

May 19, 1964

M. W. SHELER

3,133,503

HYDRAULIC PRESSURE TRANSFORMER

Filed May 25, 1962

5 Sheets-Sheet 1

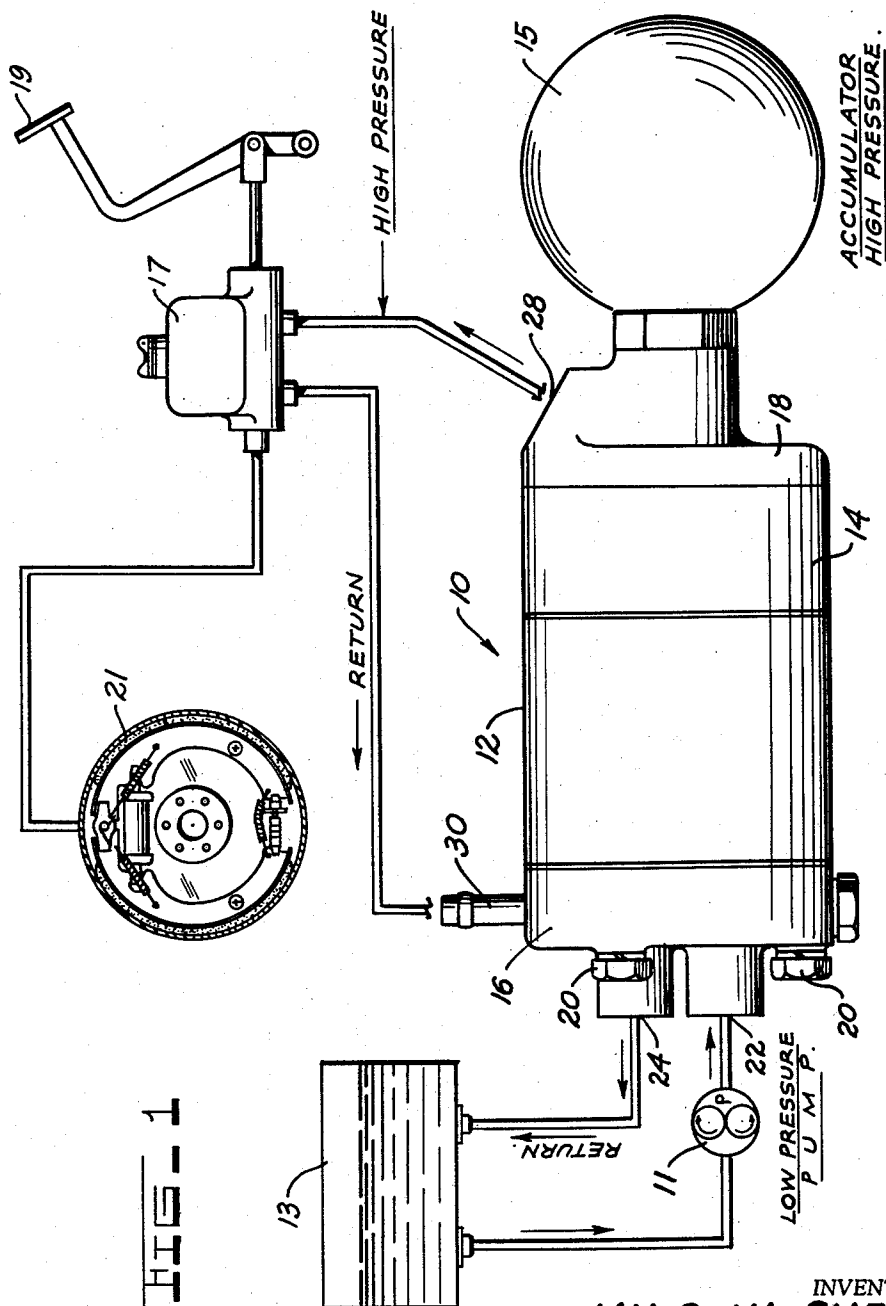


FIG. 1

INVENTOR
MILO W. SHELER
BY
William N. Antonis
ATTORNEY.

May 19, 1964

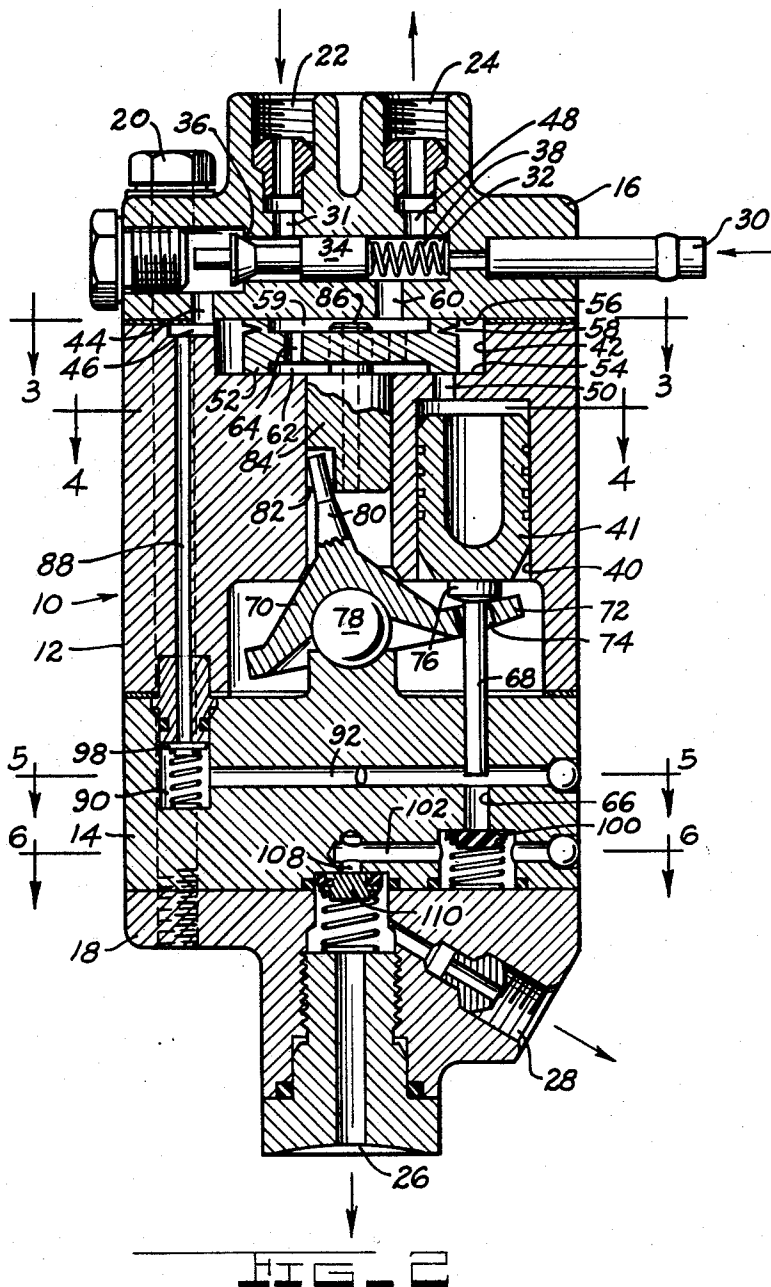
M. W. SHELER

3,133,503

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INVENTOR.
MILO W. SHELER.
BY
William N. Antonis
ATTORNEY.

May 19, 1964

M. W. SHELER

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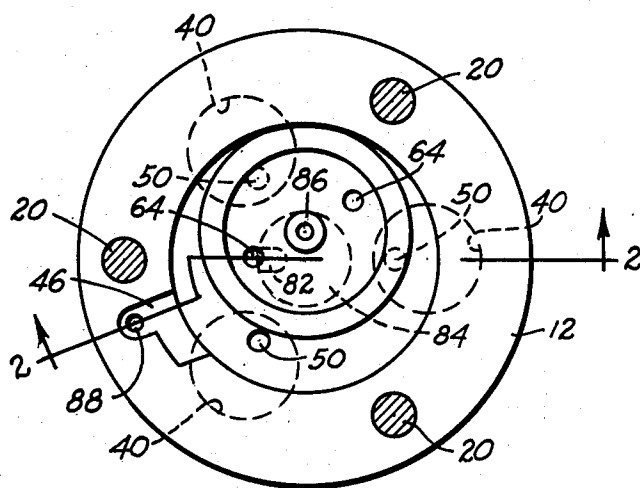


FIG. 3

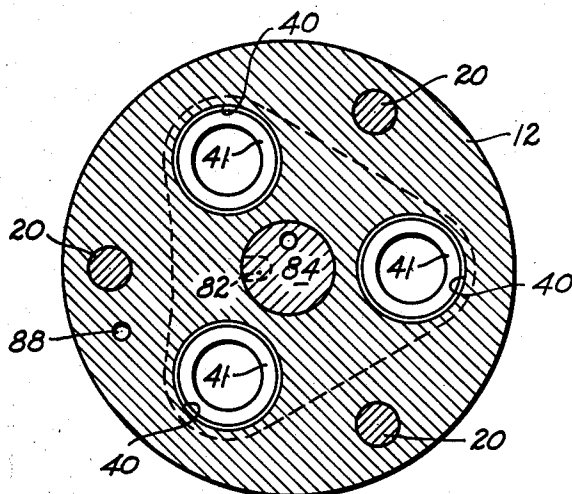


FIG. 4

INVENTOR.

MILO W. SHELER.

BY

William N. Antonis

ATTORNEY.

May 19, 1964

M. W. SHELER

3,133,503

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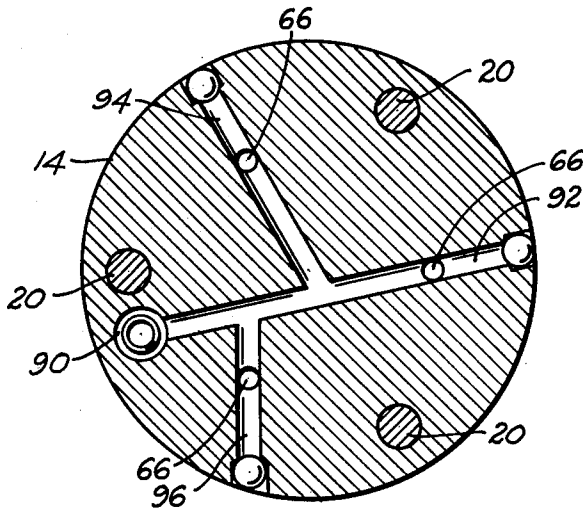


FIG. 5

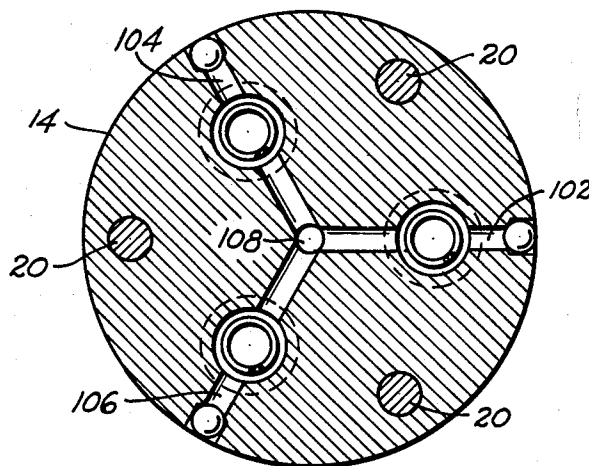


FIG. 6

INVENTOR.

MILO W. SHELER

BY

William N. Antonis

ATTORNEY.

May 19, 1964

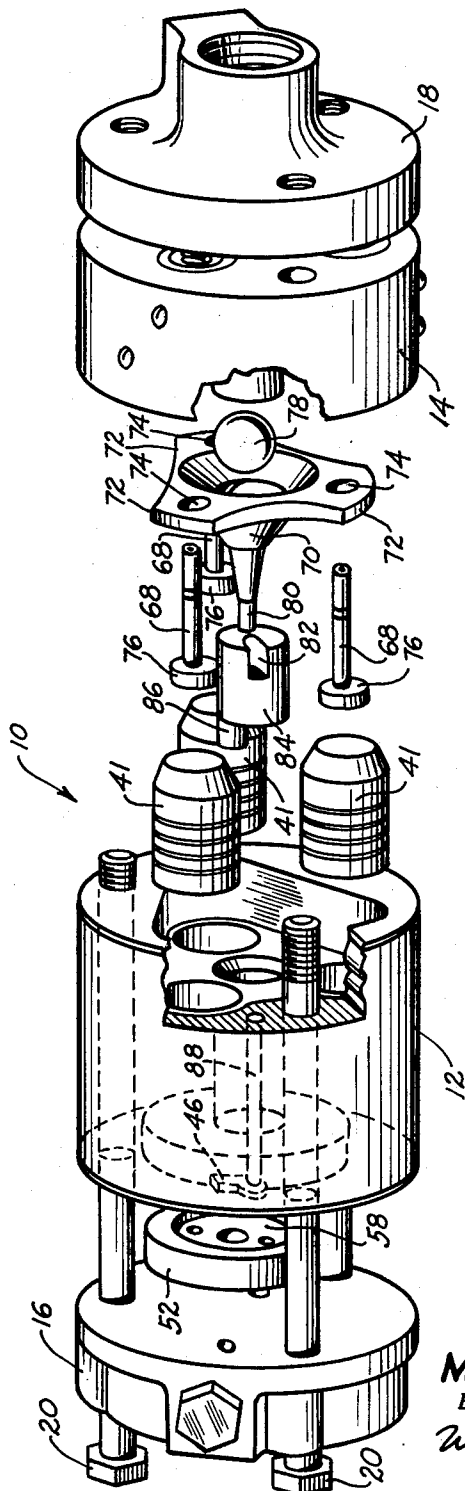
M. W. SHELTER

3,133,503

HYDRAULIC PRESSURE TRANSFORMER

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HYDRAULIC PRESSURE TRANSFORMER

Milo W. Sheler, Mishawaka, Ind., assignor to The Bendix Corporation, Mishawaka, Ind., a corporation of Delaware

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9 Claims. (Cl. 103—49)

This invention relates to a hydraulic pressure transformer and more particularly to a multiple piston hydraulic intensifier.

One of the trends in motor vehicle development is the increased use of power operated vehicle components and particularly hydraulically operated components such as power brakes and power steering. Although each power device may be provided with its own power supply system, it is readily apparent that the duplication of pumps, motors, reservoirs, etc. represents an undesirable and expensive multiplication of units.

Accordingly, it is an object of this invention to provide a hydraulic pressure transformer for use in a motor vehicle hydraulic system or any other system having hydraulic power components requiring low and/or high pressure fluid for effective operation.

Another object of this invention is to provide a hydraulic pressure transformer which will operate off of any low pressure fluid source and generate a predetermined high pressure fluid for use in connection with power components requiring such a high pressure fluid.

Another object of this invention is to provide a small efficient compact unit which combines both a low pressure prime mover and a high pressure hydraulic pump in the same package, both of which operate off of the same fluid medium.

A further object of this invention is to provide a hydraulic intensifier having a high cyclic rate, minimum vibration, small displacement per cycle and a low noise level.

A still further object of this invention is to provide an intensifier having pulsation characteristics at the high pressure discharge minimized by using three or more pistons.

Another object of this invention is to provide an intensifier which utilizes relatively simple novel valving and a minimum number of parts in order to reduce the cost thereof.

A further object of this invention is to provide a multiple piston intensifier which achieves a degree of inherent balance between the reciprocating parts to minimize vibration and wear and minimizes the number of rotating parts, close concentricities and tolerances.

More particularly, it is an object of this invention to provide a hydraulic intensifier comprising a housing having a low pressure inlet port, a return port, and a high pressure outlet port, a plurality of axially extending motor cylinders and coaxial pump cylinders located in said housing and equally spaced from each other and a central axis, a plurality of abutting motor pistons and pump pistons located in said motor cylinders and pump cylinders respectively, a gyrating disc valve for sequentially controlling flow to and from said motor pistons, a nutating member centrally located with respect to said cylinders and operatively connected to said motor pistons for controlling movement of said disc valve, and suitable passages in said housing for communicating the various ports with the motor and pump pistons.

Another object of this invention is to provide an intensifier which utilizes a nutating member to drive only a disc type face valve thereby reducing friction of the mechanism to a minimum.

The above and other objects and features of this invention will become apparent from the following description

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of the mechanism taken in connection with the accompanying drawings which form a part of this specification and in which:

FIGURE 1 is a diagrammatic view of a hydraulic system incorporating the present invention;

FIGURE 2 is a sectional view of the hydraulic intensifier embodied in the present invention which is taken along line 2—2 of FIGURE 3;

FIGURE 3 is a sectional view taken along line 3—3 of FIGURE 2;

FIGURE 4 is a sectional view taken along line 4—4 of FIGURE 2;

FIGURE 5 is a sectional view taken along line 5—5 of FIGURE 2;

FIGURE 6 is a sectional view taken along line 6—6 of FIGURE 2; and

FIGURE 7 is an exploded view of part of the mechanism shown in FIGURE 2.

Referring to the drawings it will be noted that hydraulic intensifier assembly 10 includes a motor body 12, a pump body 14, a head 16 and an endcap 18 all of which are held together by bolts 20. Located in the head 16 is a low pressure hydraulic inlet port 22 which is connected to any suitable low pressure source, such as pump 11, and a return port 24 which is suitably connected to a reservoir 13. A high pressure hydraulic outlet port 26 is located in the endcap 18 and may be suitably connected to an accumulator and/or to one or more power operated components requiring high pressure. As shown in FIGURES 1 and 2, the high pressure outlet port 26 is intended to communicate with an accumulator 15, whereas auxiliary pressure port 28, which is also located in endcap 18, is intended to communicate with a full power brake valve 17 which is controlled by brake pedal 19 for applying brakes 21 (only one of which is shown). A brake valve exhaust port 30 is located in head 16 and communicates with the return port 24 via one end of bore 32 which communicates with both the low pressure inlet port 22 and return port 24. A pressure regulating valve 34 is slidable in said bore and prevents communication between the inlet and return ports 22 and 24. The purpose of the regulating valve is to maintain a substantially constant pressure downstream thereof so that a substantially constant high pressure will be generated by the intensifier. Since the intensifier has a set intensification ratio, any variations in pressure from the low pressure source will result in proportionate variations at the high pressure outlet unless such a regulating valve is utilized. The regulating valve 34 which is of a conventional type, is seatable on a valve seat 36 formed at the end of bore 32 and operates against a spring 38.

A plurality of axially extending motor cylinders 40, each having a large diameter motor piston 41 slidable therein, are located in the motor body 12 and are equally spaced from each other and a central axis. It will be noted that the embodiment shown contains only three cylinders, but more than three may be used, if desired. A cylindrical valve chamber 42, which is also located in the motor body, communicates with the low pressure inlet port 22 via passage 31, bore 32, a drilled hole 44, and a recess 46; communicates with the return port 24 via passage 48, bore 32 and drilled hole 60; and communicates with each of the motor cylinders 40 via one of the cylinder ports 50. A gyrating face type disc valve 52, formed out of an elastomeric material such as Teflon, is located in valve chamber 42 and sealingly engages the face 54 of the valve chamber and the face 56 of the head. The annular wedge-shaped groove 58 on the periphery of the disc is provided in order to create a more effective sealing surface without being required to hold the disc to extremely close tolerances. Use of such a groove permits the fabrication of a disc having a slightly nonparallel

upper surface which is permitted to become parallel when the unit is assembled. The disc valve 52 includes a recess 59 on the upper face thereof which continually communicates with return port 24 via drilled hole 60, and a recess 62 on the lower face thereof which sequentially communicates with each of the cylinder ports 50. A pair of drilled holes 64 permit communication between the two recesses. The disc valve 52 is arranged in the valve chamber 42 so that flow from the low pressure inlet port 22 to each of said cylinder ports 50 will occur sequentially via that portion of the chamber which is bounded by the walls thereof and the periphery of the disc valve.

A plurality of axially extending pump cylinders 66, each having a small diameter pump piston 68 slidable therein, are located in the pump body 14 and are also equally spaced from each other and a central axis in the same manner as the motor cylinders 40 so that each of the pump pistons 68 will directly engage one of the motor pistons 41.

A nutating member 70 is centrally located with respect to said motor and pump cylinders 40 and 66 and is operatively connected to said motor pistons 41 to be driven thereby by a plurality of arms 72 each of which has an opening 74 therein for passage of one of the pump pistons 68 therethrough and each of which abuts a flange 76 formed at the abutting ends of the pump pistons. The nutating member 70, which is pivotable about a ball journal 78, has a projection 80 extending from the center thereof for engagement with a socket 82 formed in a shaft 84. At the other end of the shaft and ninety degrees from the socket 82 is located an eccentric journal 86 which drives the disc valve 52.

As seen in FIGURES 2 and 5, fluid from the low pressure inlet port 22 is communicated to each of the pump cylinders 66 via a common drilled passage 88, check valve chamber 90, and drilled passages 92, 94 and 96, respectively. A single check valve 98 is located at the end of drilled passage 88 and serves all three of the pump cylinders. Because of the particular arrangement of the pump pistons with respect to the induction ports (intersection of passages 66 and 92, 94 or 96), the check valve 98 will open to permit flow therethrough only on the return stroke of one of the pump pistons and never during the pumping stroke of any of the pistons. Thus, there is no lost motion or loss in efficiency and the full stroke of each piston is used for pumping. Accordingly, my particular novel arrangement eliminates the use of a separate check valve for controlling flow from a low pressure fluid source to each of the pump cylinders. Flow out of the pump cylinders to the high pressure outlet port 26 is provided via three check valves 100, one of which is located at the end of each pump cylinder, three passages 102, 104 and 106 which communicate respectively with one of the three pump cylinders and all of which communicate with a common passage 108 having a master check valve 110 at the end thereof to insure against any check valve malfunction upstream thereof.

It will be noted from FIGURES 2 and 3 that at certain times only one cylinder port 50 will be in communication with the low pressure inlet port 22 and that as one of the motor pistons 41 is pressurized and caused to move in a downward direction, such movement will cause one of the arms 72 of the nutating member to likewise move in a downward direction. This downward movement of the nutating member arm will result in a pivotal movement of the nutating member such that the other two arms will tend to be moving in an upward direction but at different stages. More particularly, relative movement between the arms will be at a 120° phase relationship. As the motor pistons 41 move up and down, the projection 80 of the nutating member will cause shaft 84 to rotate. Since the journal 86 on the shaft is eccentric, such rotation of the shaft will cause the face-type disc valve 52 to gyrate in such a way that it will permit communi-

cation between the inlet port 22 and each cylinder port 50 only in a predetermined sequential manner, and, likewise, will permit communication between each cylinder port 50 and the return port 24 only in a predetermined sequential manner. Since the phase relationship is such that the check valve 98 is never open during that portion of the pumping stroke at which any of the pump pistons 68 are moving across any of the drilled passages 92, 94 or 96, the full stroke of each piston is utilized for pumping, and maximum efficiency is achieved.

It will be understood by those skilled in the art that the disclosed embodiment achieves a multi-cylinder continuous intensifier with reciprocating elements which are balanced to each other through a nutating disc. Only a small portion of the reciprocating force is bypassed through the nutating disc to become a rotating force and drive the motor or disc valve 52. The pump pistons are valved by port and check valve induction and check valve discharge.

Furthermore, the particular embodiment which is disclosed lends itself very well to low cost and ease of production. For example, the large diameter motor pistons and small diameter pump pistons abut, but are not actually connected. Therefore, their respective bores do not require critical concentricity with respect to each other. Likewise, the nutating plate relationship to the pistons and to the valve actuating shaft is not critical and there are no expensive bearings required to absorb heavy radial or thrust loads. In addition, the unit can be small and compact for a given displacement by designing for a high cyclic rate.

While the present proposal suggests a single fluid device, suitable seals could easily be devised to isolate the pump section and permit it to handle a different fluid than that which powers the motor section. Furthermore, the hydraulic pressure transformer which is disclosed could be utilized to generate a low fluid pressure from a high pressure fluid source simply by utilizing motor pistons which are smaller in diameter than the pump pistons.

Thus, those acquainted with this art will readily understand that the invention herein set forth is not necessarily limited and restricted to the precise and exact details presented and that various changes and modifications may be resorted to without departing from the spirit of my invention. Accordingly, I do not desire to be limited to the specific details described herein, primarily for purposes of illustration, but instead desire protection falling within the scope of the appended claims.

Having thus described the various features of the invention, what I claim as new and desire to secure by Letters Patent is:

1. A hydraulic intensifier for generating a high pressure from a low pressure source comprising a housing having a low pressure hydraulic inlet port, a return port, and a high pressure hydraulic outlet port, a plurality of axially extending motor cylinders located in said housing and equally spaced from each other and a central axis, a valve chamber located in said housing, a separate cylinder port communicating said chamber with each of said motor cylinders, first passage means for communicating said inlet port with said chamber, second passage means for communicating said return port with said chamber, a gyrating disc valve located in said chamber for sequentially communicating said motor cylinders with said inlet and return ports via said cylinder ports, a movable large diameter motor piston located in each of said motor cylinders, a plurality of axially extending pump cylinders located in said housing and equally spaced from each other and a central axis, a movable small diameter pump piston located in each of said pump cylinders, each of said pump pistons being directly engaged by one of said motor pistons, a nutating member centrally located with respect to said cylinders and operatively connected to said motor pistons to be driven thereby, a shaft having an eccentric journal for driving said disc valve and ninety degrees

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therefrom a socket located at the other end thereof, a projection extending from the center of said nutating member for engagement with said socket, third passage means located in said housing for communicating said inlet port with said pump cylinders, check valve means interposed in said third passage means, fourth passage means for communicating said pump cylinders with said high pressure outlet port, and second check valve means interposed in said fourth passage means.

2. A hydraulic intensifier as defined in claim 1 wherein said disc valve includes a first recess on one face thereof for continually communicating with said return port via said second passage means, a second recess on the opposite face thereof for sequentially communicating with the cylinder ports, and passage means for communicating said first recess with said second recess.

3. A hydraulic intensifier as defined in claim 2 wherein said valve chamber is cylindrical and said disc valve is arranged so that flow from said inlet port to each of said cylinder ports occurs sequentially via a portion of the chamber bounded by the walls thereof and the periphery of said disc valve.

4. A hydraulic intensifier as defined in claim 3 wherein said disc valve is formed of an elastomeric material and includes an annular groove on the periphery thereof for providing a more effective seal between the upper and lower faces of said disc and said housing.

5. A hydraulic intensifier as defined in claim 1 wherein said nutating member is pivotable about a spherical bearing and includes a plurality of arms each of which has an opening therein for passage of one of the pump pistons therethrough.

6. A hydraulic intensifier as defined in claim 1 which includes pressure regulating valve means interposed between said inlet port and said first and third passage means.

7. A hydraulic intensifier as defined in claim 1 in which said check valve means interposed in said third passage means includes a single check valve for controlling flow to all of said pump cylinders.

8. A hydraulic intensifier as defined in claim 1 in which said second check valve means interposed in said

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fourth passage means includes two check valves in series flow relationship.

9. In a fluid system having a pressure source, a reservoir and working means, a fluid pressure transformer for generating a predetermined pressure from said pressure source comprising a housing having a fluid inlet port communicating with said pressure source, a return port communicating with said reservoir, and a fluid outlet port for transmitting said predetermined pressure to said working means, a plurality of axially extending motor cylinders located in said housing and equally spaced from each other and a central axis, a valve chamber located in said housing, a separate cylinder port communicating said chamber with each of said motor cylinders, first passage means for communicating said inlet port with said chamber, second passage means for communicating said return port with said chamber, a gyrating disc valve located in said chamber for sequentially communicating said motor cylinders with said inlet and return ports via said cylinder ports, a movable motor piston located in each of said motor cylinders, a plurality of axially extending pump cylinders located in said housing and equally spaced from each other and a central axis, a movable pump piston located in each of said pump cylinders, each of said pump pistons being directly engaged by one of said motor pistons, a nutating member centrally located with respect to said cylinders and operatively connected to said motor pistons to be driven thereby, a shaft having an eccentric journal for driving said disc valve and a socket located at the other end thereof, a projection extending from the center of said nutating member for engagement with said socket, third passage means located in said housing for communicating said inlet port with said pump cylinders, check valve means interposed in said third passage means, fourth passage means for communicating said pump cylinders with said outlet port, and second check valve means interposed in said fourth passage means.

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