between O and Q, Fig. 144, then since the acceleration is $Q''O \cdot \omega^2$, the acceleration of the piston is in the same sense as the motion of the piston, or the piston is being accelerated. Conversely, when Q'' lies on QO produced the acceleration being in the opposite sense to the motion of the piston, the latter is being retarded. If now the accelerations for the different piston positions on the forward stroke be plotted, the diagram EJH will be obtained, Fig. 144, where the part of the diagram EJ represents accelerations of the piston, and the part JH negative accelerations, or retardations. The corresponding diagram for the return stroke of the piston is omitted to avoid complexity.

Let the combined weight of the piston, piston rod and cross-head be w_c lbs., the corresponding mass being $m_c = \dfrac{w_c}{g}$, and let f represent the acceleration of the piston at any instant, then the force

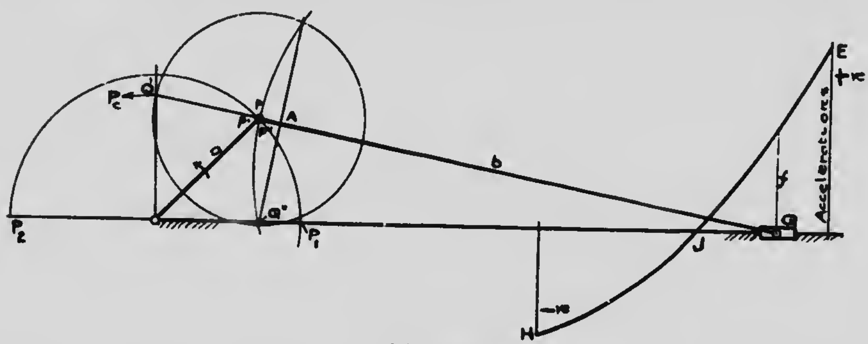

Fig. 144

P_c necessary to produce this acceleration will be $P_c = m_c \cdot f$. This force will be positive if f is positive and vice versa, i.e., if f is positive a force must be exerted on the piston in its direction of motion and if it is negative the force must be opposed to the motion. In the first case energy must be supplied by the fly-wheel, or steam, or gas pressure, to speed up the piston, whereas, in the latter case, energy will be given up to the fly-wheel due to the decreasing velocity of the piston, but it is to be remembered that since no net energy is received during the operation, therefore, the work done on the piston in accelerating it must be equal to that done by the piston while it is being retarded.

Two methods are employed for finding the turning effect of this force, P_c : (a) to reduce it to an equivalent amount per square inch of