WORTHINGTON CENTRIFUGAL PUMPS

For Heads Up to 2000 Feet

The John McDougall Caledonian Iron Works Co.

Limited

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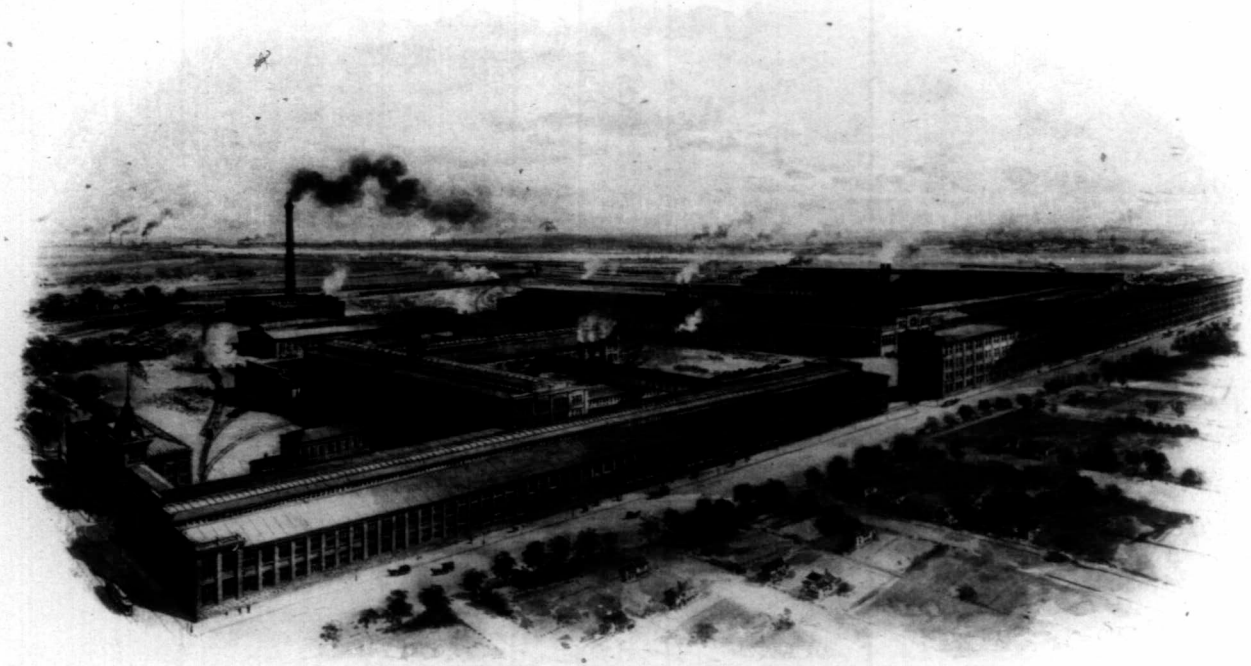
WORTHINGTON CENTRIFUGAL PUMPS.



Henry R. Worthington Hydraulic Works, Harrison, N. J.

Contain 18 Acres of Floor Space and will Accommodate 5,000 Men.

WORTHINGTON CENTRIFUGAL PUMPS

TURBINE
VOLUTE
CONOIDAL

CATALOGUE W.-50

HENRY R. WORTHINGTON.
NEW YORK

Established 1845

THE JOHN McDOUGALL CALEDONIAN IRON WORKS CO., Ltd.

WORKS :

Corner William and Seigneur Streets,

MONTREAL.

Licensees and Manufacturers for Canada.

Canadian Patents 1901, No. 73,076 ; 1902, No. 75,069.

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All correspondence should be addressed to The John McDougall Caledonian Iron Works Co., Ltd., Montreal, Que.

All shipments F. O. B. Montreal, unless otherwise agreed upon.

HENRY R. WORTHINGTON.

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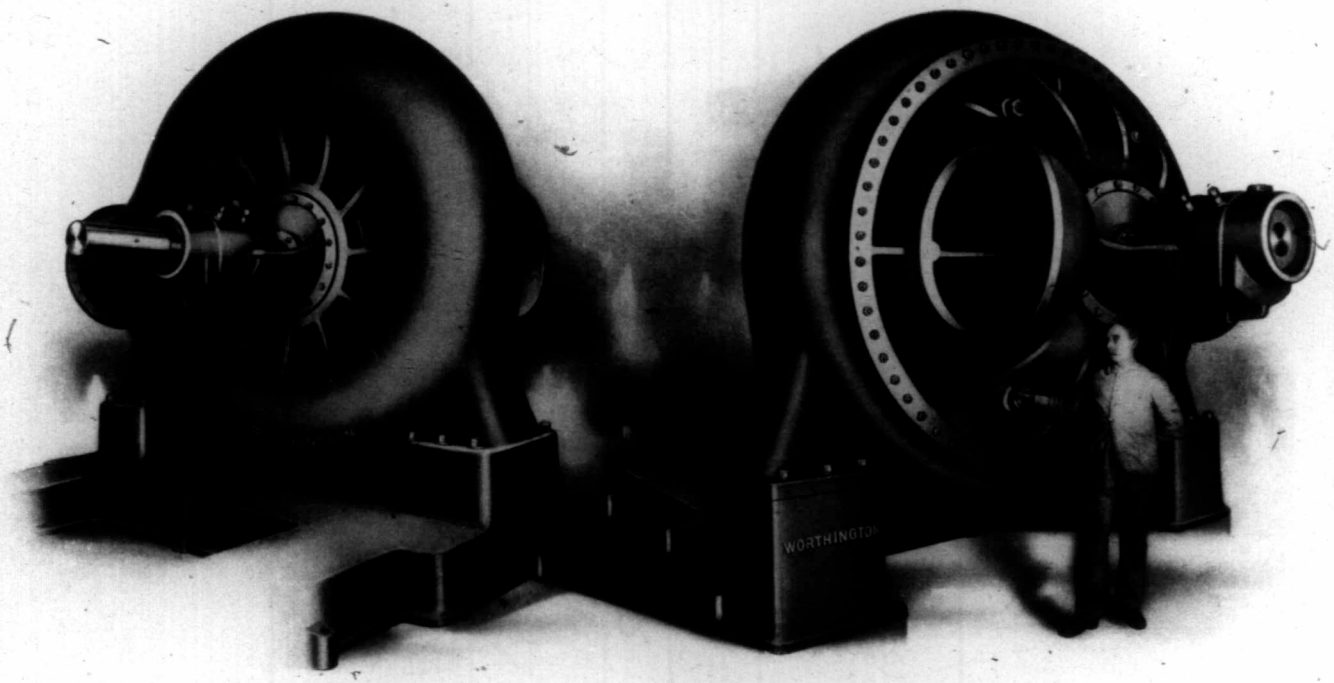

(Patented.)

36-INCH TURBINE PUMP.

Capacity, 35,000 gallons per minute against 160 feet head. Three of these pumps, each driven by a 2,000-H. P. motor, will supply the Grand Cascade at the St. Louis Exposition, 1904.

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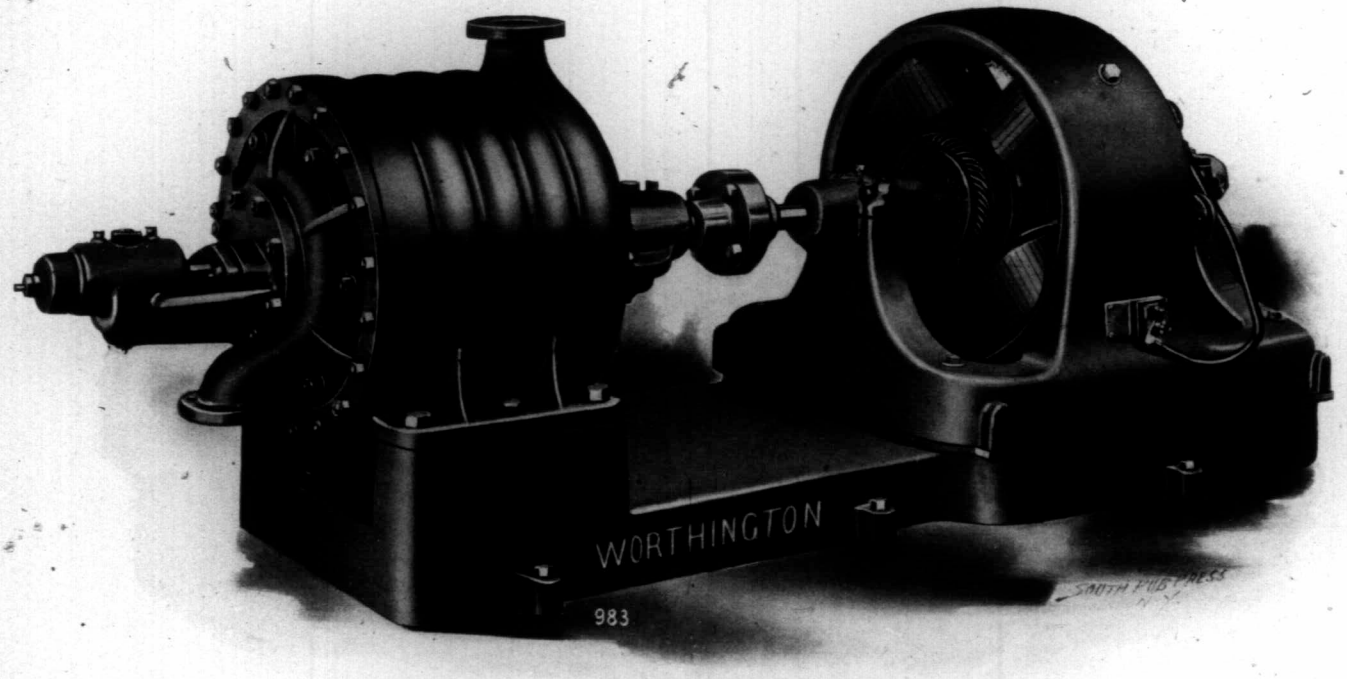
HISTORICAL INTRODUCTION.

Few problems in the field of hydraulics present more interesting possibilities and at the same time have been so universally neglected as centrifugal pumping. The centrifugal pump is the converse of the turbine water-wheel. Its development has been analogous to that of the steam turbine in that both were pioneers in their respective fields and both were abandoned in favor of reciprocating machines before having been thoroughly exploited, the pump because the principles of its action were not clearly understood, and the steam turbine because of mechanical difficulties in construction.

The earliest history of the centrifugal pump cannot be traced, but it is known that centrifugal machines for lifting liquids were in use during the latter part of the Seventeenth Century. About 1703, Denis Papin, the famous French engineer, designed his "Hessian Suck," a form of centrifugal pump embodying nearly all of the essential features of the present day machine. Drawings of this pump are in existence which show that Papin was not only a designer of no mean ability, but that he had a good comprehension of the principles with which he was dealing. After Papin there seems to have been no further development of his ideas until 1818, when the earliest prototype of the present form of centrifugal was brought out in Massachusetts and has since been known as the "Massachusetts pump." This pump was of the type herein designated "volute," and was provided with double suction openings and an open impeller. It was re-invented by Andrews and others in 1846, and was shortly afterwards introduced into England, by Mr. John Guynne.

The commercial history of the centrifugal pump dates from the year 1849, when Appold exhibited a model at the meeting of the British Association at Birmingham. During the next two years he so improved on this first model



(Patented.)

FIVE-STAGE TURBINE PUMP

This illustration conveys an excellent general idea of the Worthington multi-stage turbine pump as constructed for deep mine and other services where heavy pressures are encountered. The five-stage pump is adapted to any capacity, and for heads up to 750 feet.

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This illustration conveys an excellent general idea of the Worthington multi-stage turbine pump as constructed for deep mine and other services where heavy pressures are encountered. The five-stage pump is adapted to any capacity, and for heads up to 750 feet.

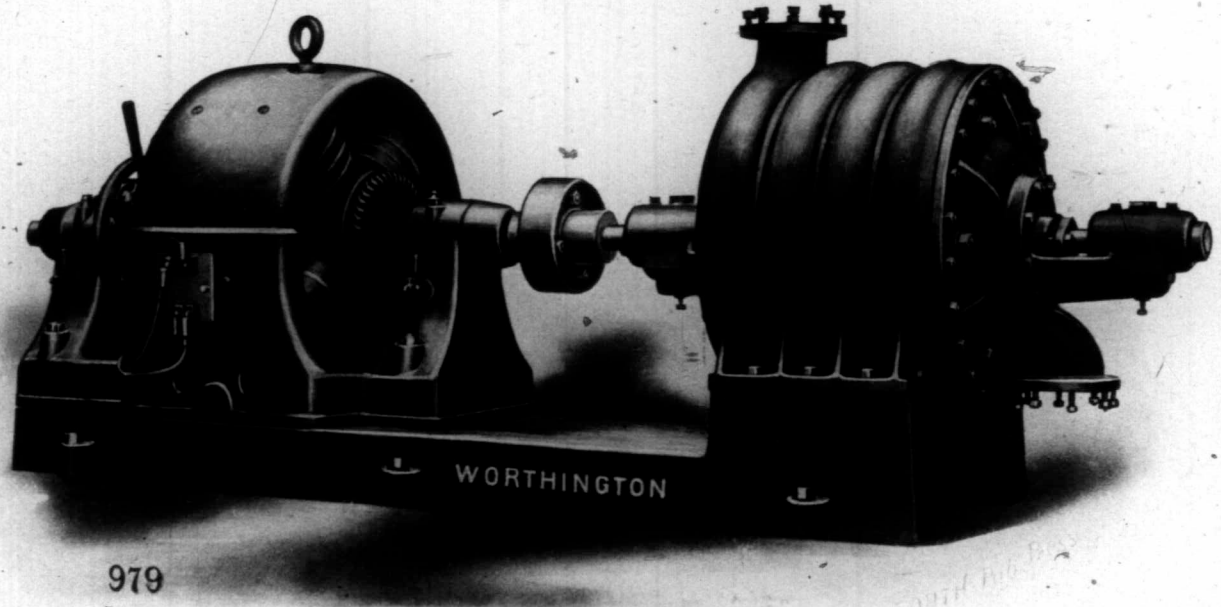
that his pump became one of the chief features at the Exhibition in London, in 1851. The interest aroused by Appold's pump was productive of much experimentation and discussion, which resulted in improving the pump until it assumed the form that it has maintained up to the last two or three years. Many attempts were made at high-head work, but without success.

From the crude and inefficient low-lift pump this Company has developed a scientifically designed, high-lift centrifugal, which has found application within the field hitherto occupied by displacement pumps exclusively. While 50 feet head was formerly considered the maximum for efficient operation, 2,000 feet is now practicable, and the efficiency has been placed on a par with that of displacement pumps. There has also been plenty of room for improvement in low-head pumps and these have not been neglected while perfecting the high-head pump.

THE PROBLEM.

The problem of the centrifugal pump designer is to so proportion the parts of his pump that it will pick up the water from rest, or from, perhaps, a velocity of 10 feet per second, bring it to the high velocity required by the head pumped against and then allow it to come to rest again in such manner that during the whole operation there shall be as little internal or other friction or loss by leakage or slippage as possible. Success depends almost wholly upon the form and proportions of the passages through which the water enters the impeller chamber, the shape of the impeller vanes and the design of the chamber into which the water is delivered from the vanes.

The early centrifugal pumps were made with straight, flat vanes, which discharged into a chamber of more or less conventional form. The result was excessive internal friction. All velocity consumed by friction and eddy currents in the water is so much lost work and is not effective in producing hydraulic head. The great improvements which



(Patented.)

FIVE-INCH, FOUR-STAGE TURBINE

Used as a station pump in a gold and silver mine. Capacity, 500 gallons per minute against 520 feet head.

have been made in the characteristics of centrifugal pumps have followed from careful, scientific design in proportioning severally the various parts of the pump chamber, the impeller and the diffusion vanes between the periphery of the impeller and the case. It is possible by properly proportioning the several parts to build a pump having almost any desired characteristics and fitted for any special requirements of service.

EFFICIENCY OF CENTRIFUGAL PUMPS.

The Worthington centrifugal pumps show efficiencies nearly always in excess of those of other types of power-driven pumps used in the same services. Heretofore, the efficiency curves of centrifugal pumps have always reached maximum values at points which the builders (endeavoring to adapt one design to all services) seem to have been unable to control. However, by intelligent, specialized design, this maximum point can be made to occur at any desired head. This is accomplished by modifying the internal proportions of the pump without in any way changing the general mechanical features.

FIVE-INCH, FOUR-STAGE TURBINE

Used as a station pump in a gold and silver mine. Capacity, 500 gallons per minute against 520 feet head.

(Patented.)

FOUR-STAGE TURBINE PUMP

With the driving motor enclosed in a cast-iron housing. This machine was constructed for mine service in Mexico, where the mines are frequently flooded, and the design permits continuous pumping, even though the motor and pump be submerged to a depth of several hundred feet. Capacity, 200 gallons per minute against 500 feet head.

THE WORTHINGTON CENTRIFUGALS.

The Worthington centrifugal pumps are divided into three classes, viz.: Conoidal, Volute and Turbine.

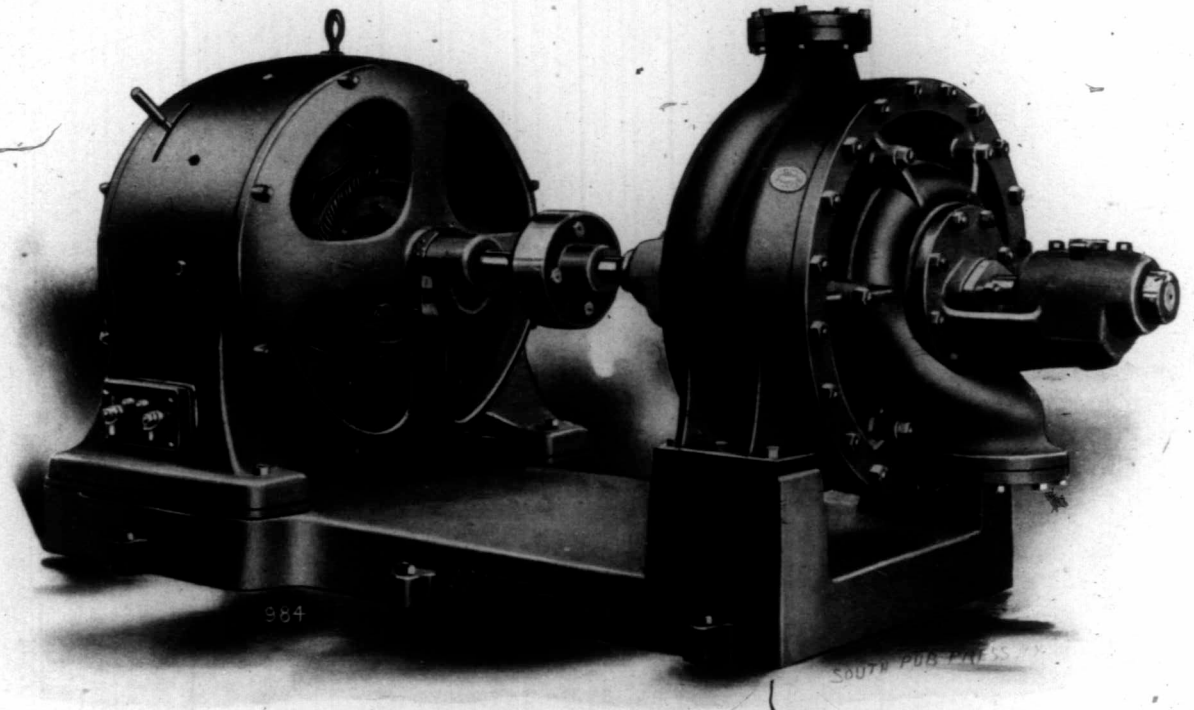
The Conoidal Centrifugals (described on Page 23) are designed especially for low lifts and large deliveries and are adapted to irrigation work, the handling of sewage and similar purposes. They are comparatively inexpensive and operate at high rotative speeds, making possible direct connection to electric motors. For heads up to 30 feet they are unexcelled in the pumping field.

The Volute Centrifugals (described on Page 25) are built for medium lifts, but for all capacities. Since they run at moderate speeds, diffusion vanes are not needed, but the volute casing has been carefully designed to obtain high efficiency and 86 % has been shown under test. These pumps are recommended for heads up to 70 feet, although they will safely withstand 150 feet.

The Turbine Pump is suited to very high lifts, even exceeding 2,000 feet. This class of pump is described in the following paragraphs :

WORTHINGTON TURBINE PUMPS.

The Worthington turbine pump has been developed by a long series of experiments conducted by able engineers under the direction of the foremost specialist in this field. The diffusion vanes, which form the distinguishing feature, take the place of the usual whirlpool chamber in other forms of centrifugal pumps and assist in bringing the water to rest without internal commotion or shock. They correspond in function to the guide vanes of turbine waterwheels. One of the difficulties presented by high-lift centrifugal pumps has been the great peripheral speed required when only a single impeller is employed. This has been overcome in the Worthington multi-stage turbine pump by mounting a number of discs or impellers, each operating in a separate chamber, upon a single shaft and passing the water through the impeller chambers in succession. The



(Patented.)

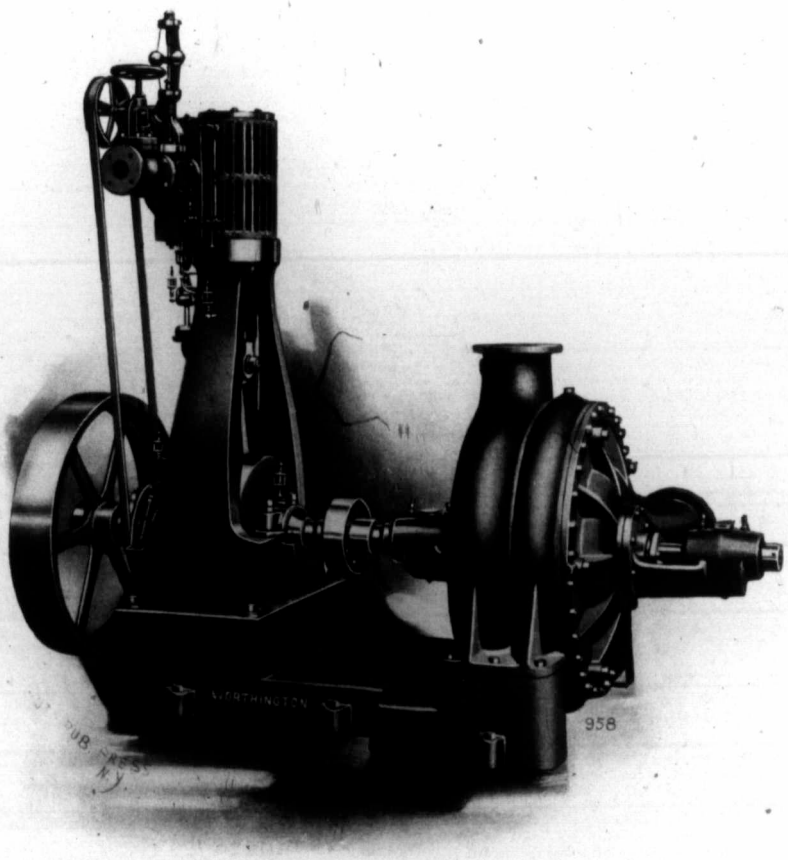
FIVE-INCH, TWO-STAGE TURBINE

Used in mine service. Capacity, 500 gallons per minute against 200 feet head.

lift can thus be multiplied three, four or five times, while the number of revolutions is kept within such bounds that it is possible to connect the pump directly to a steam engine or an electric motor. It has been demonstrated by experiment that on the same work and within reasonable limits, multi-stage centrifugals are more efficient than single-stage pumps, the increased efficiency being due to a decrease in the frictional losses coincident with the reduced peripheral speed of the impeller.

Particular attention has been devoted to the mechanical details in order to produce a machine that would withstand the most severe service for long periods of time without renewals or repairs. The bearings, of liberal proportions, are supplied with ring oilers and are lined with the best quality of babbitt, hammered in, reamed true and scraped to a perfect fit. In all except the very small sizes, these bearings have been entirely separated from the pump casing, an improved form of construction effectually eliminating all possibility of foreign matter working into the bearings when the pump is handling water containing silt or sand. This construction further makes it possible to renew the bearings without entirely dismantling the pump and will meet with the approval of all engineers familiar with centrifugal or rotary pumps. The shafts are of machine steel. They are mathematically accurate and straight and are perfectly polished.

Used in mine service. Capacity, 300 gallons per minute against 200 feet head.



(Patented.)

TEN-INCH, TWO-STAGE TURBINE

Direct-connected to a steam-engine. This pump delivers 2,500 gallons per minute to an elevated jet condenser, the head varying between 25 and 50 feet and the speed between 275 and 325 revolutions per minute.

THE IMPELLER.

The usual method of compounding hitherto practised by other manufacturers has consisted in combining separate pumping units, one discharging into the other through a complex system of piping. We have found this so inefficient as to preclude its use in connection with the Worthington turbine pump, on which only suction and discharge pipes are employed, the water entering axially and issuing radially. The impellers remain in perfect longitudinal balance regardless of their number or the head against which the pump is operated, this balancing of the impeller being secured by an ingenious patented system of "triple vanes."

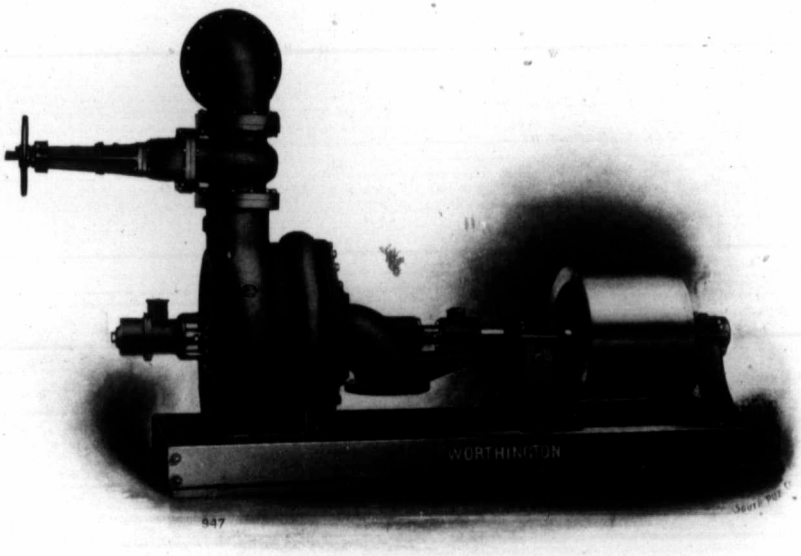
THE DIFFUSION VANES.

It is impossible to produce an efficient high-lift centrifugal pump unless the design be such as to bring about nearly complete conversion of the kinetic energy of water in motion into potential energy of water under static head. Remembering that the so-called "whirlpool chamber" in the ordinary form of centrifugal pump does not average more than six inches in depth, and that in this space the velocity must frequently be reduced from 80 feet per second to ten feet per second, it is obvious that the open chamber construction is totally unsuited for high-lift service.

In the Worthington Turbine Pump the efficient conversion of energy is assured by a patented system of diffusion vanes disposed in the throat opening between the periphery of the impeller and the annular casing, in much the same manner that guide vanes are placed in a reaction turbine water-wheel. These vanes form tangential, expanding ducts from which the fluid emerges at about the velocity existing in the chamber. They also eliminate all drag and friction between the periphery of the rapidly revolving impeller and the slowly moving water in the discharge chamber.

THE SPECIAL FIELD OF THE TURBINE PUMP.

The Worthington Turbine Pump has created an entirely new field of application for centrifugal pumps, embracing mine drainage, water-works, and numerous other services where rotary pumps are desirable but have not been employed, owing to their former poor efficiency at high heads.



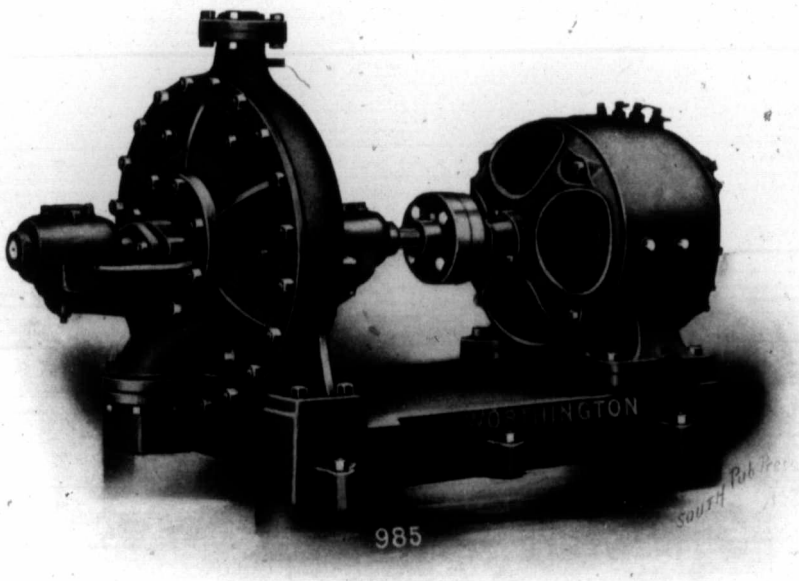
(Patented.)

EIGHT-INCH, TWO-STAGE TURBINE

Belt driven from a water-wheel and used for placer mining in Idaho. Capacity, 1,750 gallons per minute against 170 feet head.

As a sinking or station pump for mine service, the turbine pump is ideal. There are no valves, guards or springs, no reciprocating parts, and, most important of all, there is not a contact surface in the entire machine except the shaft and its bearings. The design is such that parts subjected to the action of mine water may be made of

acid-resisting metal, and, when desired, lead-lined pumps will be supplied. The space occupied is less than one-third of that required by a reciprocating pump of equal capacity, and the first cost, including the motor for driving, is only about one-half. Since there are no rubbing surfaces exposed to the water, the pump will run for years without renewal or repairs. In case of accident, the parts are so

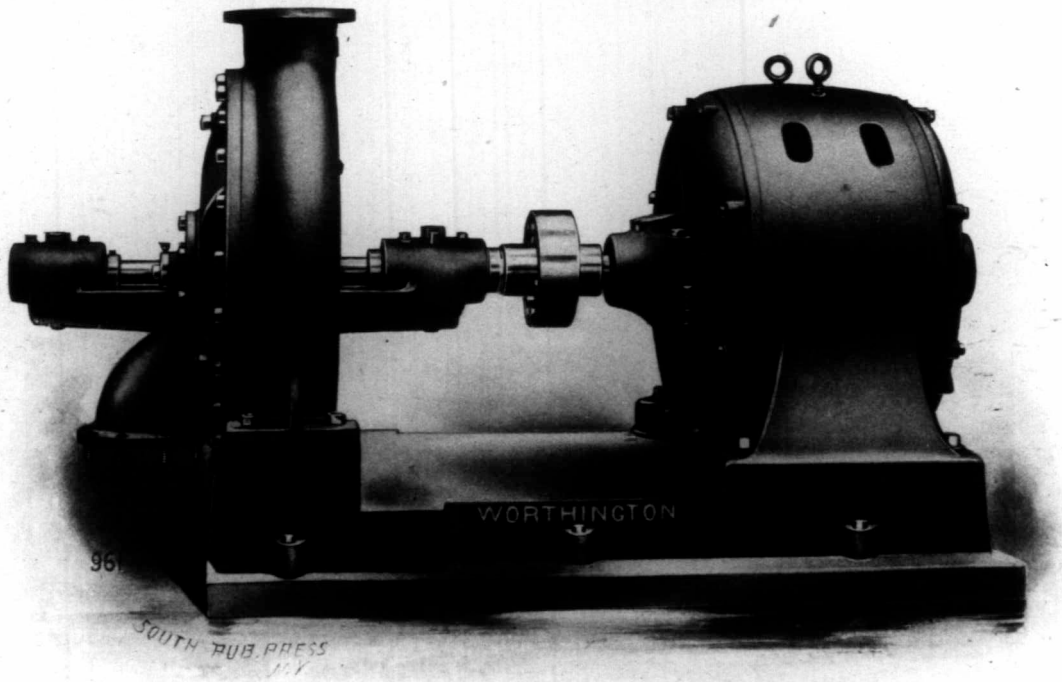


(Patented.)

2½-INCH SINGLE-STAGE TURBINE

Used as a sinking pump. Capacity, 150 gallons per minute against 90 feet head.

few and the construction so simple that any part of the machine can be replaced in less than one hour. The cost of attendance is reduced to the minimum, since the only necessary attention is to see that the pumps and motors are properly lubricated. The simplicity and reliability of the centrifugal pump make it especially suitable for isolated stations.



(Patented.)

EIGHT-INCH SINGLE-STAGE TURBINE PUMP

Driven by an induction motor; used in the general water service of a large smelter plant. Capacity, 1,800 gallons per minute against 70 feet head.

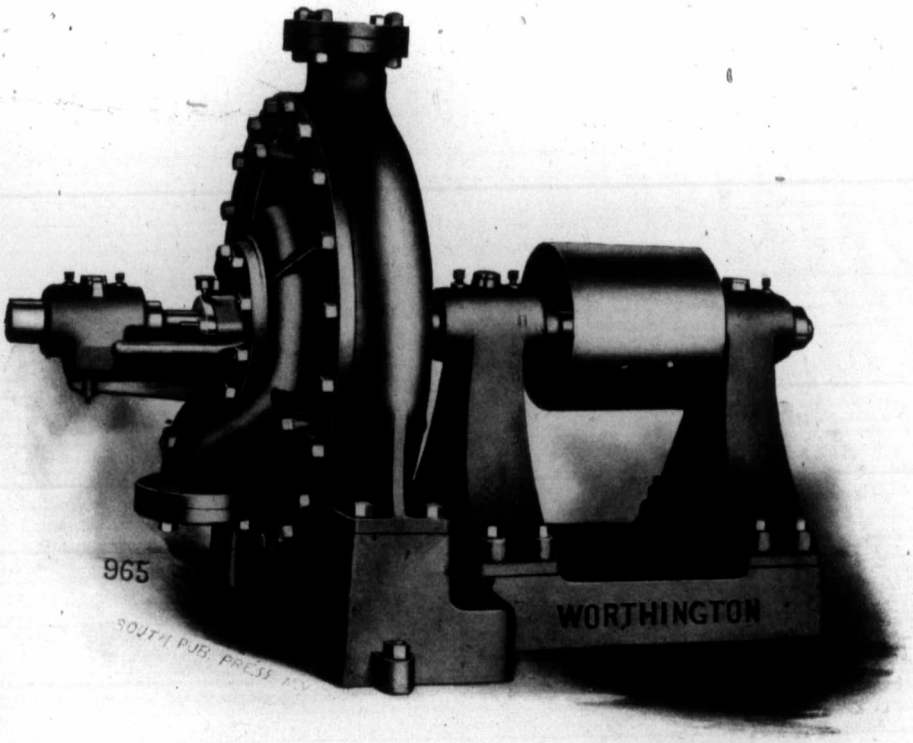
The turbine pump is adapted to be driven by either an electric motor or a steam engine, but the former is much preferable for mine service, as it eliminates heat, avoids the use of condensers, occupies less space, requires less attention and is more efficient. Special motors are not required for direct-connected work, our range of patterns being so large that it is possible to adapt the pumps to any motor of standard speed. Either direct or alternating current motors can be used and the pumps can be started against full delivery pressure without the use of special starting devices. Where power-driven pumps are applicable, the turbine pump will be found eminently satisfactory. Worthington turbines are daily supplying water for steel plants, water works, elevators, and other services where the average water pressure exceeds 125 pounds per square inch.

In addition to the Turbine pump a complete line of low-lift centrifugals has been developed, and patterns of high-efficiency machines for all conditions of service are kept on hand. On the accompanying pages are illustrated some of the various types in service.

THE CONOIDAL PUMP.

One of the best known of these is the "Conoidal." This pump has been designed to meet the demand for a thoroughly well-built, compact machine for direct connection to electric or other high-speed motors. The general appearance is somewhat different from the ordinary centrifugal, due partly to the widening of the pump chamber to admit a special form of impeller. The latter consists of a double, conical-shaped core, on which radial vanes are cast or mounted. The peculiar shape of this core serves to modify gradually the direction of the incoming current, thereby preventing sudden changes of velocity and direction whereby power is absorbed and wasted. The pump chamber, or shell, is divided into two equal parts by a radial diaphram, or partition, extending

...connected motor; used in the general water service of a large smelter plant. Capacity, 1,800 gallons per minute against 70 feet head.



(Patented.)

FOUR-INCH, SINGLE-STAGE TURBINE PUMP

Having a capacity of 350 gallons per minute against 130 feet head.

entirely around the interior of the chamber and enclosing the base of the conoidal impeller. This partition prevents the impingement and consequent disturbance of the two entering columns of water.

The design of the moving parts of the conoidal has received special attention. The impellers are of cast-iron or brass of a suitable mixture. The shafts are of cold-rolled steel, and all outboard bearings are babbitt-lined and provided with ring oilers.

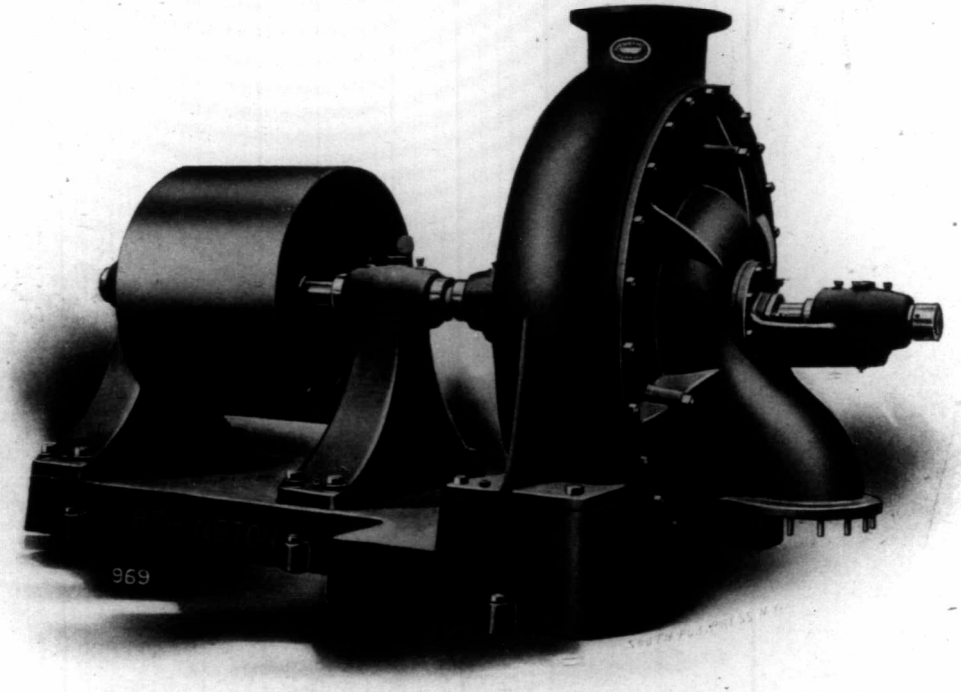
The conoidal pump is particularly adapted to belt driving where an efficient and compact machine is desired. The space required, in relation to the quantity of water delivered, is about one-half that of an ordinary centrifugal. The conoidal is designed for a maximum head of 30 feet only, but the capacity is practically unlimited. Several of these machines are now in operation, each handling 35,000 gallons of water per minute.

VOLUTE CENTRIFUGALS.

This type of centrifugal, as before stated, was one of the first to be developed and, with a few changes, has to the present day been adopted by most manufacturers as the standard. It has furnished the basis of published tests of centrifugals and of the commonly accepted notions concerning such pumps. Since the pumps have usually been designed without a correct understanding of fundamental principles, the results have mostly been poor or indifferent. For instance, William Kent, in his "Mechanical Engineers' Hand-Book," states:

"With centrifugal pumps, the lift at which maximum efficiency is obtained is approximately 17 feet. At lifts from 12 feet to 18 feet some makers of large experience claim now to obtain from 65 % to 70 % of useful effect, but .613 appears to be the best done at a public test under 14.7 foot head."

The new Worthington volute pumps embody important improvements which enable them to work efficiently up to



(Patented.)

SIXTEEN-INCH, SINGLE-STAGE TURBINE

Delivering 10,000 gallons per minute against 70 feet head for the general water service of steel works. The pump is arranged to be driven by belt from a steam engine.

a head of 85 feet, and they have shown under test an economy of 86%. It has been found possible to obtain a high efficiency at any head between 15 feet and 65 feet without making the pumps either especially large or expensive.

In the volute pump, because of the moderate heads and velocities, diffusion-vanes may be dispensed with. The impeller is of the triple-vane type employed in the turbine pump.

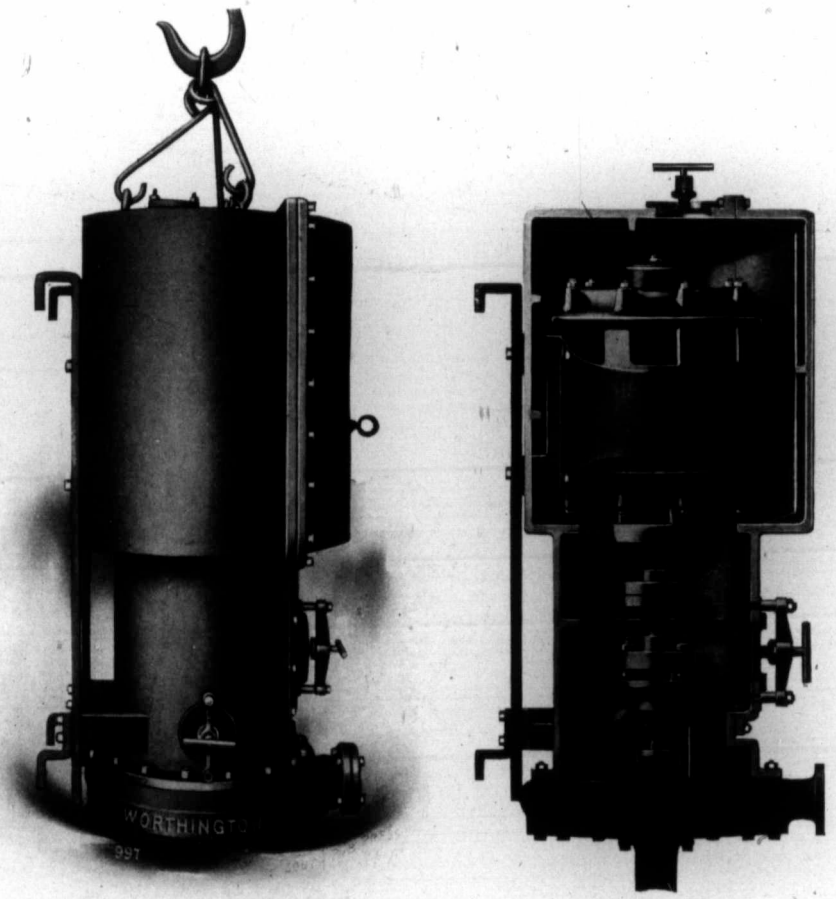
VERTICAL-SHAFT PUMPS.

It is frequently found necessary to locate a centrifugal pump in a pit below the floor level, in order to get within suction distance of the water supply. In cases of this kind the vertical centrifugal has been extensively used and has proved most satisfactory.

The pumps can be either belted or connected directly to vertical motors. The latter method makes an ideal pumping plant, as the motor can be located above ground where it is free from all moisture and can receive proper care. The design of the pump is such that it requires very little attention, and it is necessary for the attendant to go down into the pit only at long intervals. A number of these pumps are being used at blast furnaces and steel mills for general water service. They are also widely used in irrigation for pumping from wells in which the water level fluctuates greatly, often submerging the pump and rendering the use of horizontal belted or motor-driven pumps inadmissable.

GENERAL CHARACTERISTICS OF CENTRIFUGAL PUMPS.

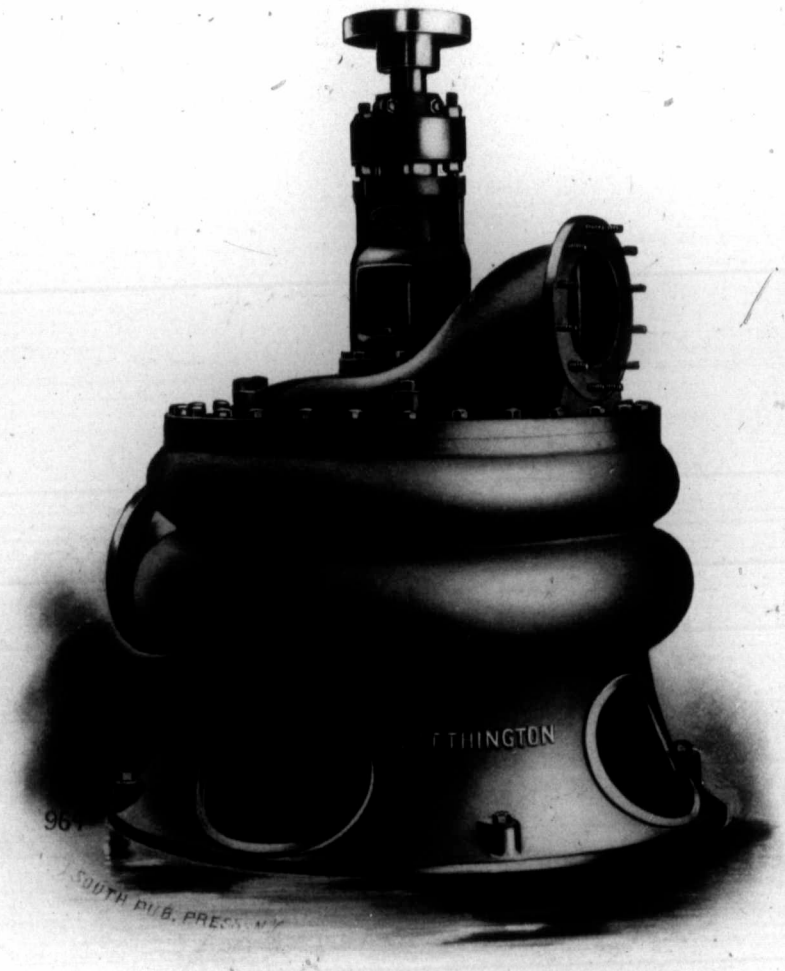
The relative values of the several quantities pertaining to the operation of a centrifugal pump such as speed, head and capacity, can be varied through wide limits to suit given requirements.



(Patented.)

THREE-INCH, TURBINE SINKING PUMP

The direct-connected motor is enclosed in a cast-iron housing.



(Patented.)

TWELVE-INCH, TWO-STAGE, VERTICAL TURBINE

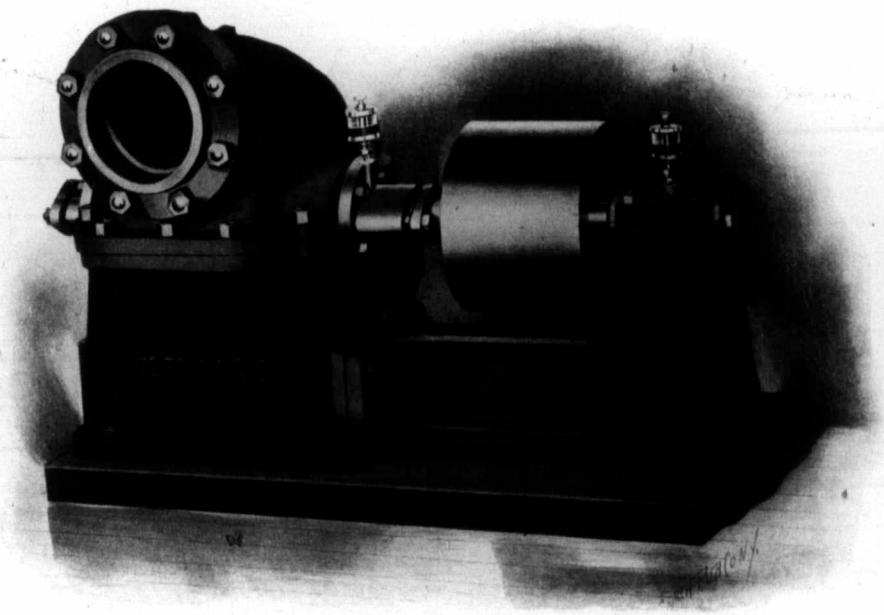
Designed for direct-connection to a vertical-shaft motor. For general water service in a large steel plant. Capacity, 5,000,000 gallons per day against 140 feet head.

(Patented.)

FOUR-INCH, VERTICAL, HOT-WELL TURBINE PUMP

Designed for direct-connection to a vertical-shaft induction motor. Capacity, 300 gallons per minute against 70 feet head. This pump is employed to remove the water of condensation from a surface condenser and takes its suction under a vacuum of 28 inches.

In pumping for city water supply, for instance, it is desirable to maintain a practically uniform head independently of the volume of water supplied, the speed being constant. Again, in dry-dock and other variable-head



(Patented.)

SIX-INCH CONOIDAL PUMP

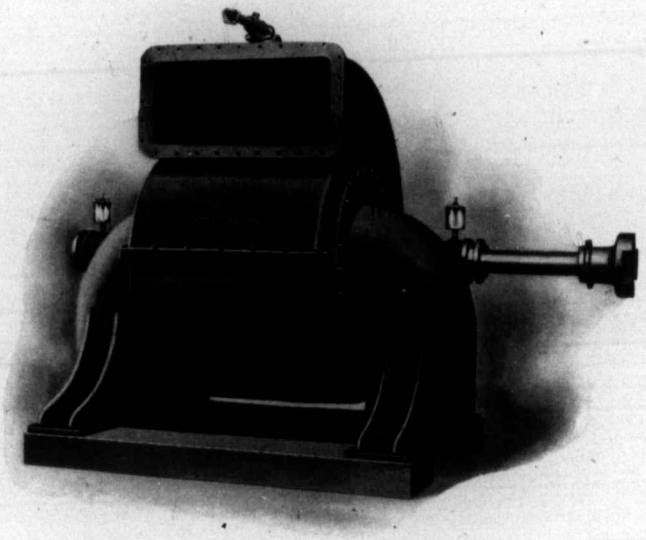
For pumping out excavations and coffer-dams and for other constructional work.

work, it may be desirable, in order not to overload the motor, that the power required should be practically constant through wide variations of head. While maintaining a constant speed, the quantity of water delivered may be made to vary almost inversely with the head.

In barometric condenser service it is often desirable that the pump should be capable at starting of forcing a small supply to the total height of the condenser, and then, after the vacuum is formed, of giving the normal quantity

of water, all the while operating at constant speed. These results can be obtained by intelligent and specialized design, which does not seem to have been fully understood or appreciated heretofore.

The ordinary standard centrifugal pumps on the market are all made to practically the same proportions and hence their characteristics are much alike. A pump



(Patented.)

THIRTY-SIX-INCH CONOIDAL PUMP

Used in irrigation service. Capacity, 30,000 gallons per minute against 20 feet head. A number of these pumps are in operation on Rice canals of Louisiana and Texas. They can be arranged either for direct connection to steam engines or for belt drive.

of this class may be well adapted for one service and entirely unsuited for another, with the result that the purchaser rejects centrifugal pumps in general, where-as it is in reality only the particular design which is unsuitable.

For general service it is usually desirable to have a pump so designed that at constant speed a wide variation

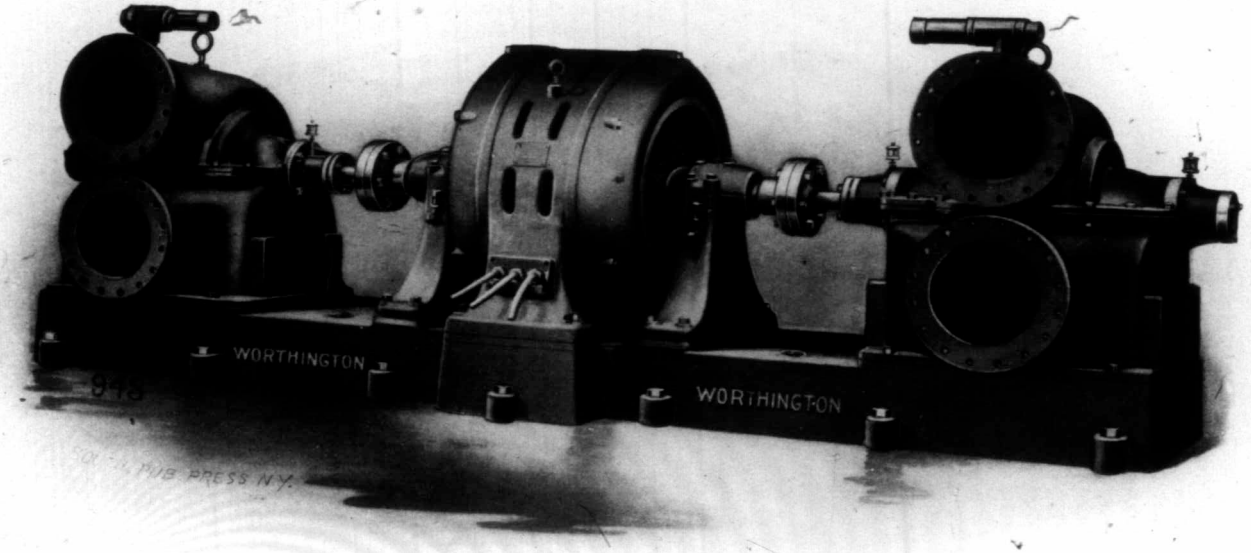
of head can be obtained by changing the quantity flowing through the pump. A pump so designed, say for 500 gallons per minute against 30 feet will, perhaps, be required to work against 40 feet head during low water, while the speed may not be subject to change owing to alternating current being used for power. With a Worthington pump specially designed for such work, there would simply be a decrease in capacity, which decrease would be made very small if necessary.

To obtain satisfactory results under all conditions requires careful study of each special case, and it is this attention to minute details that has brought about results considered impossible a short while ago. Building pumps under our system, each adapted to the conditions under which it is to operate, prevents carrying the completed pumps in stock, since the impeller and diffusion rings must be changed for every different set of conditions.

DIRECT CONNECTION TO ELECTRIC MOTORS.

The electric motor enters a widened field of usefulness through the improvement of the centrifugal pump, as the two are perfectly adaptable to each other. A motor-driven pump set is very similar in operation to a motor-generator set, the output being water under pressure in the first case, instead of electric current. At constant speed the power and output are inversely proportional to the resistance to flow, and the efficiency is practically constant within wide limits.

The operation of pumps by electric motors is often a complicated problem. First of all, there are very few places where a constant delivery of water is wanted. To vary the quantity, then, it is necessary either to vary the speed of the motor or to provide a complicated and unsatisfactory system of by-pass valves, both of which methods are in general wasteful of power and unsatisfactory in operation. In some cases automatic devices are



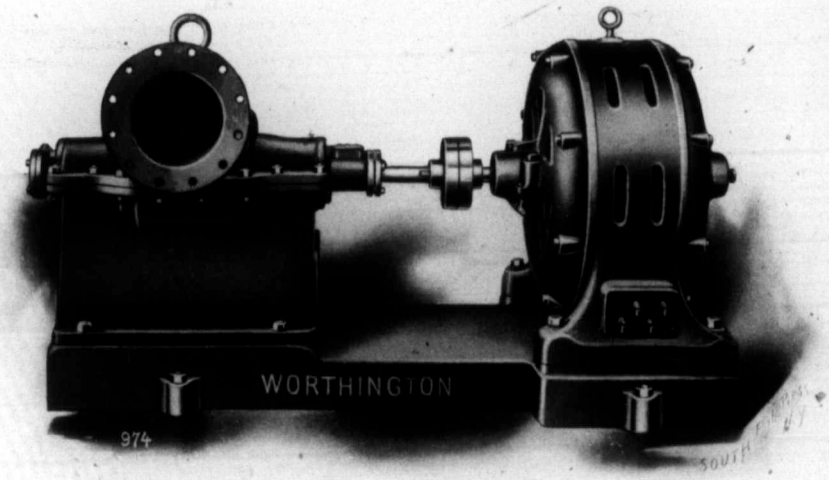
(Patented.)

TWIN 16-INCH CONOIDAL PUMPS

Driven by an induction motor. These pumps deliver 6,000 gallons per minute, each, against 20 feet head. One pump forces the water from the hot-well to the cooling tower, while the other delivers the cold water from the tower to the condenser.

installed, intended to stop and start the motor whenever the pressure falls short of or exceeds certain limits. In the centrifugal pump, on the other hand, the flow is automatically regulated by the pressure and the pump may be so designed that this regulation will be very close and exact.

The centrifugal pump is noiseless and the speed can be made to fit the requirements of the motor.



(Patented.)

TEN-INCH CONOIDAL PUMP

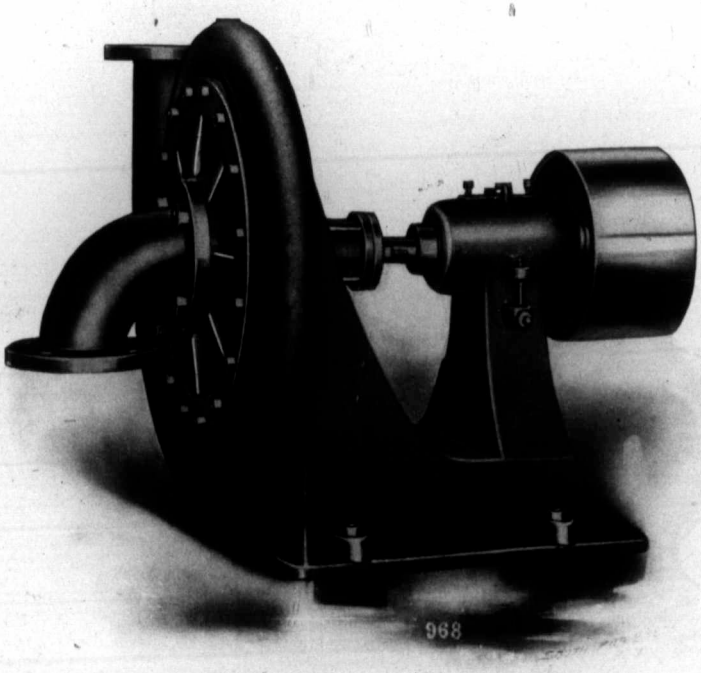
Direct-connected to an induction motor. Used for supplying cooling water to a surface condenser.

There is no shock or pulsation in the piping and nothing disastrous happens if the discharge is stopped.

In the case of alternating-current motors the centrifugal pump has a decided advantage in that the starting torque is very low, especially if the discharge valve is closed.

APPLICATIONS OF CENTRIFUGAL PUMPS.

Various applications of centrifugal pumps have been incidentally mentioned in the preceding pages. A complete list of the uses to which these pumps can be applied profitably would be interminable, especially since the per-

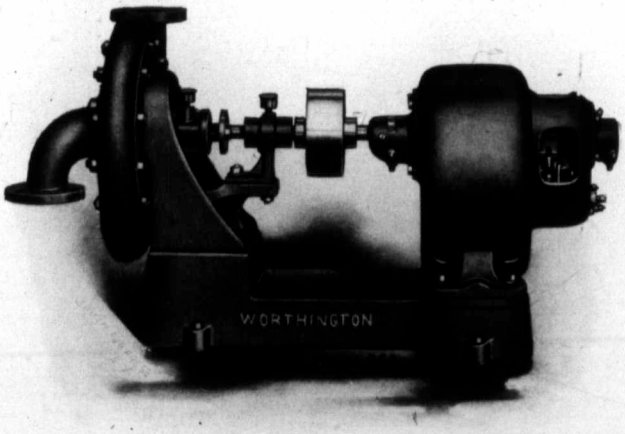


(Patented.)

FOUR-INCH VOLUTE PUMP

Having a capacity of 350 gallons per minute against a head of 25 feet. Arranged to be driven by belt from a line-shaft. Overhanging pulleys are employed in the very small sizes only.

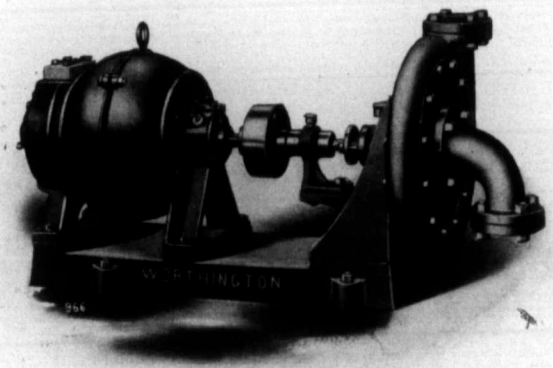
fection of the Worthington turbine pump has made high lifts practicable. We shall, therefore, name here only a few representative applications. Our salesmen and engineers, however, will be pleased to refer prospective customers to pumps in operation in different industries, or to



(Patented.)

TWO-INCH CENTRIFUGAL PUMP AND MOTOR

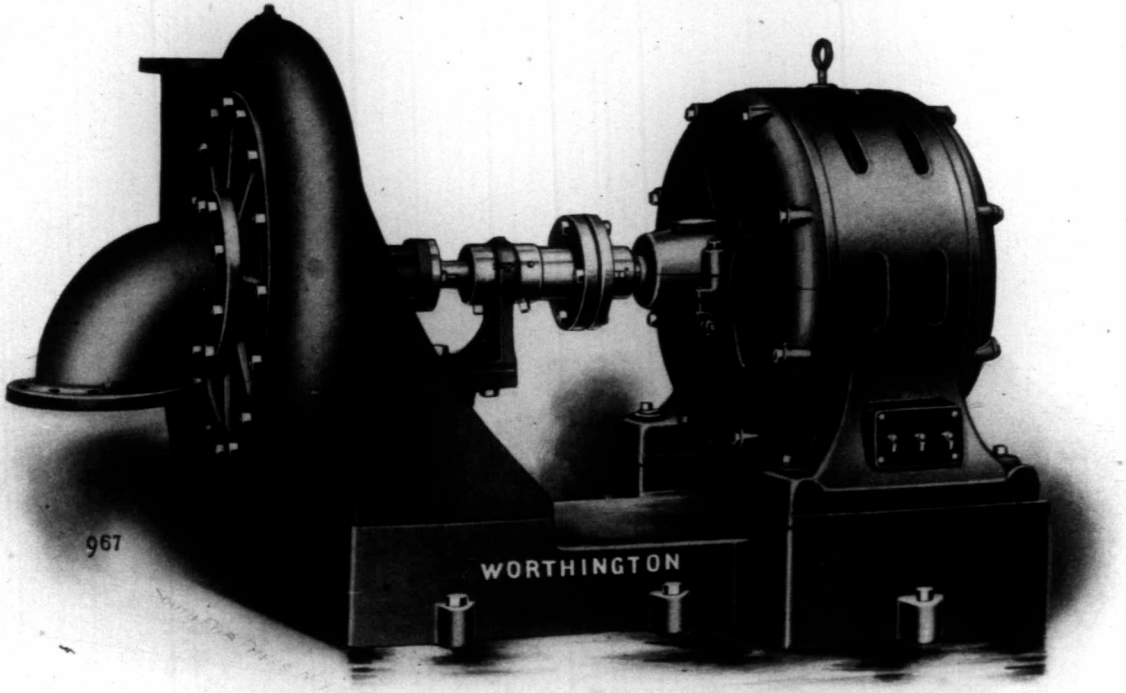
For house-tank service. Capacity, 50 gallons per minute against 120 feet head.



(Patented.)

TWO-INCH VOLUTE PUMP

In use in a brewery. Capacity, 100 gallons per minute against 25 feet head.

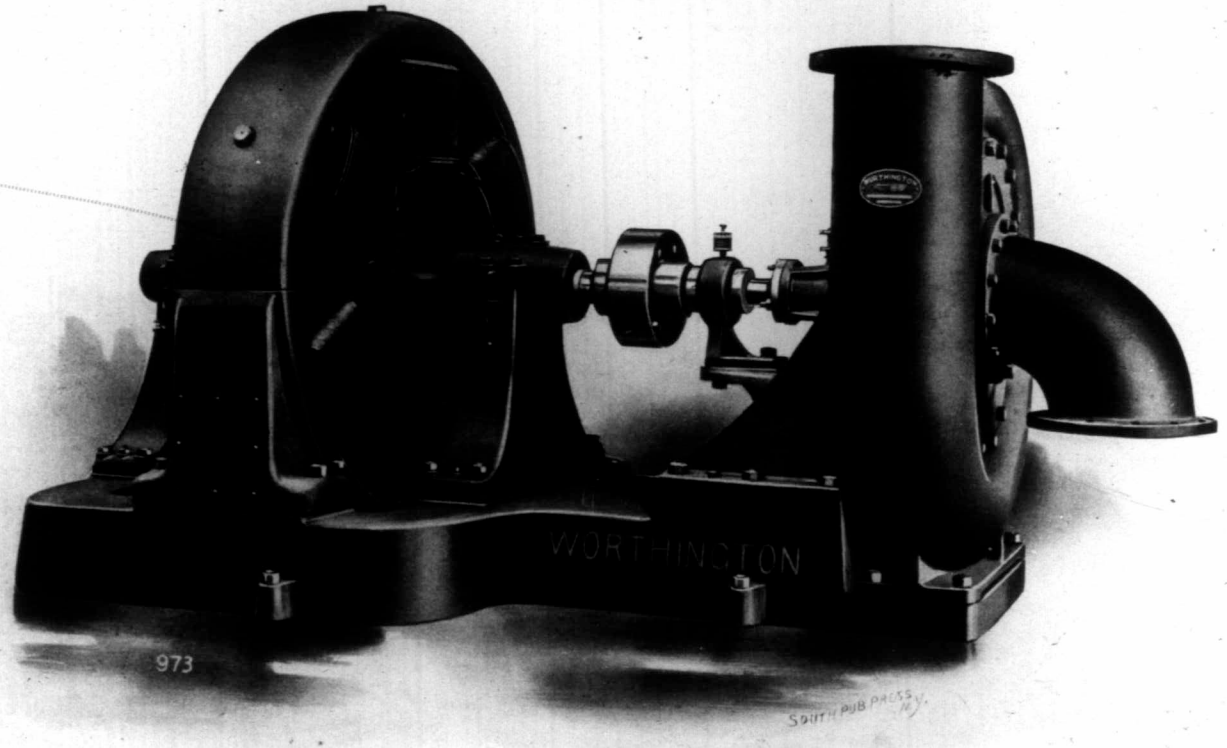


(Patented.)

EIGHT-INCH VOLUTE CENTRIFUGAL

Used to supply cooling water to a condenser. Capacity, 1,400 gallons per minute against 40 feet head.

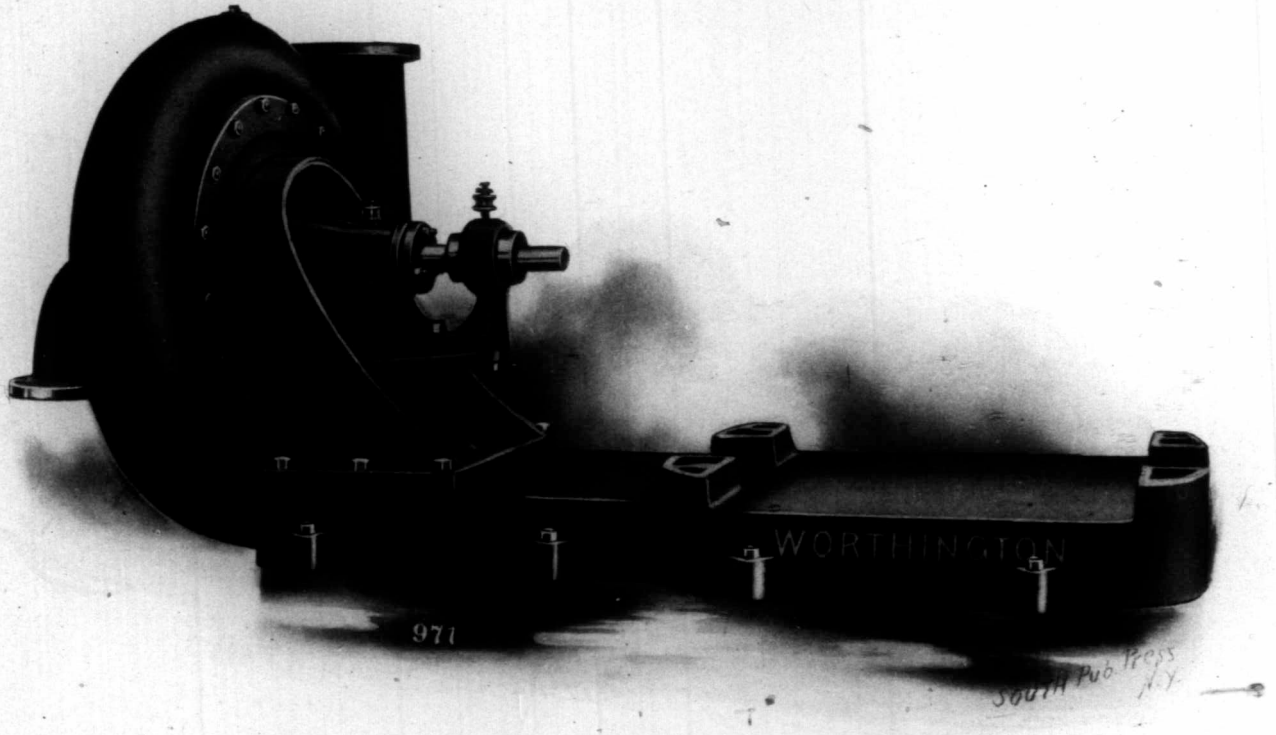
...gallons per minute against 40 feet head.



(Patented.)

TWELVE-INCH VOLUTE PUMP

Supplying 3,500 gallons per minute to an elevated jet condenser. The head required varies between 25 and 50 feet.



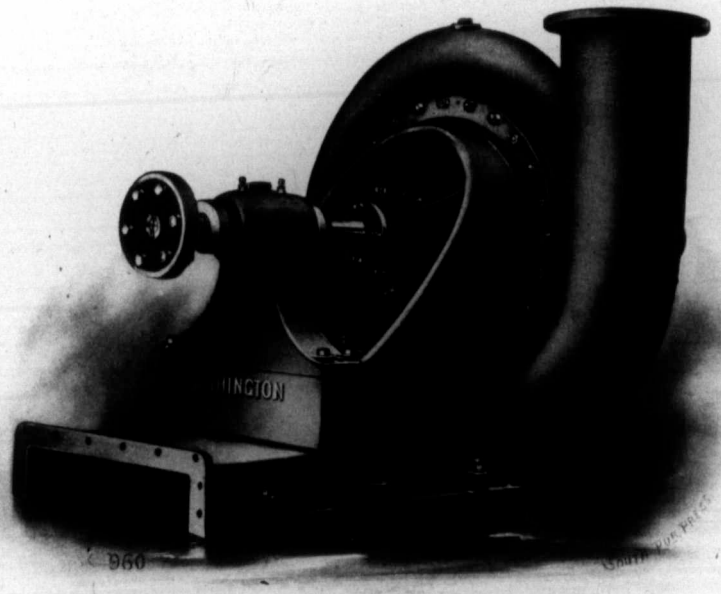
(Patented).

TWELVE-INCH VOLUTE PUMP

With extended base for engine or motor. Used in water-works for filtration service. Capacity, 5,000,000 gallons per day against 25 feet head.

furnish any desired information upon receipt of a statement of requirements.

For irrigation and for handling sewage and other liquids containing solids in suspension, the centrifugal pump is especially adapted on account of the absence of valves and rubbing surfaces.



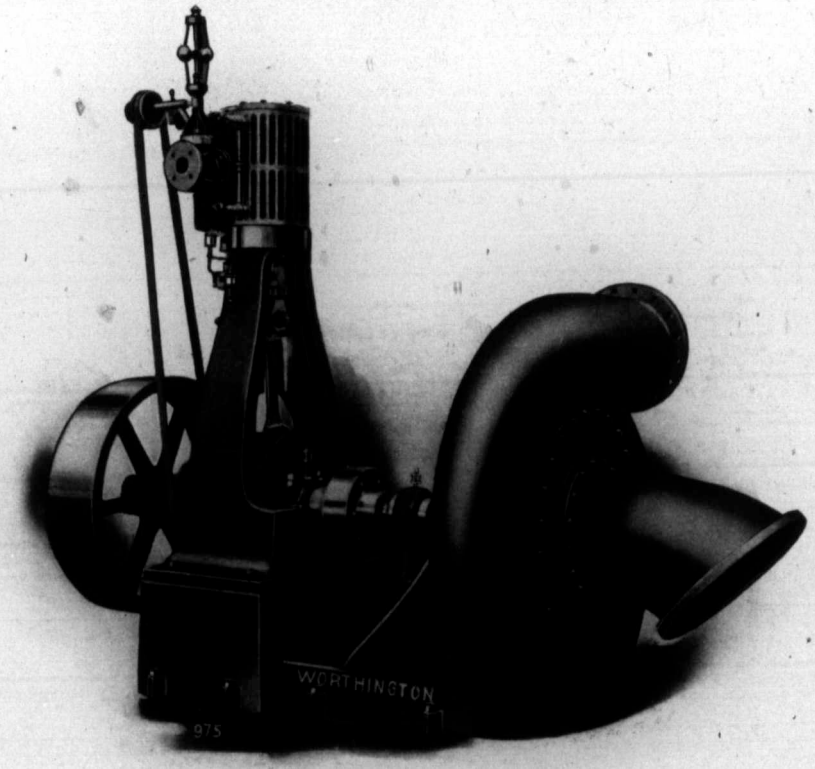
(Patented.)

EIGHTEEN-INCH VOLUTE PUMP

Designed for direct connection to a steam engine, and used for supplying water to elevated jet condensers in the power-house of the Manhattan Elevated Railway Co., New York City. Capacity, 10,000 gallons per minute against 25 feet head.

For coffer-dam and excavating work and for dredging, the pumps are specially designed to withstand the abrading action of stones and gravel, while for handling acids or other corrosive fluids they are lined with suitable resisting material. They can be used for conveying almost any fluid or semi-fluid substance, such as wood-pulp, heavy oil, etc.

In pumping out dry-docks, circulating condenser water, removing bilge water and circulating water in hot-water heating systems, or brine in ice and refrigerating plants, the centrifugal pump is pre-eminent because of its



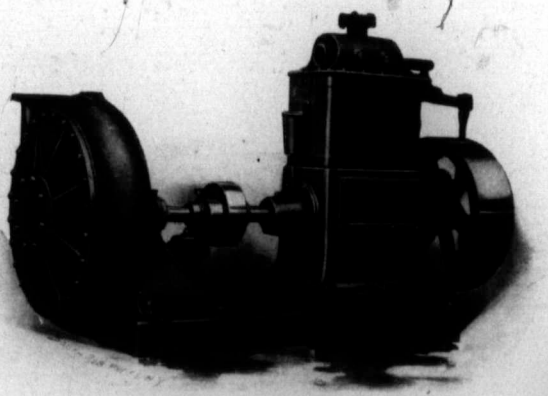
(Patented.)

SIXTEEN-INCH VOLUTE PUMP

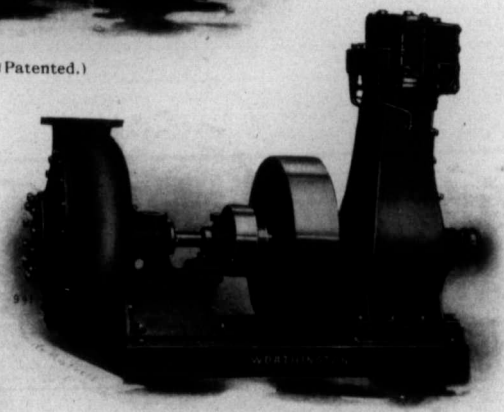
Used for supplying injection water to a condenser. Capacity, 6,000 gallons per minute against 25 feet head.

efficiency, small space requirements and uniform and high speed, suiting it for direct connection to electric motors.

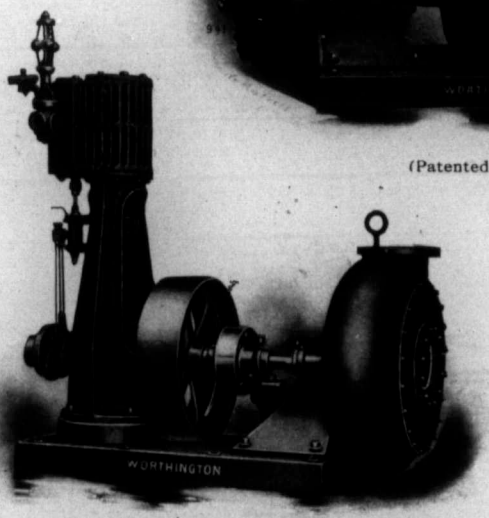
The high efficiency and great convenience of electric power distribution renders the electric-motor-driven centrifugal very valuable for mine pumping. The motors are



(Patented.)



(Patented.)



(Patented.)

CENTRIFUGAL PUMPS

Direct-connected to vertical engines for pumping sewage, circulating condenser water, etc.

entirely enclosed in water-tight housings and the great simplicity and durability of the sets, especially when induction motors are used, renders them highly desirable

Patented.)

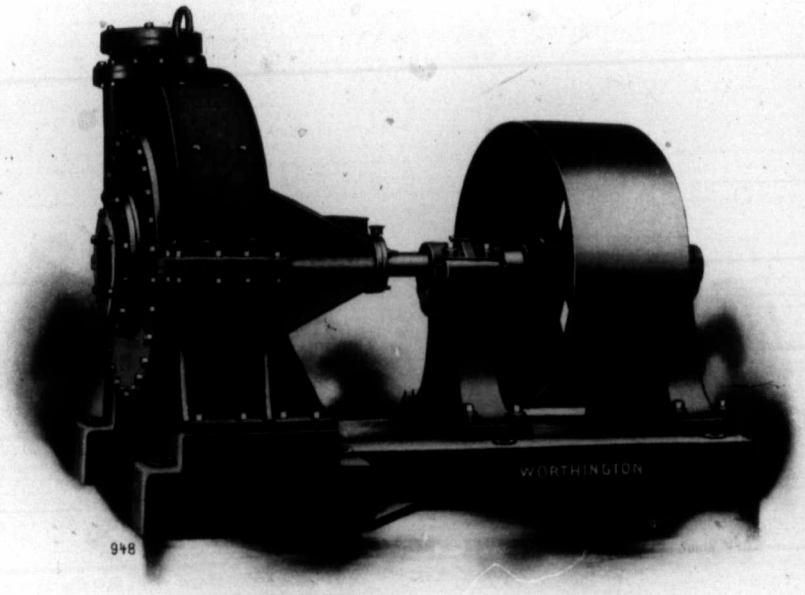
TWELVE-INCH, VERTICAL VOLUTE PUMP

For pumping sewage at the Louisiana Purchase Exposition, St. Louis. Designed for direct-connection to a vertical-shaft motor. Capacity, 3,000 gallons per minute against 60 feet head.

where the care of the pumping outfit must be left to ignorant and unskilled men. The entire unit may be submerged without injury.

As shaft-sinking pumps the motor-driven sets are light, occupy little space and may be easily raised or low-

ered. The wires supplying power are installed with little trouble. For this work vertical-shaft motors and pumps are employed, and the motors are enclosed in iron casings. The pumps are not affected by foreign material in the water and the ordinary turbine sinker will readily handle water containing 10 % of solid matter.

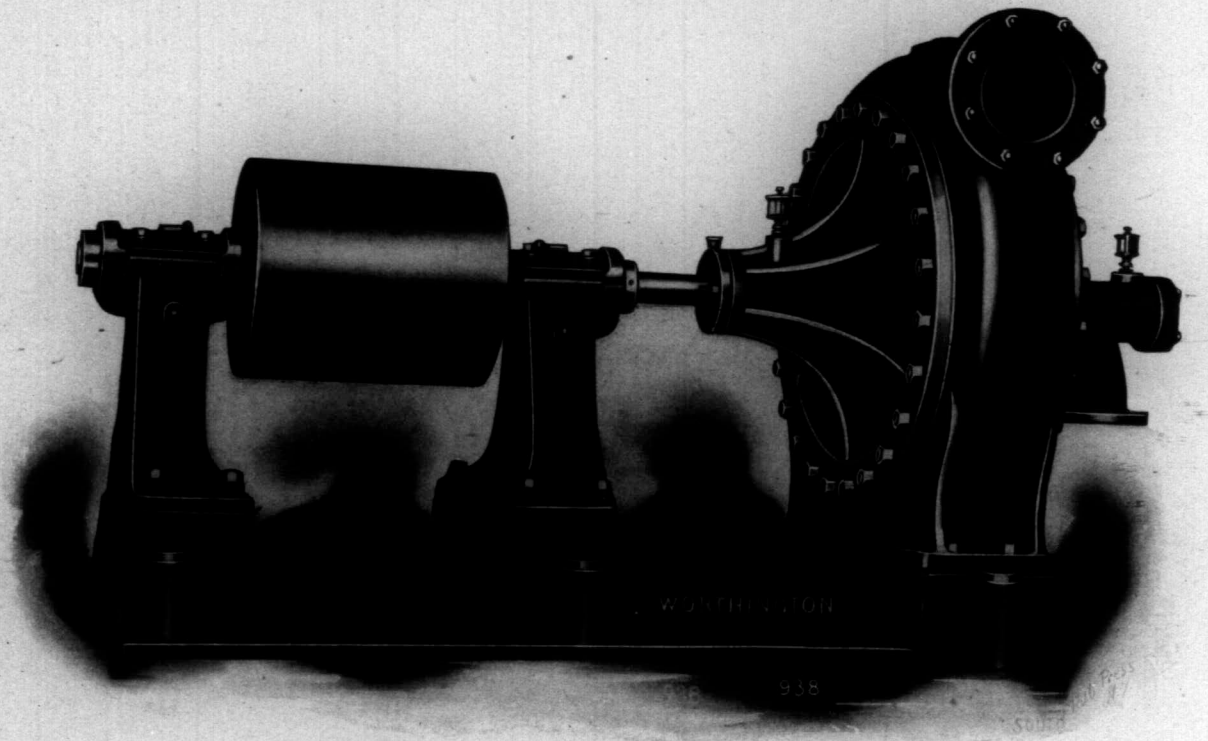


(Patented.)

TEN-INCH DREDGING PUMP

With removable chrome-steel lining and manganese-steel impeller. Used for handling phosphate rock and for dredging purposes. Capacity, 2,500 gallons per minute against 50 feet head.

Wherever the driving power must be transmitted some distance the motor-driven centrifugal is unrivalled. The pumps may be scattered over a considerable territory and operated with considerable economy of power and attendance. If necessary they may be started or stopped from the power-house.



(Patented.)

DREDGING PUMP

For handling liquids containing a large percentage of solid matter.

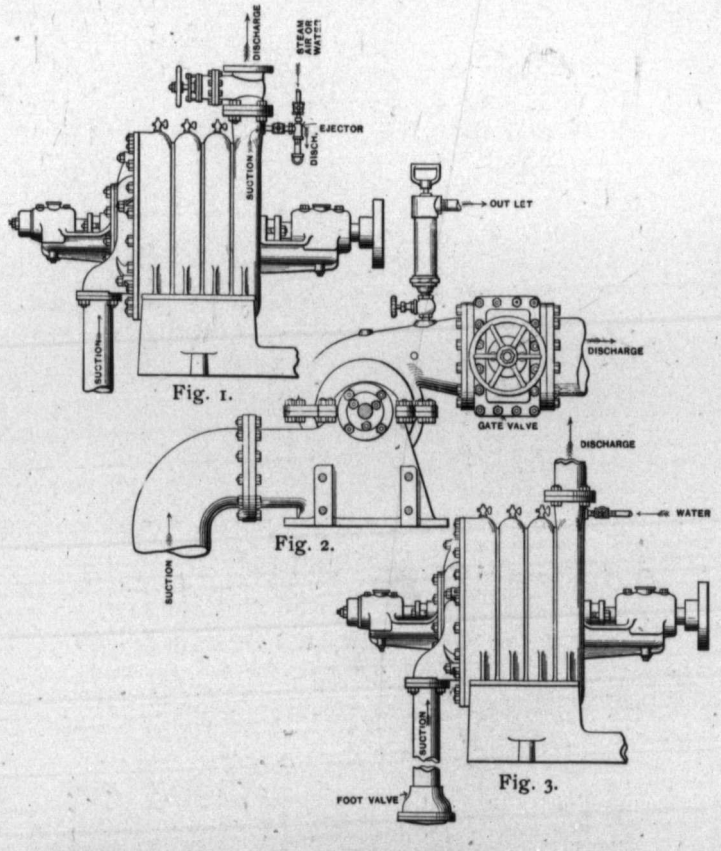


Fig. 1.

Fig. 2.

Fig. 3.

METHOD OF STARTING CENTRIFUGAL PUMPS.

Massive foundations are not necessary, but the pump should be so placed that perfect alignment is assured. The suction line must be free from air leaks and, if more than twenty feet in length, it should be larger than the pump suction to avoid undue friction.

The discharge line must be of sufficient size to remove the water without excessive friction loss. A gate valve should be located in the discharge near the pump.

Before starting the pump, it is necessary to fill the casing and suction line with the fluid to be pumped, as machines of this type will not create a vacuum of any moment without first being primed. Numerous devices

are employed for this purpose, but the methods illustrated above are those most generally used.

Figure 1 illustrates a multi-stage turbine pump with ejector for priming. The ejector is connected to the highest point on the pump casing, and either steam, air or water under pressure may be employed to produce a vacuum.

Figure 2 shows an auxiliary hand pump mounted on top of the discharge casing. When the pump is ready to start, the gate valve on the discharge is closed, and by operating the hand pump a vacuum is produced and water drawn in, filling the suction pipe and casing.

The method of priming shown in figure 3 may be resorted to where a foot valve is used on the suction pipe. Water is allowed to run into the pump until it reaches the discharge flange, when the supply is shut off, and the pump may be started.

After the pump has been properly primed, it should be started before the gate valve on the discharge is opened. When full speed is reached, the discharge gate may be slowly opened, and the pump will perform its work in a proper manner.

DATA REQUIRED FOR ESTIMATES UPON PROPOSED CENTRIFUGAL PUMPING PLANTS.

Our engineers will be pleased to advise fully regarding any proposed pumping equipment. Information concerning the following points should be given in the letter of inquiry.

1. The number of pumps wanted.
2. The capacity of each in gallons per minute.
3. The total head in feet to be pumped against (the suction lift, if any, should be included in this).
4. The type of pump desired—horizontal or vertical.
5. From what source will the water supply be taken?
6. Will the water be clear, muddy or gritty?
7. Length and size of the discharge pipe.
8. Length and size of the suction pipe.
9. State the average suction lift, if variable.
10. Is the service continuous or intermittent?
11. Character of the driving power; if electric state kind of current, voltage, phase, frequency, etc.

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