering cylinder receiving fluid to increase the volume of the metering cylinder to receive the fluid supplied to said motor to effect its rotation.

5. In a hydraulic system, a rotary hydraulic fluid motor having inlet and outlet ports, means for supplying hydraulic pressure fluid to said inlet port to effect the rotation of said motor when exhaust fluid emerges from said outlet port, a pair of metering cylinders for alternatively receiving exhaust fluid from said outlet port, a plurality of control pistons, one in each metering cylinder, a valve having an inlet connected to said outlet port, a piston in said valve for connecting said outlet port during the first period of operation to one of said metering cylinders, and during the next period of operation to the other metering cylinder, whereby exhaust fluid supplied to each of said metering cylinders causes said motor to be rotated by said hydraulic pressure fluid to an extent according to the volume of fluid directed to each of said metering cylinders, a return duct for said exhaust fluid, a plurality of pistons in said valve for connecting the return duct to one metering cylinder during each period of operation to empty the previously filled cylinder while the other metering cylinder receives the exhaust fluid, and means comprising a cam for simultaneously positioning said first named piston and said plurality of pistons, said cam adapted to position said first named piston between each period of operation of the valve to completely close

said outlet port of the motor to stop said motor intermediate periods of rotation for an appreciable period, and said cam adapted to position said control pistons in said metering cylinders to cause the piston in the metering cylinder receiving exhaust fluid to increase the volume of the cylinder, and to cause the piston in the other metering cylinder which is being emptied to decrease its volume.

6. In a hydraulic system, a rotary hydraulic fluid motor having inlet and outlet ports, means for supplying hydraulic pressure fluid to said inlet port to effect the rotation of said motor when exhaust fluid emerges from said outlet port, a pair of metering cylinders each for receiving exhaust fluid from said outlet port, a plurality of control pistons, one in each metering cylinder, a valve having an inlet connected to said outlet port, a piston in said valve for connecting said outlet port during the first period of operation to one of said metering cylinders, and during the next period of operation to the other metering cylinder, whereby exhaust fluid supplied to each of said metering cylinders causes said motor to be rotated by said hydraulic pressure fluid to an extent according to the volume of fluid directed to each of said metering cylinders, and means comprising a cam for simultaneously positioning said first named piston and said control pistons, said cam adapted to position said first named piston to cause said exhaust fluid to be directed to said metering cylinders in succession during successive periods of operation, and to position each of said control pistons in the respective cylinder to increase the volume of the metering cylinder as the fluid supplied to said motor is exhausted therein.

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