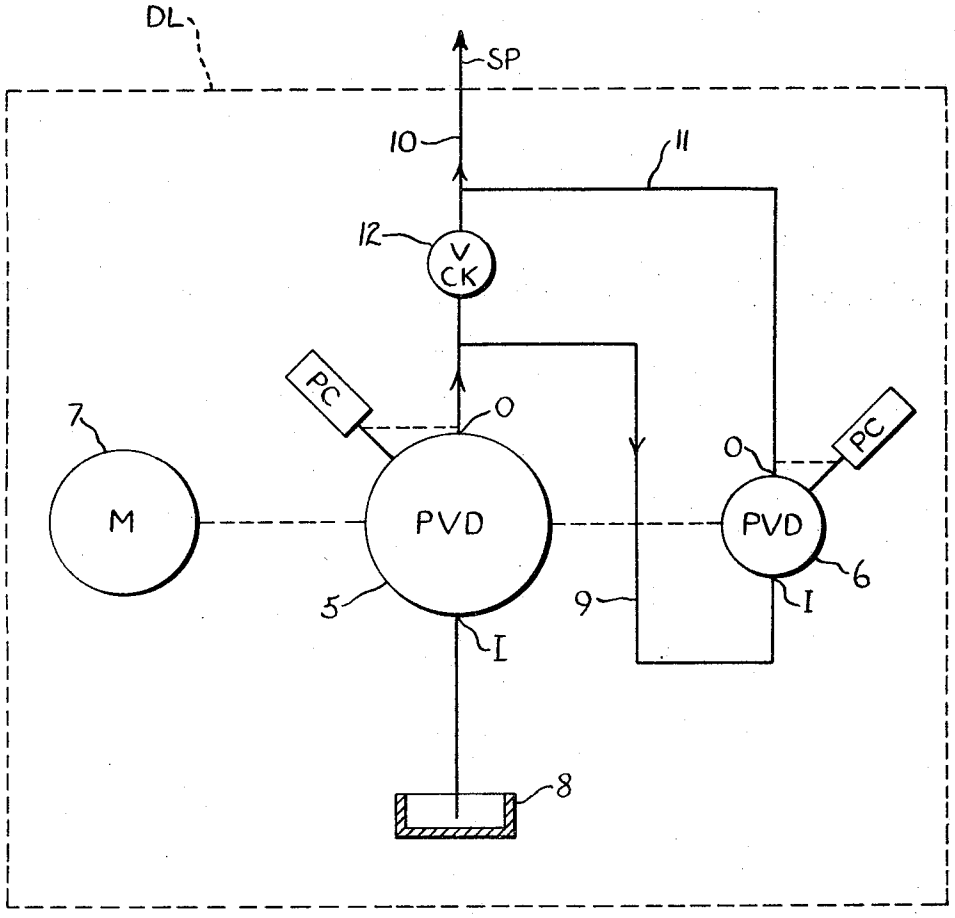
March 11, 1969 C. H. WHITMORE ET AL 3,431,856

TWO-STAGE PUMPING APPARATUS

Filed Feb. 6, 1967



Inventors
Charles H. Whitmore
Walter Ernst
By

United States Patent Office 3,431,856
Patented Mar. 11, 1969

3,431,856

TWO-STAGE PUMPING APPARATUS

Charles H. Whitmore, Burnsville, Minn., and Walter Ernst, Dayton, Ohio, assignors to Continental Machines, Inc., Savage, Minn., a corporation of Minnesota

Filed Feb. 6, 1967, Ser. No. 614,128
U.S. Cl. 103—5 1 Claim
Int. Cl. F04b 23/04, 49/08

ABSTRACT OF THE DISCLOSURE

A pair of variable displacement, pressure compensated pumps connected to provide a high volume low pressure output when the work load is below a predetermined value and for staged series operation to provide a lower volume at higher pressure when the work load is above said predetermined value.

This invention relates to pumping apparatus and refers more particularly to hydraulic pumps.

The purpose and object of the invention is to provide an improved hydraulic pumping apparatus in which a pair of pumps driven by a common drive motor are so connected that they coact to provide pressure fluid over a wide range of pressures.

More specifically, it is the purpose and object of this invention to provide a pumping apparatus in which a pair of pressure compensated variable displacement pumps are driven by a common electric motor, and so connected that the pumps operate to deliver pressure fluid at high volume up to a predetermined pressure, and, above that pressure, they operate in series with the entire output of the first pump being staged into the second pump, so that the pressure that can be maintained by the apparauts of this invention exceeds the pressure obtainable with a single pump of a capacity comparable to that of the pumps used in the apparatus.

The single figure is a diagrammatic illustration of a pumping apparatus embodying this invention.

The pumping apparatus of this invention, as shown in the accompanying drawing, comprises first and second pressure compensated variable displacement pumps **5** and **6**, respectively, connected in tandem and driven by a single prime mover, preferably an electric motor **7**.

In pressure compensated variable displacement pumps, the pressure at which the pump delivers fluid usually remains substantially constant, though the volume of the delivered fluid may vary from zero displacement to the maximum for which the pump is designed. Although any suitable pressure compensated variable displacement pump may be employed, and there are several upon the market, it is preferred to use pumps of the sliding vane type—as shown for instance in Patent No. 3,252,423, issued May 24, 1966, to Continental Machines, Inc. In such sliding vane type pumps, the individual vanes—which are mounted in the rotor of the pump—ride on the inside surface of a pressure ring that encircles the rotor and is arranged to shift towards and from concentricity with the rotor axis. When this pressure ring is in its position of maximum eccentricity, the volumetric output of the pump is greatest, and as the pressure ring approaches concentricity with the pump rotor, the volumetric output decreases proportionately.

The location of the pressure ring with respect to the rotor axis depends upon the relationship between two opposing forces that act upon the ring. One of these forces is obtained from a spring which tends to shift the ring to its position of maximum eccentricity, the other is the fluid pressure developed by the pump. The volume of the fluid delivered is thus automatically adjusted to

the requirements of the system supplied by the pump; but the manner in which these pressure compensated variable displacement pumps operate is well known to those skilled in the art and really needs no explanation, especially since reference may be had to the aforesaid patent for a full description thereof.

To return to the description of the instant invention, each of the two pumps has an inlet and an outlet, respectively designated I and O on the accompanying drawing. The inlet of the first pump **5** is connected to a reservoir or other suitable source of fluid **8**, and a supply passage or line **9** communicates the inlet of the second pump **6** with the outlet of the first pump. This supply line or passage provides the sole means of delivering fluid to the second pump.

The outlets of both pumps are communicated with a service port SP. For the first pump **5**, the communication between its outlet and the service port is provided by a duct **10**, and for the second pump a duct **11** leads from the outlet of the pump, either directly to the service port or to the duct **10** at a point somewhere upstream of the service port.

A check valve **12** is connected in the duct **10**. This check valve is arranged to be open as long as the pressure at the outlet of the first pump exceeds the pressure at the service port, but closes whenever the reverse condition obtains. If, as indicated in the diagrammatic illustration, the duct **11** from the outlet of the second pump connects with the duct **10**, the check valve **12** must be at a location in the duct **10** upstream from its connection with the duct **11**.

Quite obviously, the displacement of the second pump should not exceed that of the first pump, for otherwise the second pump would tend to cavitate, and while substantial advantages are gained by using pumps of substantially the same rated capacity, it is preferable to have the first pump of considerably or substantially larger capacity than the second. In an actual embodiment of the invention, the first pump was rated at thirty gallons per minute at 1000 p.s.i., while the second pump was rated at six gallons per minute at 1000 p.s.i. With the pumps of such different displacements, it is possible to deliver high volume at low pressure and low volume at much higher pressure.

As will be understood by those skilled in the art, the two pumps can have a common casing or housing structure and, if desired, the entire apparatus can be built into a single manifold structure, which for purposes of illustration is represented by the dotted line DL encompassing the diagrammatically illustrated apparatus.

Operation

With the prime mover **7** in operation, both pumps are of course running. The first pump draws fluid from the reservoir or other source of supply **8** and delivers it through the service port SP to whatever fluid pressure actuatable device or system may be connected therewith, and also to the inlet of the second pump through the supply passage **9**. This situation obtains as long as the pressure at the outlet of the first pump exceeds the pressure at the service port, since at this time the check valve **12** is open.

Assuming that both pumps are set to deliver 1000 p.s.i., as long as the pressure requirements manifested at the service port are less than 1000 p.s.i., the output of the first pump will be sufficient to meet the requirements of the load, with the result that the second pump, for all practical purposes, will be coasting and relatively free from wear. Also, it should be noted that the volume of the fluid delivered to the service port at this time can reach thirty gallons per minute, which is the maximum volumetric displacement of the first pump.

However, as soon as the pressure demands manifested at the service port exceed 1000 p.s.i.—the maximum pressure that can be maintained at the output of the first pump **5**—the check valve **12** closes and the entire output of the first pump is delivered by the passage means **9** to the second pump.

Obviously, when the check valve closes, the volumetric displacement of the complete apparatus cannot exceed the displacement of the second pump, which for purposes of illustration is six gallons per minute. But now, the entire output of the first pump is being staged into the second pump, with the result that the maximum pressure that can be delivered to the device or system connected to the service port can rise to 2000 p.s.i., 1000 p.s.i. being supplied by the first pump and the second 1000 being supplied by the second pump.

From the foregoing description, taken in connection with the accompanying drawing, it will be apparent to those skilled in this art that this invention produces a pumping apparatus which possesses many advantages over prior hydraulic pumps and that, through this invention, demands for high pressures can be met far more economically than by the conventional method of designing a single pump with sufficient capacity to supply the entire demand.

What is claimed as our invention is:

1. Pumping apparatus having a service port connectible with a fluid pressure actuatable device and operable to deliver pressure fluid through its service port either at high volume and low pressure or low volume and higher pressure, said apparatus comprising the combination of:

(A) first and second pressure compensated variable displacement pumps connected to be driven in unison and each having an inlet and an outlet,

the displacement of the first pump being greater than that of the second pump; and

(B) passage defining means by which the entire output of the first pump is compelled to flow to the service port, said passage defining means comprising

(1) first duct means connecting the outlet of the first pump with the service port,

(2) a check valve in said first duct means arranged to open in response to pressure at the outlet of the first pump in excess of that obtaining at the service port,

(3) second duct means connecting the inlet of the second pump with the outlet of the first pump and with said first duct means upstream of the check valve,

said second duct means providing the sole means of supplying fluid to the second pump, so that said pumps are at all times connected in series, and

(4) third duct means connecting the outlet of the second pump with the service port and with the first duct means downstream of the check valve,

whereby said first duct means can deliver to the service port at the pressure developed by the first pump all or part of the output of the first pump, and said second and third duct means, being communicated through the second pump, can deliver to the service port at the pressure developed by the first pump any balance of the output of the first pump or deliver to the service port at a pressure in excess of that developed by the first pump the entire output of the first pump.

References Cited

UNITED STATES PATENTS

2,146,037	2/1939	Wahlmark	103—5 X
2,377,556	6/1945	Jeannin	103—10
2,655,109	10/1953	Walker	103—10 X
2,957,419	10/1960	Michel.	
2,965,036	12/1960	Wood	103—10
3,053,186	9/1962	Gondek	103—5
3,080,819	3/1963	Mayes	103—10

DONLEY J. STOCKING, *Primary Examiner.*

W. J. KRAUSS, *Assistant Examiner.*

U.S. Cl. X.R.

103—11; 230—45