and that this pitting was very marked at 700 pounds. The small pieces torn from the balls and races were very different in shape from the flakes torn from the shaft by the rolls.

The diagram giving a comparison of the friction line of the two kinds of bearings shows the friction of the roller bearing to be more than twice as great as that of the ball bearing. Calculations from the figures taken during the tests gave the co-efficient of friction for the ball bearings used to be .00475, or less than one-half of one per cent., while that for the roller bearings was .014, or nearly one and one-half per cent. I have no doubt that if the shaft used was of steel, hardened and ground, as the rest of the parts were, that the friction would be reduced. As the shaft was torn by the rolls, new parts were brought into contact and a marked drop of the pull occurred.

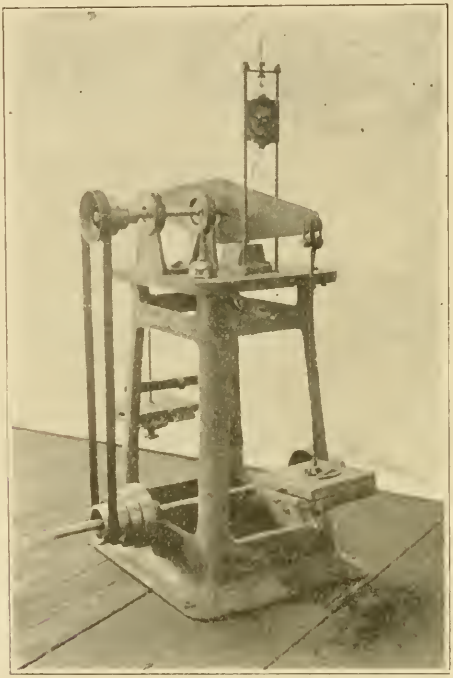
Bearing-Testing Dynamometer.

By M. J. Golden.

In making some tests to determine the amount of power lost by friction in different forms of shaft bearings, so much trouble was experienced in separating the loss in other parts of the apparatus used from that in the part being tested, when the regular transmission type of dynamometer was used, that the apparatus described here was devised for that purpose. It was tried in various forms experimentally before the present form was adopted. One of the rougher forms was described here last year in connection with a report then made on some bearing tests. In such tests the whole friction is so small that it is difficult to separate the friction due to the part being tested from that of the rest of the apparatus.

The machine as now used consists of a cast iron frame, made heavy enough to be stiff and to absorb a large portion of the vibration due to the rapidly moving parts. To the top of the frame is bolted a cast-iron table with planed surface. On this table are bolted two carriages, shown in the illustration at (a), that are fitted with ball bearings, in which a spindle or shaft revolves. These bearings are used because of the ease of alignment with them, and by fastening a set collar on each side of one of them end thrust is provided for. Different sizes of spindle may be used by having spare sleeves to be slipped on the smaller sizes and into the bearings.

The special features of the machine are the way in which the load is applied and measured. This is accomplished by having a stiff, cast-iron yoke (b), through the center of which the spindle passes. The ends of



the yoke project over the ends of the table and are provided with hardened steel knife edges (c) on which rods are hung, and the weights used for the load are suspended on these rods (d). The knife edges on which the weights are hung are on a line that passes an eighth of an inch above the center of the yoke, and as the rods are free to move on the edges, a nice balance of the yoke can be maintained. The bearing to be tested is placed in a cage that is fitted in the center of the yoke, and the shaft or spindle is revolved inside of it. The tendency of the yoke to revolve around the spindle, due to the friction of the bearing, is met in this way: At nine inches from the center of the yoke, and on the line of knife edges for weights, is an inverted knife edge (f). Above this a sensitive scale (e) is suspended and a link connection is made between the scale and the knife edge. The tendency of the yoke to revolve is met by the pull of the scale and the amount of the pull is registered on the scale.

Variation in speed is arranged for by placing on the end of the spindle that passes through the yoke a cone pulley of four steps (g), and this is driven by a belt from a corresponding cone pulley on a shaft (h) in the lower part of the frame. On this shaft is another cone pulley of three steps (j) driven from one on a countershaft. So a wide range of speeds can be gotten, and from a countershaft driven at 300 turns in a minute the spindle in the yoke has been made to revolve at speeds varying from thirty turns in a minute to 9,000 turns in a minute.

On the assumption that in some forms of bearings the suspension of the yoke on the spindle would be from some point near the top of the bearing, a yoke was made in which the knife edges for the weight rods could be raised and lowered, and some tests were made on different types of bearings with the edges at places above and below the center of the yoke; but though the suspension varied from the top to the bottom of the spindle no measureable change could be found.

To overcome the difficulty of finding the zero point for any test, a slightly greater weight was given to the scale side of the yoke than to the other side; and any one reading was made by driving the spindle first in one direction and then in the other, as this would give the amount of pull due to friction on the scale, as from the point found when driving one way to the corresponding point found when driving the other would be twice the amount that would be gotten when driving in either way alone.

The Toepler-Holtz Machine for Roentgen Rays.

By J. L. Campbell.