

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 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.

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.

The Worthington centrifugal pumps are divided into three classes, viz.: Conoidal, volute and turbine. The conoidal centrifugals 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 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 per cent. has been shown under test. These pumps are recommended for heads up to 70 feet, although they will safely withstand 150 feet.

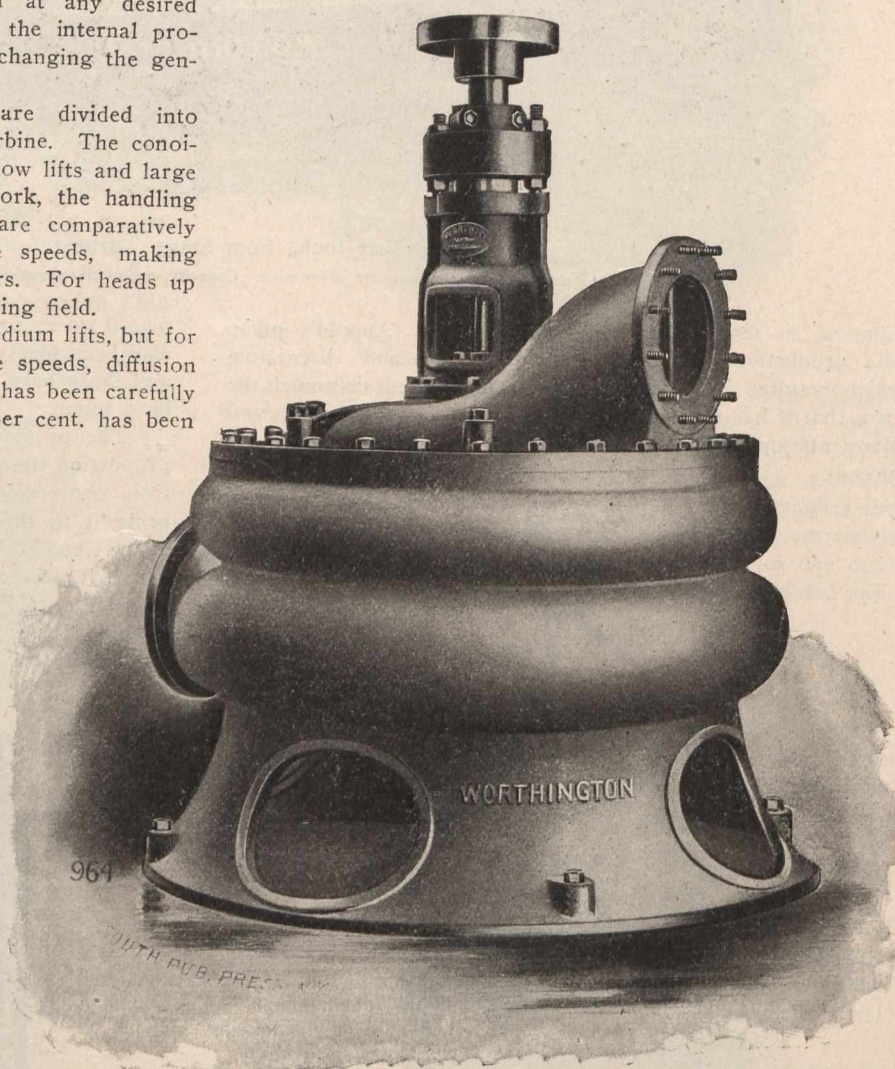
The turbine pump is suited to very high lifts, even exceeding 2,000 feet.

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 water-wheels. 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 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.

It is frequently found necessary to locate a centrifugal pump in a pitch 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



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.

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 inadmissible.

In 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.

The accompanying illustrations show several types of Worthington centrifugal pumps. These pumps are manufactured by the John McDougall Caledonian Iron Works Co., Limited, Montreal.