No. 742,231. PATENTED OCT. 27, 1903.

A. C. E. RATEAU.

CENTRIFUGAL PUMP.

APPLICATION FILED OCT. 7, 1901.

NO MODEL. 5 SHEETS—SHEET 1.

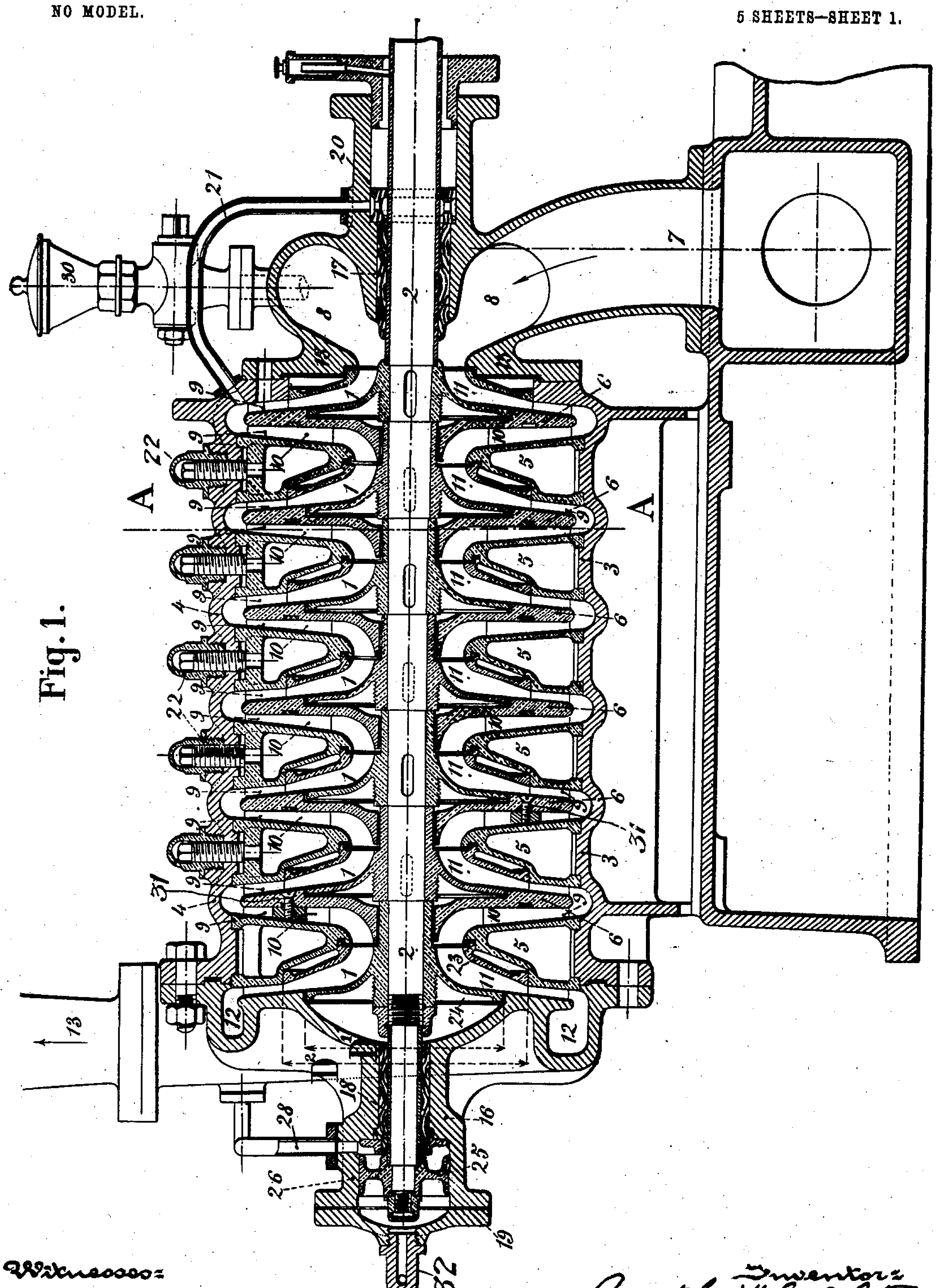

Fig. 1.

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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NO MODEL. 5 SHEETS—SHEET 2.

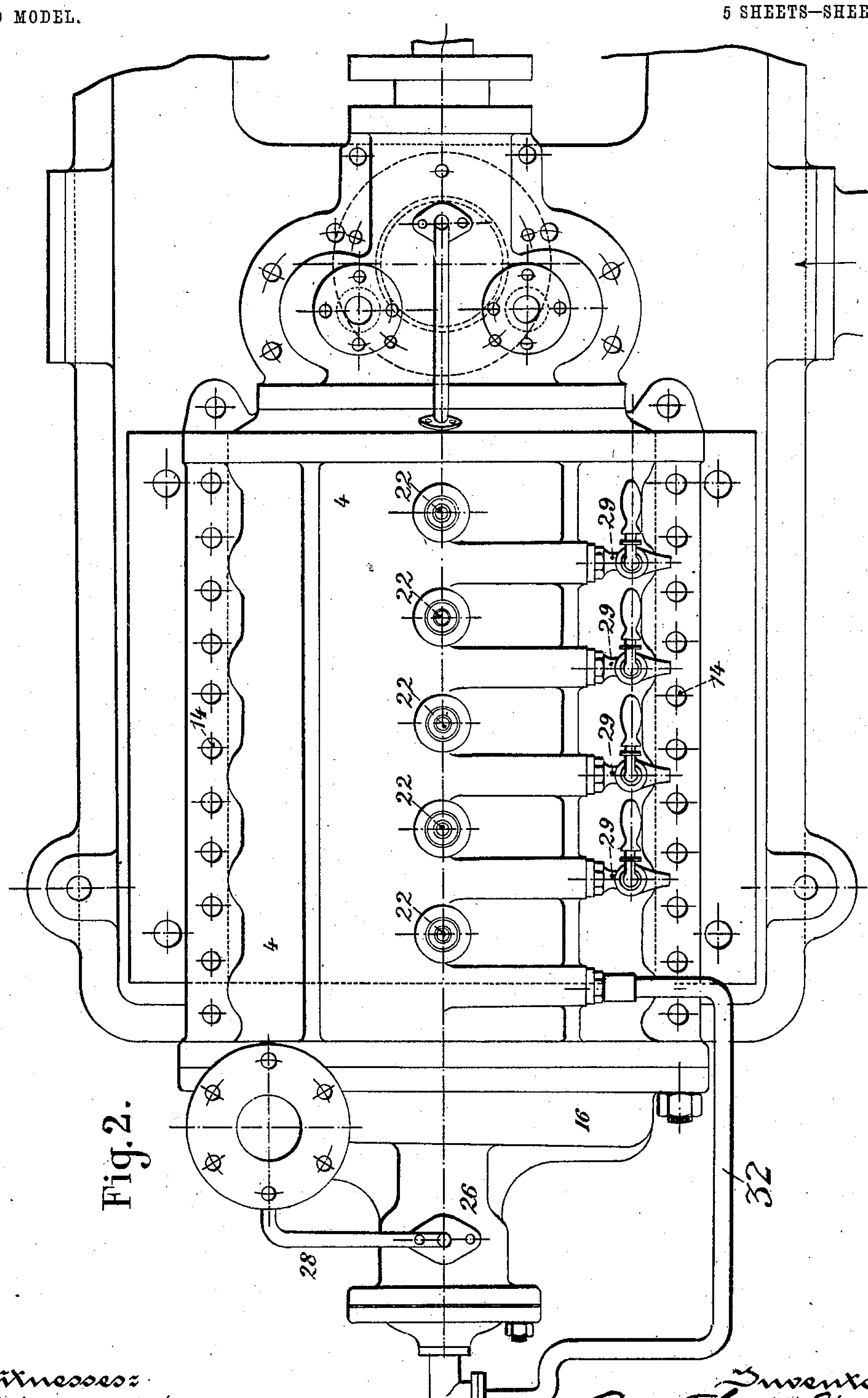

Fig. 2.

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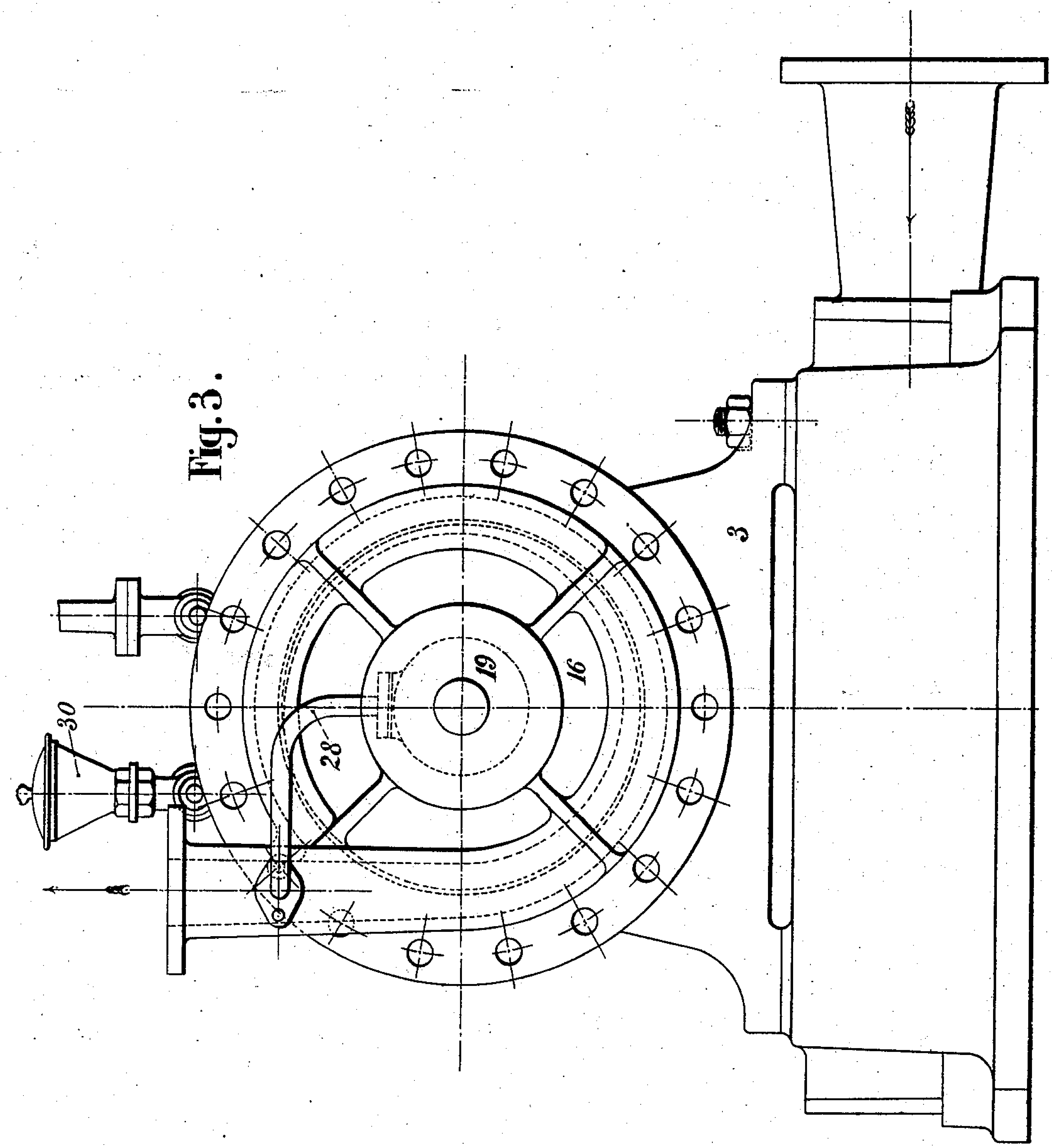
NO MODEL. 5 SHEETS—SHEET 3.

Fig. 3.



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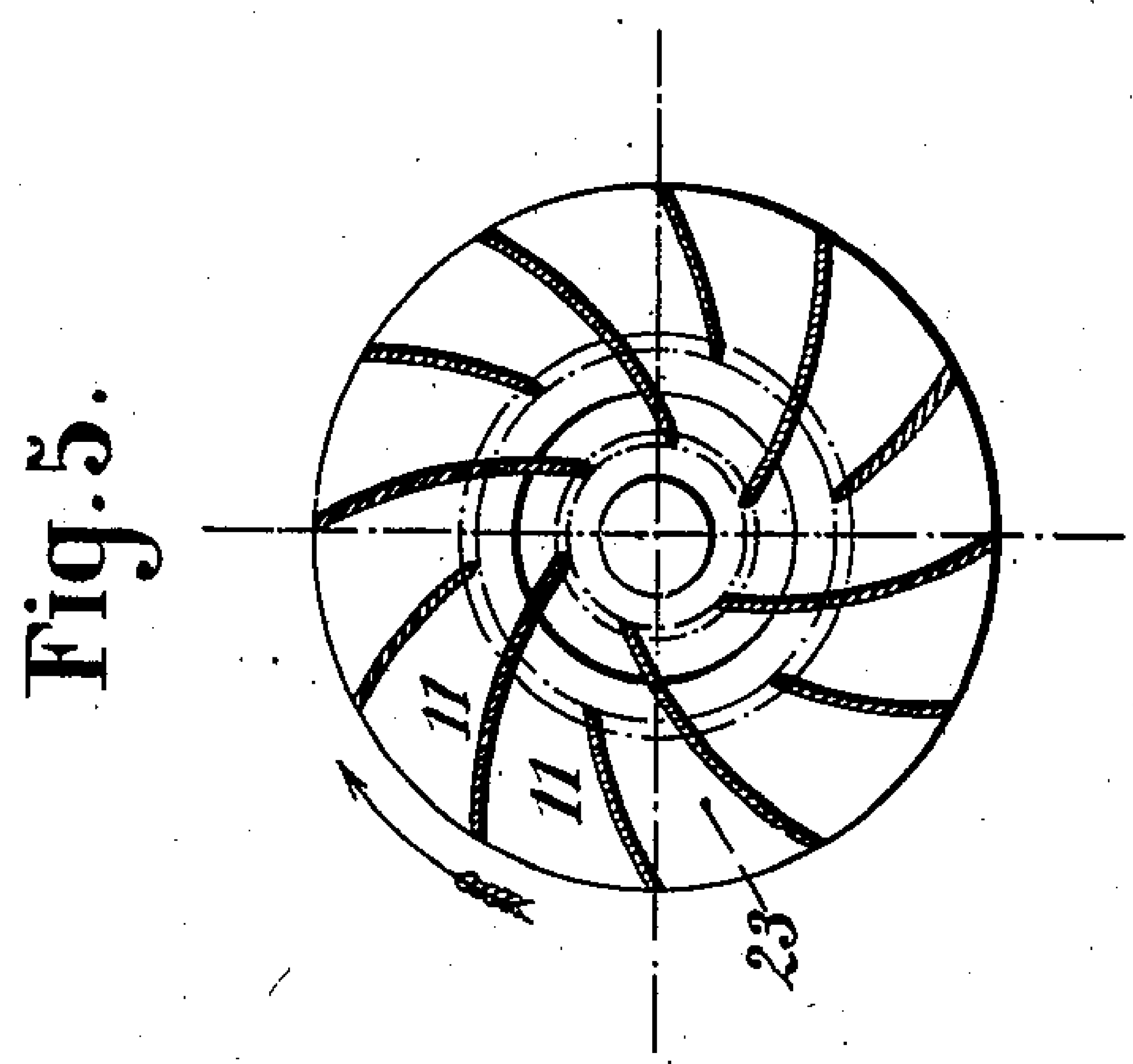
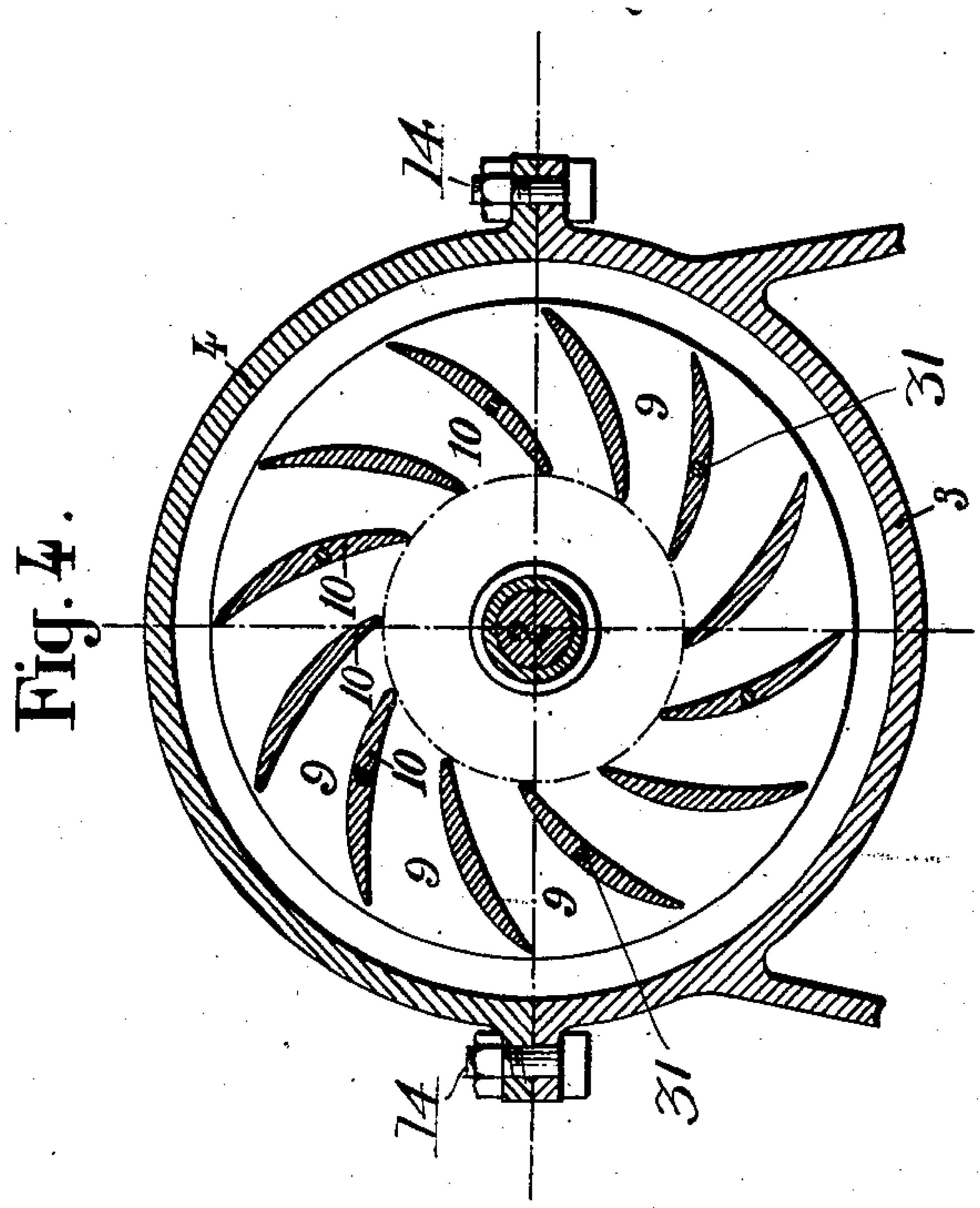
NO MODEL. 5 SHEETS—SHEET 4.





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NO MODEL. 6 SHEETS—SHEET 5.

Fig. 6.

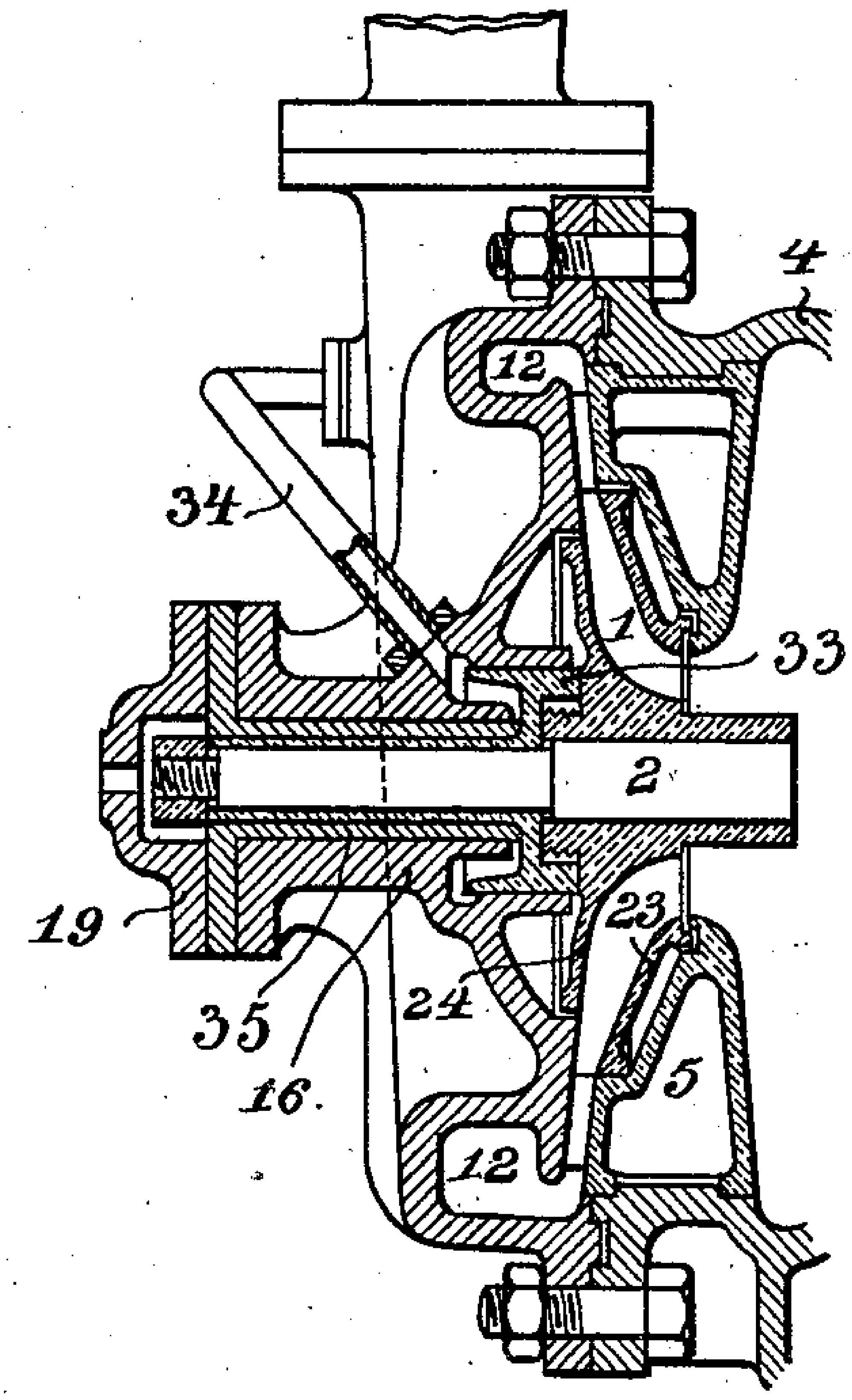
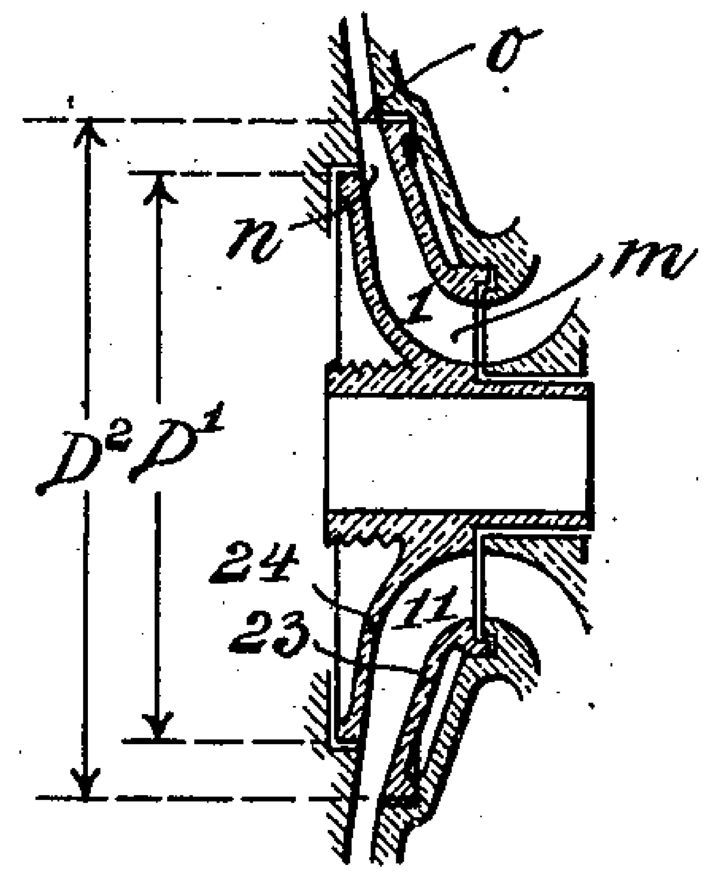


Fig. 7.



Witnesses:
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No. 742,231. Patented October 27, 1903.

UNITED STATES PATENT OFFICE.

AUGUSTE CAMILLE EDMOND RATEAU, OF PARIS, FRANCE.

CENTRIFUGAL PUMP.

SPECIFICATION forming part of Letters Patent No. 742,231, dated October 27, 1903.

Application filed October 7, 1901. Serial No. 77,825. (No model.)

To all whom it may concern:

Be it known that I, AUGUSTE CAMILLE EDMOND RATEAU, a citizen of the Republic of France, residing at Paris, France, have invented certain new and useful Improvements in Centrifugal Pumps, of which the following is a specification.

My invention has relation to a system of multicellular turbine centrifugal pumps rotating within a case divided into compartments by a series of transverse partitions, and in such connection it relates to the arrangement and construction of such a pump.

Heretofore as a general rule centrifugal pumps have been used solely for lifting the liquid or fluid to moderate heights. It is, however, possible to apply such pumps for lifting to great heights. To accomplish this under efficient mechanical conditions, a certain number of centrifugal turbines, through which the current of liquid or fluid successively passes, must be connected in series, and the simplest manner of doing this is to arrange all the turbines side by side upon the same shaft. In such an arrangement, however, two main difficulties are encountered—namely, first, the apparatus must be so arranged that loss from churning and friction of the fluid in the passages of the pump is not too great, and, secondly, extreme care must be taken to prevent the longitudinal thrust upon the shaft, which when the fluid is forced to a great height is very great.

The object of my present invention is to provide a centrifugal turbine-pump of the multicellular type, whereby the fluid may be raised to any height and wherein the aforementioned difficulties are avoided and the mechanical efficiency of the pump is improved.

The nature and scope of my invention will be more fully understood from the following description, taken in connection with the accompanying drawings, forming part hereof, in which—

Figure 1 is a longitudinal sectional view of a multicellular pump of seven turbines embodying main features of my invention. Fig. 2 is a plan view of the same. Fig. 3 is an end elevational view of the discharge end of the pump. Fig. 4 is a transverse sectional view taken on the line A A of Fig. 1 and illustrating the passages connecting the turbines together. Fig. 5 is a sectional view illustrating in detail one of the turbines. Fig. 6 is a sectional view illustrating in detail a modified form of supporting the thrust upon the turbine-shaft, and Fig. 7 is a diagrammatic view illustrating the construction of the front and rear disks of the turbine.

Referring to the drawings, the pump is made up of turbines 1, keyed side to side upon a common shaft 2. These turbines 1 are each identical in construction with the others and their mouths point in the same direction. They turn in a cylindrical case made in two parts 3 and 4, connected by a central joint. The cylinder is divided by circular partitions or diaphragms 5, forming as many cells as there are turbine-wheels. The water enters by the passage 7 and the circular pocket 8 and passes successively through the turbines or moving wheels, going from one to the other by passages 9 in the diaphragms, which are of an inverted-**U** shape in section. It will be understood that after the liquid has escaped from the periphery of one of the turbines 1 it moves away from the shaft in the first branch of the **U**. Then having turned the edge of the fixed disk 6 it comes back toward the entrance of the next turbine, approaching the shaft by the other branch of the **U**. The two branches of the **U** passage are of substantially equal area in cross-section. These passages 9 diverge slightly in the direction of the movement of the liquid. The return-passage toward the entrance of the next turbine has fixed vanes 10, having a concave inner side and a convex outer side, as illustrated in Fig. 4. These vanes extend substantially the entire length of the return-passage from the upper bend to the eye or opening leading to the next succeeding turbine in series. The object of these vanes is to divide the mass of fluid and to prevent the churning movement which it has on leaving the preceding wheel from increasing in proportion as the liquid approaches the shaft. The liquid thus passes from turbine to turbine and the pressure rises proportionally as it goes from one to the other. The last turbine delivers it into an annular chamber 12, from which it passes by a cone 13 to the delivery-pipe.

The diaphragms are surfaces of revolution and are not divided in a diametrical plane. They are made in two circular parts 5 and 6, between which are the vanes 10, cast in one piece with the part 5, the two parts 5 and 6 being put together by screws 31, as illustrated in Figs. 1 and 4, which go through the vanes 10. The diaphragms are held in the cylindrical case by grooves into which they fit. This method of construction allows as many moving wheels as are necessary to obtain the required pressure to be put on the shaft while using the speed suitable to the motor coupled to the shaft, and thus enables a pump to be made suited to the work required to be done by it. The first turbine 1 is first put on the shaft and keyed to it. Next the first diaphragm, which is an easy fit, is slipped onto the shaft. Then the second turbine is keyed onto the shaft. Then the second diaphragm is slipped on, and so on until the last turbine is put on. In this manner a series of wheels keyed to the shaft alternately with unkeyed diaphragms is obtained. The whole is then put into the lower half of the outer cylindrical case of the pump as a cradle, the diaphragms being properly placed in the grooves made to receive them. The top half 4 of the case can now be placed in position and fastened to the lower half by the side bolts 14.

The ends of the casing of the pump consist of a standard 15 on the right made in two pieces, which contains the suction-pipe, and by a standard 16 on the left, which contains the delivery-passage 12. The shaft works in two wooden bearings 17 and 18. At the delivery side on the left the shaft does not pass through the standard 16, which is closed by a cover 19, while on the right the shaft passes through the standard 15 by a stuffing-box 20, through which water is passed by the pipe 21.

The diaphragms are made without a diametrical division in order to render them stiffer and to prevent the water returning from one turbine to the preceding one. If the grooves in which the diaphragms are put are well made, the water can only return by the very slight play on the shaft or between the center of the turbines and the central part of the disks 6 of the diaphragms. In order to take it to pieces, there are provided screws 22, as shown in section, Fig. 1, which bear on the diaphragms and act like screw-jacks to raise the upper half of the cylindrical case after removing the bolts which fasten it to the lower half.

The vanes 11 of the moving turbines are shown in Fig. 5. These are of the usual construction, though there may be used two series of vanes, six long and six short.

The great difficulty, as previously stated, in high-pressure pumps with multiple disks is to equalize the longitudinal thrusts on the shaft. These thrusts may be balanced in the following way: The vanes of the turbines are cast with two disks. One, 23, Fig. 5, which may be called the "face" of the turbine, goes from the outer edge of the opening to the periphery of the turbine. The other, 24, which is the back of the turbine, extends from the center to a point nearer the axle than the peripheral end of the vanes. Thus the diameter D' of the back 24, Fig. 1, is less than the maximum diameter D^2 of the wheel. The vanes 11 have between the edge of the back and their end a free edge, which moves with a little play against the face of the disk 6. In this way the pressure on the back exercised by the liquid which is behind is less than if the back was continued up to the periphery of the turbine, and the diameter D' of this back can be so calculated that the pressure of the liquid behind the back exactly or very nearly balances the total pressure of the liquid on the other face or front of the turbine. In Fig. 7 there is illustrated in diagram this feature of my invention. As there shown the diameter D' of the rear disk 24 is smaller than the diameter D^2 of the disk 23, carrying the wings of the turbine. When the curved canal through which the water passes in the turbine-wheel is considered in detail, it will be seen that the water enters at the center and leaves at the periphery and that the pressure of the water will steadily increase along this canal from the center to the periphery of the wheel. The pressure is at a minimum at the point m. It is greater at the point n and is at its maximum at the point o, the outlet from the wings of the turbine. If now a communication be made between the space to the rear of the back disk 24 and one of the points of the canal through which the water passes, the pressure at that point of the canal will be the same as the point to the rear of the disk 24, from which communication is made with the point of said canal. Where the diameters D' and D^2 are equal, it will be evident that the pressure upon the disk 24 will be equal to the pressure of the water as it issues from the wheel. When, however, this diameter D' is smaller than the diameter D^2, the pressure on the disk 24 is more feeble than the pressure of the water at the exit from the wheel. In Fig. 7 the pressure upon the disk 24 is equal to the pressure of water at the point n in the canal. If the diameter D' be still further diminished, the pressure upon the disk 24 would become less. Hence it will be readily understood that by varying the proportions of the disk 24 the pressure thereon may be correspondingly varied, thus furnishing a means of varying the forward pressure upon the wheel. It is thus possible to accurately equalize the longitudinal pressure or even to give it a certain value in one or the other direction. Nevertheless the calculation of this equilibrium cannot be made with absolute exactness, and there is often a residual thrust on the shaft. It is possible to get rid of this residual thrust by means of a piston at the end of the shaft. This piston (shown at 25, Fig. 1) turns with little friction, fitting with a little play the cylindrical case 26. One of the faces of the piston is open to the bottom of the delivery-pipe by the pipe 28 and the other face by a pipe 32 with some other point in the body of the pump. There can be found by trial the point in the body of the pump at which this second pipe must be connected in order that the difference of pressure between the two faces of the piston may cause the exact longitudinal equilibrium. A simpler method is to place this piston immediately behind the end of the last turbine instead of placing it at the end of the shaft, as illustrated in Fig. 6. The method of operation remains the same. In this modification the piston is placed, as at 33, in the interior of the body of the pump behind the last wheel in series. A pipe 34 leads the water from the exit to the rear of the piston. The piston has a sleeve projecting along the shaft and turning in a bearing 35.

The cocks 29 for getting rid of air and the funnel 30 for filling the pump may be mentioned as accessory details.

The multicellular pump hereinabove described may be used to pump liquids or gases and, if desired, may be used as a centrifugal ventilator.

Having thus described the nature and objects of my present invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a pump of the character described, a series of turbines arranged side by side upon a common shaft, a diaphragm separating contiguous turbines, a U-shaped passage formed in each diaphragm and having a delivery and a return branch of substantially the same area in cross-section, and a series of fixed vanes arranged in the return branch and each of a length substantially equal to the distance from the bend of the U-shaped passage to the eye or opening communicating with the next succeeding turbine in series.

2. In a pump of the character described, a series of turbines arranged side by side upon a common shaft, a diaphragm separating contiguous turbines, a U-shaped passage formed in the diaphragm and connecting the discharge from one turbine with the inlet-opening of the next succeeding turbine, and a fixed vane having a concave inner side and a convex outer side extending in the discharge branch of the U-shaped passage from the bend of said passage to the inlet-opening.

3. In a pump of the character described, a series of turbines arranged side by side upon a common shaft, a diaphragm separating contiguous turbines, and extending annularly around the shaft, a cylindrical casing formed of a plurality of separable parts inclosing the diaphragms and turbines, the interior of said casing being grooved to receive and retain the diaphragms and a U-shaped passage formed in each diaphragm and connecting the discharge from one turbine to the inlet-opening of the next succeeding turbine.

4. In a pump of the character described, a series of turbines arranged side by side upon a common shaft, a series of disks alternating with the turbines and each separating contiguous turbines, a series of diaphragms coacting with the disks to form U-shaped passages for the fluid leading from one turbine to the next turbine in series, said diaphragms connected with and supporting said disks in fixed relationship with the shaft, and a two-part casing inclosing the shaft, turbines, diaphragms and disks, and having its interior grooved to receive and support said diaphragms.

5. In a pump of the character described, a series of turbines, each comprising two disks separated from each other to form the delivery-passage of the turbine, the rear disk of the turbine being of smaller diameter than the other disk, all arranged so that the pressure upon the rear disk is less than the pressure of fluid escaping from the periphery of the turbine, substantially as and for the purposes described.

6. In a pump of the character described, a turbine comprising two disks separated from each other to form the delivery-passage for the fluid, one of said disks having a central opening for the entrance of the fluid and the other disk being solid and of a diameter less than the diameter of the first disk, all arranged so that the pressure upon the second disk is less than the pressure of fluid escaping from the periphery of the first disk, substantially as and for the purposes described.

7. In a pump of the character described, a series of turbines arranged side by side upon a common shaft and successively traversed by the fluid, in combination with a means for relieving the pressure upon the forward face of each turbine and independent means for relieving the longitudinal thrust upon the shaft, substantially as and for the purposes described.

8. In a pump of the character described, a shaft, a series of turbines arranged side by side on said shaft and successively traversed by the fluid, in combination with means for relieving the pressure upon the forward face of each turbine and means for relieving the longitudinal thrust upon the shaft, comprising a piston, having one face bearing against the thrust end of the shaft, and means for placing both faces of the piston under pressure of fluid taken respectively from the delivery-passage and from a point directly in front of the forward face of a turbine arranged intermediate of the entrance and outlet of the pump, substantially as and for the purposes described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

AUGUSTE CAMILLE EDMOND RATEAU.

Witnesses:
PAUL DE MESTREL,
J. ALLISON BOWEN.