The main difficulty to overcome was the thrust, especially when the turbine was to be direct connected to an electrical generator. As the capacity of the units was increased, the initial cost of the development per horse power decreased; consequently it soon became apparent to engineers that when conditions would allow, it would be the most economical to install the largest units possible. Under low heads this meant the absolute use of a single runner. This type of set-

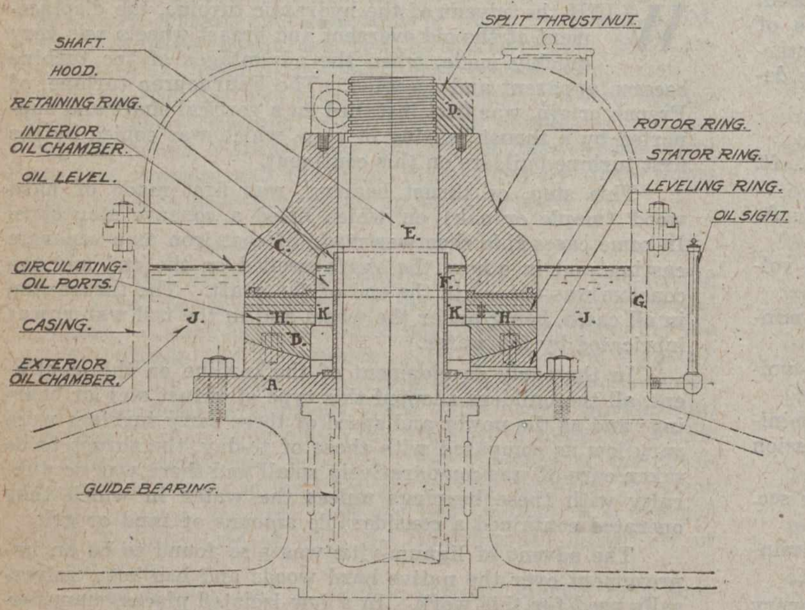

Fig. 1— Section Through Vertical Thrust Bearing

ting, with direct connected turbine, was recommended several years before it was adopted. The reason for the delay was the thrust bearing. Ball thrust bearings were tried as well as roller thrust bearings, but were not satisfactory.

The oil pressure thrust bearing now made its appearance, and consisted of a stationary and a revolving ring, the revolving ring being above the stationary one. Oil was pumped between the rings under pressure and so separated them that when the turbine operated, it was supported on a film of high pressure oil.

But should the pressure fail in the oil supply, the rings would come together and the bearing would immediately be out of service, thereby making it necessary to replace the rings, which was an expensive operation.

New Bearing Needed

It was very evident that a new bearing would have to be developed which would operate without external high pressure,—one practically placed in an oil bath. After several years of experimenting along these lines, the "Gibbs Thrust Bearing" was developed in 1911 and has given results beyond the most sanguine expectations. It consists of three principal elements; namely, a rotor ring, a stator ring and a levelling ring, enclosed in a casing and submerged in oil. It operates on the principle of the wedge, in the following manner:—

The stationary ring or stator has (depending on the size of the ring) four or more radial grooves across the bearing surface dividing it into a corresponding number of segmental sectors. Each sector face has a definite portion flat, and the remaining part of the sector has a gradual taper or bevel to the radial groove. The circumferential width of the face and the depth of the taper face depends on the unit pressure on the bearing face and the speed of the rotor.

The stator ring, for low and medium pressures up to 300 pounds per square inch, is made of close grain cast iron, and is generally made in one piece, except in some cases where it is necessary to make it in halves so that it can be removed without disturbing the shaft or other parts attached to the shaft.

The bottom face of this ring is made spherical to fit the spherical seat of the levelling ring, and is connected to the the levelling ring by means of a dowel pin, so as to allow the stator ring to have a limited amount of adjustment.

The revolving ring, or rotor, is made of cast iron, on to which is placed a soft metal face (babbitt), and is perfectly flat. When the rings are placed in normal position (the rotor ring on the stator ring) there will be a series of flat faces, with alternating wedge surfaces, which, when the bearing is at rest, are filled with oil.

When the rotor ring is rotated, it pulls in the oil, by adhesion, from the radial groove, up the wedge surface. It also carries the oil across the flat surface of the stator ring. The rotor ring in drawing the oil up the wedge surface, develops automatically a pressure between the rotor and stator rings that equals the total load on the bearing.

No Critical Speed

The levelling ring has its upper face spherical, to fit the spherical face of the stator ring, in order to allow for a small amount of alignment, so that the rotor ring will rest properly on the stator ring. The levelling ring is also securely fastened to the casing in which the bearing is placed.

The casing is made of cast iron, of such design and capacity that for low unit pressures, or not exceeding 150 pounds per square inch, auxiliary devices for cooling the oil are not required; but when unit pressures are higher than this, cooling coils are placed in the casing, or the oil circulated through an external cooling system by means of a small pump.

Owing to the fixed oil film, these bearings have no critical speed at which point the babbitt will wipe off. They can be run slowly as desired without wiping the babbitt. Peripheral speeds up to 5,000 feet per minute have been obtained without any detrimental effect whatever on the bearing. For the most efficient service, an average unit pressure of 150 to 300 pounds per square inch can be used without deteriorating the oil.

The principal advantages of the "Gibbs Thrust Bearing"

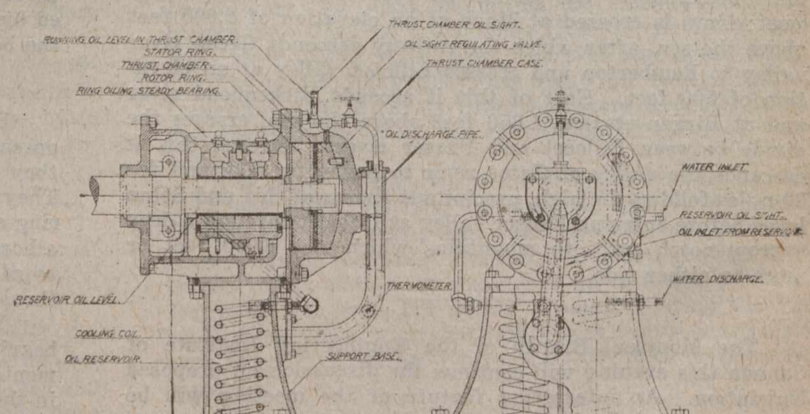

Fig. 2—Gibbs Bearing on Horizontal Shaft

are simplicity, minimum number of parts, fixed oil film and absolute distribution of the load over the bearing surfaces.

Vertical Shaft Bearing

The accompanying illustration (Fig. 1) shows a bearing for a vertical shaft. Similar construction is used for horizontal shaft installations. "A" is a levelling ring bolted to the base of casing "G". The top face of the levelling ring is