If the fly-wheel is only of sufficient weight for the speed as it is, if the speed is reduced, it will be too light. The momentum of a fly-wheel varies as the diameter, and as the square of its revolutions; hence, reducing the speed decreases its capacity rapidly. There are several rules for determining the proper weight of a fly-wheel, and I think the following rule is as simple as any. Rule for finding the weight of the rim of a fly-wheel for an automatic engine: Multiply 6,000,000 by the indicated horse-power of the engine, and divide the product by the diameter of the wheel in feet, multiplied by the square of its number of revolutions per minute. Take, for example, an engine developing 75 indicated horse-power, having a fly-wheel pulley 14 feet diameter, running 80 revolutions per minute. What should be the weight of metal in the rim of the wheel? 6,000,000 × 75 = 450,000,000; the square of 80 is 80 × 80 = 6,400, and 6,400 × 14 = 89,600. Then 450,000,00 ÷ 89,600 = 5,022 pounds for the weight of the rim of the wheel.

Some builders use a larger constant than 6,000,000, which gives greater weight of wheel, but more use a smaller constant. Cast-iron weighs about .26 pound per cubic inch, so by finding the cubic inches in the rim of the wheel, and multiplying by this decimal, .26, the weight will be found with reasonable exactness; then finding by the use of the indicator the horse-power developed, it can be told whether the speed can be decreased with satisfactory results without increasing the weight of wheel.

Reducing the speed is usually the only practical means of increasing the economy of fuel consumption in an under-loaded, non-condensing engine. By this means the useless work done against the pressure of the atmosphere is diminished—the inevitable loss from filling the clearance space with steam at every stroke is less, and friction is generally reduced. A slight saving may sometimes be effected by working with reduced steam pressure, but what it will amount to, if anything can only be told by trial. It will depend upon the steaming qualities of the boiler under the higher and lower pressures; upon the construction of the engine, particularly as to whether the valves work under full pressure or are wholly or partly balanced; upon whether leakage will be less at low pressure, and upon a variety of conditions that cannot well be enumerated. Usually in a well-constructed boiler—unless expansion is considerable—say 2 or 3 pounds at least below the atmosphere, working with lower boiler-pressure will not decrease the coal consumption. If advisable to reduce the initial pressure, better results will usually follow a small amount of throttling, keeping the boiler pressure as it is. Reducing the boiler pressure in the instance of an under-loaded condensing engine is much more likely to save fuel than in one working non-condensing. In any case the effect can only be known by trial. Weighing the coal used running both ways will settle the matter conclusively. If an engine is overloaded the remedy that most naturally suggests itself is to increase the speed. The diagram will show, by the freedom with which the steam gets into and out of the cylinder, whether in this respect higher speed is advisable, or will accomplish the end sought. If initial-pressure is nearly equal to boiler-pressure, with only a pound or two of back-pressure, then there will be no trouble in increasing the speed from 10 to 20 per cent., if the wearing or moving parts can be run faster without danger or inconvenience. Increasing the speed of an engine ought to improve the regulation, because it increases the capacity of the fly-wheel. Frequently the very best remedy for an overloaded engine is increasing the steam-pressure. Doing this, of course, involves previous consideration of strength of boiler, and of various parts of the engine, as well as the amplitude of the wearing surfaces to resist the higher pressure. When there are no objections to increasing the pressure, doing so generally increases economy.

Another plan for helping out an overloaded non-condensing engine is to add a condenser. Where fairly high pressure of steam is carried—say, not less than 75 pounds gauge pressure—and the cut-off is from one-quarter to one-third stroke, a condenser will, by adding from 9 to 11 pounds pressure below atmosphere, shorten the cut-off and the economy will be increased. Adding a condenser to a lightly loaded engine working with high steam pressure in the expectation of saving coal, as is frequently done, will generally end in disappointment. Condensation in the cylinder will be increased and colder feed must be used, the two frequently neutralizing all that is otherwise gained by the use of the condenser.

When, from any cause, it is necessary to materially reduce the steam pressure carried, thus in effect making the engine small for the work, then a condenser is a valuable addition.

In a non-condensing engine advantage should always be taken of heating the feed-water by the exhaust steam; in this way a saving of coal equal to from 10 to 15 per cent. will be effected, besides which it is much better for the boiler to feed hot water. With a condensing engine there is very little gain from the use of a heater, provided the temperature of the hot well is not unnecessarily low.

For THE CANADIAN ENGINEER.

WATER IN THE BOILERS.

BY W. SUTTON.

All waters used in steam boilers contain, in solution or suspension, more or less mineral and organic matter, acquired by contact with the earth's surface, or by percolation through its alluvium and rocks. Of this river and lake water contain from 5 to 20 grains to the gallon in solution, and a varying quantity in suspension. Well and spring hold but little in suspension, but, in solution, a quantity varying from 10 to 650 grains. This matter consists of a variety of substances, namely, carbonates lime, magnesia, iron; chlorides of lime magnesium, potassium; sulphates lime, magnesia, soda and potash; phosphate lime, bromides and iodides of calcium and magnesium, alumina and silica. Besides these substances, certain gases are more or less present. These are oxygen, hydrogen, carbonic acid and sulphuretted hydrogen—the three first being always found. All of the above substances are not uniformly present. The quantity and character of the matter in any particular water depends much on the constitution of the earths and rocks over or through which it has passed, and upon the condition of location, and motion, and exposure to light, heat and air which it has undergone. Consequently, there is much variety in the constitution of various waters with reference to their adventitious ingredients.

EVAPORATION.

All water, on being evaporated by boiling in an open pan, leaves a residue composed of all the elements contained in it; the deposits of the residue take place