

Oct. 8, 1968

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3,404,634

PUMP

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2 Sheets-Sheet 1

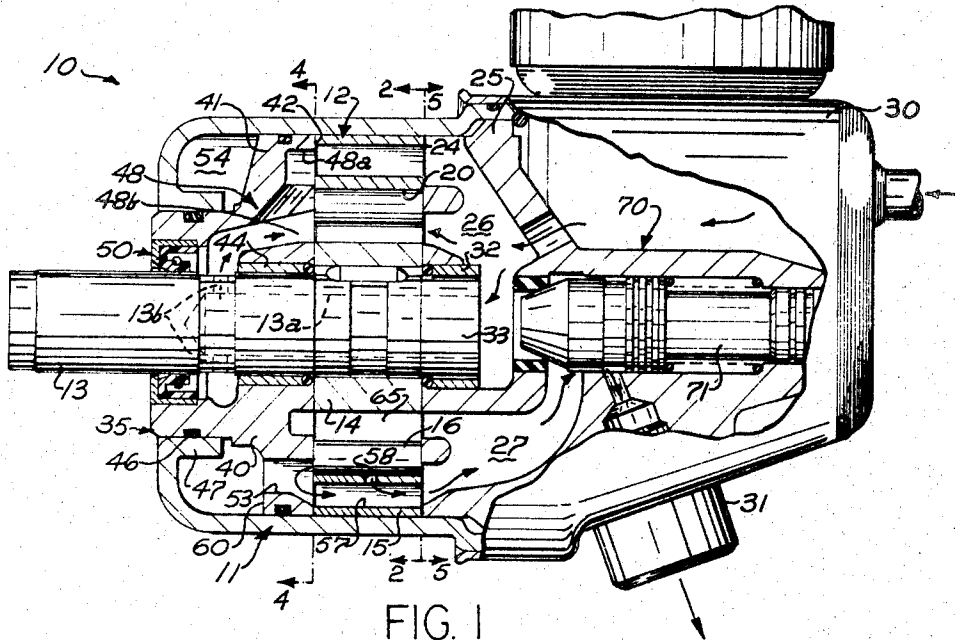


FIG. 1

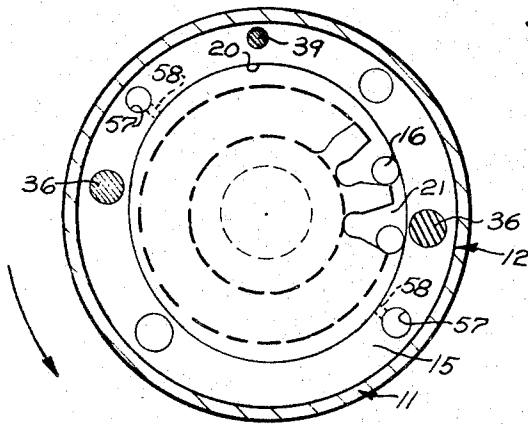


FIG. 2

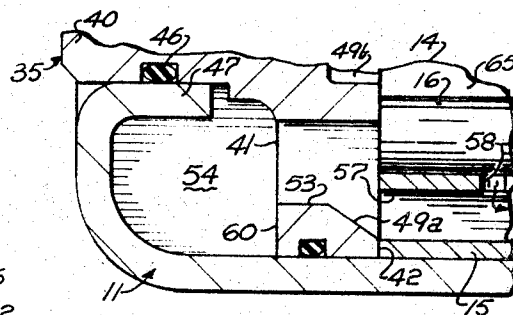


FIG. 3

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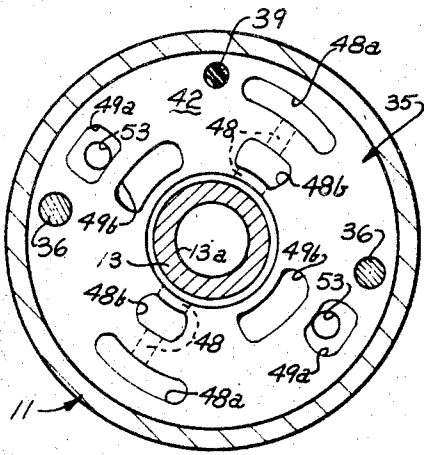


FIG. 4

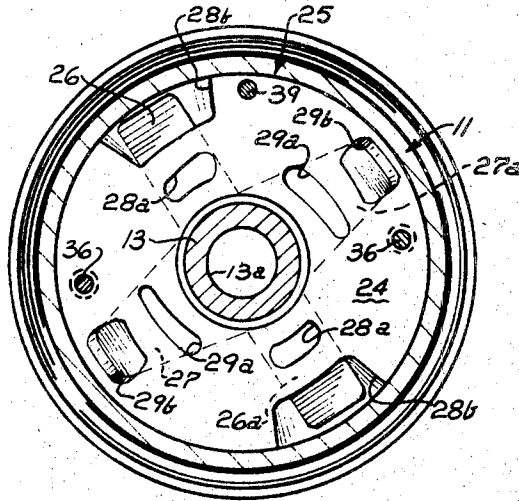


FIG. 5

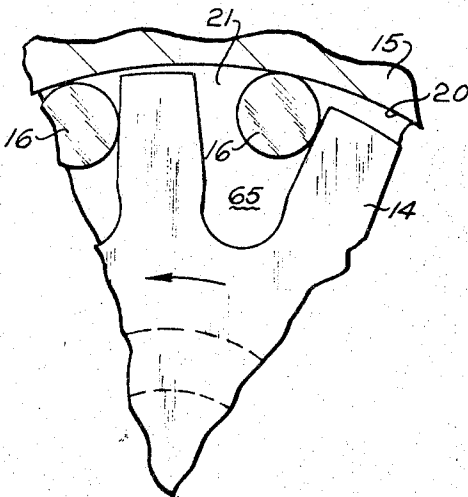


FIG. 6

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ABSTRACT OF THE DISCLOSURE

An improved pump includes a resiliently deflectable sheet metal flange portion which is exposed to fluid at discharge pressure and cooperates with an end plate to provide a seal pressure therewith which increases with increases in pump discharge pressure to minimize leakage from the pump at high pressures. A pressure chamber is provided opposite from a discharge chamber to minimize distortion or deflection of the parts of the pump. A passage is formed in the pump to provide unimpeded fluid communication between a pumping chamber and a remote discharge chamber to minimize restrictions to the flow of fluid between a pumping means and a discharge chamber.

The present invention relates to a fluid pump, and more particularly relates to a fluid pump having improved means for communicating fluid to a discharge chamber thereof and for utilizing the discharge pressure of the pump to increase the volumetric efficiency thereof.

An object of the present invention is the provision of a new and improved pump which is constructed to provide for high discharge flows with a minimum of resistance and wherein fluid at discharge pressure is utilized to maintain parts of the pump in predetermined positions relative to each other at high discharge pressures so that leakage of high pressure fluid between the parts is minimized and volumetric efficiency of the pump is increased.

A further object of the present invention is the provision of a new and improved pump having a housing supporting a pumping means and wherein a flange portion of the housing and a part of the pump cooperate to form a chamber for fluid at substantially discharge pressure so that the pressure acting on the flange portion of the housing acts on the flange portion to increase the sealing pressure between the flange and the part of the pump as pressure in the chamber increases.

Yet another object of the present invention is the provision of a new and improved pump having rotary pumping means operable to pump fluid between inlet and discharge chambers of the pump and wherein a cover member is located on one axial side of the rotary pumping means and defines a discharge chamber of the pump and an end plate member is located on the other axial side of the pumping means and wherein the end plate member and housing define a chamber located so that fluid in the chamber acts on the end plate member urging the end plate member toward the rotary pumping means.

Still another object of the present invention is the provision of a new and improved pump, as noted in the next preceding paragraph, wherein the end plate member is provided with means for communicating fluid at substantially discharge pressure with the chamber.

Another object of the present invention is the provision of a new and improved pump having a rotor member which moves pumping elements along a cooperating cam surface of a cam member to effect pumping of a fluid and wherein conduit means for discharge fluid is provided in the cam member and includes a first passageway communicating fluid discharged at one axial side of the rotor to a discharge chamber at the other axial side of the rotor and a second passageway extending between the cam

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surface and the first passageway and wherein the passageways are effective to provide a high volumetric efficiency for the pump.

Other objects and advantages of the present invention will become apparent from the following detailed description thereof made with reference to the accompanying drawings and wherein:

FIG. 1 is a sectional view, partially in elevation, of a pump embodying the present invention;

FIG. 2 is a sectional view of the pump of FIG. 1, taken approximately along section line 2-2 thereof;

FIG. 3 is an enlarged fragmentary sectional view of a portion of the pump shown in FIG. 1;

FIG. 4 is a sectional view, taken approximately at line 4-4 of FIG. 1;

FIG. 5 is a sectional view, taken approximately at line 5-5 of FIG. 1; and

FIG. 6 is an enlarged fragmentary sectional view of a portion of the pump of FIG. 2.

A pump 10 embodying the present invention is shown in FIG. 1. While the pump 10 is preferably utilized in conjunction with a hydraulic power steering system in an automotive vehicle and driven from an engine of the vehicle, it will become apparent from the following that the pump embodying the present invention may be utilized in many different applications.

The pump 10 includes a housing 11 supporting a pumping means 12 therein. The pumping means 12 is a rotary pumping means secured to a driving shaft 13 for rotation therewith. The pumping means 12 includes a rotatable rotor member 14 secured to the shaft 13 and a stationary cam member 15 which is secured to the housing 11. The rotor member 14 is an annular member having a plurality of radial slots therein which carry pumping elements 16. The pumping elements 16 engage a surface 20 on the cam member 15 and define pumping pockets 21 therebetween. The elements 16 are moved radially inwardly and outwardly of the rotor member 14 upon rotation thereof in pumping strokes. The elements are moved radially by the cam surface and thereby effect pumping of fluid in a well-known manner.

The pumping means 12 is supported in the housing 11 closely adjacent a planar surface 24 of a cover member 25. The cover member 25 includes inlet passageways 26, 26a therein which extend between the pumping means 12 and a fluid reservoir 30 of the pump. The inlet passageways 26, 26a are spaced approximately 180 degrees apart in the cover member. Each passageway opens into the surface 24 at radially spaced locations to provide radially inner and outer inlet ports 28a, 28b, respectively, for the pumping means 12. The cover member 25 also includes discharge passageways 27, 27a which communicate with the pumping pockets 21 and with an outlet fitting 31 which directs fluid discharged from the pump to the system. The discharge passageways 27, 27a each open into the surface 24 at radially spaced locations to form pairs of radial inner and outer discharge ports 29a, 29b, respectively. The radially inner ports 29a and the radially outer ports 29b are spaced approximately 180 degrees from each other in the cover member 25, and are spaced approximately 90 degrees from the inlet ports 26, 26a. The cover member 25 additionally includes a central portion which provides a support for a bearing 32 which is operable to rotatably support an end 33 of the shaft 13 therein.

An end plate 35 is located on the axial side of the pumping means 12 opposite the axial side thereof at which the cover member is located. The end plate 35 is fixed to the cover 25 by suitable screws 36 which extend through the cam member 15 and are threadedly engaged with the cover 25. The screws 36 maintain the end plate 35 in close proximity to the pumping means 12.

The end plate 35, cam member 15 and cover 25 are additionally held in radially aligned relation by a locating pin 39 which extends through the end plate 35, the cam member 15, and into the cover 25. In the illustrated embodiment, the subassembly formed by the end plate 35, cover 25 and cam member 15 is press fitted into the housing 11 and thereby held against movement relative to the housing.

The end plate 35 includes an axially extending body portion 40 which rotatably supports the shaft 13 by means of a suitable bearing 44 and a radially extending web or flange portion 41 including an annular planar surface 42 located closely adjacent an axial side of the pumping means 12. The body portion 40 of the end plate 35 is sealingly engaged with the housing 11 by means of an O-ring seal 46 positioned between the body portion 40 and a flange portion 47 of the housing 11 which surrounds the outer peripheral surface of the body portion 40 and the seal 46. An inner periphery of the body portion 40 of the end plate 35 is provided with a fluid seal means 50, shown schematically, located between the body portion and the shaft 13 to prevent leakage of fluid therebetween.

The flange or web portion 41 has a generally planar annular surface 42 which is positioned closely adjacent the pumping means 12, as previously noted. The end plate 35 includes inlet passageways, generally indicated at 48, which are spaced 180 degrees apart therein and which communicate the pumping means 12 with the inlet passageways 26, 26a. The inlet passageways 48 open into the surface 42 at radially spaced locations therein to provide radially outer and inner inlet ports 48a, 48b, respectively. The inlet passageways 48 communicate with the inlet passageways 26, 26a in the cover member 25 by means of a flow passage 13a in the shaft 13 which opens into the inlet passageways 26, 26a at the end 33 of the shaft 13. The flow passage 13a in the shaft communicates with the inlet passageways 48 through ports 13b, see FIG. 1, which extend radially through the shaft between the flow passage 13a and the inlet passageways 48.

The end plate 35 also includes groove portions or chambers 49a, 49b communicating with an axial side of the pumping pockets 21 of the pumping means 12. As shown in the drawings, the grooves or chambers 49a, 49b are spaced radially apart on the surface 42 and at locations on the end plate corresponding to discharges of the pumping means. The grooves 49a communicate with the discharge chambers 27, 27a in the cover member to provide a flow of discharge fluid from the pumping pockets to the discharge chambers by means which will be described in detail hereinafter. The web or flange 41 also includes a port or channel 53 which extends there-through from the chamber 49a at a discharge of the pumping means 12 and to a fluid chamber 54 defined by the end plate 35 and the housing 11, located to the left of the flange portion 41, as viewed in the drawings, and remote from the discharge chamber 27 and flow control valve means 28. It should be apparent from the above that the grooves 49a are in fluid communication with the discharge chambers 27, 27a as well as with the chamber 54.

Operation of the pumping means 12 and its associated parts should be apparent from the foregoing. Fluid from the reservoir 30 enters the inlet passages 26, 26a and is directed in part to the pumping means 12 through the inlet ports 28a, 28b in the cover member 25. Fluid in the passageways 26, 26a is also directed through the flow passage 13a in the shaft 13, the inlet passageways 48 in the end plate 35 and to the pumping means 12 through the ports 48a, 48b in the end plate. Inlet fluid entering the pumping means 12 enters the pumping pockets 21 and is pumped through the discharge ports 29a, 29b and 49a, 49b in the cover member and end plate, respectively. The fluid flows from discharge ports 29a, 29b and

49a, 49b to the discharge passageways 27, 27a in the cover member 25. Pumped fluid in the discharge passageways is directed therefrom to the system through the fitting 31.

In accordance with the present invention, fluid substantially at the discharge pressure of the pump is communicated into the chamber 54 through the port 53 and the pressure of the fluid in the chamber 54 acts upon the flange 47 of the housing 11 to force the flange 47 into tight sealing engagement with the body portion 43 and O-ring 46 of the end plate 35. The sealing pressure in the chamber 54 increases with the discharge pressure of the pumping means so that leakage of fluid from the housing 11 is minimized at high discharge pressure. To provide for the afore-mentioned force, the housing 11 is preferably composed of a resiliently deflectable metallic material. While, in the illustrated embodiment, the housing 11 is sheet metal, the housing may also be cast.

Fluid at discharge pressure in the chamber 54 additionally acts on a rear surface 60 of the web or flange 41 to urge the end plate 35 toward the pumping means 12. This pressure applies a force on the end plate acting toward the rotor and which opposes the pressure forces acting on the surface 42 of the end plate in a direction away from the rotor. It should be apparent from the foregoing description that the flange portion 41 of the end plate is exposed to axially acting pressure forces imposed thereon by fluid in the pumping pockets 21. Moreover, it should be apparent that the forces acting on the flange portion 41 vary from point to point thereon due to the changing pressure in the pockets 21 as the rotor member 14 rotates. The high pressure in the chambers adjacent the discharge of the pumping means tends to produce localized distortions or deflections of the flange portion 41 which tend to move the surface 42 axially away from the pumping means. If distortion of the surface 42 occurs as described, leakage of fluid between the pumping pockets 21 along the interface between the surface 42 and the pumping means 12 will result to cause a decrease in volumetric efficiency of the pump. The pressure in the chamber 54 balances the forces acting on the flange 41 and minimizes the localized deflections thereof to minimize the afore-mentioned leakage and maintain a high volumetric efficiency for the pump.

The pump 10 additionally includes conduit means for freely communicating fluid discharged from the pumping pockets 21 of the pumping means 12 to the discharge chambers 27, 27a with a minimum of flow restriction to obtain a high volumetric efficiency of the pump. As shown in the drawings, the afore-mentioned conduit means includes an opening 57 extending through the cam member 15 between the radially outer chamber 49a in the end plate and the discharge chambers 27, 27a in the cover, as well as a port 58 extending radially between the cam surface 20 and the opening 57. The opening 57 and port 58 provide an unimpeded flow path from the discharge of the pumping means adjacent the end plate 35 to the discharge chambers 27, 27a and with less resistance and less restriction of flow than if no such passages were provided. The radially inner grooves or chambers 49b in the end plate 35 communicate with the discharge chambers 27, 27a through passageways 65 formed by the portions of the pumping pockets 21 located radially inwardly of the pumping elements 16. It should be apparent from the above that a large flow area is provided for discharged fluid flowing from the grooves 49a, 49b to the discharge chamber to minimize restriction of the flow and, therefore, for a given amount of input power, the pump provides a higher output flow than if these passages were omitted.

The pump 10 additionally includes flow control means 70 for metering the amount of fluid directed from the pump to the system through the fitting 31. The flow control means 70 is operable to control the amount of fluid flowing to the system by by-passing fluid from the dis-

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charge passageways 27, 27a to the inlet passageways 26, 26a. As illustrated in FIG. 1, the flow control means includes a valve member 71 movable between a first position wherein fluid in the discharge passageways 27, 27a is directed to the system and a second position wherein the valve member permits fluid communication between the inlet and discharge passageways to effect the above-mentioned by-passing of discharged fluid. In view of the function of the control means, the valve 71 is located so as to provide the fluid communication to effect by-passing of fluid to the pump inlet.

It can now be seen that an improved pump has been provided which is constructed so that fluid at discharge or high pressure is utilized to provide a sealing pressure which increases with increases in pump discharge pressure to minimize leakage from the pump at high pressures. The construction is further effective to minimize distortion or deflection of the parts of the pump which are remote from a discharge chamber thereof by providing a pressure balance to the parts, resulting in decreased internal leakage in the pump and maintenance of volumetric efficiency thereof at high pressures. Moreover, a pump constructed according to the invention is effective to provide unimpeded fluid communication between a pumping chamber and a remote discharge chamber thereof to minimize restrictions to the flow of discharged fluid flowing between the pumping means and the discharge chamber to further maintain volumetric efficiency of the pump at relatively high levels.

While a preferred embodiment of the present invention has been illustrated and described herein in considerable detail, it should be apparent to those skilled in the art that certain modifications, adaptations, and changes can be made without departing from the invention. Therefore, the invention is not to be considered to be limited to the precise construction shown, but rather it is my intention to cover hereby all adaptations, modifications, and changes which come within the scope of the appended claims.

Having described my invention, I claim:

1. A fluid pump operable to pump fluid from an inlet to an outlet thereof and comprising a housing, rotary pumping means contained in said housing, shaft means extending into said housing and operable to drive said pumping means, means defining a fluid chamber including a resiliently deflectable flange portion of said housing, an end plate having a cooperating surface in engagement with said flange portion of said housing and providing a fluid seal therebetween, and means for communicating fluid at substantially discharge pressure to said chamber with said fluid pressure acting on said flange portion to deflect the same and to force said flange portion into tight sealing engagement with said surface and to increase said sealing pressure with increases in discharge pressure of said pumping means.

2. A fluid pump operable to pump fluid from an inlet to an outlet thereof and comprising a housing, rotary pumping means contained in said housing, shaft means extending into said housing and operable to drive said pumping means, means defining a fluid chamber including a resiliently deflectable flange portion of said housing, a cooperating surface in engagement with said flange portion and providing a fluid seal therebetween, means for communicating fluid at substantially discharge pressure to said chamber with said fluid pressure acting on said flange portion to force said flange portion into tight sealing engagement with said surface, and an end plate member surrounding said shaft and positioned adjacent said pumping means, said end plate member carrying a seal member which engages said flange portion, said flange portion defining one wall of said chamber and said chamber being additionally defined by a portion of said end plate member, said chamber being located so that fluid pressure in said chamber is effective to urge said end plate member toward said pumping means to minimize leakage between said end plate member and said pumping means.

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3. A fluid pump operable to pump fluid from an inlet to an outlet thereof and comprising a housing, rotary pumping means contained in said housing, shaft means extending into said housing and operable to drive said pumping means, means defining a fluid chamber including a resiliently deflectable flange portion of said housing, a cooperating surface in engagement with said flange portion and providing a fluid seal therebetween, and means for communicating fluid at substantially discharge pressure to said chamber with said fluid pressure acting on said flange portion to force said flange portion into tight sealing engagement with said surface, said flange portion of said housing being constructed of sheet metal and said fluid pressure being effective to force said flange toward engagement with said surface and increase said sealing pressure with increases in discharge pressure of said pump.

4. A fluid pump for providing a supply of fluid to an external fluid system comprising a housing, rotary pumping means in said housing providing for pumping of said fluid between inlet and discharge passageways of said pump, said inlet and discharge passageways of said pump located adjacent each other at one axial side of said pumping means, an end plate member having a first surface adjacent said pumping means at an axial side thereof axially opposite from said one axial side of said pumping means and said inlet and discharge passageways, said first surface of said end plate member being exposed to fluid pressure in said pumping means, and conduit means for communicating fluid substantially at discharge pressure of said pumping means to a chamber formed within said housing at a second surface of said end plate member axially opposite from said first surface to urge said end plate member toward said one axial side of said pumping means and minimize deflection of said end plate member by said fluid pressure of said pumping means.

5. A pump as defined in claim 6 wherein said chamber is formed in part by a flange portion of said housing surrounding a peripheral surface on said end plate member and in sealing engagement with said peripheral surface, said pressure in said chamber acting on said flange portion to produce a sealing pressure between said flange portion and said surface which increases in response to increased discharge pressure of said pumping means.

6. A pump as defined in claim 5 wherein said end plate member includes sealing means having a member which forms at least a part of said peripheral surface and sealingly engaging said flange portion.

7. A pump as defined in claim 4 and further including groove means in said first surface of said end plate member and communicating said discharge of said pumping means with said conduit means.

8. A pump as defined in claim 10 and further including a flow passage extending between said groove means and said discharge passageway in said pump remote from said groove means, said flow passage effective to direct fluid from said groove means to said discharge passageway with a minimum of flow resistance to maximize the flow of discharge fluid from said pump for a given power input to said pumping means.

9. A pump as defined in claim 8 and wherein said second surface of said end plate member is positioned in a chamber formed by said end plate member and said housing, and said housing includes a flange portion surrounding a cooperating surface in engagement with said flange portion to provide a fluid seal therebetween and with said fluid pressure in said chamber effective to force said flange portion into tight sealing engagement with said cooperating surface.

10. A fluid pump operable to direct fluid to a fluid system through a discharge passageway thereof and comprising a housing, rotary pumping means supported in said housing and including rotor means rotatable in said housing about an axis, a cam member surrounding said rotary pumping means, pumping rollers movable relative

to a cam surface of said cam member and cooperating with said cam member and said rotor means to provide pumping pockets which vary in volume as said rotor means rotates, an end plate member forming a chamber at an axial side of said rotor means remote from said discharge passageway and operable to receive high pressure discharge fluid from said pockets, and conduit means operable to communicate fluid from said chamber to said discharge passageway in an unrestricted manner with said fluid flowing from said chamber to said discharge passageway with a minimum of flow resistance, said conduit means including a first fluid passageway extending between said chamber and said discharge passageway and a second fluid passageway in said cam member extending between said first passageway and said cam surface and communicating with said pockets.

11. A pump as defined in claim 10 wherein said end plate member includes a first side positioned adjacent said rotor means and further including means for com-

municating an opposite side of said end plate member with said chamber, said fluid pressure from said chamber acting on said opposite side of said end plate member and urging said end plate member toward said rotor means.

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U.S. DEPARTMENT OF COMMERCE

PATENT OFFICE

Washington, D.C. 20231

**UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION**

Patent No. 3,404,634

October 8, 1968

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It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 53, claim reference numeral "10" should read
-- 7 --.

Signed and sealed this 27th day of January 1970.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

WILLIAM E. SCHUYLER, JR.

Commissioner of Patents