A LABORATORY EXPERIMENT FOR TESTING THE EFFICIENCY OF A SCREW JACK

A. P. Carmen and R. F. Paton, University of Illinois

Our object in devising this experiment has been to get a feasible quantitative college experiment which would fix the principle of work and the concept of efficiency of a machine. We chose as the machine a small screw jack, the particular jack being an inexpensive one used to lift light weight automobiles. The apparatus is shown in Figs. 1 and 2. The hand lever was removed from the gear

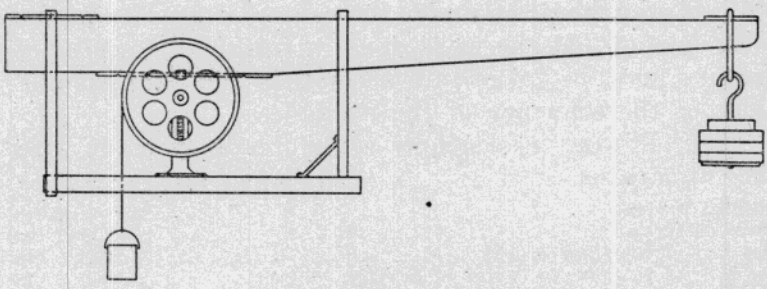

Fig. 1

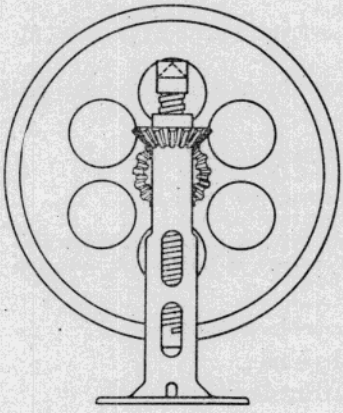

Fig. 2

wheel of the jack and a disk was substituted. The "power" force is applied as a weight hung by a wire cord which is wound in a groove on the periphery of the disk. This applies a moment of force to the small gear wheel

which acts in turn on the gear turning the screw on the jack. The "weight" force which is overcome consists of a number of large iron weights hung on the end of a lever. The fulcrum of this lever is at the opposite end of the bar and the "power" force on the lever is the force exerted by the jack. The lever as constructed by us consists of an oak beam 1.5 inches thick, about 4 inches wide and about 70 inches long. The upper end of the jack screw was fitted with a wedge-shaped piece and this rests on an iron plate screwed on the lower part of the oak beam. The point of application of this "power" force can thus be shifted along the lever bar. This point of application will not in general be under the center of gravity of the lever bar so that the work done in raising the center of gravity must be taken into account in the final calculations of the efficiency of the machine.

The following is a sample set of readings made with this apparatus.

weight of lever	6490	grams
pitch of screw	.847	cm
distance of fulcrum to jack	46.0	cm
distance of fulcrum to center of gravity of lever	66.0	cm
distance of fulcrum to weight	166.0	cm
distance "weight" is shifted for two revolutions of disk	6.35	cm
distance "power" force moves for two revolutions of disk	177.8	cm
weights at end of lever	12410.0	cm
"power" weights in bucket required to just lift above "weight"	2040.0	gm

From the above data, the student calculates directly the following:

ideal mechanical advantage of jack	105.
actual mechanical advantage of jack	26.8
ideal mechanical advantage of lever	.266
actual mechanical advantage of lever	.230
ideal mechanical advantage of combined machine	28.0
actual mechanical advantage of combined machine	6.08
efficiency of jack	25%
efficiency of lever	86%
efficiency of combined machine	22%

Laboratory of Physics
University of Illinois
April, 1924