piston area by the formula $p_c = \frac{P_c}{A}$ where A is the area of the piston, and then to correct the corresponding pressures as shown by the indicator diagram by this amount. In this way a reduced indicator diagram for each end is found, as shown for a steam engine in Fig. 145, where the dotted diagram is the reduced diagram found by subtracting the quantity p_c from the upper line on each diagram. The remaining area is the part effective in producing a turning moment on the crank shaft.

(b) The second method is to find directly the turning effect necessary on the crank shaft to overcome the force P_c, and from the

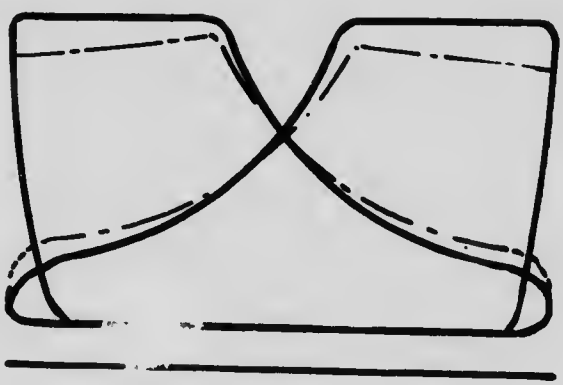

Fig. 145

principles of the phorograph this torque is evidently $T_c = P_c \times OQ' = m_c \cdot f \cdot OQ'$. In the position shown in Fig. 144, P_c would act as shown, and a torque acting in the same sense as the motion of a would have to be applied.

The first method is very instructive in that it shows that the force necessary to accelerate the piston at the beginning of the stroke in very high speed engines may be greater than that produced by the steam of gas pressure, and hence, that in such cases the connecting rod may be in tension at the beginning of the stroke, but, of course, before the stroke has very much proceeded it is in compression again. This change in the condition of stress in the rod frequently causes "pounding" due to the slight slackness allowed at the various pins.