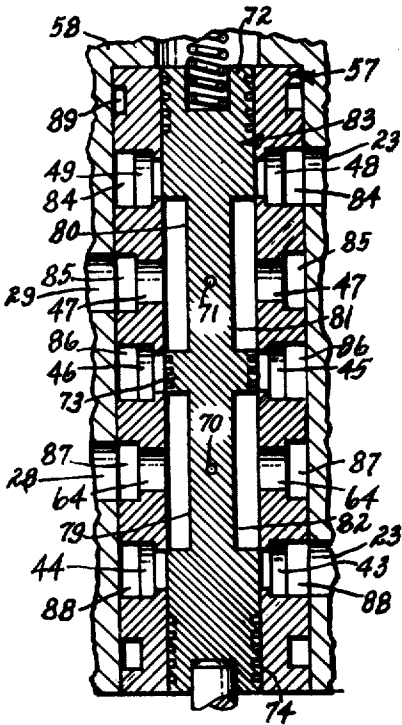


[54] **MULTISECTION VALVE AND HOUSING THEREFOR**
[72] Inventor: **Wendell I. Evans**, Cincinnati, Ohio
[73] Assignee: **Cincinnati Milacron Inc.**, Cincinnati, Ohio
[22] Filed: **March 15, 1971**
[21] Appl. No.: **124,164**
[52] U.S. Cl.**137/625.18, 137/625.25, 137/625.69**
[51] Int. Cl.**F16k 11/07**
[58] Field of Search.....**137/625.18, 625.25, 625.26, 137/625.27, 625.67, 625.68, 625.69**

3,004,555 10/1961 **Haberland**.....137/625.68
3,095,907 7/1963 **Latham, Jr.**137/625.67
Primary Examiner—**William R. Cline**
Attorney—**Howard T. Keiser and Jack J. Earl**

[57] **ABSTRACT**
A valve mechanism has a single bushing and spool containing a plurality of separate valve functions. Each valve function is a section angularly spaced from other valve function sections in the same longitudinal region of the bushing and spool.

[56] **References Cited** **4 Claims, 7 Drawing Figures**
UNITED STATES PATENTS
990,304 4/1911 **Skinner**137/625.67



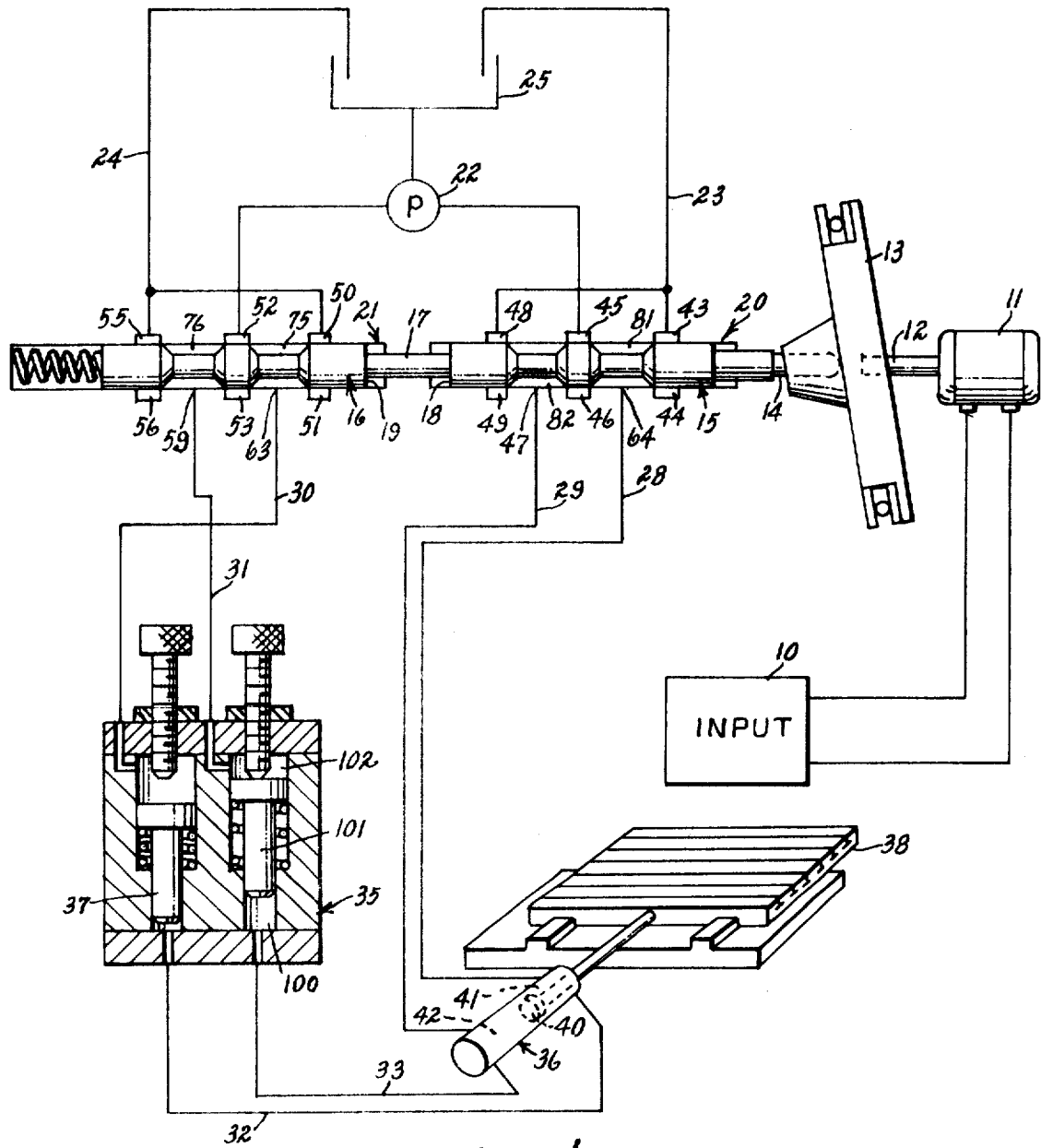


Fig. 1

INVENTOR.
WENDELL I. EVANS

BY
Howard H. Kiger
Jack J. Earl
ATTORNEYS

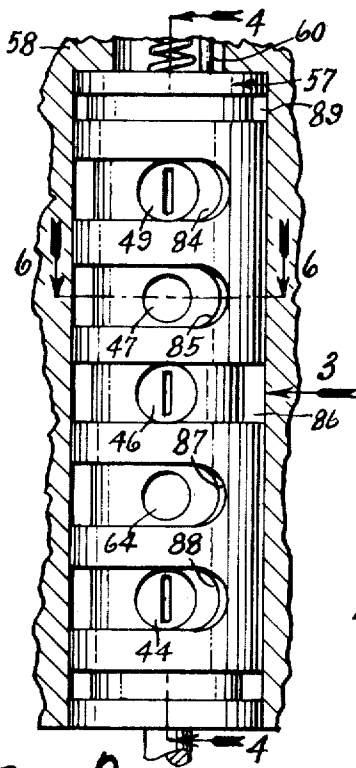


Fig. 2

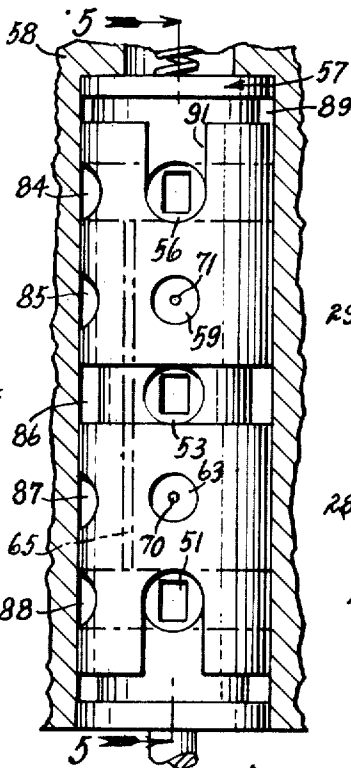


Fig. 3

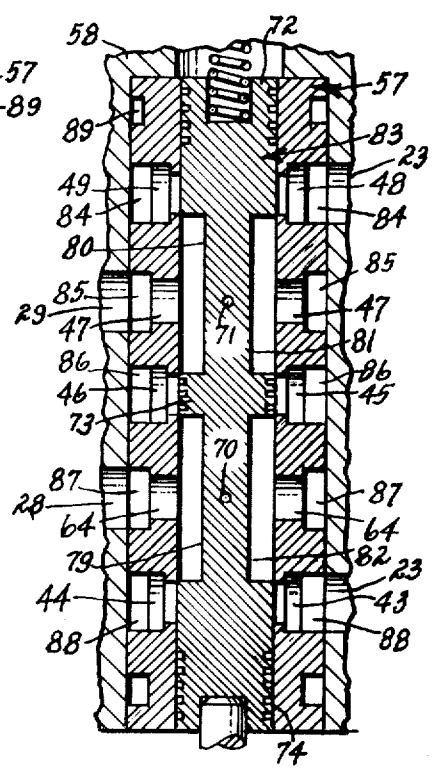


Fig. 4

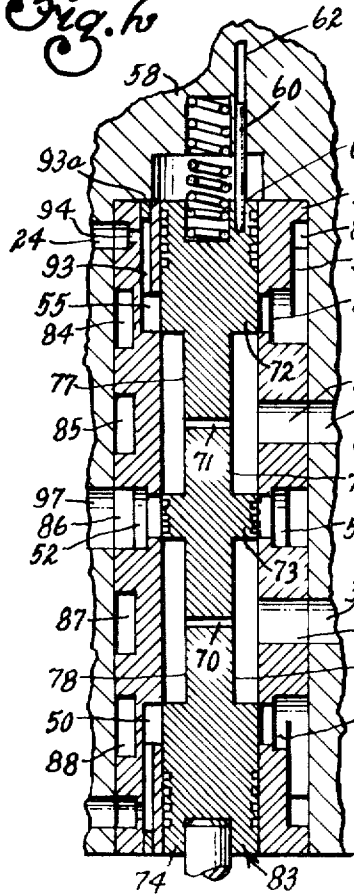


Fig. 5

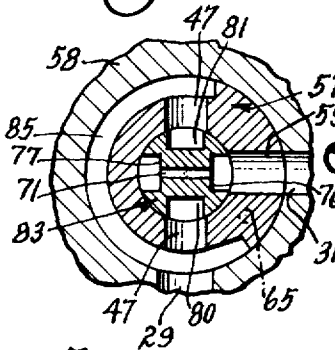


Fig. 6

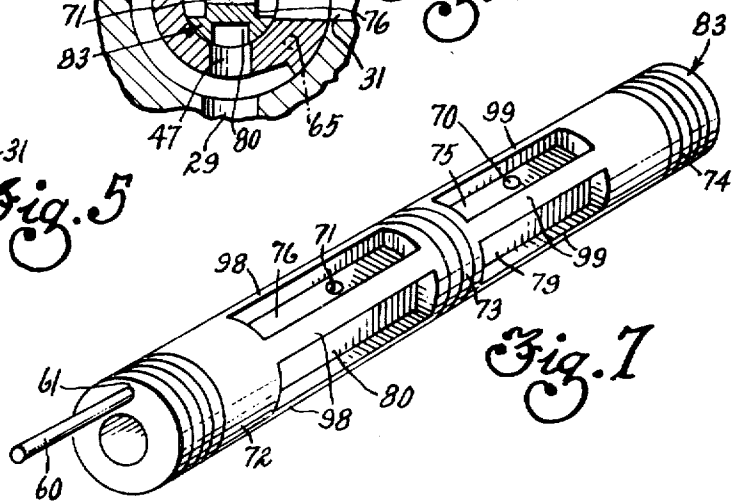


Fig. 7

MULTISECTION VALVE AND HOUSING THEREFOR

BACKGROUND OF THE INVENTION

It is often desirable to have hydraulic control valves mechanically operating in tandem while maintaining hydraulic isolation. In the past, this has been done by rigidly connecting a plurality of control valve spools in series. Thus, when the first valve spool is moved all spools so connected move in tandem with it. The major drawbacks of this device are the increased space requirements necessary to house tandem valves rather than one single unit, the amount of external piping necessary to provide supply and exhaust lines for each separate valve, the amount of force necessary to move the spools so connected in tandem, and the difficulty in maintaining synchronization of the valves.

The present invention comprises an apparatus which permits enclosure of tandem control valves in a valve mechanism which requires no more space than a single control valve of the prior art, yet hydraulically isolates the valves.

Another feature of this invention is that once the tandem valves are properly assembled they cannot become unsynchronized because there is only a single spool and bushing.

This invention further provides an apparatus which permits directed fluid flow to a number of tandem valve units with a reduction in the amount of necessary tubing.

The present invention also provides a valve spool which is no larger than a typical single control valve spool and therefore reduces the force necessary to move such a spool to that required for the operation of a single control valve.

The valve mechanism of the present invention consists of a cylindrical bushing that has a number of integral passages for directing fluid to various ports therein. These integral passages replace external tubing often necessary in tandem valve arrangements.

The valve spool is separated by lands into a number of isolated channels. Circumferential lands separate the valve spool into separate longitudinal sections which are separated into angularly spaced channels by longitudinal lands.

When inserted in the bushing the valve spool and bushing are kept in angular orientation by a securing means that prevents rotation of the spool relative to the bushing.

Through use of predetermined flow pathways and ports which are integral with the spool and the bushing a number of separate hydraulic valve functions are provided.

Other advantages and features of the invention will be apparent in the accompanying drawings and description.

THE DRAWINGS

FIG. 1 is a schematic diagram of a hydraulic servo-system utilizing a set of tandem valves units.

FIG. 2 is an elevational view of the valve bushing of this invention showing the portion conforming to one of the tandem valve units of FIG. 1.

FIG. 3 is an elevational view of the valve bushing showing a portion 90 degrees displaced from the view of FIG. 2 as indicated by arrow 3 in FIG. 2, this portion

conforming to the other of the tandem valve units of FIG. 1.

FIG. 4 is a sectional view taken along line 4—4 of FIG. 2 showing the spool portion conforming to the same tandem valve unit as the bushing in FIG. 2.

FIG. 5 is a sectional view taken along line 5—5 of FIG. 3 showing the spool portion conforming to the same tandem valve unit as the bushing in FIG. 3.

FIG. 6 is a sectional view taken along lines 6—6 of FIG. 2.

FIG. 7 is a perspective view of the spool.

DESCRIPTION

FIG. 1 illustrates a hydraulic servo-system utilizing a tandem valve arrangement. The system is more fully described in the co-pending application of the present inventor, entitled "Variable Gain Amplifier for Hydraulic Servo-System", filed Mar. 15, 1971, Ser. No. 124, 165, and assigned to the assignee of the present application.

An input 10 is supplied to a motor 11 which rotates the shaft 12 either clockwise or counter-clockwise. The circular wobble plate 13 is secured at its center to the shaft 12. As the shaft 12 rotates, the wobble plate 13 displaces rod 14 of valve spool 15.

Valve spools 15 and 16 are mechanically connected in tandem by connector 17. The connector 17 is rigidly secured to ends 18 and 19 of spools 15 and 16, respectively. Control valves 20 and 21, therefore, must operate mechanically in tandem.

On supply pump 22 supplies fluid flow to both control valves 20 and 21. The exhaust system 23 for valve 20 is isolated from the exhaust system 24 of valve 21 for purposes of illustration. However, in the described apparatus the exhaust systems 23 and 24 could be integrated. Reservoir 25 serves as an exhaust drain and a fluid source for pump 22.

Spools 15 and 16 are both illustrated at null. As wobble plate 13 rotates, the spools 15 and 16 will be displaced. Assuming displacement to the left, pressure ports 45 and 52 will then be open to chambers 81 and 75, respectively. Control line 28 will then supply fluid under pressure to chamber 41 of slide cylinder 36. Control line 30 of valve 21 likewise becomes a supply line, supplying fluid to hydraulic intensifier 35. This pushes plunger 37 down and injects a shot of fluid into line 32 which increases the pressure of the fluid in chamber 41 in the manner described in the aforementioned co-pending application.

Piston 40 is moved out and table 38 is moved to the position called for by input 10. The fluid in chamber 42 now must be evacuated through exhaust lines 29 and 33. Exhaust line 29 directs fluid to chamber 82 of valve 20, which is open to the exhaust system 23 through port 48. Exhaust line 33 directs fluid to chamber 100 of hydraulic intensifier 35. This pushes plunger 101 up and forces fluid in chamber 102 into line 31. Line 31 is open to exhaust system 24 through port 55 in chamber 76 of valve 21.

Thus, it can be seen that the valves 20 and 21 must operate in tandem in the present application.

Now turning to FIGS. 2 and 3, the two tandem valves 20 and 21 can be housed in the same longitudinal section of a single cylindrical bushing 57. The spool 83, illustrated in FIG. 7, controls the same functions as both spools 15 and 16 of FIG. 1.

In FIG. 2, the portion of the bushing 57 which is visible corresponds to the control valve 20 of FIG. 1. The portion visible in FIG. 3 which is a view displaced 90° from FIG. 1, as indicated by sight arrow "3" of FIG. 1, corresponds to valve 21. The housing 58 provides isolation of the channels of bushing 57 as will be apparent from the description. Since the same supply system is used for both valves 20 and 21 only one supply line 97 need be provided in the bushing 57, instead of two, lines 26 and 27, as before. By providing circumferential channel 86 around the entire periphery of bushing 57 one fluid supply passage 97 supplies all pressure ports 45, 46, 52 and 53.

Exhaust ports 48 and 49 are isolated from exhaust ports 55 and 56. It should be noted that ports 48 and 49, and ports 55 and 56, could be connected in the fashion similar to that used in joining the pressure ports 45, 46, 52 and 53 by using a channel identical to channel 86 if isolation is not desired.

A circumferential channel 84 exists around at least half but not all of the periphery of bushing 57, connecting the diametrically opposed ports 48 and 49, as best seen in FIGS. 2 and 4. To isolate the ports 55 and 56, which are also diametrically opposed but displaced 90°, from ports 48 and 49 internal channeling must be utilized. In FIG. 5 is shown a hole 93 drilled in bushing 57 to port 55. The hole 93 is then plugged by plug 93a. The channel 89 extends around the entire periphery of bushing 57. A hole 94 is drilled into hole 93, connecting port 55 with channel 89. The diametrically opposite port 56 can be connected to circumferential channel 89 by longitudinal external channel 91 as shown best in FIGS. 3 and 5. The diametrically opposite exhaust ports 55 and 56 are thus connected to each other but isolated from exhaust ports 48 and 49. Exhaust ports 43 and 44 are isolated from exhaust ports 50 and 51 in the same fashion.

As seen in FIG. 3, all exhaust ports 43, 44, 48, 49, 50, 51, 55 and 56 could be joined simply by continuing channels 84 and 88 around the external circumference of bushing 57 and drilling a hole 65 as indicated in phantom, allowing fluid flow from channel 84 to channel 88 without any external piping.

Control ports 63 and 64 may also be isolated. In FIG. 4, the diametrically opposite ports 63 are connected by channel 87 which has the same configuration of channels 84 and 88. Diametrically opposite control ports 47 are connected in the same fashion by channel 85.

As shown in FIG. 5 only a single port 63 is utilized in the illustrated embodiment of the invention. Therefore, no channeling in bushing 57 is necessary.

The spool 83, shown in perspective in FIG. 7, also must be of unique construction to provide a plurality of valves in a single mechanism. Instead of the land and cannellure configuration illustrated in spools 15 and 16, spool 83 consists of isolated channels. The circumferential lands 72, 73 and 74 are the same as the lands of spool 15 and 16. The longitudinal lands 98 and 99, however, separate the cannellures of a typical spool into isolated channels 75 through 82. Channels 79, 80, 81 and 82 correspond to the cannellure of spool 15, and channels 75, 76, 77 and 78 correspond to the cannellures of spool 16. Thus both valves 15 and 16 are contained in the same longitudinal region of the valve mechanism of the present invention.

As herein described, and illustrated in FIG. 5 only a single control port 59 is provided in the valve mechanism of the preferred embodiment. The section view illustrated in FIG. 6 is cut through bushing 57 and spool 83 to better illustrate the use of single porting in the valve mechanism. To maintain hydraulic balance within the spool fluid must be present in both of diametrically opposite channels 76 and 77. A hole 71 is drilled through spool 83 communicating these channels. Thus hydraulic balance is maintained in the valve mechanism as herein described, even through external channeling is not used. It can be seen in FIG. 5 that port 63 communicating with channels 75 and 78 in the same manner through hole 70.

Spool 83 is inserted in the bore of bushing 57 to form a plurality of valves angularly spaced in the same longitudinal region of the spool and bushing. The spool 83 must not rotate in bushing 57 when used in this manner. For this purpose a hole 61 is provided in spool 83 in which is inserted and secured a pin 60. Pin 60 slides in hole 62 of housing 58 thus keeping spool 83 in rotational orientation while permitting movement along its longitudinal axis.

If desired, more than two valves could be housed in the apparatus as herein described. The diametrically opposite channels of spool 83 could be isolated from each other by alternate channeling of fluid flow in the bushing 57 or by eliminating holes 70 and 71.

It can be seen that as many as four valves could be housed in the preferred embodiment of the present invention. It should further be understood that the embodiment of invention as herein described is illustrative only and the invention includes all alterations and modifications within the scope of the appended claims.

What is claimed is:

1. A valve mechanism having a cylindrical bushing with a bore therethrough, a spool inserted in said bore, said spool comprising a plurality of valve function sections, and said valve mechanism being suited to receive hydraulic fluid under pressure for directing flow to various elements of an hydraulic circuit, said valve mechanism comprising:

- a. means for providing a plurality of separate valve function sections spaced angularly about the circumference of said cylindrical bushing;
- b. means associated with said bushing for providing isolated flow pathways through the separate valve function sections;
- c. means associated with said spool for isolating said function sections from one another to maintain independent circuit utility, whereby independent valve functions are controlled by movement of said spool relative to said bushing; and
- d. means for maintaining the angular displacement of the spool relative to the bushing.

2. The apparatus of claim 1 wherein said valve mechanism further comprises means for providing separate valve function sections spaced longitudinally along the axis of said cylindrical bushing.

3. The apparatus of claim 1 wherein said means associated with said bushing further comprises:

- a. one set of diametrically opposite ports whereby hydraulic fluid is introduced into the bore of said cylindrical bushing;

5

- b. another set of diametrically opposite ports which are angularly displaced from said one set of diametrically opposite ports and contained in substantially the same longitudinal position in the bushing, whereby hydraulic fluid may be introduced or removed from the bore in said bushing;
- c. flow pathways integral within said bushing communicating selective ports with one another.
- 4. The apparatus of claim 1 wherein said spool further comprises:
 - a. one set of diametrically opposite channels for controlling the rate of fluid flow through the fore to

6

- the ports in said bushing;
- b. another set of diametrically opposite channels which are angularly displaced from said one set of diametrically opposite channels and at substantially the same longitudinal position in the spool whereby the flow rate of hydraulic fluid through the bore and bushing is controlled; and
- c. means for communicating selected channels of the valve spool, whereby hydraulic fluid flow is maintained through the cylindrical bore of the bushing in a preselected manner.

* * * * *

15

20

25

30

35

40

45

50

55

60

65