Oct. 26, 1965 V. P. DONNER 3,213,880

HYDRAULIC CONTROL VALVE

Filed June 19, 1963 2 Sheets-Sheet 1

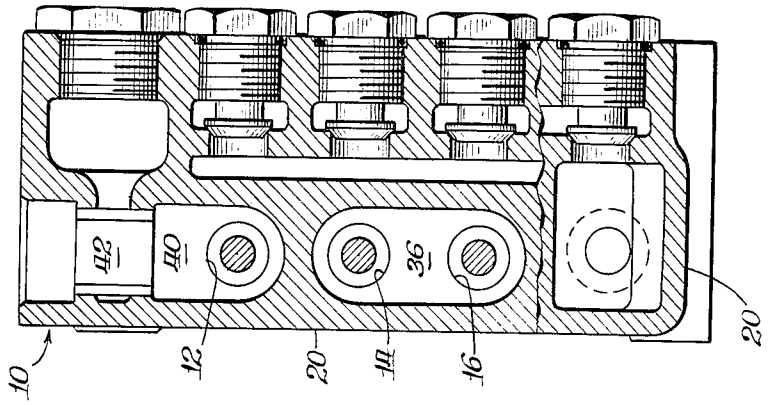


Fig. 2.

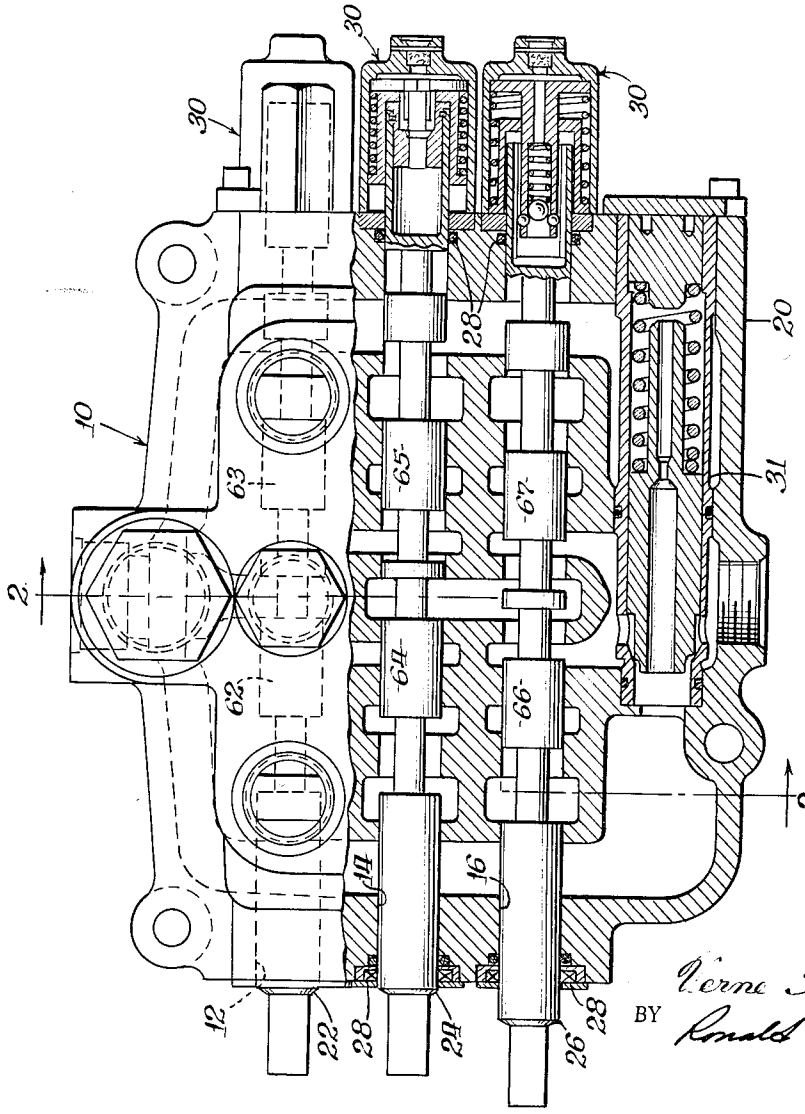


Fig. 1.

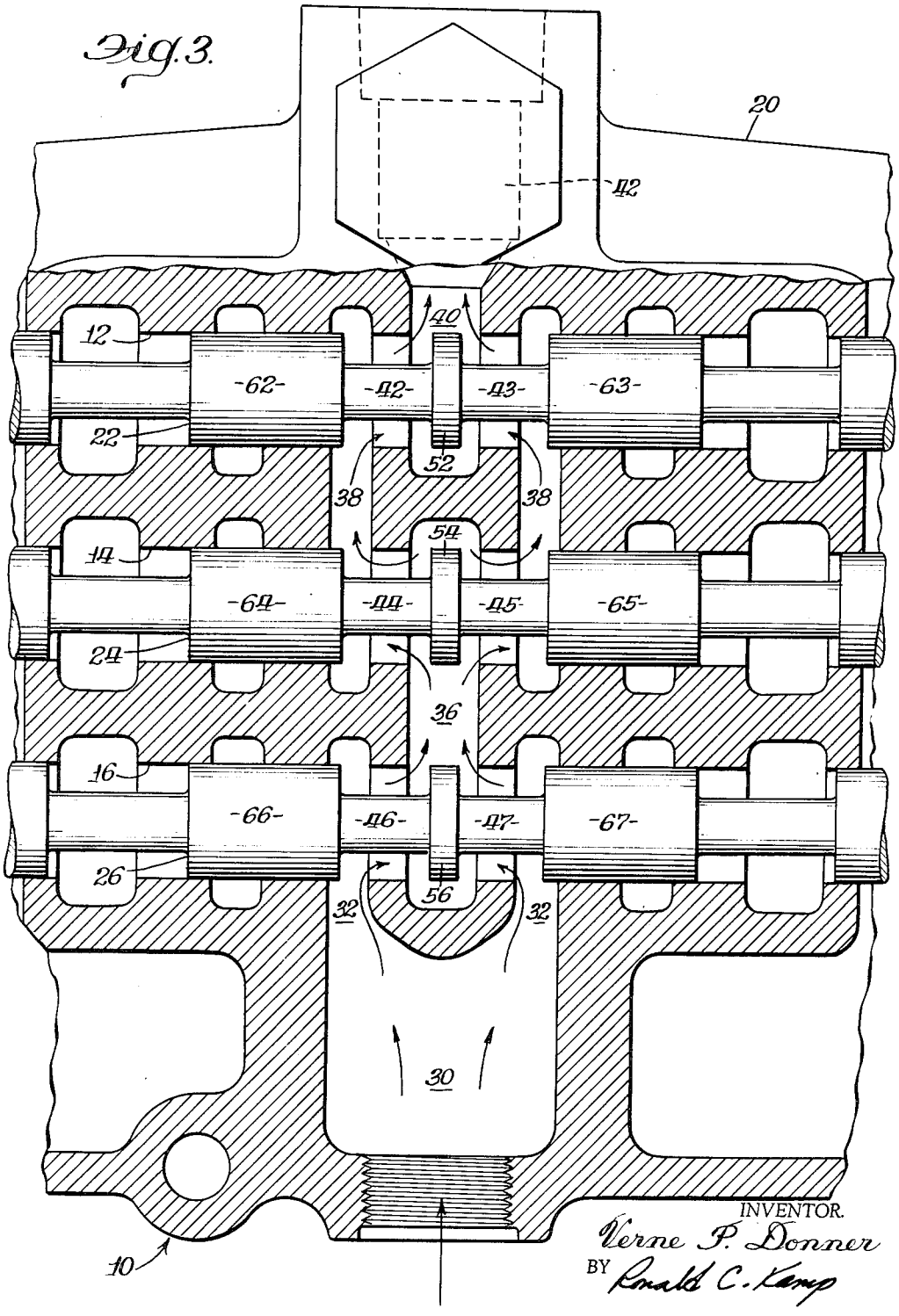
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Fig. 3.



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HYDRAULIC CONTROL VALVE

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The present invention relates generally to hydraulic control valves and more particularly to hydraulic control valves which are subjected to a high flow rate of hydraulic fluid and which have a plurality of control plungers or spools.

In the field of hydraulic control valves, it is desirable to produce them in as small and as compact a unit as possible. The reasons for the desired compactness are many, but one of the most obvious is that it permits the control valve to be located or positioned within confined quarters on the apparatus or equipment with which it is associated. When a multiple spool-type hydraulic control valve is encountered, it becomes necessary to locate the plungers or spools as closely together as possible in order to achieve the desired compactness. Close spacing or positioning of the spools may be achieved by utilizing a "Z" flow pattern as shown, for example, in U.S. Patent No. 2,848,014. However, such a flow pattern results in a hydraulic imbalance of the spools. That is, as the flow of hydraulic fluid changes from a direction transverse to the bore in which the spool is movable to a direction parallel to the bore, a reaction force is imparted to the spool in a direction opposite to the flow of fluid within the bore. As the fluid leaves the bore and changes direction to flow transverse thereto the reaction force is radial to the spool. Thus it can be seen that there is a reaction force on the spool in an axial direction which tends to shift the spool within the bore. When high rates of flow are encountered this hydraulic imbalance becomes a serious problem.

It is possible to achieve hydraulic balance of the spools in a hydraulic control valve by utilizing a "Y" flow pattern, as shown for example in U.S. Patent No. 3,000,397, which flow pattern achieves hydraulic balance at the expense of compactness or close spacing of the spools contained within the control valve. That is, the spools must be placed farther apart in order to permit the "Y" shaped passage to be physically positioned between two of the adjacent spools. Additionally the angle of divergents between the two arms of the "Y" can not be too large in order to prevent excessive heating of the hydraulic fluid due to numerous changes in direction thereof as it flows through the control valve and also to get the proper type of flow therethrough.

It is, therefore, an object of the present invention to provide a hydraulic control valve having hydraulically balanced spools and which may be of compact or small size.

Other objects and many of the attendant advantages of the present invention will become apparent when considered with the following description and the drawings wherein:

FIGURE 1 shows a typical hydraulic control valve partly in section, with two of the plungers or spools in extended position;

FIGURE 2 is a sectional view taken on line 2—2 of FIGURE 1; and

FIGURE 3 is a detail view partly in section of the control valve of FIGURE 1 in which the control plungers or spools are in neutral position.

Referring now to FIGURE 1, there is shown a typical control valve unit indicated generally as **10** having a valve body or member **20** with three substantially parallel bores **12**, **14** and **16** extending therethrough. The valve **10** may

be utilized for example to actuate three separate elements on a given apparatus by directing or porting the hydraulic fluid to hydraulic rams or the like associated with the particular element. Each of the three control plungers or spools, **22**, **24** and **26**, which are slidable within bores **12**, **14** and **16**, may be either extended or retracted in order to move the element with which it is associated in either of two directions. Detent means indicated generally as **30** may be attached to the valve body **20** to lock or hold the spools in a given position. Seals **28** are mounted in valve body **20** at each end of the bores **12**, **14** and **16**. The usual relief valve mechanism, designated generally as **31**, is positioned within valve body **20** to prevent the build-up of higher than normal operating pressures within the valve passages.

Referring now to FIGURE 3, there is shown a detailed view of the central portion of valve **10** with each of the spools **22**, **24** and **26** being in their centered or neutral position. This is the relationship of the spools to the valve body **20** when none of the hydraulic mechanisms associated therewith are being operated and the hydraulic fluid supplied under pressure from a pressure source, not shown, passes only through the control valve **10** and returns to the sump or tank, also not shown. An inlet chamber **30** formed in the valve body **20** receives the hydraulic fluid being supplied by the pressure source. Two passages **32** extend from the inlet chamber **30** transverse to the bores **16** and provide a fluid communication between the inlet chamber and the bore. Preferably each of the passages **32** extends in a radial direction a distance greater than the radius of bores **16** to provide easy access of the fluid into the bore **16**. The spool **26** which is slidable in the bore **16** is provided with two control grooves **46** and **47** which define lands **66**, **56** and **67**. Each of the lands has a diameter substantially equal to the diameter of the bore and serve to effectively block off or seal the bore to prevent flow of the hydraulic fluid in an axial or longitudinal direction along the bore. A central passage **36** extends from the bore **16** to the bore **14** and provides a fluid communication between these bores. The central passage **36** extends in a radial direction a distance greater than the radius of either of the bores **16** or **14** as best shown in FIGURE 2, and has a width greater than the width or thickness of the central lands **56** and **54** of spools **26** and **24** respectively. This allows the hydraulic fluid to flow from the inlet chamber through the passages **32** and into the bore **16** around the land **56** and into central passage **36** and around the land **54** into the bore **14**. Since the diameter of the spool at each of the control grooves **46** and **47** is equal, the area of each of the lands **66** and **67** upon which the fluid will react as it changes directions in flowing from the passage **32** into the bore **16** will be equal and opposite. Thus the spool **26** will be in hydraulic balance. Similarly the diameter of the spool at the control grooves **44** and **45** on the spool **24** are equal in diameter and thus the area acted on by the fluid as it changes directions in flowing from central passage **36** into the bore **14** will be equal. Since the fluid is reacting on equal areas on each side of the land **54** the spool **24** will also be in hydraulic balance. A pair of passages **38** extend substantially perpendicular or transverse to the bore **14** into contact with the bore **12** and provide fluid communication between bore **14** and the bore **12**. A passage **40** extends transversely to the bore **12** and into contact with outlet chamber **42**, preferably both passages **38** and passage **40** extend in a radial direction a distance greater than the radius of the bore **12** to provide easy access of the fluid from the passages **38** into bore **12** and from the bore **12** into the passage **40**. The passage **40** has a width greater than the axial width or thickness of the land **52** on the spool **22** to allow the fluid to pass by the land **52** as the

spool 22 is in neutral position. Since the diameter of the spool 22 at the control grooves 42 and 43 are equal, the area of land 62 upon which the fluid will react will be equal to the reaction area of land 63 as the fluid changes directions in flowing from the passages 38 into the bore 12. Thus the spool 22 will be in hydraulic balance. Since the passages 36 and 38 are straight and extend substantially perpendicular to the bores 12, 14 and 16, it is apparent that the spools 22, 24 and 26 may be positioned as closely together as the strength of the material utilized to make the body 20 will permit.

From the foregoing description taken together with the accompanying drawings, it will be readily apparent to those skilled in the art that this invention has been illustrated by means of a preferred embodiment thereof and that the scope of the invention is not to be limited thereto but is to be determined by the appended claims.

I claim:

1. A hydraulic valve unit comprising a body member having at least three substantially parallel bores therein, an inlet chamber in said member, a pair of first spaced passages extending from said inlet chamber into communication with the first of said bores and substantially perpendicular thereto, a second passage positioned between and centrally of said pair of first passages and extending substantially perpendicularly throughout from said first bore into substantially perpendicular communication with the second of said bores, a pair of third passages positioned one on either side of said second passage and substantially equidistant therefrom, said pair of third passages extending substantially perpendicularly throughout from said second bore into substantially perpendicular communication with the third of said bores, a fourth passage positioned between and centrally of said pair of third passages and communicatively connected with said third bore, and an outlet chamber in said member and communicating with said fourth passage.

2. A hydraulic valve body according to claim 1 and further comprising annular port means formed in said member at the intersections of each of said passages with each of said bores.

3. A hydraulic control valve comprising, a valve body having three substantially parallel bores therein, a spool having a center and two outer lands thereon reciprocably retained within each of said bores, inlet and outlet chambers in said body on opposite sides thereof, said spools being movable to a neutral position to permit flow of hydraulic fluid from said inlet chamber only to said outlet chamber, a pair of first passages in said body extending from said inlet chamber to the first of said bores, said first passages being substantially perpendicular to said first bore and spaced apart a distance substantially equal to the distance between the adjoining faces of said center land on the first spool, a second passage in said body substantially perpendicular throughout to said bores extending from said first bore to the second bore and positioned substantially centrally of said first passages, a pair of third passages extending from said second bore to the third bore, said third passages being substantially perpendicular throughout to said bores and spaced apart a distance substantially equal to the distance between the adjoining faces of said outer lands on the second spool, and a fourth passage in said valve body extending perpendicularly from said third bore to said outlet chamber and positioned substantially centrally of said third passages, said second and fourth passages having a width greater than the axial thickness of said center lands.

4. A control valve comprising a valve body having three substantially parallel bores therein, a spool having a center and two outer lands thereon slidable in each of said bores, each of said outer lands having inner and outer faces, said spools each being movable to a center neutral position wherein said center lands and said outer lands of each spool are respectively in alignment with the center lands and the outer lands of the other spools when also in said neutral position, an inlet chamber in said valve body, a pair of first passages in said valve body substantially adjacent the inner faces of said outer lands on the first spool when said first spool is in neutral position and extending from said inlet chamber to the first bore, a second passage extending from said first bore to the second bore and being substantially perpendicular throughout to said first and second bores, the center lands on the first and second spools being located substantially centrally of said second passage when said first and second spools are in neutral position, a pair of third passages extending from said second bore to the third bore and being substantially perpendicular throughout to said second and third bores and adjacent the inner faces of said outer lands on the third spool when said third spool is in said neutral position, and an outlet passage communicating with said third bore, said center land on the third spool being located substantially centrally of said outlet passage when said third spool is in said neutral position, said outlet passage having a width greater than the axial thickness of said center land on said third spool and said second passage having a width greater than the axial thickness of said center lands on said first and second spools.

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