

June 17, 1952

H. C. FRENCH

2,600,632

VARIABLE CAPACITY VANE-TYPE ROTARY PUMP, INCLUDING AUTOMATIC
MEANS FOR MAINTAINING UNIFORM DELIVERY

Filed Nov. 14, 1945

2 SHEETS—SHEET 1

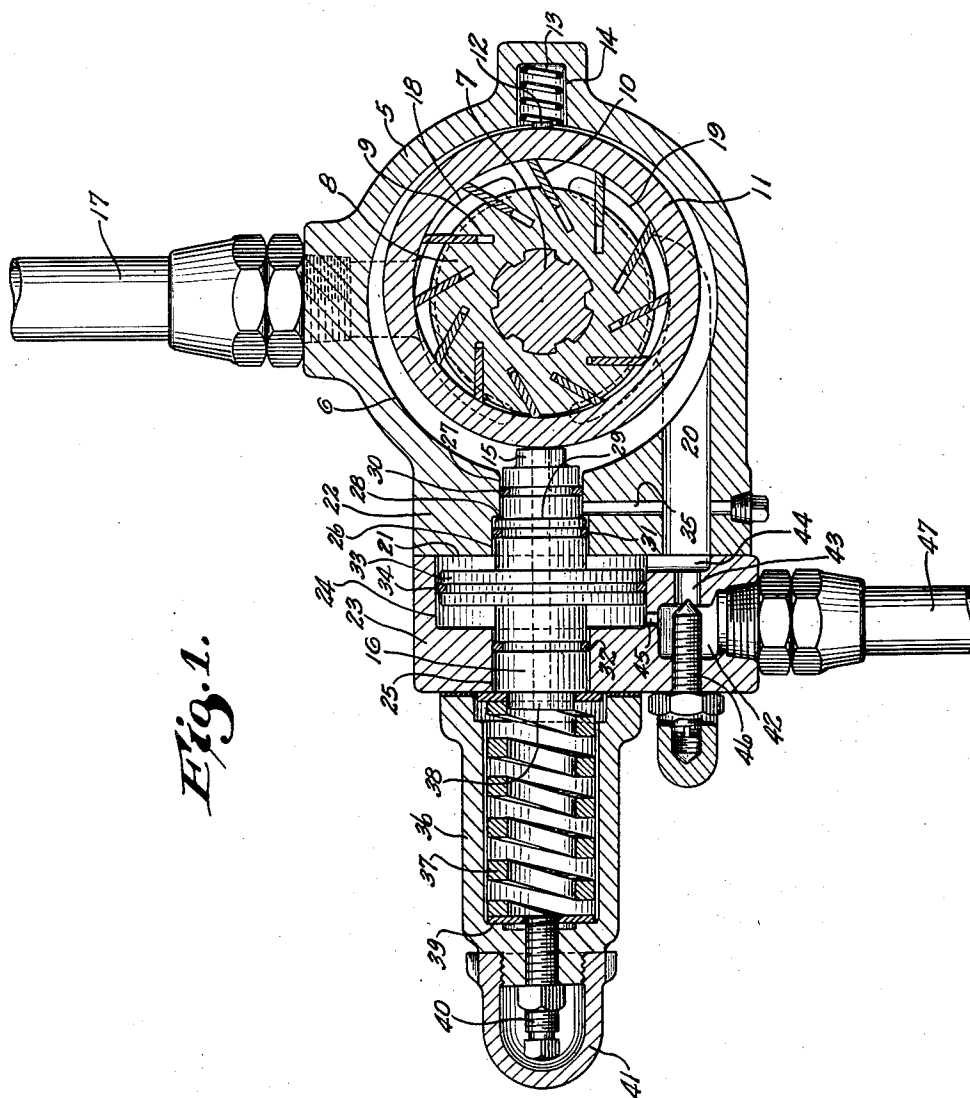


Fig. 1.

INVENTOR.

Henry C. French

BY

Morsell Morsell

ATTORNEYS.

June 17, 1952

H. C. FRENCH

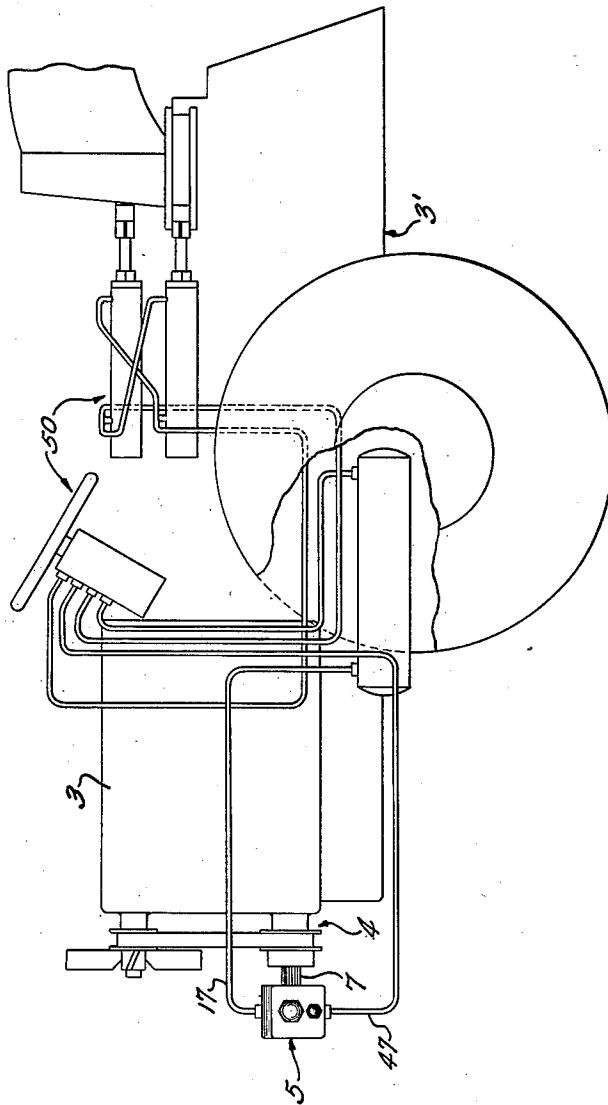
2,600,632

VARIABLE CAPACITY VANE-TYPE ROTARY PUMP, INCLUDING AUTOMATIC
MEANS FOR MAINTAINING UNIFORM DELIVERY

Filed Nov. 14, 1945

2 SHEETS—SHEET 2

Fig. 2.



INVENTOR.

Henry C. French

BY

Monell Monell
ATTORNEYS.

UNITED STATES PATENT OFFICE

2,600,632

VARIABLE CAPACITY VANE-TYPE ROTARY
PUMP INCLUDING AUTOMATIC MEANS
FOR MAINTAINING UNIFORM DELIVERYHenry C. French, Elm Grove, Wis., assignor to
The Heil Co., Milwaukee, Wis., a corporation of
Wisconsin

Application November 14, 1945, Serial No. 628,435

6 Claims. (Cl. 103—120)

1

This invention relates to improvements in vane pumps.

Vane type pumps, when driven by a variable speed engine, are objectionable in a number of situations because of the fact that variations in the speed of operation of the engine will cause the volume of liquid delivered per unit of time to vary in accord and with the speed of the engine. When this type of pump is used in an hydraulic steering system this objectionable feature is particularly noticeable. The pump is, of course, driven by the same engine which propels the vehicle and must be capable of furnishing suitable hydraulic power for steering regardless of the speed at which the vehicle is being driven, as steering must be done at all speeds. If a tractor is proceeding at very slow speed the volume of oil delivered by the pump for steering purposes may be entirely insufficient to cause steering. On the other hand, for certain uses, a vane type of pump may deliver too great a volume of fluid when the propelling engine is being driven at a high speed.

Vane pumps of the type with which the present invention is concerned are, however, generally desirable for use in hydraulic systems and it is, therefore, a general object of the present invention to provide a structure of the class described having means whereby a substantially constant volume of hydraulic fluid per unit of time is delivered into the pressure line regardless of the speed of the propelling engine or other prime mover.

It is a more specific object of the present invention to provide in a pump of the class described having a rotor formed with floating vanes and having a regulating ring around the vanes, means including a spring urged plunger for normally maintaining the regulating ring in a maximum position of eccentricity with respect to the rotor, and a piston on said plunger so positioned as to have one side acted upon by the pressure of fluid immediately after it leaves the rotor and the other side acted upon by the pressure of fluid as this pressure exists in the pressure line, after it has passed through a restricted orifice of a metering valve. The piston thus forms a differential control which is responsive to changes in speed of the pump driving engine to cause a substantially constant volume of hydraulic fluid per unit of time to be delivered into the pressure line regardless of the speed of the vehicle engine and regardless of the pressure demand.

A further object of the invention is to provide a structure as above described in which the

2

differential control feature may have mechanism in common with and be employed in conjunction with a positive cut-off means for entirely stopping delivery from the pump in case of abnormal pressure conditions. The use of positive cut-off means acting on the pump itself is an improvement over the use of an ordinary relief valve in the hydraulic circuit. Where the latter is employed where there is a stoppage in the pressure line the pump continues to operate and the oil overheats.

With the above and other objects in view, the invention consists of the improved vane pump and all its parts and combinations, as set forth in the claims and all equivalents thereof.

In the accompanying drawing illustrating one complete embodiment of the preferred form of the invention:

Fig. 1 is a longitudinal sectional view through the pump casing, fragments of the suction and pressure lines being illustrated in outside view; and Fig. 2 is a diagrammatic view in side elevation showing the pump applied to the hydraulic steering system of a vehicle.

Referring more particularly to the drawing, the numeral 5 designates a main casing portion having a cylindrical pump chamber 6 therein. A drive shaft 7 extends axially of the chamber 6 and its ends are suitably journaled in opposite ends of the casing 5. One end of the shaft 7 projects externally of the casing and may be driven by any suitable source, such as a power take-off 4 from the combustion engine 3 of a vehicle 3'. Rotatable with the shaft 7 and positioned within the chamber 6 is a rotor 8 having its periphery concentric with the wall of the chamber 6.

The periphery of the rotor is formed with angled transversely extending slots 9 for slidably receiving vanes 10 as is customary in a vane type of pump. Surrounding the outer ends of the vanes is a regulating ring 11, the internal diameter of which is substantially greater than the external diameter of the rotor 8. The ring 11 is a floating ring and in the claims the term "floating ring" means a ring which is free of attachment with the housing.

The periphery of the regulating ring is provided with a projection 12 which is surrounded by one end of a coil spring 13. The spring is seated in a spring pocket 14 in the casing 5. The spring 13 provides for cushioning of the regulating ring on one side thereof and the arrangement prevents rotating movement of the ring.

3

Opposite the spring 13 the regulating ring is engaged by the inner end 15 of a plunger 16.

Oil drawn into the pump through the suction line 17 enters an end of the chamber 6 through an arcuate opening 18. This opening is arranged to direct the oil into the space between the rotor and regulating ring and between the vanes as is customary. At the opposite side of the rotor from the intake opening 18 is an arcuate discharge opening 19 which communicates with an outlet duct 20 in the casing.

Connected to the face 21 of a projection 22 from the main casing portion 5 is the end of an auxiliary casing 23. The auxiliary casing has a cylindrical pressure chamber 24 therein which communicates with the inner end of the auxiliary casing. A bore 25 connects the opposite end of the auxiliary casing with the cylindrical chamber 24. The extension portion 22 of the main casing 5 is formed with a bore 26 which communicates with the cylindrical chamber 24 and which is in alignment with the bore 25. There is also a counter-bore 27 connecting the bore 26 with the pump chamber 6 and there is an annular shoulder 28 between the bore 26 and the counter-bore 27. The plunger 16 is slidably mounted in the bore portions 25, 26 and 27 and is provided with an annular shoulder 29 which coacts with the bore shoulder 28 to limit inward movement of the plunger. The plunger is equipped with piston rings 30, 31 and 32. The shoulder 29 forms what will be termed a small piston. Rigidly connected to the plunger and positioned within the chamber 24 is a large piston 33 having a piston ring 34 therearound. While all of the piston rings fit snugly in their respective bores or chambers, there is substantial clearance between the periphery of the plunger and the bore portions 25, 26 and 27. A relief duct 35 connects the outlet duct 20 from the pump with the clearance space around the plunger and between the rings 30 and 31.

Connected to the auxiliary casing portion 23 and projecting laterally therefrom is a cup 36 accommodating a spring 37. The inner end of the spring surrounds a knob 38 projecting from the outer end of the plunger 16 and serves to normally urge the plunger to the innermost position, as illustrated. The other end of the spring is engaged by a disk 39 which is connected to the inner end of an adjustment screw 40. A threaded cap 41 normally covers the projecting end of the adjustment screw. It is apparent that manipulation of the screw 40 will vary the tension exerted by the spring on the plunger 16.

Below the piston chamber 24 in the auxiliary casing 23 is a reduced pressure fluid chamber 42 which is connected by an orifice 43 of a metering valve with a transverse duct 44 and with the discharge duct 20 of the main casing. The transverse duct 44 communicates with the piston chamber 24 on one side of the piston 33. A duct 45 connects the chamber 42 with the chamber 24 on the other side of the piston 33.

Threaded into the auxiliary casing 23 is a metering screw 46 which projects through the chamber 42 and has a conical valve end which cooperates with the orifice 43 to adjustably regulate the volume of fluid delivered per unit of time by the pump into the chamber 42 and into the pressure line 47 leading from the chamber 42.

In use of the pump and with the rotor 8 in operation, and with the regulating ring positioned as illustrated, oil or other hydraulic fluid will be drawn into the pump through the intake 18

4

and will be delivered into the outlet duct 20. During normal operation the spring 37 will maintain the regulating ring in the eccentric condition illustrated so that there will be a maximum delivery from the pump. If, however, abnormal pressures develop in the pressure line or parts connected therewith, this pressure will act through fluid in the duct 35 to urge the small piston forming portion of the plunger 16 toward the left against the tension of the spring and cut off the delivery of oil. This relief feature is not claimed to be new by itself.

Where the pump is to be used in an hydraulic steering system 50 of the vehicle 3' the parts are so proportioned and the spring 37 is so adjusted by the screw 40 that the tension of the spring 37 will resist a pressure of up to 500 pounds per square inch acting toward the spring 37 in the clearance space between the rings 31 and 30 and will resist a pressure of up to 30 pounds per square inch acting on the right hand side of the piston 33.

The metering valve screw 46 is set to permit flow into the pressure line 47 of a selected volume per unit of time according to the particular requirements. In the example which follows the valve is set to permit a flow of all of the oil that can be moved when the differential in pressure between the pressure in the duct 20 and in the chamber 42 does not exceed 30 pounds.

Assuming that there is 230 pounds per square inch pressure in the duct 20, and 200 pounds per square inch pressure in the chamber 42 and pressure line 47, which differential in pressure is due to the continuous outflow through 47 coupled with the inability of the orifice 43 to allow more than a predetermined amount to pass into the line 47 per unit of time, the novel features of the present invention will prevent this pressure differential from substantially exceeding 30 pounds regardless of the speed at which the rotor 8 is being driven. When the rotor is being driven at relatively slow speed the regulating ring 11 will be maintained in the maximum eccentric position, as illustrated. If the speed of the rotor increases, however, the excess pressure in the duct 20, due to the restriction of the orifice 43, will act through the transverse duct 44 and on the right hand side of the piston 33 to move the piston 33 and plunger 16 toward the left against the tension of the coil spring 37. This movement toward the left, however, is always counteracted by the pressure of the oil which has entered the piston chamber 24 on the left hand side of the piston 33 through the port 45. This pressure acting on the left hand face of the piston 33 will be the pressure existing in the pressure line 47. This counteracting pressure acting on the left hand face of the piston 33 permits movement of the piston toward the left only a distance which is in direct proportion to the difference in the pressures between that existing in the duct 20 and that existing in the chamber 42. The net result will be a small movement of the piston 33 toward the left to permit movement of the regulating ring 11 to a less eccentric position and cause a decrease in the pumping action and decrease in the volume of oil flowing from the pump through the metering valve orifice 43. It is thus apparent that the differential piston 33 will act to always maintain a desired pressure differential between the duct 20 and pressure line 47. This, therefore, results in the delivery of a substantially constant volume by the pump regardless of the speed of the engine 3 which is driving the rotor 8.

When there is an abnormal pressure condition, such as would result from a stoppage in the line 47, then the pressures on the two sides of the piston 33 will be equal. However, as the rotor is continuing to rotate, pressure is built up in the duct 20. Inasmuch as no more oil can pass out of the line 47 this increased pressure will be transmitted through the ducts 44 and 45 equally to both sides of the piston 33. However, this increased pressure is also acting on the small piston-forming shoulder 29 to cause a net movement toward the left. This permits the regulating ring 11 to move to a concentric position and completely stop the delivery of oil.

Various changes and modifications may be made without departing from the spirit of the invention, and all of such changes are contemplated as may come within the scope of the claims.

What I claim is:

1. In a vane pump having a casing, having a rotor in said casing provided with movable vanes projecting from its periphery, having a regulating ring within said casing normally eccentrically surrounding said rotor and having its inner periphery engaged by the outer ends of said vanes whereby the regulating ring together with portions of the rotor form a work chamber, and having a discharge duct leading from said work chamber, there being a metering orifice of restricted size interposed in said discharge duct, spring means for biasing said regulating ring toward a concentric position with respect to said rotor, means engaging said regulating ring and including a piston of relatively large size and a relatively small piston, said relatively large piston being responsive to changes in the pressure differential between the discharge duct on the two sides of said metering orifice for causing said pump to deliver a substantially constant volume of fluid regardless of variations in the driven speed of said pump, and said small piston being constantly responsive to abnormal fluid pressure conditions in said discharge duct to stop delivery from the pump.

2. In a vane pump, a casing having a pump chamber, a rotor rotatable in said pump chamber; movable vanes projecting from the periphery of said rotor; a floating regulating ring within said casing surrounding said vanes and having its inner periphery engaged by the outer ends of said vanes whereby the regulating ring together with portions of said rotor form a work chamber, said casing having a bore communicating with said pump chamber, a plunger slidable in said bore and having an inner end engageable with a peripheral portion of the regulating ring, resilient means acting on said plunger to normally urge the regulating ring in one radial direction to a position of maximum eccentricity with respect to said rotor, means urging said regulating ring in the opposite radial direction to the direction in which it is urged by said plunger, a piston on said plunger, there being a piston chamber in said casing within which said piston is movable, said work chamber having a discharge duct leading therefrom and including a metering orifice, and there being means on one side of said metering orifice affording constant direct communication between said discharge duct and said piston chamber on one side of the piston, and there being means on the other side of said metering orifice affording constant direct communication between said discharge duct and said piston chamber on the other side of said piston.

3. In a vane pump, a casing having a pump chamber, a rotor rotatable in said pump chamber, movable vanes projecting from the periphery of said rotor, a floating regulating ring within said casing surrounding said vanes and having its inner periphery engaged by the outer ends of said vanes whereby the regulating ring together with portions of said rotor form a work chamber, said casing having a bore communicating with said pump chamber, a plunger slidable in said bore and having an inner end engageable with a peripheral portion of the regulating ring, resilient means acting on said plunger to normally urge the regulating ring in one radial direction to a position of maximum eccentricity with respect to said rotor, means urging said regulating ring in the opposite radial direction to the direction in which it is urged by said plunger, a piston on said plunger, there being a piston chamber in said casing within which said piston is movable, said work chamber having a discharge duct leading therefrom and including a metering orifice, and there being means on one side of said metering orifice affording communication between said discharge duct and said piston chamber on one side of the piston, and there being means on the other side of said metering orifice affording communication with said piston chamber on the other side of said piston, the communication afforded by said last two means being simultaneous.

4. In a vane pump, a casing having a pump chamber, a rotor rotatable in said pump chamber, movable vanes projecting from the periphery of said rotor, a regulating ring surrounding said vanes and having its inner periphery engaged by the outer ends of said vanes whereby the regulating ring together with portions of said rotor form a work chamber, said casing having a bore communicating with said pump chamber, a plunger slidable in said bore and having an inner end engageable with a peripheral portion of the regulating ring, resilient means acting on said plunger to normally urge the regulating ring in one radial direction to a position of maximum eccentricity with respect to said rotor, means urging said regulating ring in the opposite radial direction to the direction in which it is urged by said plunger, a relatively large piston on said plunger and a relatively small piston also on said plunger, there being piston chambers in said pump casing within which said pistons are movable, said work chamber having a discharge duct leading therefrom and including a metering orifice, there being a first passageway on the pump side of said metering orifice affording constant communication between said discharge duct and said large piston chamber on one side of said piston, and there being a second passageway on the same side of said metering orifice affording constant communication between said discharge duct and the chamber for the small piston, and there also being a passageway on the other side of the metering orifice affording constant communication between said discharge duct and the large piston chamber on the opposite side of the large piston.

5. In a vane pump, a casing having a pump chamber, a rotor rotatable in said pump chamber, movable vanes projecting from the periphery of said rotor, a regulating ring within said casing surrounding said vanes and having its inner periphery engaged by the outer ends of said vanes whereby the regulating ring together with portions of said rotor form a work chamber, said

7

casing having a bore communicating with said pump chamber, a plunger slidable in said bore and having an inner end engageable with a peripheral portion of the regulating ring, resilient means acting on said plunger to normally urge the regulating ring in one radial direction to a position of maximum eccentricity with respect to said rotor, means urging said regulating ring in the opposite radial direction to the direction in which it is urged by said plunger, a relatively large piston on said plunger and a relatively small piston also on said plunger, there being piston chambers in said pump casing within which said pistons are movable, said work chamber having a discharge duct leading therefrom and including a metering orifice, an adjustable valve for regulating the discharge from said metering orifice, there being a first passageway on the pump side of said metering orifice affording constant communication between said discharge duct and said large piston chamber on one side of said piston, and there being a second passageway on the same side of said metering orifice affording constant communication between said discharge duct and the chamber for the small piston, and there also being a passageway on the other side of the metering orifice affording constant communication between said discharge duct and the large piston chamber on the opposite side of the large piston.

6. In a vane pump having a casing, having a rotor in said casing provided with movable vanes projecting from its periphery, having a floating regulating ring within said casing normally eccentrically surrounding said rotor and having its inner periphery engaged by the outer ends of said vanes whereby the regulating ring

8

together with portions of the rotor form a work chamber, and having a discharge duct leading from said work chamber, there being a metering orifice of restricted size interposed in said discharge duct in said casing, means for driving said pump at variable speeds, spring means for biasing said regulating ring toward a concentric position with respect to said rotor, and control means for said floating regulating ring including a member in said casing movably engaging a peripheral portion of said regulating ring to cause floating movement of the latter, said member having piston mechanism thereon including two opposed piston faces simultaneously in communication with said discharge duct on both sides of said metering orifice whereby said member is responsive to changes in the pressure differential between the duct portions on the two sides of said metering orifice.

HENRY C. FRENCH.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,467,208	Sumner	Sept. 4, 1923
1,914,267	Leupold	June 13, 1933
2,033,920	Centervall	Mar. 17, 1936
2,062,310	Hittell	Dec. 1, 1936
2,142,275	Lane	Jan. 3, 1939
2,238,061	Kendrick	Apr. 15, 1941
2,302,922	Tucker	Nov. 24, 1942
2,318,292	Chandler	May 4, 1943
2,322,568	De Lancey	June 22, 1943
2,407,013	Ifield	Sept. 3, 1946