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[54] **SPOOL VALVE**
29 Claims, 7 Drawing Figs.

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85/50

[51] Int. Cl. **F16k 11/07,**
F16b 43/00

[50] Field of Search **137/625.6,**
625.63, 625.64, 625.66, 625.69; 85/50

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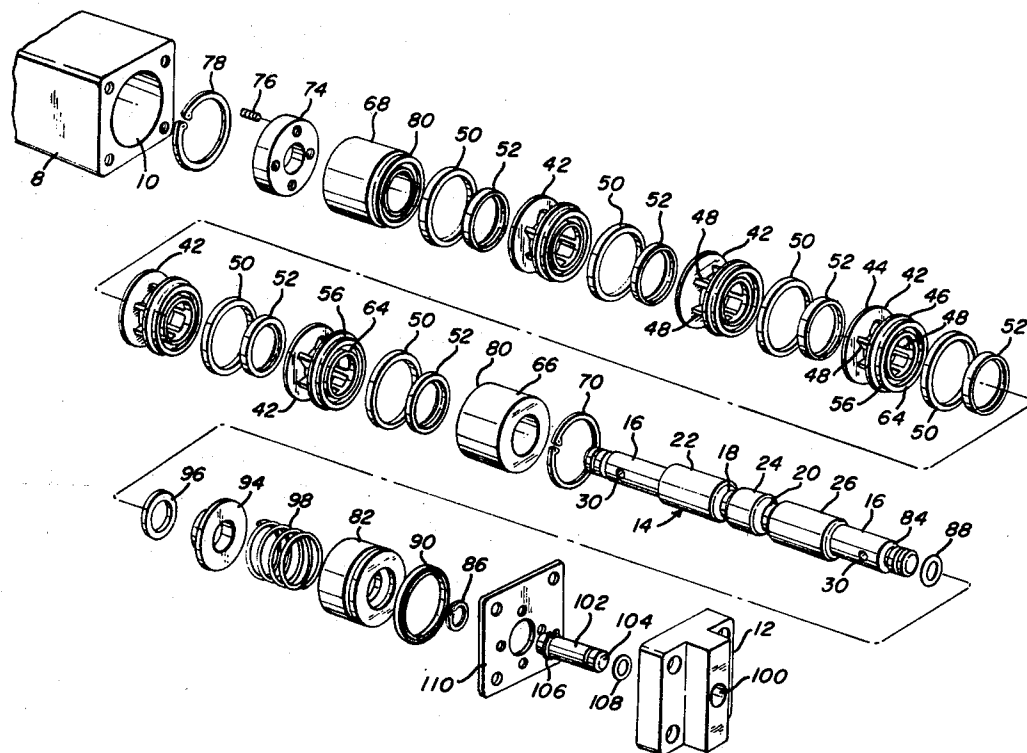
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ABSTRACT: A spool valve constructed of an inexpensive metal extrusion, with the spool chamber formed during extrusion as a straight bore of uniform diameter. The bore requires no precision machining since it does not directly support the valve spool. The spool is supported by an assembly of replaceable simple parts readily removable from the body bore when necessary. An improved spool is assembled from parts formed of different metals, for improving the wear qualities and reducing manufacture cost. Novel spool chamber dividers carry effective seals and, optionally, means minimizing turbulence and resistance to flow of fluid through the valve ports.



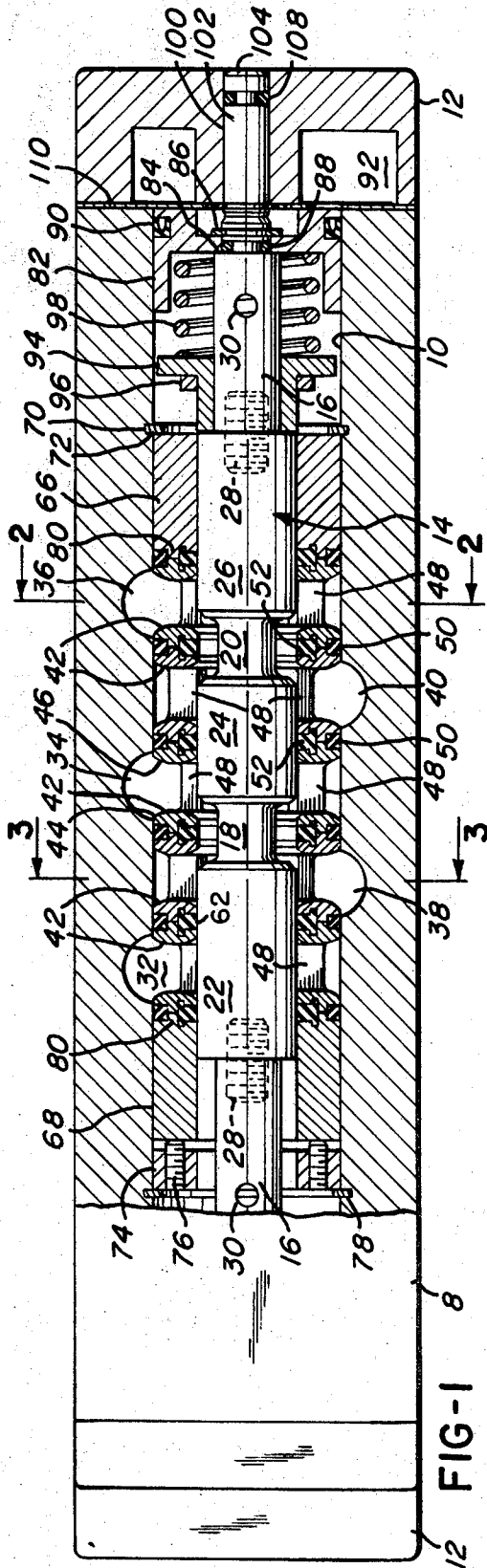
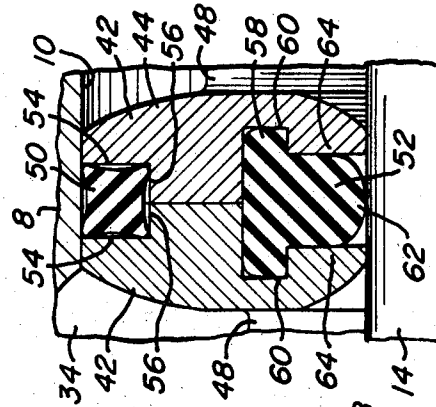


FIG-4

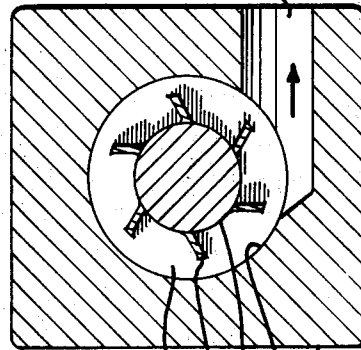


FIG-3

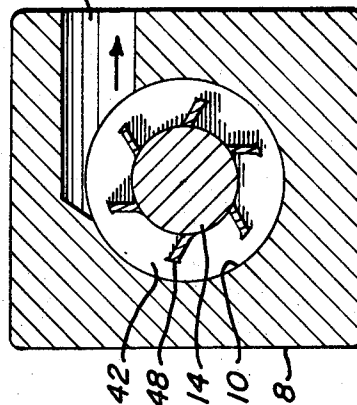
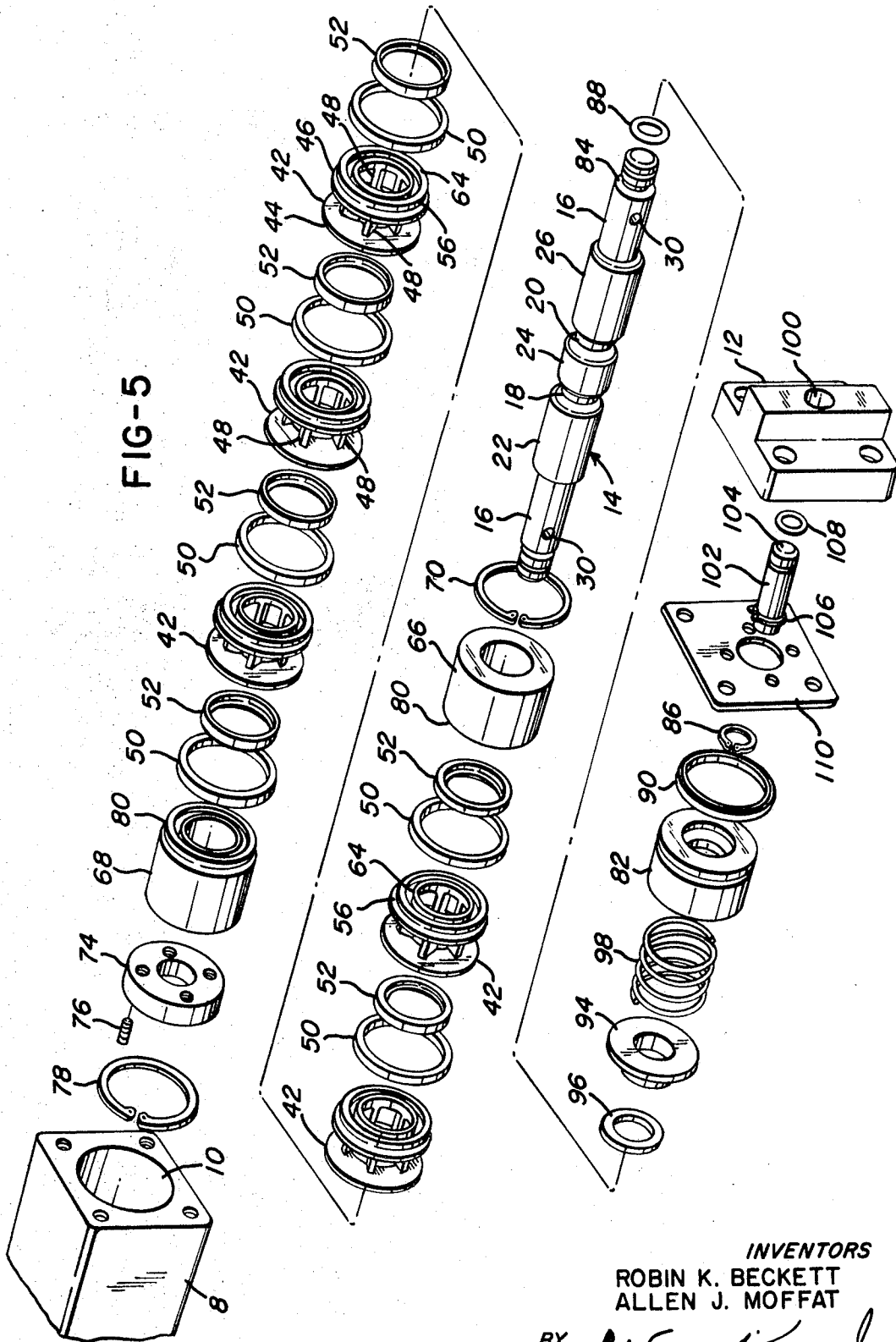


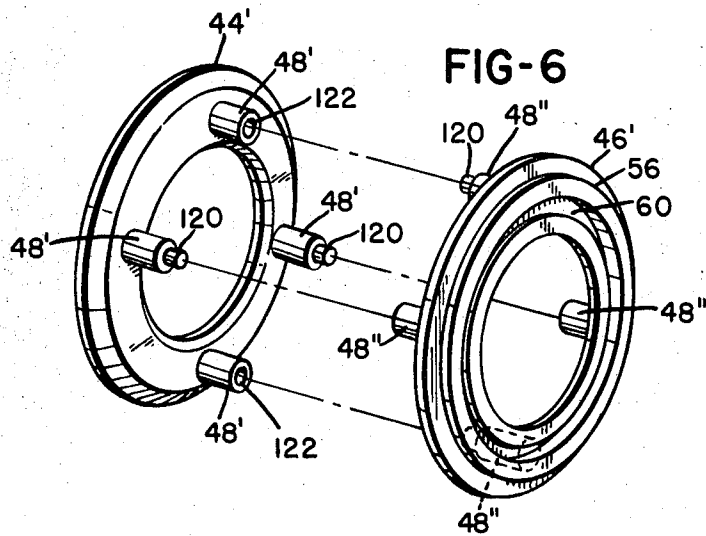
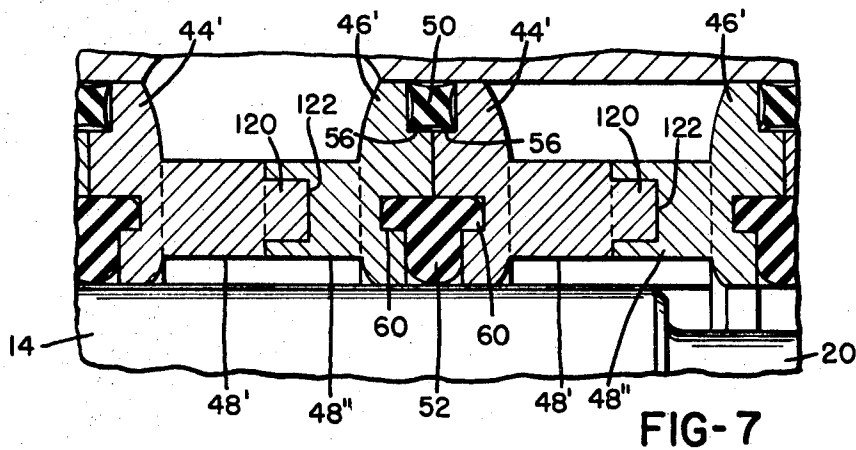
FIG-2

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SPOOL VALVE

The present invention relates to improvements in a spool valve.

An object of the invention is to provide a spool valve construction which simplifies and expedites assembly and disassembly of the valve in production and servicing.

Another object of the invention is to reduce the amount of precision machining needed to produce a satisfactory spool valve, thereby to reduce production time and manufacturing cost.

Another object is to provide means in a spool valve for reducing turbulence in the ports thereof, with resultant decrease in resistance to flow of fluid through the valve.

A further object of the invention is to provide in connection with a spool valve, an inexpensive valve body the spool chamber or bore of which is of uniform diameter throughout, and requires no extensive and costly machining.

Another object of the invention is to reduce the cost and materially increase the service life of a spool valve.

The foregoing and other objects are attained by the means described herein and illustrated upon the accompanying drawings, in which:

FIG. 1 is a side elevation, partly in cross section, showing the interior construction of the improved spool valve.

FIG. 2 is a cross section taken on line 2-2 of FIG. 1.

FIG. 3 is a cross section taken on line 3-3 of FIG. 1.

FIG. 4 is a greatly enlarged detail view, showing a spool chamber dividing and sealing means.

FIG. 5 is an exploded perspective view of the valve.

FIG. 6 is a perspective view of a modified chamber divider, and

FIG. 7 is a cross section of a sealing means utilizing the modifier divider.

The body 8 of the valve may comprise a simple elongate tube having a bore or chamber 10 of uniform diameter extending from end to end of body 8. The body is an inexpensive extrusion of aluminum or similar metal, if desired, and the bore or chamber thereof need not be machined or polished so long as it is reasonably smooth and straight, and is of substantially uniform inside diameter. The bore ends are closed by end caps 12.

The spool 14 of the valve is considerably smaller in diameter than bore 10, and includes end spindles 16, 16, and an intermediate portion provided with annular grooves 18 and 20. Between said spindles and grooves are cylindrical lands 22, 24, 26, all of equal diameter. The intermediate portion of the spool, exclusive of the end spindles, may be inexpensively formed from 7075 type aluminum, or aluminum hard anodized, or not anodized, with or without Teflon impregnation.

The end spindles 16 preferably are formed of stainless steel, or other suitable hard metal, and are mounted coaxially upon opposite ends of the spool, as by means of screw-threaded studs 28, 28 anchored in the spindles and in the spool ends. The transverse holes 30, 30 in the spindles are receptive of a punch or similar tool whereby the spindles may be rotated to fixedly mount them upon the spool at the studs.

Spool 14 is bodily slidable longitudinally, for placing its grooves and lands in various positions relative to the several fluid ports of the valve body denoted 32, 34, 36, 38, 40. The ports 38 and 40, merely by way of example, are work ports conveying fluid to and from opposite ends of a double-acting work cylinder, and port 34 is a fluid supply port. In the illustrated position of the valve spool, supply port 34 delivers fluid by way of groove 18 to work port 38, while the other work port 40 exhausts fluid to an exhaust port 36 through groove 20.

In order to reverse the fluid flow through work ports 38 and 40, the spool would have to be shifted to the left until land 24 places supply port 34 in communication with work port 40, at which time the port 38 would exhaust through port 32.

To effect a neutral position of the spool, it would occupy an intermediate position at which land 24 spans and closes off the

supply port 34. Depending upon the type of service the valve is to perform, the spool may shift between the two extreme positions mentioned above, or it may be stopped at an intermediate shutoff position. The spool may be shifted either manually or by pressure of fluid, as will be explained.

Means are provided for dividing the spool chamber 10 into sections usually equal in number to the number of ports controlled by the valve spool. Such dividing means, or chamber dividers, comprise a plurality of circular cages 42 which are best illustrated by FIG. 5, to be stationarily supported within the spool chamber near the body ports. Each cage comprises a pair of identical discs 44 and 46 spaced apart in parallelism by a plurality of vanes or struts 48 which preferably are integral with the discs. The cages preferably are castings of metal, or possibly plastic moldings.

As FIG. 1 plainly indicates, a port such as 34 is straddled by the discs 44 and 46 of a single cage 42, whose vanes or struts 48 span the port. In like manner, a cage straddles a port 40; another straddles the port 36; and two other straddle the ports 38 and 32, respectively.

The discs 44 and 46 of adjacent cages 42 coincide with one another in the assembled valve, to support outer flexible sealing rings 50 and inner flexible sealing rings 52. As best illustrated in FIG. 4, the outer sealing ring is squeezed between marginal flanges 54, 54 of two adjacent discs, and rests upon the annular shoulders 56, 56. The ring so supported seals against the bore 10 adjacent to a port such as 34.

The inner flexible sealing ring 52 preferably has a T-shaped circumferential flange 58 which is supported in annular grooves 60, 60 of the discs of the adjacent cages. Ring 52 has also a radial portion 62 extended inwardly from flange 58 to abut and seal against the valve spool 14. The portion 62 of the ring preferably is squeezed between the inner marginal flanges 64, 64, for distending the ring yieldingly against the valve spool. Rings 50 and 52 may be formed of resilient rubber or a rubberlike material, certain plastics being suitable for the purpose as will be understood.

Means are provided for anchoring the chamber dividers against shifting movement longitudinally of the valve body. Said means comprises end sleeves or spacers 66 and 68, of which one, such as 66, abuts a removable snap ring 70 normally seated in an annular groove 72 formed in bore 10. The second sleeve or spacer 68 may include an adjustable extender in the form of a ring 74 drilled and tapped to receive several adjusting screws 76 to abut the outer end face of spacer 68, so that the effective length of said spacer may be altered by rotating the adjusting screws. The extender ring is adapted to abut the removable snap ring 78 anchored in the body bore 10. The adjusting screws determine the force with which the several sealing rings 50 and 52 abut the bore of the valve chamber and the lands of the spool respectively.

It will be noted that each of the end sleeves or spacers 66, 68 carry surfaces to support the rings 50 and 52, corresponding to the surfaces 54, 56, 60, and 64, as shown at 80.

Means are provided for reciprocating the spool 14, either manually, electrically, or by fluid pressure. Said means may comprise a piston 82 reciprocable in spool bore 10, said piston having connection with spindle 16 so as to move therewith. The piston may be held in abutment against a shoulder 84 of the spindle, by means of a small snap ring 86. A gasket 88 effects a seal between the piston and the spindle. The piston carries a resilient sealing ring 90 slidable in bore 10. Fluid under pressure fed to the chamber 92 defined by cap 12 acts against piston 82 to shift the piston and spool 14 to the left in FIG. 1.

The numeral 94 indicates a spool stop slidable on spindle 16 and carrying a cushion or bumper member 96 which, upon shifting of the spool, strikes one end of sleeve 66 to soften the stroke of the spool. A spring 98 surrounding the spindle yieldingly spaces the piston from stop 94, and coacts with a similar spring and piston assembly (not shown), located at the opposite end of the valve, to position the spool in a neutral or center position.

If the spool is to be shifted manually or electrically, rather than by means of piston 82, the end cap 12 may be provided with a bore 100 to slidably support a shaft 102 having an exposed end 104 to be manipulated exteriorly of the valve in any suitable manner. A snap ring 106 applied to shaft 102 (FIG. 5) may preclude displacement of the shaft from bore 100. A resilient sealing ring 108 precludes leadage of fluid along shaft 102 when the spool is shifted by fluid pressure against piston 82. The inner end of shaft 102 is adapted to strike the outer end of spindle 16 in shifting the valve spool by means of said shaft. A gasket 110 prevents fluid leakage between the cap 12 and body 8, but permits operating fluid to pass from chamber 92 to piston 82.

It should be understood that the operating means shown at the right end of the valve in FIG. 1, may be duplicated at the left end of the valve, if desired, for effecting a reverse shifting of the valve spool. It should be understood, further, that means other than that illustrated may be employed to shift the valve spool; for example the spool may be shifted both right and left from one end of the valve body, by securing the operating shaft to the outer end of spindle 16, and extending the outer end 104 of the shaft so that it may be exposed for manual or electromagnetic shifting in opposite directions axially.

Various other expedients for shifting the valve spool may be adopted, as desired, and depending upon the type of service the valve is to perform, the spool may be shiftable to two or three positions. The spool may be shiftable by fluid pressure in one direction, and returned by spring pressure to a position of normalcy at one end of the spool chamber, if desired.

For electromagnetic or solenoid operation of the valve, the actuating solenoid may be located either adjacent to the cap 12, or it may be located beyond the cap, or intermediate the cap and the valve body. In one practical application, two solenoids may be employed, one at each end of the valve body, for shifting the valve spool in opposite directions.

Attention is now directed to the circular divider cage 42 as disclosed by FIGS. 2, 3 and 5, particularly with reference to the vanes or struts 48. The vanes or struts, it will be noted, are not radial from the central axis of the cage, but are instead, disposed in planes which are offset from the axis though in parallelism therewith. All of the vanes or struts are offset equally, and in a common direction with reference to the cage axis.

The cages are symmetrically formed, so that they may be supported in the valve chamber in either of the two positions depicted by FIGS. 2 and 3, wherein the directions of extension of the vanes are reversed. When assembling the valve, the cages are so inserted that the angularity of the vanes 48 assists, rather than opposes, flow of fluid through the body ports. Such disposition of the angular vanes reduce turbulence and back pressure in the ports and the spool chamber, resulting in rapid and efficient fluid flow through the valve. In FIG. 1, successive cages 42 have their vanes or struts projected in opposite directions, (see FIGS. 2 and 3). It must be appreciated that the cages 42 are fixed against rotation within the spool chamber.

Disassembly of the valve for inspection or servicing may be accomplished with a minimum of labor and time expenditure. If the valve has all of its spool-shifting mechanism located at one end, disassembly may be accomplished by removing the cap 12, then the snap ring 86. Piston 82, spring 98, and spool stop 94 may then be withdrawn from the open end of the bore 10, to expose the snap ring 70. Upon removal of snap ring 70, the entire inside of the valve may be displaced, including all of the cages 42, the sleeves 66, 68, and the spool, as a unit, or individually if desired.

In the event that the spool is to be removed without disturbing the cages and sleeves 66, 68, the cap 12 is to be removed first, whereupon the spool with the piston 82 and parts 98 and 94 assembled thereon, may be drawn as a unit from the open end of the body bore. In valves which incorporate spool-shifting means at both ends of the body bore, disassembly may

require the procedure recited in the paragraph next above, involving removal of both pistons 82 and the adjacent parts 98 and 94. From the foregoing it will be understood that full disassembly will involve removal of one or both of the snap rings 70, 78, whereas partial disassembly of the valve may be accomplished without removal of said snap rings.

Attention is now directed to FIGS. 6 and 7, which illustrate a modified form of spool chamber dividing and sealing means, that may be substituted for the dividing and sealing means previously described in connection with FIGS. 1 through 5. In the modified structure, a cage corresponding to cage 42 is made in two parts, or sections, each comprising a first disc 44' and a second disc 46', which discs may be spaced apart by interlocking strut members 48' and 48''. The strut members take the place of the vanes 48 heretofore described.

The strut members 48', 48'' may take the form of short posts or studs integral with the discs 44' and 46', the posts being interlockable endwise in pairs, as by means of the inter-fitting tongues 120 and sockets 122 (FIG. 7). Means other than the tongues and sockets may be employed, if desired, for interlocking the struts and spacing the discs 44' and 46' from one another. The strut members space the discs apart a distance equal to the span of the vanes 48 in FIG. 5.

It may be noted that discs 44' and 46' are formed with annular shoulders 56 and grooves 60, to support the sealing rings 50 and 52, in the same manner as depicted by FIG. 4. The principal distinction between FIGS. 4 and 7, resides in the discarding of vanes 48 in favor of the separable struts 48', 48'' of FIG. 7. The separable cage or divider of FIGS. 6 and 7 may be manufactured at extremely low cost, and can be incorporated in the valve during assembly with the same ease and despatch as cages 42. The tongues 120 by preference, may have a reasonably tight fit in the assembled condition during handling of the cages. The base ends of the strut sections may be integral with the disc members, when the cages are produced as castings.

Assembly and disassembly of the valve is greatly facilitated and expedited in practice, according to the present invention. Great savings in manufacturing costs are realized, due to the fact that body bore 10 is of uniform diameter from end to end, and requires no precision machining or finishing. The body may be inexpensively formed from a relatively inexpensive metal, if desired, and may be an extrusion or a die casting. The spool itself may be inexpensively constructed of a metal such as aluminum, with spindle ends 16, 16 preferably of a harder metal such as stainless steel or equivalent. The lands of the spool if necessary may be electropolished, ground, or hard coated and Teflon filled, for wear-resistant easy sliding in the cage seals 58.

We claim:

1. A spool valve comprising in combination; a body having an elongate openend bore of uniform diameter, and a plurality of transverse ports spaced from one another within the bore for conveying fluid into and from the bore; and elongate reciprocable valve spool of substantially lesser diameter than the diameter of the body bore, said spool including a plurality of lands spaced apart, and an end portion adjacent to one of said lands; a plurality of dividers within the bore, each including an inner sealing ring to effect fluid seals about the lands of the spool, each of said dividers including stationary vanes directed generally tangentially with respect to the diameter of the spool to direct flow along a selected path between the valve bore and the ports to minimize fluid turbulence within the valve; and means associated with the end portion of the spool, for moving the spool axially of the body bore to control fluid flow through said ports.

2. The spool valve as specified by claim 1, wherein is included an outer sealing ring on each divider effecting seals within the bore intermediate the spaced ports aforesaid, and means for displaceably anchoring said dividers within the bore for bodily removal of said dividers and the sealing rings thereon through the open end of the bore.

3. The combination as specified by claim 2, wherein the means last mentioned includes spaced abutments within the body bore, at least one of which is displaceable to release the dividers for bodily removal through said bore.

4. The combination as specified by claim 2, wherein the dividers include stationary vanes angled to direct fluid flow along a selected path between the valve bore and the ports, to minimize fluid turbulence within the valve.

5. The spool valve as specified by claim 1, wherein the bored valve body is inexpensively formed as an extrusion of moldable material, the body bore being formed during the extrusion process.

6. The combination as specified by claim 1, wherein the spool lands are formed of hard aluminum, and the end portion thereof is a separate part of harder metal detachably fixed relative to the lands.

7. The combination as specified by claim 1, wherein the dividers are formed as castings with which the vanes are integrally formed.

8. The combination as specified by claim 7, wherein the valve body and the bore thereof are formed by extrusion of moldable metal.

9. The combination as specified by claim 1, wherein the dividers comprise each a pair of separable disc members spaced apart by a plurality of struts spanning the space between said disc members, and means in the form of seats on said disc members for supporting said inner and outer sealing rings.

10. The combination as specified by claim 9, wherein each strut of a divider comprises a pair of post sections each having a free end and a base end, the base end of each post section being fixed upon a disc member; and means for joining the free end of a post section of one disc member with the free end of a post section of the remaining disc member; and means in the form of seats on said disc members for supporting said inner and outer sealing rings.

11. A spool valve as defined in claim 1, wherein said plurality of transverse ports includes an inlet port and two outlet ports, at least one of said ports being tangentially disposed with respect to said openend bore.

12. A spool valve as defined in claim 11, wherein said inlet port and said outlet ports are tangentially disposed with respect to said openend bore.

13. A spool valve comprising in combination: a body having an elongate openend bore of uniform diameter, and a plurality of fluid ports spaced from one another within the bore for conveying fluid into and from the bore; and elongate reciprocable valve spool of substantially lesser diameter than the diameter of the body bore, said spool including a plurality of lands spaced apart, and an end portion adjacent to one of said lands; a plurality of bore dividers each in the form of a cage comprising a pair of centrally apertured discs and struts holding said discs in spaced relationship such that the discs of a cage span one of the fluid ports of the valve body; a plurality of outer sealing rings, a plurality of inner sealing rings, means along an outer margin of each disc for supporting an outer sealing ring in sealing contact with the body bore; means marginally of each disc aperture for supporting an inner sealing ring in position to seal against a land of the valve spool; a removable snap ring in said body engaging one end of the cages, an axially adjustable ring engaging the other end of the cages, and means for imparting movement to the spool axially of the body bore, to control fluid flow through the ports aforesaid.

14. The combination as specified by claim 13, wherein the cages are axially aligned within the body bore, with adjacent discs of successive cages in substantial contact against the inner and outer sealing rings.

15. The combination as specified by claim 14, wherein the struts between the discs of the cages are substantially flat, and angled to direct fluid flow along a selected path to minimize turbulence of fluid within the valve.

16. The combination as specified by claim 14, wherein said snap ring permits removal of said cages and the sealing rings

supported thereof, through the open end of the body bore.

17. The combination as specified by claim 16, wherein said releasable means includes a second snap ring spaced from said first snap ring within the body bore to embrace the cages therebetween; said ring adjusting the force with which the snap rings embrace said cages.

18. The combination as specified by claim 17, wherein the struts of the cages are substantially planar and angled to direct fluid flow along a selected path between the body bore and the ports, to minimize fluid turbulence within the valve.

19. The combination as specified by claim 18, wherein each cage with the struts thereof is formed as a metal casting.

20. The combination as specified by claim 18, wherein the valve body and the bore thereof are formed by extrusion of moldable metal.

21. The combination as specified by claim 13, wherein the spool lands are formed of hard aluminum, and the end portion thereof is a separate part of harder metal detachably fixed relative to the lands.

22. The combination as specified by claim 21, wherein the said end portion has a screw-threaded connection with the spool portion carrying the lands; and means associated with said end portion to accommodate a tool for selectively establishing and disengaging said screw-threaded connection.

23. The combination as specified by claim 13, wherein said last-mentioned means comprises a piston reciprocable within the body bore; means for detachably mounting said piston upon the end portion of the spool for movement with the spool; a spool stop member having a marginal portion in position to be struck by the piston, said member having a hub slidable upon the spool end portion; yielding means acting constantly to yieldingly maintain the spool stop hub in abutment against a land of the spool, and means for directing pressure of fluid against the piston in the direction of said spool stop member.

24. The combination as specified by claim 23, wherein is included means for manually advancing the piston in the direction of the spool stop member.

25. The combination as specified by claim 13, wherein is included a removable end cap closing the open end of the body bore and limiting shifting of the spool in one direction, removal of said end cap being effective to free the last-mentioned means for unrestricted withdrawal, along with the valve spool, from the open end of the body bore.

26. The combination as specified by claim 13, wherein the spaced discs of a divider cage are separable from one another.

27. The combination as specified by claim 26, wherein each strut of a divider cage comprises a pair of post sections each having a free end and a base end, the base end of each post section being fixed upon a disc; and means for joining the free end of a post section of one cage disc with the free end of a post section of the remaining disc of the same cage.

28. The combination as specified by claim 13, wherein each strut spacing the discs of a cage, comprises two separable sections each carrying one of the discs of a cage.

29. A spool valve comprising in combination:

a body having an elongate open end bore of uniform diameter, and a plurality of transverse ports spaced from one another within the bore for conveying fluid into and from the bore; and elongate reciprocable valve spool of substantially lesser diameter than the diameter of the body bore; said spool including a plurality of lands spaced apart, and an end portion adjacent to one of said lands; a plurality of dividers within the bore, each including an inner sealing ring to effect fluid seals about the lands of the spool; a removable snap ring in said body engaging one end of said dividers to axially position the same, an axially adjustable ring engaging the other end of said dividers for positioning said one end of said cages against said removable snap ring; and means associated with the end portion of the spool, for moving the spool axially of the body bore to control fluid through said ports.