HYDRAULICALLY OPERATED VIBRATION DRIVES

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ABSTRACT
A vibratory drive comprises a double acting power piston arranged to be reversed by position detecting jet sensing means. The latter are connected with a reversing valve via bistable fluidics storage means.

22 Claims, 1 Drawing Figure
HYDRAULICALLY OPERATED VIBRATION DRIVES

This application is a continuation-in-part of application ser. no. 53,482, filed July 9, 1970, now abandoned. The disclosure of this application no. 53,482, is incorporated by reference herein.

BACKGROUND OF THE INVENTION

Field to which the invention relates.

The present invention relates to hydraulically operated vibration drives and, more particularly, to such drives which comprise a thrust piston unit which is double acting, a reversing valve and a hydraulic or pneumatic auxiliary control system with control elements whose signals are supplied to the reversing elements of the reversing valve which are operated in accordance with the position of the working piston.

The prior art

In a previously proposed vibratory drive system of the type mentioned above, valves, to be provided for auxiliary control, were opened by the operating piston at its end position. Via the valves, respective control pistons were acted upon by compressed air and a reversing valve was actuated by the control pistons. The reversing valve served for passing compressed air in alternate directions to the working piston. In constructions of this previously proposed type, the auxiliary control valves are arranged either in the cylinder heads, in which case they have an actuating projection extending into the cylinder spaces of the drive and are operated directly by the working piston, or they are operated via a two-armed lever one arm of which engages the working or power piston and another arm of which cooperates with the control piston.

The previously proposed vibratory drives have, on the one hand, the disadvantage that specially constructed drive cylinders must be used and, on the other hand, that the drives have a pre-set stroke which cannot be modified.

BRIEF SUMMARY OF INVENTION

One object of the present invention is to provide a 45 displacement controlled drive which may be essentially manufactured from commercially available components and in which the terminal positions of the thrust piston drive unit can easily be adjusted.

A further object of the present invention is to provide a vibratory drive which is capable of operating with frequencies greater than one Hertz and up to a few tens of Hertz. Such drives can be used, for example, as shaking drives, drives for fatigue testing machines, and the like.

In accordance with one aspect of the invention control elements are provided in the path of movement of the piston rod of the working piston or a part moved by it in the two desired end positions by arranging pneumatic jet receiving nozzles which are respectively disposed to feed signals to a bistable fluidics storage means, so as to serve as reversing signals and the output signals of the storage means are supplied directly or indirectly to the switch-over elements of the reversing valve.

In accordance with a convenient feature of the invention, between respective outputs of the storage means and the switch-over or reversing elements of the reversing valve, a signal amplifier is provided.

Preferably, between the jet receiving nozzle and the storage means an amplifier is arranged. This amplifier can preferably be a low-pressure-normal pressure transducer.

More particularly, in the case of fatigue testing of machines and such, it is often desired to operate the drive with a pre-set program with periods or sections of different displacement. This requirement can be met by the vibratory drive in accordance with the invention by arranging a number of jet receiving nozzles in two rows in the path of movement and providing means with which one of the receiving nozzles can be connected with the control circuit.

Another possibility for meeting this requirement to arrange the receiving nozzles in the path of movement so that they can be adjusted.

The invention is shown in the drawing in one embodiment with a pneumatically driven control circuit and is explained below in detail with reference to the accompanying drawing.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The drive shown in the accompanying drawing comprises a double acting thrust piston drive 2 with a piston 4 and a continuous piston rod 6 connected thereto. The working surfaces of the piston are equal in extent in the two cylinder spaces 8 and 10 of the thrust piston. The load is denoted by the arrow L. The cylinder spaces 8 and 9 are connected via ducts 16 and 18 with the output connections A and B of a reversing valve 20 which can be of conventional construction and of the commercially available type and is controlled by fluid pressure.

A fluid pump 22, which can be regulated, is connected via a duct 24, 27 with the pressure connection P of the reversing valve 20. The duct 24 is connected with a conventional pressure release valve 26 and a pressure accumulator 28.

From the return fluid (e.g. oil) connection R of the reversing valve 20 there is provided a duct 30 to the tank 32. In the duct 30 a biasing choke 31 is arranged, which can also be adjustable. The choke serves to ensure that in the case of an elastic stressing, which together with the mass of the working or power piston has a natural frequency, this natural frequency does not influence the working frequency of the vibratory drive.

The operating or working frequency is determined by the output rate of the pump 22.

In the path of movement of the piston rod 6 or a component of the drive fixed to the piston rod on both sides of the thrust piston drive unit 2, these are two sets of pneumatic jet detecting means 34 and 34', 34" having jet discharge nozzles 34a, 34'a and 34"a associated receiving jets 34b, 34'b and 34"b. These jet discharge and receiving nozzles may be of the type described, for example, in U.S. Pat. No. 3,071,157 or 3,457,940 or commercially available from Elliott Automation GmbH, West Germany. The discharge nozzles are supplied, via duct 35, pressure reducer 37 duct 80 and air source 81, with a fluid supply to be discharged therefrom and directed onto the corresponding jet receiving nozzles. As long as the fluid discharge path between a corresponding jet discharge and receiving nozzle is not interrupted by the passage of a piston rod, such as rod
the actuating pressure space 50 of the valve and switches-over this valve.

The oil under pressure then flows into the cylinder space 10 and the piston 4 is moved to the left until the left hand end of the piston rod 6 is detected by the jet detecting means 34', so that the storage means 42 will receive a signal via duct 40' for switching over, so that at the output 44' a signal again appears, while at the output 44 there is no signal. With this signal the reversing valve 20 is then switched over again via the amplifier 48'.

The jet detecting means 34, 34' preferably do not cooperate directly with the piston rod 6 but, instead, with vanes and the side of the piston rod. In the case of the use of such vanes, both jet detecting means 34, 34' can be arranged on one side of the thrust piston drive unit, which can thus also be constructed with a piston rod extending only to one side. The spacing of the two jet detecting means then corresponds with the pre-set displacement of the piston 4 between the two switching-over points. The jet detecting means can also cooperate with a component moved by the thrust piston drive unit. This unit drive can then include, in some cases, a step-up or step-down transmission or linkage system, if required.

It is, furthermore, possible to arrange, in the path of the piston rod 6 or in the path of an element fixed to the piston rod, a row of jet detecting means and provide means with which these jet detecting means may be connected with the auxiliary control circuit.

In this manner, by switching-over from one jet detecting means to another, the displacement can be changed. Such a switching-over can also be carried out in accordance with a program, so that, for example, a fatigue testing machine can readily carry out a pre-set program with different displacements of the piston 4.

A particular advantage of the reversal by means of jet detecting means is that they operate without making physical contact with each other, so that at working frequencies between 1 and 100 Hertz wear, which would occur with mechanically operated control elements, is avoided.

In place of several jet detecting means arranged in a row, it is also possible to use a single adjustable arranged jet detecting means for one or both end positions, which are capable of being driven by a servomotor such as motor 60, connected by way of a linkage arrangement 61–62 to jet detecting means 34, the output of which is connected to pressure transducer amplifier 38 through a duct including a flexible hose 63. The servo-motor can then be controlled by a conventional program control means 70. In the case of this arrangement it is then simultaneously possible in one program to increase or decrease, continuously, the displacement of the drive as time progresses. The jet detecting means for the two terminal switching operations can be arranged on a common carrier which can be displaced by a servomotor. In this manner, the working range can be displaced as a whole, for example, in order to follow a yielding load, as is the case with compacting equipment.

It is also possible to use a thrust piston drive which is only single acting and which, for example, is moved back again by the load applied. In this case, the reversing valve only needs to be a 2/2 displacement valve with an actuating pressure space and a return spring. The storage means then only needs to have one output
which alternately passes a signal and is free of a signal. If, in this case, a thrust piston drive with a piston rod extending to only one side is used, the jet detecting means for the reversal are to be arranged on one side of the cylinder. On the piston rod, a suitable lateral projection or vane is to be provided, which alternately cooperates with the jet detecting means.

The control circuit has been described principally with reference to the use of pneumatically driven fluidics elements. It can, however, be used partially or completely with liquid driven fluidics elements.

A particular advantage of the drive in accordance with the invention is to be found in that commercially available elements, such as those available from the aforesaid Elliott Automation GmbH, General Fluids Corporation, Paterson, New Jersey, or Fluicon Corporation, Hackensack, New Jersey, for example, can be used for the various elements such as for the auxiliary control, for example, with very small dimensions and low costs of production, so that it is possible to construct the whole auxiliary storage means in a very compact manner. Furthermore, by the use of such commercially available elements any problem of replacement is considerably simplified.

1 claim:
1. A fluid operated vibratory drive system comprising:
   a drive cylinder,
   a drive piston arranged in said cylinder such that said drive cylinder and drive piston define first drive piston chamber pressure means attached to and movable with said drive piston, said rod means being reciprocally movable along a predetermined rod path during reciprocating movement of said drive piston,
   jet discharge nozzle means and receiving jet means arranged spaced from one another in facing relationship at opposite sides of said rod path, said jet discharge nozzle means and receiving jet means being positioned sufficiently far apart to accommodate free movement of portions of said rod means therewith, said jet discharge nozzle means and receiving jet means being located with respect to said rod path such that portions of said rod means only extend between said jet discharge nozzle means and receiving jet means when said drive piston is adjacent one of said predetermined opposite end positions,
   a second pressure source for supplying a fluid medium under pressure to said jet discharge nozzle means such that the fluid medium is sprayed from said jet discharge nozzle means across the open space between said jet discharge nozzle means and receiving jet means with the supply of fluid medium to said receiving jet means being at a relatively high pressure when said drive piston is in other than said predetermined end positions and such that portions of said rod means interrupt the jet spray to said receiving jet means with a consequent reduction in pressure at the receiving jet means when said drive piston is adjacent one of said predetermined end positions,
   and receiving jet line means for communicating the pressure supplied to said receiving jet means as said drive piston position control signals.

2. A system according to claim 1, wherein said first pressure source includes means for supplying a first fluid medium under pressure to said reversing valve means, and wherein said second pressure source includes means for supplying a second fluid medium, different from said first medium, under pressure to said jet discharge nozzle means.

3. A system according to claim 1, wherein said rod means extend outwardly from said drive cylinder, and wherein said jet discharge nozzle means and receiving jet means are outside of and spaced from said drive cylinder.

4. A system according to claim 2, wherein said rod means extend outwardly from said drive cylinder, and wherein said jet discharge nozzle means and receiving jet means are outside of and spaced from said drive cylinder.

5. A system according to claim 2, wherein said first medium is a liquid, and wherein said second medium is gaseous.

6. A system according to claim 5, wherein said first medium is oil and said second medium is air.

7. A system according to claim 4, further comprising adjusting means for varying the position of said jet discharge nozzle means and receiving jet means along the length of the rod path so as to effectively vary the predetermined end positions of said drive piston.

8. A system according to claim 7, wherein said adjusting means is separate from said drive cylinder and drive piston, whereby the travel path of said drive piston can be varied while utilizing an unchanged drive piston and drive cylinder configuration.
9. A system according to claim 3, wherein said reversing valve control means includes reversing valve switch-over elements and a bistable fluidics storage means having means for accepting said drive piston position control signals as input signals and means for supplying output signals to control operation of said reversing valve switch-over elements.

10. A system according to claim 9, further comprising signal amplifying means interposed between said storage means and said switching elements for amplifying the output signals of said storage means which are supplied to said switching elements.

11. A system according to claim 9, further comprising signal amplifying means interposed between said receiving jet means and said storage means and including means for increasing the fluid pressure received by said receiving jet means and means for supplying the increased pressure as said input signals to said storage means.

12. A system according to claim 4, wherein said reversing valve means includes first and second switch-over elements, a first one of which is coupled to a first output of said storage means and a second one of which is connected to a second output of said storage means and further including first and second amplifier means for connecting the outputs of said storage means to said respective switch-over elements of said reversing valve means.

13. A system according to claim 12, wherein each of said first and second amplifier means includes a pilot valve and amplifier connected to an auxiliary unit for supplying an exhausting control fluid to said reversing valve means.

14. A system according to claim 13, wherein said jet detecting means comprises a plurality of jet detectors disposed along the axis of movement of said piston rod.

15. A system according to claim 14, further including means for displacing at least one of said jet detectors in a direction parallel to said axis of said piston rod.

16. A system according to claim 15, further including a servo-motor for adjusting the position of said jet detecting means in accordance with the output of a program control.

17. A system according to claim 9, wherein said input and output signals at said storage means are pneumatic signals, and wherein said first medium is oil.

18. A system according to claim 17, wherein said switch-over elements include compressed air responsive means for moving said reversing valve means.

19. A system according to claim 11, wherein said signal amplifying means includes a low pressure normal pressure transducer.

20. A system according to claim 1, further comprising adjusting means for varying the position of said jet discharge nozzle means and receiving jet means along the length of the rod path so as to effectively vary the predetermined end positions of said drive piston.

21. A system according to claim 20, wherein said jet detecting means comprise a plurality of jet detectors, each including a discharge nozzle and a receiving jet, disposed along the axis of movement of said piston rod, and wherein said adjusting means includes means for selectively communicating and interrupting flow to said receiving jet line means from at least one of the receiving jets of respective jet detectors.

22. A system according to claim 20, wherein the jet detecting means are arranged so as to be adjustable in a direction parallel to the direction of movement of the piston.

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