Jan. 20, 1925. 1,523,707

C. E. NAGEL

PUMP

Filed May 31, 1923 2 Sheets-Sheet 1

Fig. 1.

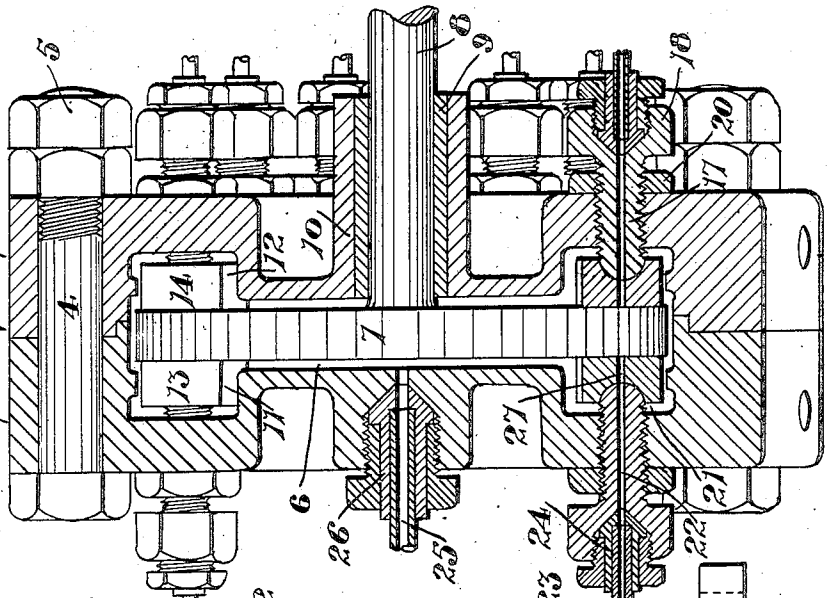
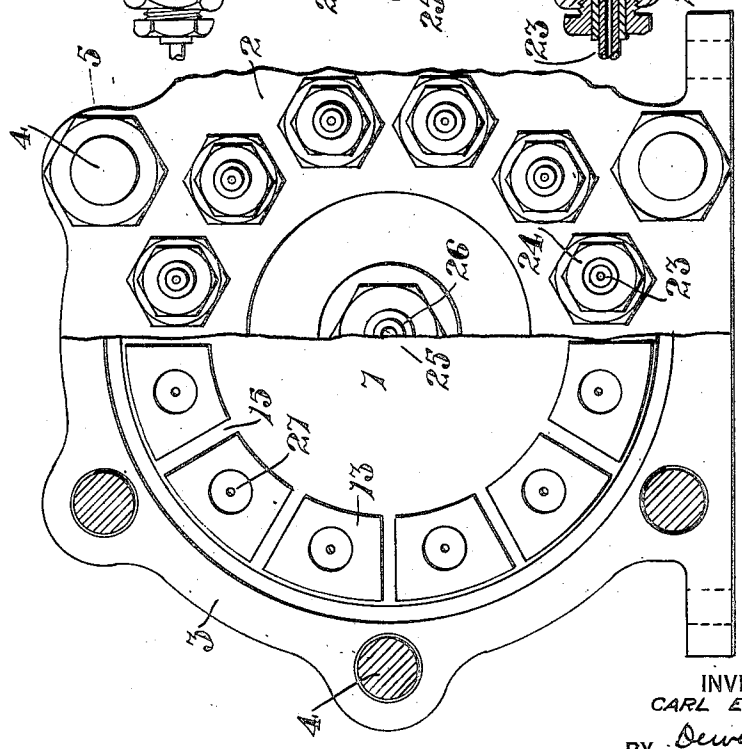


Fig. 2.



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Fig. 3

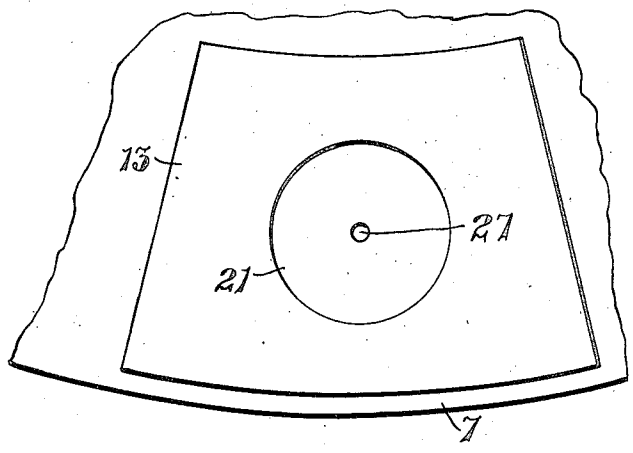
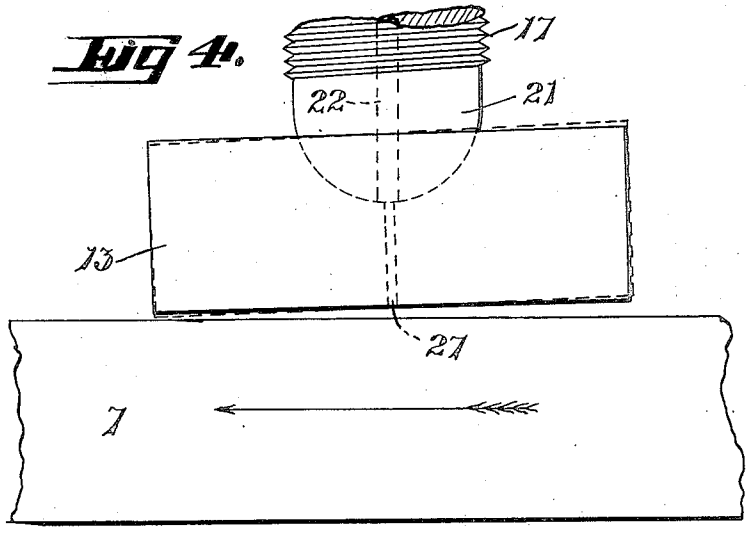


Fig 4.



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1,523,707

UNITED STATES PATENT OFFICE.

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PUMP.

Application filed May 31, 1923. Serial No. 642,412.

To all whom it may concern:

Be it known that I, CARL E. NAGEL, a citizen of the United States, residing at Oakland, county of Alameda, and State of California, have invented new and useful Improvements in a Pump, of which the following is a specification.

This invention relates to a pump and especially to that type which depends upon the viscosity of an oil or other fluid film for its operation.

Fuel pumps at present employed for the purpose of supplying fuel oil under high pressure to the fuel valve or nozzle of a Diesel engine, especially such engines as employ solid or mechanical injection are usually of the variable displacement type. Such pumps require expensive workmanship on the fitting of the plungers, valves, etc., as the pressures employed often exceed 4,000 pounds per square inch.

In the usual fuel system the pump delivery is not exactly timed to coincide with the opening of the fuel valves and various storage systems are, therefore, required as, for instance, an air dome in which the entrapped air is highly compressed when the fuel pump delivers its charge; this air being permitted to expand and force the fuel out of the line when the fuel valve lifts. Devices are also necessary in fuel systems of this character, such as spring loaded plungers which operate in a cylinder to uncover a port in the side of the cylinder, thereby by-passing any excess fuel delivered by the pump and returning it to the supply line; such a spring loaded plunger also preventing the building up of excess or dangerous pressures.

The governors employed on Diesel engines are generally of the centrifugal type and are usually connected with the part to be operated by means of a number of links, levers, etc. Such governors are generally sluggish in operation and permit considerable speed variations before they operate; this being due to the friction encountered in the levers and links and the lost motion due to wear.

The object of the present invention is to generally improve and simplify the construction and operation of pumps of the rotating type which depend upon the viscosity of an oil or like fluid film for its operation; to provide a pump of this character which will have a sufficient capacity to serve as a fuel feed pump on Diesel engines; a pump whereby high pressures may be obtained; a pump which will also serve as a governor actuating mechanism, and furthermore a pump which will entirely eliminate the use of variable displacement plunger pumps, storage systems, spring loaded return or by-pass valves, etc. Other objects will hereinafter appear.

One form which my invention may assume is exemplified in the following description and illustrated in the accompanying drawings, in which—

Fig. 1 is a central, vertical, longitudinal section of the pump.

Fig. 2 is a side elevation partly broken away, said figure also showing one-half of the pump cover removed.

Fig. 3 is an enlarged detail plan view of one of the shoes.

Fig. 4 is a side elevation of the same.

Referring to the drawings in detail, and particularly to Figs. 1 and 2, A indicates in general a pump casing which in this instance is divided into two sections such as indicated at 2 and 3; these sections being secured together by means of bolts and nuts as indicated at 4 and 5. Formed between the two pump casing sections indicated at 2 and 3 is a central chamber 6, and mounted in said chamber is a disk or rotor 7 which is secured on a driving shaft 8, the shaft 8 being journaled as at 9 in a bearing member 10 forming a portion of the casing section 3. The central chamber 6 is circular in formation and its peripheral portion is enlarged on each side of the rotor 7 to form a pair of communicating annular chambers 11 and 12. Disposed in the chamber 11 are a plurality of shoes 13 and similarly disposed in the chamber 12 are a plurality of shoes 14; these shoes being interspaced as shown at 15, in Fig. 2, and being held in what may be termed frictional engagement with the opposite faces of the rotor 7 by means of pins 16. These pins are supported by the respective pump casing sections 2 and 3 and extend therethrough, each pin being threaded as at 17 and being provided with a hexagonal head or nut 18 and a locknut 20. Each pin is rounded at the inner end to form, together with each respective shoe, a ball and socket bearing as indicated at 21. The pins are furthermore provided with central discharge passages 22 and the outer end of each

pin is connected with a discharge pipe 23 by means of suitable couplings such as indicated at 24; the pipes 23 being all connected with a common manifold not here shown.

The fuel oil to be pumped and discharged under pressure is delivered from a suitable source through a pipe 25, which is connected with the center portion of the casing 2 by means of a coupling 26. The oil thus entered is discharged by centrifugal force against the shoes 13 and 14, which, due to the viscosity and the adhesive quality of the oil, is forced between the shoes 13 and 14 and the rotor in the form of a film, a portion of this film being continuously discharged through ports 27 formed in the respective shoes which align with the ball and socket bearings 21 and the discharge passages 22 and pipes 23.

It should be remembered that the pump forming the subject matter of the present application depends upon the viscosity of an oil or like fluid film for its operations; therefore, to clearly explain the principle of operation the following facts might be stated:

When one flat surface, for instance, the inner face of the shoe 13 illustrated in Fig. 4, is pressed directly against another flat surface, for instance, the side of the rotor 7, (see the same figure), and if it is assumed that the side of the rotor or flat surface is covered with oil, the oil film between the two surfaces will be squeezed out. On the other hand, if movement is imparted to one flat surface or, in other words, the rotor, the two faces when free to move with relation to each other will assume an inclined position as illustrated in Fig. 4 and thereby become separated by a wedge-shaped film of oil. The film thickness increases with the viscosity of the oil and the speed of the rotor, but experience has shown that no low speed or high speed limits can be reached. Furthermore, that the pressure on the film between the shoe and the rotor varies from nothing or zero at the edges of the shoes and reaches a maximum about centrally of the shoe or at a point in alignment with the discharge port 27. If it is desired to discharge oil under high pressure, it is only necessary to increase the speed. Assuming that the viscosity of the oil remains constant and if it is desired to discharge the oil under lower pressure, it is only necessary to lower the speed.

To further illustrate the operation we will first consider the action when no oil is drawn off through the ports 27 and when the rotor is turning very slowly. In this case only a small amount of oil is carried under the shoes by the rotor and very little pressure is generated under the shoes, it being furthermore found that there is only a slight tendency to force the oil out at the side edges of the shoe. If this is the case the film of oil formed will, practically speaking, assume a uniform thickness from end to end of the shoe.

We will next consider an increase in speed. If this is the case the amount of oil carried by cohesion becomes greater and the leading edge of the shoe is thereby slightly lifted and a wedge shaped film is formed as shown in Fig. 4. Tilting of the shoe with relation to its stationary support causes pressure to be generated in the oil film and this pressure forces a part of the oil out under the side edges of the shoes and if we assume that the speed and pressure generated are such that one-fourth of the oil entering under the leading edge is squeezed out at the sides, then the thickness of the film of oil under the trailing edge will be three-quarters that of the film thickness under the entering edge.

For each speed of rotation there is a certain inclination on the face of the shoe which differs from that of any other speed, and where the shoes are not free to tilt on their ball and socket bearings, there would be only one speed at which high pressure could be obtained for at that speed only would the relative thickness of the film of oil at the entering and trailing ends be properly proportioned.

We will next consider the action when the rotor is turning at a fixed speed and oil is discharged through the ports 27; that is, we will assume that the faces of the shoes have assumed a position such as shown in Fig. 4, this figure showing an exaggerated wedge of oil. When a small amount of oil is allowed to pass through the port 27 in the center of the shoe, this escape or discharge reduces the amount of oil escaping at the trailing end and as this is the case the trailing end of the shoe drops, thus raising the leading dege and thereby admitting an increased amount of oil under the shoe.

With the operation continued a condition of equilibrium will be set up and the same oil pressure will be maintained when oil is drawn off through the central port 27 as exists for the same speed of rotation with no oil passing out. Again, if the shoes were fixed or caused to assume a predetermined inclined or angular position, and oil is allowed to pass out, the pressure would drop, as there would not be enough oil left under the shoe to maintain the pressure, but when the shoe is permitted to automatically tilt as here illustrated, the pressure will be constantly maintained as the amount of oil escaping through the port 27 is compensated for by automatically increasing the inclined position of the shoes. It is for this reason that the pump is particularly adapted to furnish fuel oil to a Diesel engine employing solid or mechanical injection. By employing a multiplicity of shoes with the dis-

charge pipes 23 connected to the fuel pipe which leads to the fuel valves, and with the pump driven by the engine, it can be seen that, when the fuel valves are operated in succession by the usual mechanism, fuel will be delivered from the pump direct to the fuel valves and the full pressure will be maintained as long as the fuel valve is open; that is, the fuel pressure will not drop during the opening period as is the case when the pressure is furnished by the expansion of the air in the air dome or some similar arrangement as previously referred to. When the fuel valves are closed the shoes automatically adjust themselves to this condition and the oil pressure in the piping system will thus remain the same as when the pump is discharging oil, thus eliminating the necessity of safety or by-pass valves and furthermore preventing building up of excessive or dangerous pressures in the piping system. While a pressure of 4,000 pounds is readily obtained, it should be understood that the pressure may be increased or decreased either by adjusting the position of the pins so as to bring the shoes into closer contact with the sides of the rotor or by increasing the speed of the rotor or decreasing the same as the case may be. Pressures approximating 14,000 pounds per square inch can be obtained, but such pressures are not necessary and the supporting pins 16 are therefore adjusted to produce a film which will give the quantity of oil and pressure desired. Experience has shown that the thicker films allow greater proportions of oil to be withdrawn before the trailing edge of the shoe is in danger of contacting with the rotor. It should be understood that the viscosity of the oil, practically speaking, remains constant and that the speed of the rotor varies with engine speed as it is driven thereby. As this is the case it is only necessary to adjust the individual shoes when the pump is installed as a specific or predetermined pressure is usually employed and maintained. When the shoes have been properly adjusted, it can be seen that a predetermined pressure will be maintained; this being true whether the fuel valves are open or closed. If the fuel valves are open and the fuel oil is discharging, the tilt of the shoes will increase, and if the fuel valves are closed, the tilt decreases and no rise in pressure is therefore encountered. The only change in pressure will be caused by variation in speed of the rotor.

I wish it understood that while certain features of the present structure are more or less specifically illustrated, that various changes in form and proportion may be resorted to within the scope of the appended claims. Also, that the materials and finish of the several parts employed may be such as the experience and judgment of the manufacturer may dicate or various uses may demand.

Having thus described my invention, what I claim and desire to secure by Letters Patent is—

1. In a pump of the character described, a rotor, means for applying a film of oil to the surface thereof, means for placing said film under pressure, means optionally permitting a portion of the oil in the film to continuously or intermittently discharge under pressure, and means for automatically maintaining a predetermined and constant pressure whether the discharge be continuous or intermittent.

2. In a pump of the character described, a rotor, means for applying a film of oil to the surface thereof, means for placing said film under pressure, means optionally permitting a portion of the oil in the film to continuously or intermittently discharge under pressure, means for automatically maintaining a predetermined and constant pressure whether the discharge be continuous or intermittent, and means for increasing or decreasing the pressure by increasing or decreasing the speed of the rotor.

3. In a pump of the character described, a rotor, means for applying a film of oil to the surface of the rotor, a plurality of shoes positioned adjacent the surface of the rotor and adapted to form a plurality of wedge shaped oil films, and also adapted to maintain said films under pressure, and means for increasing or decreasing the pressure of the oil in each film by increasing or decreasing the distance between the shoes and the rotor.

4. In a pump of the character described, a rotor, means for applying a film of oil to the surface of the rotor, a plurality of shoes placed on opposite sides of the rotor, said shoes adapted to assume a slightly inclined position with relation to the opposite faces of the rotor and to form a plurality of wedge shaped oil films, and an adjustable support for each shoe permitting an increase or decrease in the spacing between the shoes and the rotor.

5. In a pump of the character described, a casing, a chamber formed therein, a disk shaped rotor disposed in said chamber, means for rotating the rotor, a plurality of shoes disposed in the chamber adjacent one face of the rotor, means for maintaining a predetermined spacing between each shoe and the rotor, and means permitting a slight tilting movement of each shoe with relation to the rotor.

6. In a pump of the character described, a casing, a chamber formed therein, a disk shaped rotor disposed in said chamber, means for rotating the rotor, a plurality of shoes disposed in the chamber adjacent one

face of the rotor, a ball and socket bearing forming a support for each shoe, and means permitting adjustment of each ball and socket bearing to increase or decrease the spacing between the shoes and the rotor, said ball and socket bearings also permitting a tilting movement of each shoe with relation to the rotor.

7. In a pump of the character described, a casing, a chamber formed therein, a disk shaped rotor disposed in said chamber, means for rotating the rotor, a plurality of shoes disposed in the chamber adjacent one face of the rotor, a ball and socket bearing forming a support for each shoe, means permitting adjustment of each ball and socket bearing to increase or decrease the spacing between the shoes and the rotor, said ball and socket bearings also permitting a tilting movement of each shoe with relation to the rotor, a discharge port formed in each ball and socket bearing, and a discharge port formed in each shoe in alignment therewith.

8. A pump of the character described comprising a casing having a chamber formed therein, a shaft extending through one side of the casing and journaled therein, a disk secured on said shaft, bearing pins extending through each side of the casing and entering the chamber, said pins being adjustable on the longitudinal axis and each pin having a central discharge port formed therein and extending longitudinally therethrough, a plurality of shoes disposed in the chamber adjacent the opposite faces of the disk, each shoe having a discharge port formed therein, a ball and socket bearing formed between each shoe and pin to permit a slight tilting movement of the shoes with relation to the opposite faces of the disk, and means for delivering oil to the chamber in the pump casing.

9. In a pump of the character described, a smooth surfaced rotor, a plurality of shoes cooperating therewith, and means permitting adjustment of the shoes to and away from the surface of the rotor.

10. In a pump of the character described, a smooth surfaced rotor, a plurality of shoes cooperating therewith, and means permitting a tilting movement of the shoes with relation to the rotor.

11. In a pump of the character described, a rotor, a plurality of shoes cooperating therewith, and a ball and socket bearing forming a support for each shoe.

12. In a pump of the character described, a rotor, a plurality of shoes cooperating therewith, a ball and socket bearing forming a support for each shoe, said bearings permitting a slight tilting movement of each shoe, and means for adjusting the position of said bearings to increase or decrease the spacing between the shoes and the rotor.

13. In a pump of the character described, a rotor, a plurality of shoes cooperating therewith, a ball and socket bearing forming a support for each shoe, each shoe having a discharge port formed therein, and a discharge pipe connected with each ball and socket bearing and communicating with the discharge ports in the shoes.

14. In a pump of the character described, a rotor, a plurality of shoes cooperating therewith, a ball and socket bearing forming a support for each shoe, each shoe having a discharge port formed therein, a discharge pipe connected with each ball and socket bearing and communicating with the discharge ports in the shoes, means for delivering oil to a point intermediate the shoes and the rotor, and means for adjusting the shoes with relation to the rotor to increase or decrease the spacing between the shoes and the rotor.

15. In a pump of the character described, a rotor, means for applying a film of oil to the surface of the rotor, a plurality of shoes pivotally supported adjacent the surface of the rotor and adapted to form a plurality of wedge-shaped oil films, and also adapted to maintain said films under pressure, and means permitting discharge of a portion of the oil in each film through the shoes.

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