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For THE CANADIAN ENGINEER.

STEAM ENGINE ECONOMY.

BY P. BATTY.

Steam engine economy in a broad sense involves considerations of construction and design, as well as everything that enters into cost and maintenance and operation. With the engineer in charge of engines and boilers, however, the problem is ordinarily that of getting the best possible results from machinery already constructed and placed in his charge. An important part of his education is in the direction of how best to accomplish this end, and the value of his services is largely dependent upon his ability in this direction. Economy to him means keeping down the fuel account, having small bills for repairs, little or no loss from enforced stoppages, maintaining regular speed, and having the least possible loss from deterioration.

The cost of fuel is always an important matter, but sometimes it is of more importance that there be no enforced stoppages, or that the speed be very regular. The engineer must study this in any particular instance, and govern himself according to circumstances.

So far as the use of fuel goes, an engineer often finds himself confronted with conditions that render the attaining of good economy impossible. The only course then is to make the best of bad surroundings. The condition unfavorable to fuel economy most likely to be met with is an engine too large for its work. In a non-condensing engine the useless work of moving the piston against the pressure of the atmosphere must always be done. The resistance the piston meets with from the atmosphere being, in round numbers, 15 lbs. per sq. inch, if the mean effective pressure required to do the work is but 15 pounds, then as much work is done in overcoming the atmospheric resistance as is done in overcoming the friction of the parts and doing the useful work. If the load is increased so that the mean effective pressure is 45 lbs., only one-third as much work is done against the atmosphere as against the other resistances. One reason, then, and a very important one, why an underloaded engine works with poor economy, is that the useless work is too large a fraction of the total work done by the steam. So far only the useless work of overcoming the resistance of the atmosphere has been referred to There will be, besides this, some further back pressure which will not increase in proportion as the mean effective pressure is increased, and this, so far as it goes, strengthens the reason just given. In a condensing engine the piston has always to be moved against the pressure due to imperfect vacuum, and some back pressure besides, so the same reason holds good, but not to the same extent.

Another reason why poor economy and light loads go together is that part of the work done in the cylinder of a steam engine is done to overcome friction of moving parts, and this friction does not increase as fast as the load is increased. It is sometimes nearly as great with no load as with the engine fairly loaded.

A third reason is condensation of steam in the cylinder. When ordinary dry steam from the boiler enters the cylinder, cooled by the low temperature during expansion and exhaust, a very material portion of it is condensed, parting with latent heat to bring up the temperature of the exposed surfaces. In an engine lightly loaded the steam thus condensed is a larger fraction of the total steam used than in one more heavily loaded. The exact loss from condensation cannot from present knowledge of the subject be calculated, or very closely approximated, so that it cannot be told by calculation just what the mean effective pressure on an engine should be for the best economy in fuel consumption. Experimentally it has been found that with steam from 70 to 90 pounds, by gauge, the best economy in a non-condensing engine obtains when the load is such that cut-off will be not much, if any, earlier than one-quarter stroke. With this cut off the terminal pressure will be from 5 to 10 pounds above the atmosphere. At lower steam pressure than named the cut-off should be still later. With condensing engines the cut-off may be such that the terminal pressure will be at atmosphere, or a little below.

But the engineer has to do with the engine underloaded—too large for the work—and must consider how he can keep the coal consumption down, or loss in some other direction. When the cut-off is materially before quarter-stroke, so much so that the terminal pressure in a non-condensing engine is below atmosphere, it is in the interest of economy to reduce the speed. This is not, however, always practicable. Sometimes the construction of the engine is such that a change of speed will disarrange the governor to such an extent that the regulation will be poor; in other instances it is merely a matter, so far as the governor is concerned, of a change of a pulley.

Another important consideration in a proposed reduction is the weight of the fly-wheel. Good regulation cannot be had with a flywheel too light for the work.