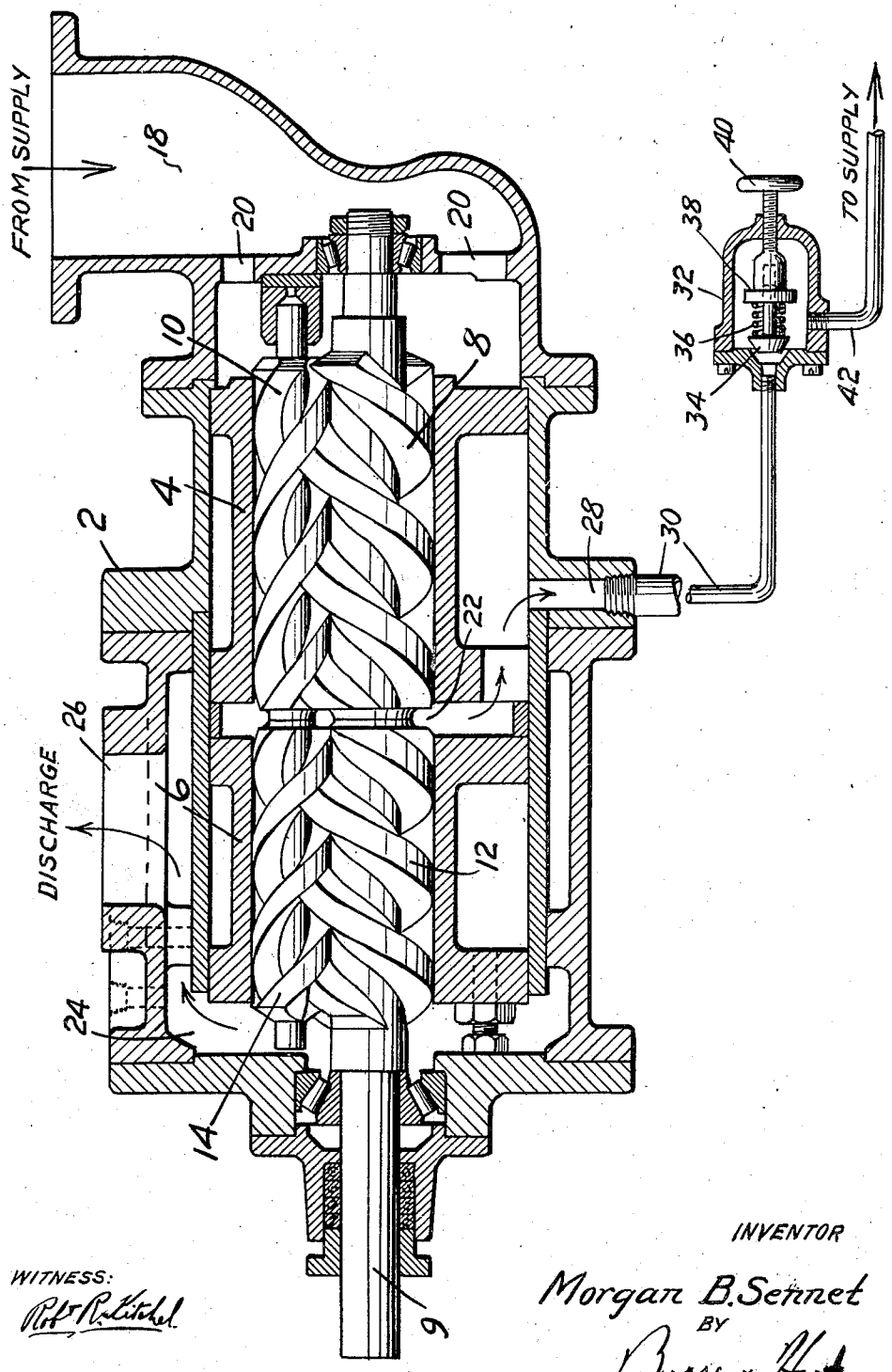
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PUMPING SYSTEM

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WITNESS:
Robt R. Mitchell

INVENTOR
Morgan B. Sennet
BY
Brescia & Hunter
ATTORNEYS.

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PUMPING SYSTEM

Morgan B. Sennet, Trenton, N. J., assignor to De Laval Steam Turbine Company, Trenton, N. J., a corporation of New Jersey

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This invention relates to a pumping system and has particular relation to a system involving a positive pump, for example of the rotating screw type following the disclosure of the patents to C. O. J. Montelius 1,698,802, 1,821,523 and 1,965,557.

Pumps constructed in accordance with said patents comprise a plurality of screws which, during operation, provide theoretically completely bounded chambers travelling endwise of the screws and adapted to transfer fluid axially thereof. These chambers are closed at their ends by engagement of the screw surfaces with each other and with the surrounding casing. The theoretically complete closure may be obtained to a very high degree of approximation with, in fact, only extremely small mechanical clearances which, in the case of the handling of liquids may be, from all practical standpoints, regarded as completely sealed. Pumps of this type, therefore, are truly positive displacement pumps capable of delivering liquids at very high pressures.

Pumps of this type, furthermore, may be operated at extremely high speeds with a driving screw connected, for example, directly to a turbine wheel. Operating speeds may run as high as 24,000 R. P. M. As a result of these very high speeds of operation, pumps of quite small size may be made with very large capacity.

At the extremely high operating speeds just indicated, it will be evident that the filling of each travelling chamber must take place, as that chamber forms, in an extremely small interval of time. (It is not to be understood, however, that an intermittent approach flow of the liquid is involved, since the action is such that the displacement is practically uniformly continuous.) The high rates of flow with the accompanying production of local turbulence tend to cause the setting up of cavitation with accompanying substantial liquid pressure drops, with the result that if a liquid such as an oil containing air and volatile constituents is being pumped, these may separate out in gaseous or vapor form at the inlet. As soon as the chamber is completed, whatever pressure existed at the inlet is essentially maintained, and the travelling chamber may contain liquid with free vapor or gas. At the discharge, this chamber is again opened, but now to the high pressure of the discharge, whereupon, if there is any free vapor, this is recompressed and probably dissolved or absorbed with resulting noise and vibration which may attain such magnitudes as to damage piping.

It has been proposed to provide a booster stage in the form, for example, of a centrifugal pump to raise the pressure at the intake of the screw pump to avoid any local cavitation drops which might cause the separation of vapor or gas. The increased pressure necessary to accomplish this is not great, and there is no necessity for imposing a higher pressure on the intake than is necessary to avoid the separation of a gaseous phase, since no difficulties are experienced in respect of vibration so long as liquid only is being handled, irrespective of the pressure thereon. The use of a centrifugal pump in this fashion, however, is unsatisfactory in several respects. First, the efficiency is low. Secondly, there is no flexibility in the matter of control of the pressure imposed on the intake of the screw pump. Third, if the amount of air or vapor is large, the centrifugal pump may lose its prime, even though the second stage, that is the screw pump, is of the positive displacement type. Under these conditions, the screw pump may draw enough volume of mixed liquid and vapor to satisfy its volumetric change, but the first stage centrifugal pump will do no work, and will fail to create the necessary intake pressure.

In accordance with the present invention, there are provided two screw pumps, preferably of the type indicated above, one of which forms the main pump and is preceded by another which acts as a booster.

The solution of the problems involved, as well as other objects of the invention, particularly relating to details, will become apparent from the following description, read in conjunction with the accompanying drawing, in which the figure shows, in section and diagrammatically, the improved type of pump, together with an associated flow controlling device.

The pump comprises a casing 2 in which there are located interior elements 4 and 6 providing housings within which there rotate the screws of the two pumps. The first stage comprises a central screw 8, cooperating with a pair of screws 10, one of which is illustrated in the figure, the other being cut away by reason of the section. As will be evident from the Montelius patents, various screw arrangements may be provided to secure the travelling fluid-tight chambers, for example, consisting of two screws, one of which is provided with a single thread and the other of which carries two threads, or three screws each of which is provided with two threads. This latter type of arrangement is usually preferable, and is the one illustrated, because of its balanced nature. In order to secure a com-

pletely positive pump, each thread has at least one complete turn. The screws are provided with thrust bearings in conventional fashion, and are otherwise guided by the walls of their bores and contact with each other. The central screw 8 is provided with a shaft 9, through which it is driven from a suitable motor or turbine. On the same shafts as the screws just described are the screws of the second stage pump, the central one of which is indicated at 12, while one of the side ones of which is indicated at 14. As will be evident from the figure, there is free fluid communication between the two pumps in the region 22, so that liquid entering the right hand first stage through the intake passage 18 and the passages 20 may flow through the two pumps in series to be discharged into the space 24 connected with the delivery passage 26.

In order to secure the boosting effect of the first stage, there are two possible alternative arrangements, or combinations thereof, to secure a greater displacement in the first pump than in the second, so that the first will deliver a greater volume of fluid. In the first stage, there may be provided screws of the same pitch as in the second stage, but of greater diameter. Alternatively, and preferably, the screws of the two pumps are the same in diameter, but the screws of the first stage have a greater pitch than those of the second stage, it being found, for example, that very good operation is achieved if, as illustrated, the pitch of the screws of the first stage is about 25% greater than the pitch of the screws of the second stage. If the screws are of the same diameters, the center lines of the rotors are in line and the design is very much simplified, especially if rotor end thrust is to be taken care of, as illustrated in the figure.

The first stage, in view of the greater pitch of its screws, will deliver a greater volume than the second stage, and to effect satisfactory operation, there is provided a bleed-off from the space 22 between the two pumps. As illustrated diagrammatically at the bottom of the figure, a connection 30 to the opening 28 in the casing permits liquid to flow from the space 22 to an adjustable valve indicated at 32, the control being effected by restriction of the flow by a valve member 34, urged in a direction to close off the passage 30 by a spring 36, the pressure exerted by which may be adjusted by movement of an abutment 38 through the medium of a handle 40. From the valve 32, the bled-off liquid passes through the connection 42 to the supply of the pump.

By reason of the provision of the valve just described, the excess liquid is recirculated, and there is maintained between the pumps a proper pressure to insure the prevention of objectionable cavitation, as mentioned above. The adjustment is made such as to prevent too great a pressure rise across the first stage. Desirably the pressure in the space 22 is kept reasonably low, for example, less than ten pounds per square inch, under which conditions there will be no vibration arising in the first stage. If a moderate pressure of this sort is provided, then vibration in the second stage is also completely avoided despite the fact that the second stage may be operating against a very high pressure. It has been found, for example, that with the conditions just indicated, a mixture of air and oil may be pumped satisfactorily even though the air may amount to 40% of the volume of the mixture. The adjustment provided in the valve 32 may be such as to maintain at 22 the necessary pressure for varying contents of vapor or air in the liquid being pumped.

As compared with the combination of a screw pump with a centrifugal first stage, the efficiency of the pump described is quite high. Due to the provision of an adjustable valve controlling the bleed-off, it is possible to make the proper pressure adjustment to correspond with the air or vapor content of the pump liquid. There is, furthermore, no question of priming involved, since the positive first stage is completely self-priming.

What I claim and desire to protect by Letters Patent is:

1. In combination, a positive displacement multiple screw pump, a second positive displacement multiple screw pump operating in unison with the first and having at least one screw coaxial with a screw of the first and operating at the same rotary speed, the second pump having a greater liquid displacement per unit time than the first pump, said pumps having a common housing and receiving and delivering liquid axially of the screws and the progress of liquid in both pumps being in the same axial direction so that the first pump receives directly the liquid discharged from the second pump, means for directing liquid to the inlet of said second pump, means for directing liquid from the outlet of the first pump, means for directing liquid from the region of the housing between the pumps, and means for regulating the pressure in the last mentioned means.

2. In combination, a positive displacement multiple screw pump, a second positive displacement multiple screw pump operating in unison with the first and having at least one screw coaxial with a screw of the first and operating at the same rotary speed, the second pump having a greater liquid displacement per unit time than the first pump, said pumps having a common housing and receiving and delivering liquid axially of the screws and the progress of liquid in both pumps being in the same axial direction so that the first pump receives directly the liquid discharged from the second pump, means for directing liquid to the inlet of said second pump, means for directing liquid from the outlet of the first pump, means for directing liquid from the region of the housing between the pumps, and a spring-controlled valve controlling diversion of liquid through the last mentioned means to maintain substantially constant the pressure existing between the pumps.

MORGAN B. SENNET.