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# Test of High-Speed Engine

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The steam engine in connection with the steam boiler is a machine designed for the purpose of developing the latent energy of coal, and making it available for useful work.

In all methods of changing energy from one form to another, there is a percentage of loss, which depends much upon the manner in which the change is made. The windmill, waterwheel, gas engine, steam engine, and electric generator, or dynamo, are all machines for changing energy from one form into another that may be made to do useful work.

It is an established fact, that the energy of work can not be had free of all cost. It requires the expenditure of money, perhaps not always directly, but in the end, it amounts to the same thing. The wood that is burned to produce warmthmust be cut, sawed and split by a considerable outlay of labor, which is the equivalent of money. In order to make the energy of the winds or rivers do useful work, it is necessary to purchase windmills or waterwheels.

At the present time, we have our greatest supplies of energy in coal. But in order to use this energy, the coal must be burned in the furnace of a boiler. By the aid of the burning coal, the water in

the boiler is changed into steam. This steam is conducted to the engine, and by pushing and expanding in the cylinder behind the piston, gives up in the form of forces in motion only a small portion of the original amount of energy in the coal.

Nowadays, when industrial competition is so great and the profits are so small, it is necessary that the returns from money spent to produce useful energy should be as great as possible. The water-wheel and windmill should be of such forms as to give out in useful work the greatest possible proportion of the energy in falling water and winds. In this part of the country, where the price of coal is high and there is every indication of a future increase in price, it is specially necessary, that we should use stoves, furnaces, boilers and engines which will give out the largest amount of the energy of the fuel used. Therefore manufacturers and others should make tests of their boilers and engines to determine their efficiency. Many times, it may be better to throw away an old boiler or engine, and replace it with a modern one of higher efficiency.

One pound of coal on the average contains 14000 heat units, or an amount of heat sufficient to raise the temperature of 14000 pounds of water one degree. It has been determined, that one unit of

heat is equivalent to 778 units of work; therefore in one pound of coal, there are 14000 X 778 = 10892000 units of work. A horse power is equal to 33000 units of work done per minute; or 33000 X 60 = 1980000 units of work per hour. Therefore the heat from one pound of coal, if all utilized, would be capable of exerting an energy of

$$\frac{10892000}{1980000} = 5.5$$

horse-power per hour, or one fifth of a pound of coal might be expected to yield one horse-power per hour. But our best stationary engines consume from one and one quarter to two pounds of coal per horse-power per hour, or about ten times as much as would be necessary if the whole of the heat of the coal could be converted into work.

Therefore it is sometimes stated, that the efficiency of the steam engine is only ten percent, and that the use of such a wasteful machine should be discouraged. It must be remembered, that the ninety percent of loss is not due to the engine alone. It is estimated that fifteen per cent of the total heat of the coal passes off into the chimney directly from the furnace. There are other large losses of energy from the boiler; such as, radiation, leakage of steam from valves and loose joints, and loss due to blowing off impurities. There is, too, a loss due to the fact, that at least 950 units of heat pass away

from the engine in every pound of exhaust steam. This is due to the large latent heat of steam. When we measure the energy of the steam actually used by the engine, and the energy of the work performed, we find that the efficiency is high and may be satisfactorily compared with that of any other prime mover.

In making an engine test, it is always necessary to determine the work that the steam performs in the enginecylinder. The indicator is used to measure this work of the steam, and the result is a graphic diagram, which may be measured to determine numerically the horse-power. The work given out by the engine may be calculated by allowing the engine to drive a dynamo or other machine in which the work is easily measured.

The efficiency of the engine is found by dividing the total work done by the steam or the engine in an hour by the amount of work that the engine delivers in an hour. This is termed the mechanical efficiency. If the work used in overcoming the friction of the engine itself is deducted from the total delivered work, the efficiency then found may be called the commercial efficiency.

The test which represents the practical work of this paper, was made on an Armington and Sims Horizontal, High-speed Engine. This

engine has two fly wheels, automatic cut-off regulator, a piston valve with packing rings at each end. The steam chest with valve seat is in one casting with the cylinder. The time of test was one hour and fifty minutes. The cards were taken every five minutes. The power of the engine was absorbed by a dynamo. Observations were made under varying loads, and the results show that the engine produces its highest efficiency when working at its greatest load.

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TEST OF SIMPLE ENGINE.

Kind of Engine... Horizontal High Speed
Duration of run... One hour and fifty minutes

DIMENSIONS.

Diameter of cylinder,.....9½.....inches.
Length of Stroke,.....10.....
Diameter of piston rod,.....1⅜.....
Piston displacement crank end cubic ft.,.....6.94.....
" " head " " " .....6.58.....
Volume of clearance " per cent.,.....9.0.....
" " " crank " " " .....4.....

Make of indicator,... Calkins
Spring,.....40.....lbs. per in.
Boiler pressure gauge, Average 537 lbs.

| | Engine Friction | Engine & Dynamo Friction | Load. I | II | III | IV |
|---|---|---|---|---|---|---|
| Rev. of Engine per minute. | 289 | 285 | 286 | 286 | 266 | 255 |
| Weight of Steam per hour. | 152.83# | 175.03# | 145.45# Head End | 364.6 | 631.13 | 749.5 |
| WORK. | | | | | | |
| I. H. P., head | 3.18 | 4.16 | 8.08 | 12.49 | 12.33 | 10.75 |
| I. H. P., Crank | 1.20 | 1.24 | 1.22 | 1.75 | 9.55 | 8.85 |
| Total I. H. P. | 4.38 | 5.40 | 9.30 | 14.24 | 21.88 | 19.60 |
| D. H. P. | | 1.02 | 4.92 | 9.86 | 17.50 | 15.22 |
| Mechanical Efficiency. | | .188 | .529 | .692 | .799 | .776 |
| WATER CONSUMPT'N: Per I. H. P. per hour. | 34# | 32.41 | 15.6 Head End | 25. | 28.8 | 38.+ |