Aug. 9, 1938. T. NORBOM 2,125,946

VACUUM BREAKER FOR HYDRAULIC MACHINES

Filed Dec. 4, 1937 6 Sheets-Sheet 1

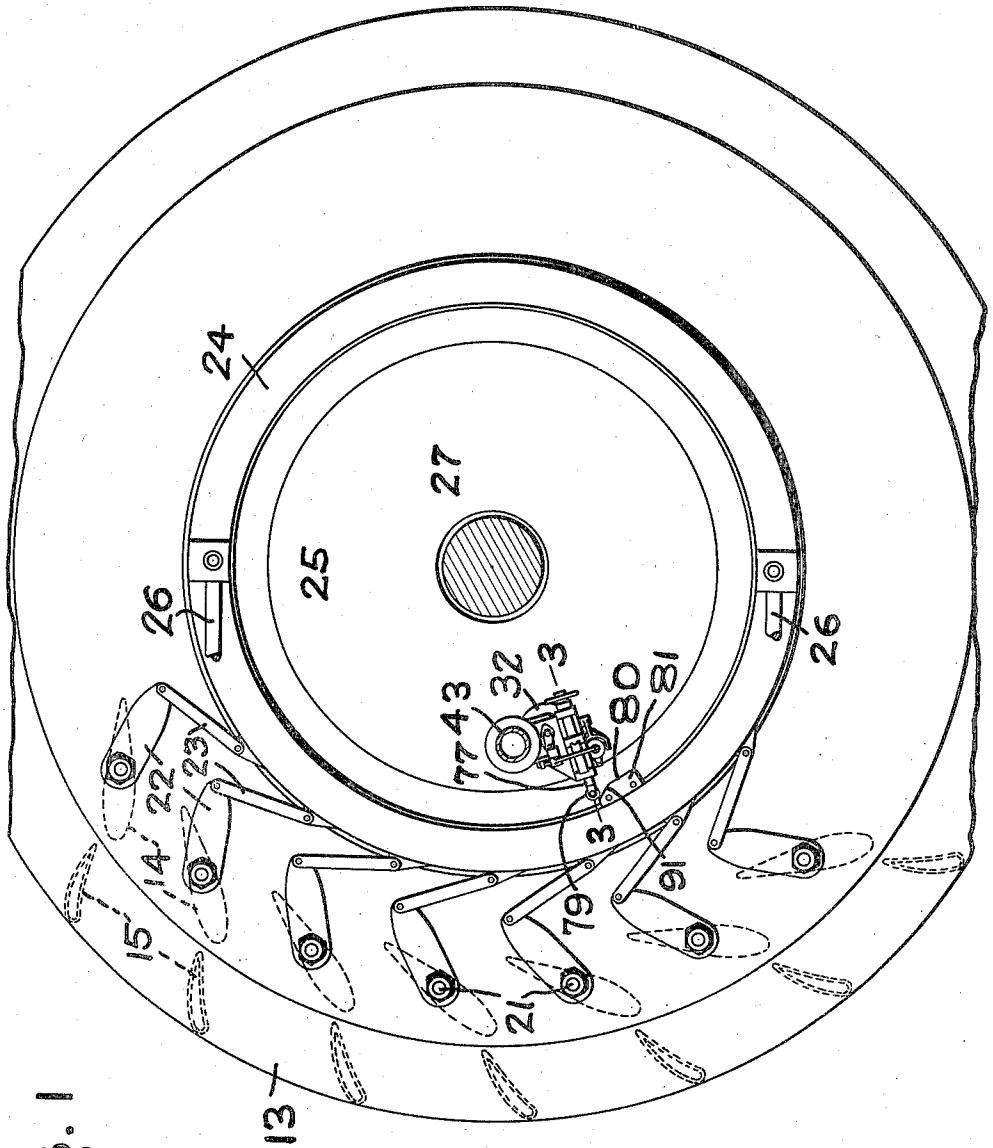


Fig. 1

Inventor
TORLEIF NORBOM

By Malcolm F. Hammett
Attorney

Aug. 9, 1938. T. NORBOM 2,125,946

VACUUM BREAKER FOR HYDRAULIC MACHINES

Filed Dec. 4, 1937 6 Sheets-Sheet 2

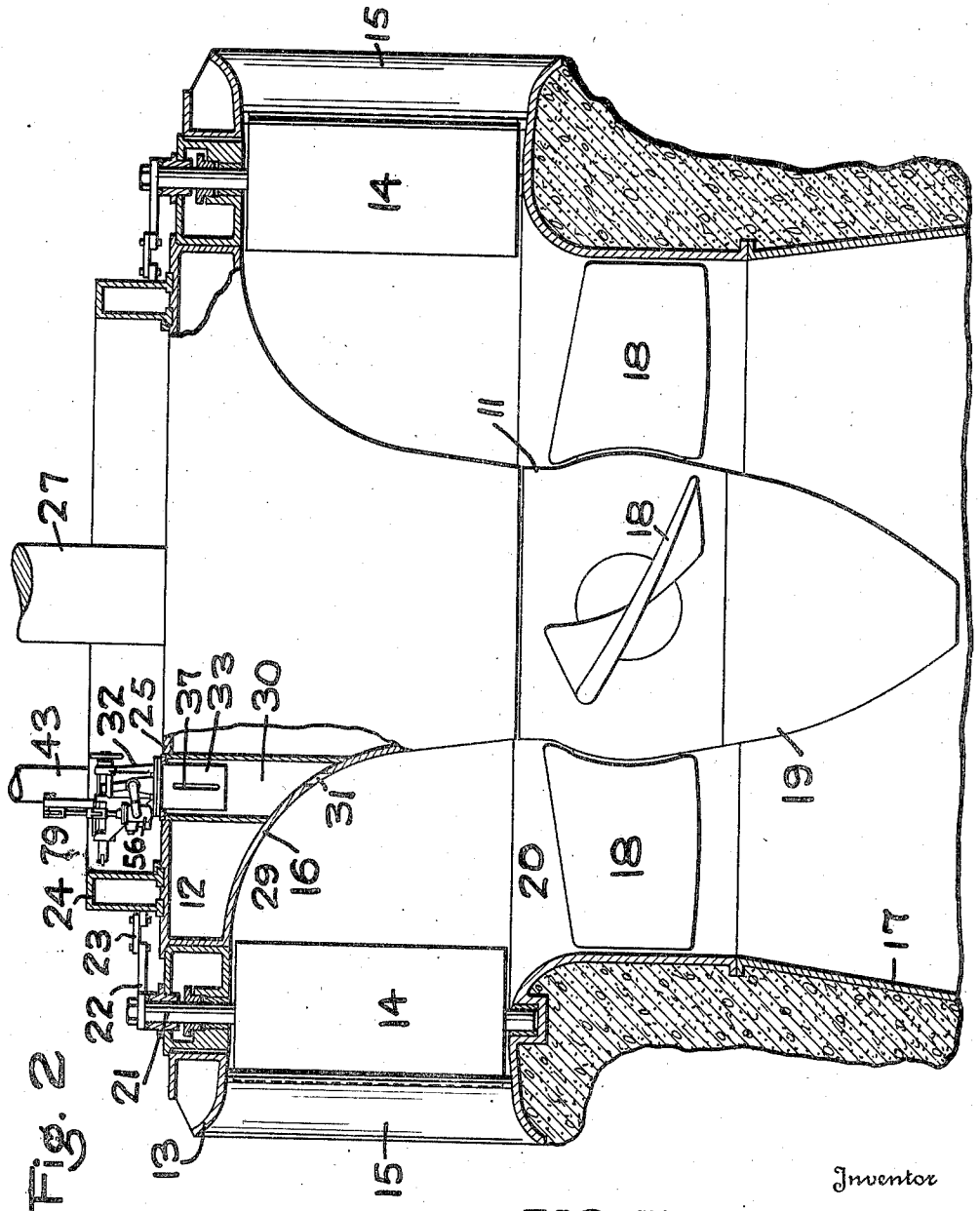


Fig. 2

Inventor

TORLEIF NORBOM

By Malcolm F. Barnett

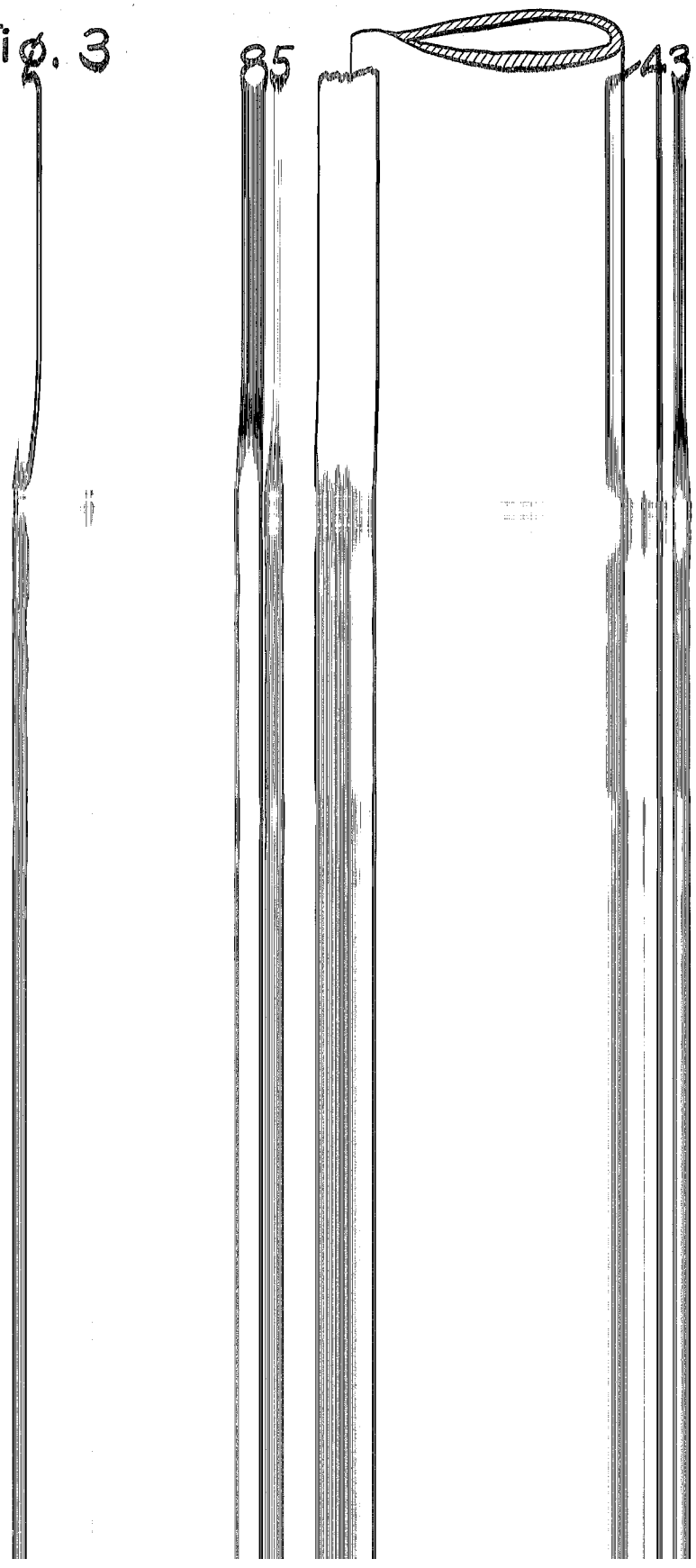
Attorney

Aug. 9, 1938. T. NORBOM 2,125,946

VACUUM BREAKER FOR HYDRAULIC MACHINES

Filed Dec. 4, 1937 6 Sheets-Sheet 3

Fig. 3

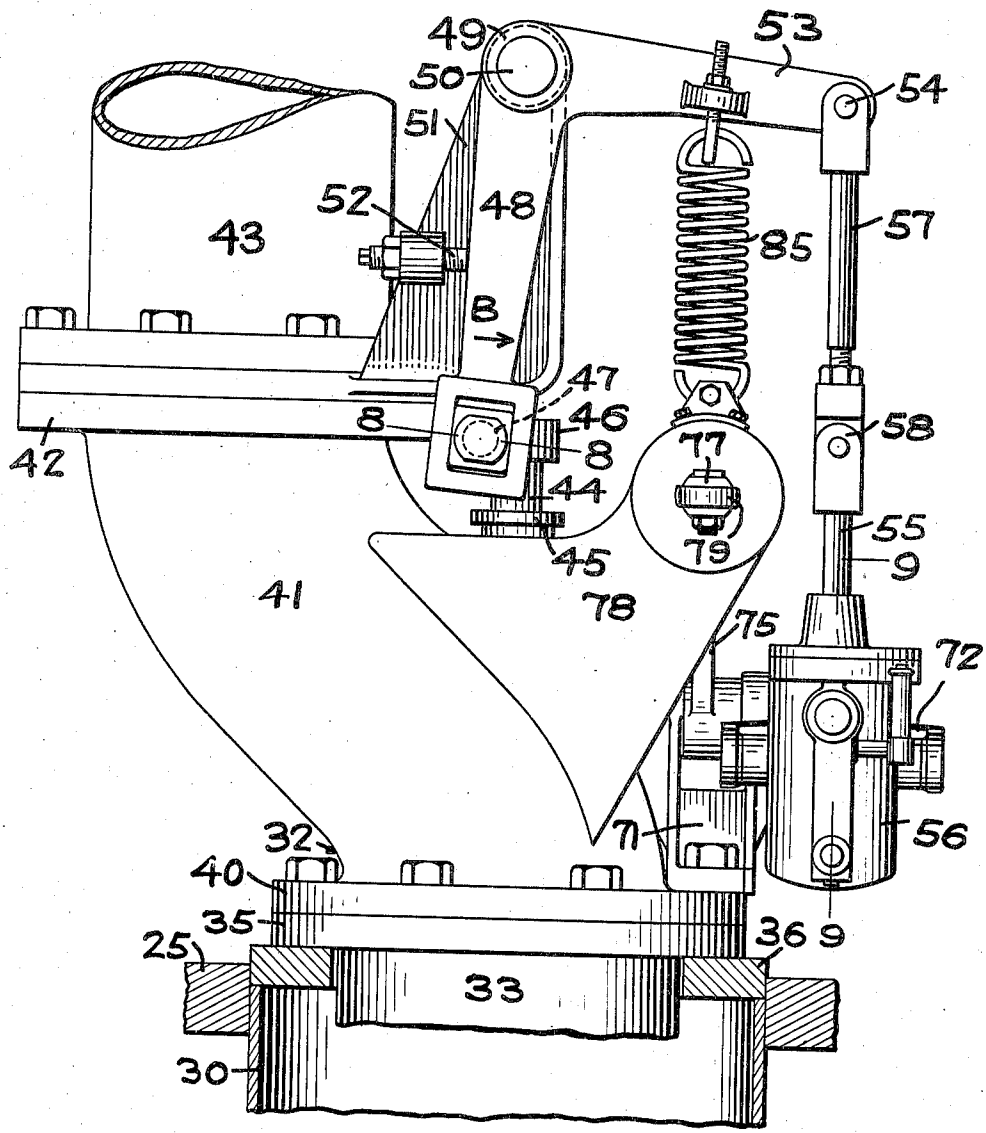


Aug. 9, 1938. T. NORBOM 2,125,946

VACUUM BREAKER FOR HYDRAULIC MACHINES

Filed Dec. 4, 1937 6 Sheets-Sheet 4

Fig. 4



Inventor

TORLEIF NORBOM

By Malcolm F. Gannett

Attorney

Aug. 9, 1938. T. NORBOM 2,125,946

VACUUM BREAKER FOR HYDRAULIC MACHINES

Filed Dec. 4, 1937 6 Sheets-Sheet 5

Fig. 5

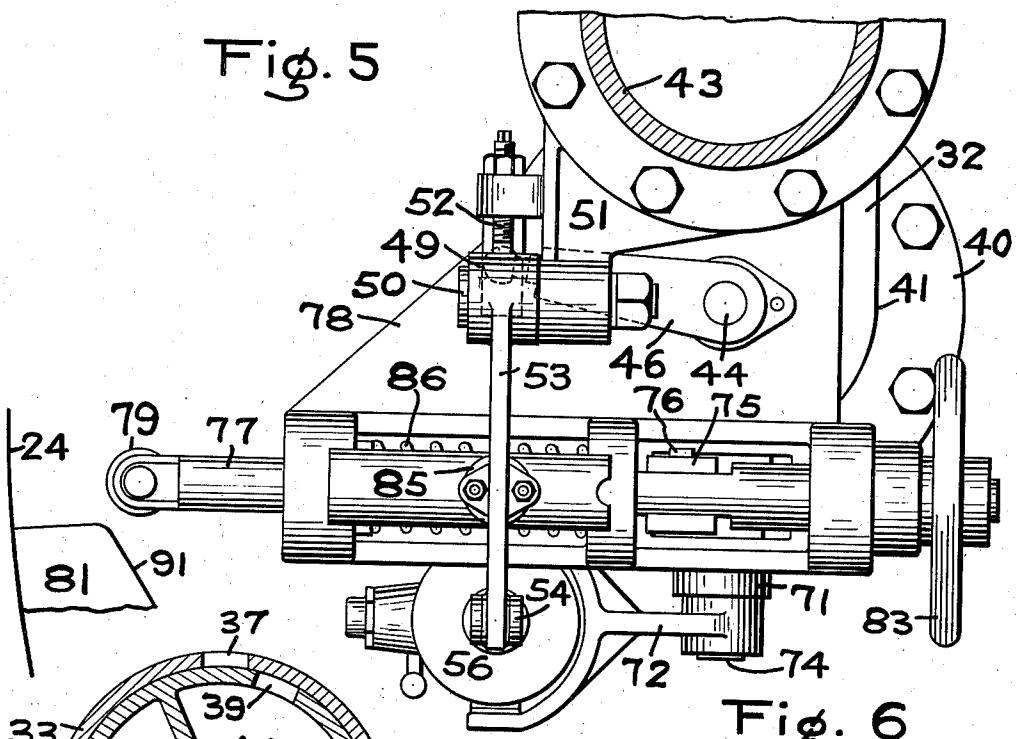


Fig. 6

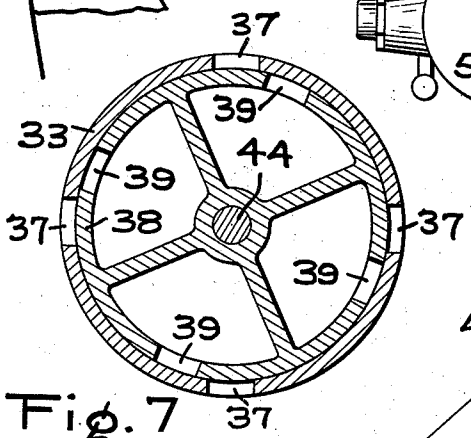


Fig. 7

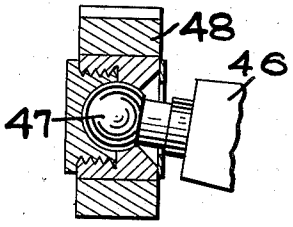
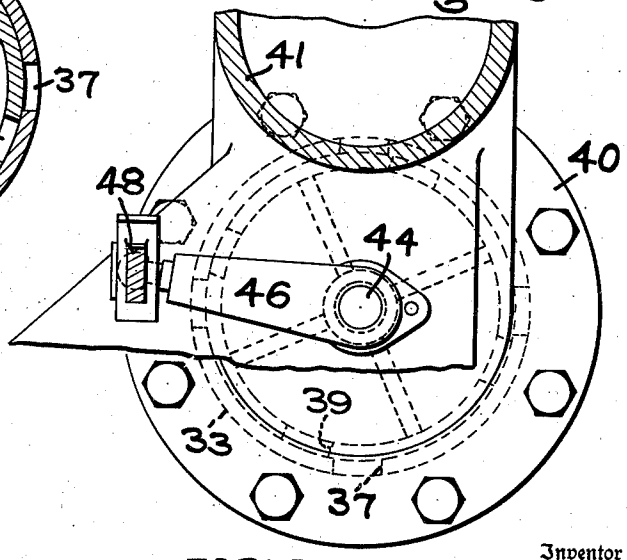


Fig. 8



Inventor
TORLEIF NORBOM

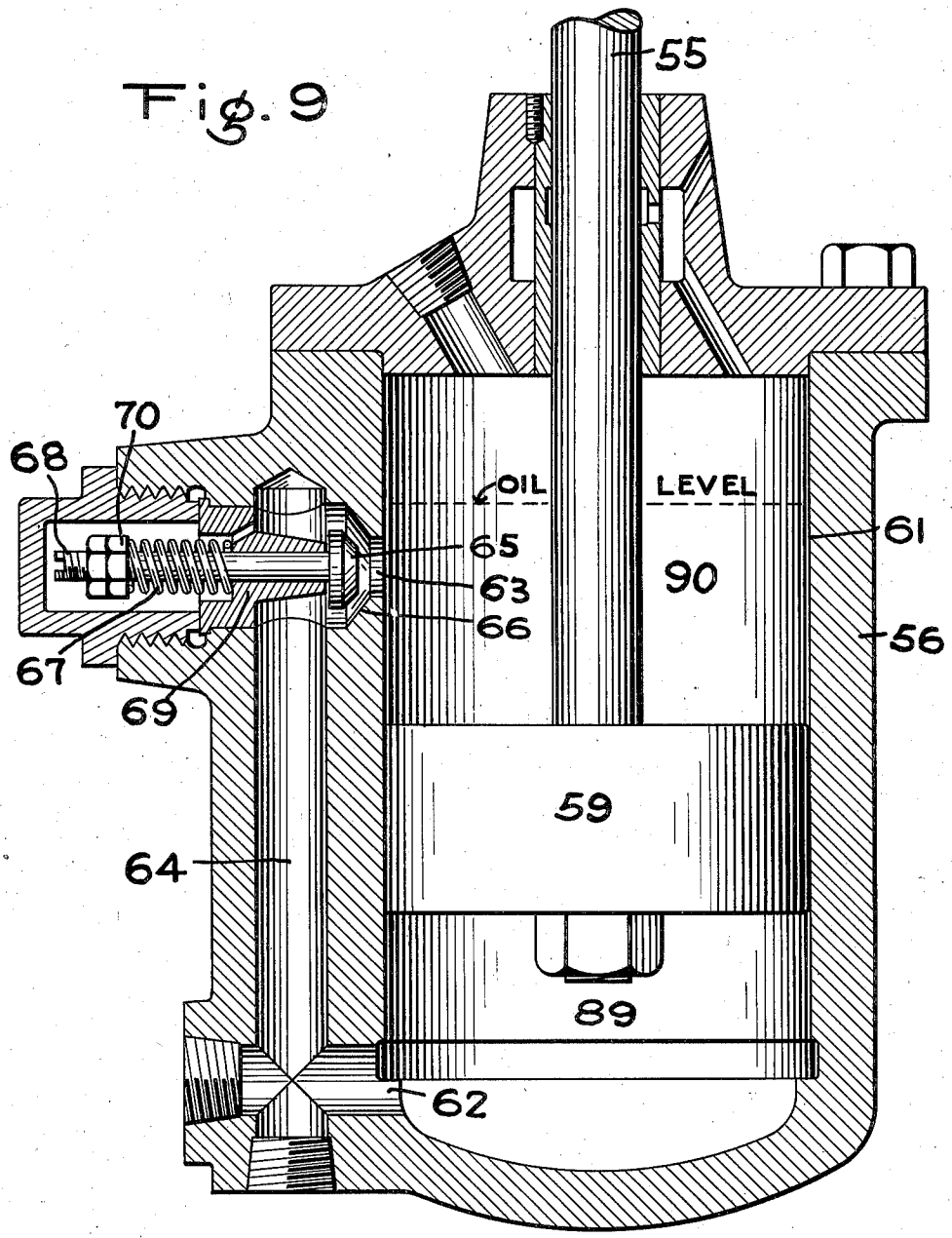
By
Malcolm F. Gannett
Attorney

Aug. 9, 1938. T. NORBOM 2,125,946

VACUUM BREAKER FOR HYDRAULIC MACHINES

Filed Dec. 4, 1937 6 Sheets-Sheet 6

Fig. 9



Inventor
TORLEIF NORBOM

By Malcolm F. Gaumett
Attorney

Patented Aug. 9, 1938 2,125,946

UNITED STATES PATENT OFFICE

2,125,946

VACUUM BREAKER FOR HYDRAULIC MACHINES

Torleif Norbom, York, Pa., assignor to S. Morgan Smith Company, York, Pa., a corporation of Pennsylvania

Application December 4, 1937, Serial No. 178,026

3 Claims. (Cl. 253—117)

This invention relates to improvements in hydraulic machines, and more particularly to means for breaking up vacuum in the gate case of hydraulic turbines and the like.

In the operation of hydraulic turbines there is a tendency of the fluid to pulsate, thereby causing the turbines to vibrate. The vibrations are more or less pronounced according to the varying conditions, with respect to the changes in load, the action of the governor, the sudden closing of the wicket gates, and other conditions encountered in the practical operation of the mechanism. The momentum of the fluid column in the turbines under the conditions mentioned, causes the fluid column to break, and on the column being arrested by the creation of the vacuum due to the break, the column is thrown upwardly again by the atmospheric pressure, and these actions being rapidly repeated, result in violent pulsations of the fluid column, with the vacuum constantly making and breaking, and thereby subjecting the mechanism to violent, injurious and annoying vibrations which greatly interfere with the efficiency of operation.

An object of the invention is to provide an improved automatically operable valve device adapted to be actuated under predetermined conditions for controlling the flow of air to a hydraulic turbine for the purpose of breaking up vacuum in the fluid column therein.

The above and other objects and advantages are attained with this invention, as will become apparent from the following description, taken in connection with the accompanying drawings, in which:

Figure 1 is a plan of the top plate and associated structure of a hydraulic turbine showing the application of the invention thereto;

Fig. 2 is an elevation, partly in vertical section, of the structure shown in Fig. 1;

Fig. 3 is a vertical section of the air valve and associated parts, taken on the line 3—3 of Fig. 1;

Fig. 4 is an elevation, partly in section, of the air valve shown in Fig. 3, looking towards the end of the dash pot actuating rod;

Fig. 5 is a plan of the structure shown in Fig. 3;

Fig. 6 is a fragmentary plan of a portion of the air valve actuating mechanism;

Fig. 7 is a horizontal section of the air valve, taken on the line 7—7 of Fig. 3;

Fig. 8 is a detail horizontal section taken on the line 8—8 of Fig. 4; and

Fig. 9 is an enlarged vertical section of the dash pot, taken on the line 9—9 of Fig. 4.

Referring to the drawings and especially to Figs. 1 and 2, the hydraulic turbine comprises a runner 11, a crown plate structure 12, and a speed ring 13.

The crown plate structure 12 is mounted on the speed ring 13 which forms a peripheral water inlet in which are mounted an annular series of movable wicket gates 14 and stationary guide vanes 15.

The crown plate structure 12 has a conical guiding surface, 16, so that the flow of the operating fluid entering the turbine through the speed ring 13, is turned downwardly and directed toward the runner 11. The flow discharging from the runner 11 passes out through a draft tube 17.

The runner 11, which may be of any type, has a plurality of blades 18 and a hub 19 tapering in the direction of the discharge, said runner blades extending across a passage 20 in the turbine installation at the upper end of the draft tube 17.

The wicket gates 14 are adapted to be simultaneously rotated into different angular positions to control the flow of water into the turbine in the usual manner, and for this purpose each wicket gate is provided with a stem or shaft 21 which is mounted in suitable bearings carried by the speed ring 13.

Fixed to the upper end of each gate stem or shaft 21 is one end of an arm 22. The other end of the arm 22 is connected by a link 23 to a gate adjusting ring 24.

The gate adjusting ring 24 is rotatably mounted on a top plate 25 of the crown plate structure 12, and said ring is adapted to be actuated from a suitable governor mechanism (not shown) by link means 26 (see Fig. 1).

The runner 11 has a shaft 27 which extends upwardly through the crown plate structure 12 and the top plate 25 in well-known manner.

For the purpose of admitting air into the transition space 29 of the turbine, the crown plate structure 12 is formed with one or more passages or openings 30, one opening being shown in the present instance.

The opening 30 extends from the top plate 25 downwardly to the conical surface 16 of the crown plate, the surface 16 also being formed with an opening 31 of suitable area.

Controlling communication through openings 30 and 31, is a valve device 32, which is preferably mounted on the top plate 25.

The valve device 32 comprises a cylindrical body 33, having a closed bottom 34, and a flanged upper portion 35 which is fastened to a supporting ring 36 fixed to the top plate 25.

The cylindrical body 33 of the valve 32 has a diameter slightly less than the diameter of the opening 30, so that the side wall of the valve device will be spaced from the wall of the opening 30, as shown in Figs. 2 and 3.

The side wall of the cylindrical body 33 is formed with a plurality of elongated vertically disposed slots 37 which constitute ports by which communication is established from the valve device to the opening 30 (see Figs. 3 and 7).

Rotatably mounted in the vlave body 33 is a cylindrical valve member 38, also formed with a plurality of vertically disposed slots 39. The valve member 38 constitutes a gate for controlling communication through the slots 37. When the slots 39 of the valve member 38 do not register with the slots 37 of the valve body 33, communication through the valve device 32 will be cut off, and when the slots 39 register with the slots 37, fluid can flow through the valve device 32, for the purpose to be hereinafter described.

Bolted to the flange 35 is the lower flanged end 40 of an elbow 41, said elbow also having an upper flanged end 42 to which is secured a pipe 43, constituting an air inlet to the valve device 32.

As shown in Figs. 3, 4, 5, 6 and 7, the valve gate 38 has an operating rod 44 fixed thereto, said rod being vertically disposed and extending upwardly through the elbow 41. The upper end of the rod 44 terminates a suitable distance above the point where it passes through the elbow 41, the joint between said rod and said elbow being packed by a suitable packing gland 45, as shown in Fig. 4.

Fixed to the upper end of the rod 44, is a laterally extending arm 46 adapted to be swung to and fro by suitable mechanism, so as to impart rotary movements to the valve gate 38 in both directions through predetermined arcs.

The outer end of the arm 46 is connected by a ball and socket connection 47 to the lower end of one arm 48 of a bell crank lever 49 (see Figs. 4 and 8).

The lever 49 is pivotally connected as at 50 to a bracket 51 supported from the elbow 41. Swinging movement of arm 48 is limited in one direction by a stop 52 also carried by the bracket 51.

The other arm 53 of the bell crank lever 49 is pivotally connected, as at 54, to the upper end of a piston rod 55 of a dash pot device 56.

As shown in Fig. 4, the rod 55 is made adjustable through the threaded connection of one portion 57 of said rod with a swivel joint 58 carried by the other portion 55 of the rod, the latter portion of the rod being connected to a piston 59 of the dash pot device 56 (see Fig. 9).

The dash pot device 56 comprises a main body having a cylinder 61 formed therein for piston 59, said cylinder being adapted to contain a suitable quantity of oil, the operating level of which is indicated by a broken line in Fig. 9.

Normally the piston 59 is disposed intermediate of the cylinder 61 so that the piston is spaced a suitable distance from the bottom of said cylinder and also so that said piston is covered to a suitable depth by the oil in the cylinder 61.

Formed in the casing of the body of the dash pot device 56 are two ports 62 and 63, the port 62 being located near the bottom of the cylinder 61 and the port 63 being disposed at a distance above the piston 59 and below the normal level of the oil in the cylinder 61.

The ports 62 and 63 are connected by a passage 64 so that a by-pass is formed around the dash pot piston 59.

Communication through the by-pass is controlled by a poppet valve 65 mounted in the upper portion of the dash pot device 56 and having a beveled surface adapted to engage a valve seat 66 formed around the port 63.

Normally the valve 65 is retained out of engagement with the seat 66 by an expansible coil spring 67 mounted on the stem 68 of said valve and bearing at one end against a wall of the supporting cage 69 of the valve and at the other end against a nut 70 threaded on to said valve stem 68.

The dash pot device 56 is swingingly supported from a stationary support provided by a bracket 71, by a yoke member 72 having forked arms straddling the main body of the dash pot device and pivotally connected thereto as indicated at 73, said yoke being pivoted to said bracket 71 by a shaft 74. The bracket 71 is bolted to the flanges 35 and 40 heretofore referred to.

The yoke member 72 is rigidly fixed to the shaft 74 so that when said shaft is turned, the yoke will be also moved.

Also fixed to the shaft 74 is the lower end of an arm 75 which is pivotally connected, as at 76, to an actuating member or rod 77.

The rod 77 is slidably mounted in a suitable supporting member 78 in the form of a bracket carried by the elbow 41, as shown best in Fig. 4.

One end of the rod 77 carries a roller 79 adapted to engage the cam surface 80 of a cam plate 81 carried by the gate adjusting ring 24, for a purpose to be hereinafter described (see Figs. 1 and 5).

The other end of the rod 77 is formed with threads 82 for receiving a hand wheel 83, the purpose of which is to permit the rod 77 to be moved toward the right (Fig. 3) so that the roller 79 is disposed out of the path of the cam surface 80.

Swinging movements of the bell crank lever 49 are tensioned by a coil spring 85 having one end connected to the arm 53 of the lever 49 and its other end connected to the supporting member 78, as shown in Fig. 4.

The operating rod 77 is urged in the direction in which the roller 79 is disposed adjacent the gate adjusting ring 24, by an expansible coil spring 86 which bears at one end against a wall of the supporting member 78 and bears at the other end against a collar 87 threaded on to the rod 77. Movement of the rod 77 in a direction towards the left (Fig. 3) is limited by engagement of the hand wheel 83 with the end of the support 78. The tension of the spring 86 may be adjusted by moving the collar 87 on the rod 77.

Referring to Fig. 1, the wicket gates 14 are shown in partly open position, in which position the roller 79 of the operating rod 77 is disposed out of engagement with, but in proximity to, the cam 81, and consequently the mechanism of the valve device 32 is in the position shown in Fig. 3 and said valve device is closed, as shown in Fig. 7, so that no air can flow downwardly into the transition space 29.

When, due to a change in the load on the turbine, the gate adjusting ring 24 moves in the direction in which the cam 81 engages the roller 79, the rod 77 will be moved in the direction of the arrow A, Fig. 3. This movement of the rod 77 results in the bell crank lever, formed by arm 73, shaft 74, and the yoke 72, being swung, so

that the dash pot cylinder 61 is moved upwardly from the position shown in Fig. 3.

If the movement of the gate adjusting ring 24 is at a slow rate of speed, then the dash pot device 56 will be moved upwardly slowly. Due to the slow upward movement of the dash pot device, the dash pot piston 59 will remain stationary, while the dash pot cylinder 61 moves upwardly. As a result of this upward movement of the cylinder 61 with respect to the piston 59, oil in chamber 89 on the lower side of the piston 59 will be forced through the by-pass provided by port 62, passage 64 and port 63, into the upper dash pot chamber 90. Furthermore, on account of the slow movement or rate of flow of oil through the by-pass, the poppet valve 65 will remain in the unseated position shown in Fig. 9, and consequently communication through the by-pass will not be closed by said poppet valve during slow upward movement of the dash pot cylinder 61. Since the piston 59 does not move along with the cylinder, the piston rod 55 and the mechanism operated thereby will remain inactive, and, therefore, the valve gate 38 will not be rotated. Consequently when a slow upward movement is imparted to the dash pot device 56, the valve device 32 will remain in the closed position shown in Figs. 3 and 7.

On the other hand, when there is a sudden change in load on the turbine, the gate adjusting ring 24 will, through its operating mechanism (not shown), be moved quickly. This quick movement of the gate adjusting ring 24 results in the dash pot cylinder 61 being moved upwardly very quickly.

When the dash pot cylinder 61 moves upwardly very quickly, oil from chamber 89 cannot flow upwardly through the by-pass provided by port 62, passage 64, and port 63, into chamber 90, since there is insufficient time for the oil to flow out of chamber 89, by passing through port 62, passage 64 and port 63 into the upper chamber 90, before pressure is built up in chamber 89. The pressure thus quickly built up in chamber 89, acting through port 62 and passage 64, forces the poppet valve 65 to its seat 66, thereby cutting off communication through the by-pass from the lower chamber 89 to the upper chamber 90. Since there is now no by-pass from chamber 89 to chamber 90, the dash pot piston 59 will also be moved upwardly with the cylinder 61.

Upward movement of the piston 59 causes a corrresponding upward movement of piston rod 55, so that the bell crank lever 49 is rotated about its pivot 50 in the direction in which the arm 48 of said bell crank lever is swung, as indicated by the arrow B, Fig. 4.

This movement of the arm 48 is transmitted to the operating rod 44 of the valve gate 38, through the operating arm 46, and consequently the slots 39 of the valve gate 38 are moved into registration with the slots 37.

In the above referred to actuation of the valve gate operating mechanism, since the lever arm 53 is swung upwardly about the pivot 50, the tension of the spring 85 will be increased.

Due to the shape of the cam surface 80, when the roller 79 is in engagement with the inclined portion 91 of said cam surface, the slots 39 will be partly in registration with the slots 37. When the roller 79 is in engagement with the surface of the cam 81, indicated by the numeral 80 in Fig. 1, the slots 39 will be fully registered with the slots 37, so that unrestricted communication through said slots is provided.

In this way air from the inlet pipe 43 will be supplied to the transition space 29 through opening 31. This air, mixing with the fluid entering the transition space 29 through the speed ring 13, fills up the voids in the transition space, thereby preventing further vibration and other causes resulting from insufficient fluid in the transition space.

After the roller 79 engages the cam surface 80 and the valve device 32 has been actuated in the above-described manner, there will be no further upward movement of the dash pot device 56, and consequently the pressure of oil in chamber 89 on the underside of the dash pot piston 59 will decrease. With the decrease in pressure of the oil in chamber 89, spring 67 will move the poppet valve 65 away from its seat 66, thereby establishing communication through the by-pass of the dash pot device. Spring 85 will then pull the lever arm 53 and the piston rod 55 downwardly, thereby moving the dash pot piston 59 downwardly of the cylinder 61 to the position shown in Fig. 9. During this downward movement of the piston 59, the bell crank lever 49 will be swung back to the position shown in Fig. 4, and consequently the valve gate 38 will be returned to the position shown in Fig. 7, in which position the slots 37 are lapped.

In this way, the parts of the dash pot device and associated mechanism will be returned to the respective positions shown in the drawings, with the exception of the dash pot cylinder 61 which, together with the lever 75, yoke 72, and operating rod 77, remain in the other positions heretofore described.

When the gate adjusting ring 24 moves in the opposite direction to the direction in which the cam 81 is engaged with the roller 79, the cam 81 will be moved to the position shown in Fig. 1, so that the roller 79 is disengaged from said cam. During this movement, the spring 86 will shift the position of the operating rod 77, thereby actuating the arm 75, shaft 74, and yoke 72, so that the dash pot cylinder 61 will be moved downwardly to the position shown in Fig. 3.

At the beginning of the downward movement of the dash pot cylinder 61, the piston 59 is disposed in the bottom of the cylinder 61, and when the cylinder 61 moves downwardly, the piston 59 does not move therewith, so that at the completion of the downward movement of the cylinder 61, the piston 59 will be disposed within said cylinder approximately in the position indicated in Fig. 9.

Also during the downward movement of the cylinder 61, since the poppet valve 65 is unseated, oil will flow from chamber 90 through the by-pass provided by port 63, passage 64 and port 62, into chamber 89.

Having thus described my invention, what I claim is:

1. In a hydraulic machine, the combination with a runner, a speed ring having a plurality of movable wicket gates for controlling the flow of operating fluid to the runner, a crown plate forming a transition space for the operating fluid between the speed ring and the runner, a ring mounted on said crown plate and operatively connected to the wicket gates for operating the wicket gates, a passage extending through the crown plate, a valve device carried by said crown plate and having means for controlling communication through said passage so that air can be introduced into the transition space, a movable dash pot device having a piston operatively connected to said valve device for operating the

valve device, means operable only upon sudden perceptible changes in load for operating said dash pot device, and means carried by said wicket gate operating ring for actuating said last named means.

2. In a hydraulic machine, the combination with a runner, a speed ring having a plurality of movable wicket gates for controlling the flow of operating fluid to the runner, a crown plate forming a transition space for the operating fluid between the speed ring and the runner, a ring mounted on said crown plate and operatively connected to the wicket gates for operating the wicket gates, a passage extending through the crown plate, a valve device carried by said crown plate and having means for controlling communication through said passage so that air can be introduced into the transition space, a movable dash pot device having a piston operatively connected to said valve device for operating the valve device, means operable only upon sudden changes in the position of said dash pot device for controlling the operation of said piston, and means carried by said wicket gate operating ring for moving said dash pot device.

3. In a hydraulic machine, the combination with a runner, a speed ring having a plurality of movable wicket gates for controlling the flow of operating fluid to the runner, a crown plate structure forming a transition space from the speed ring to the runner for the operating fluid, a ring mounted on said crown plate and operatively connected to said wicket gates for operating the wicket gates, a passage extending through the crown plate, a valve device carried by said crown plate and adapted to control communication through said passage whereby air can be introduced into the transition space, an operating member, a cam carried by said gate ring for operating said member upon a predetermined movement of said gate ring, a movable dash pot device moved by said operating member, said dash pot device having a piston, mechanism operated by said piston for operating said valve device, and means rendered operative only upon sudden movement of said dash pot device for controlling the operation of said piston.

TORLEIF NORBOM.