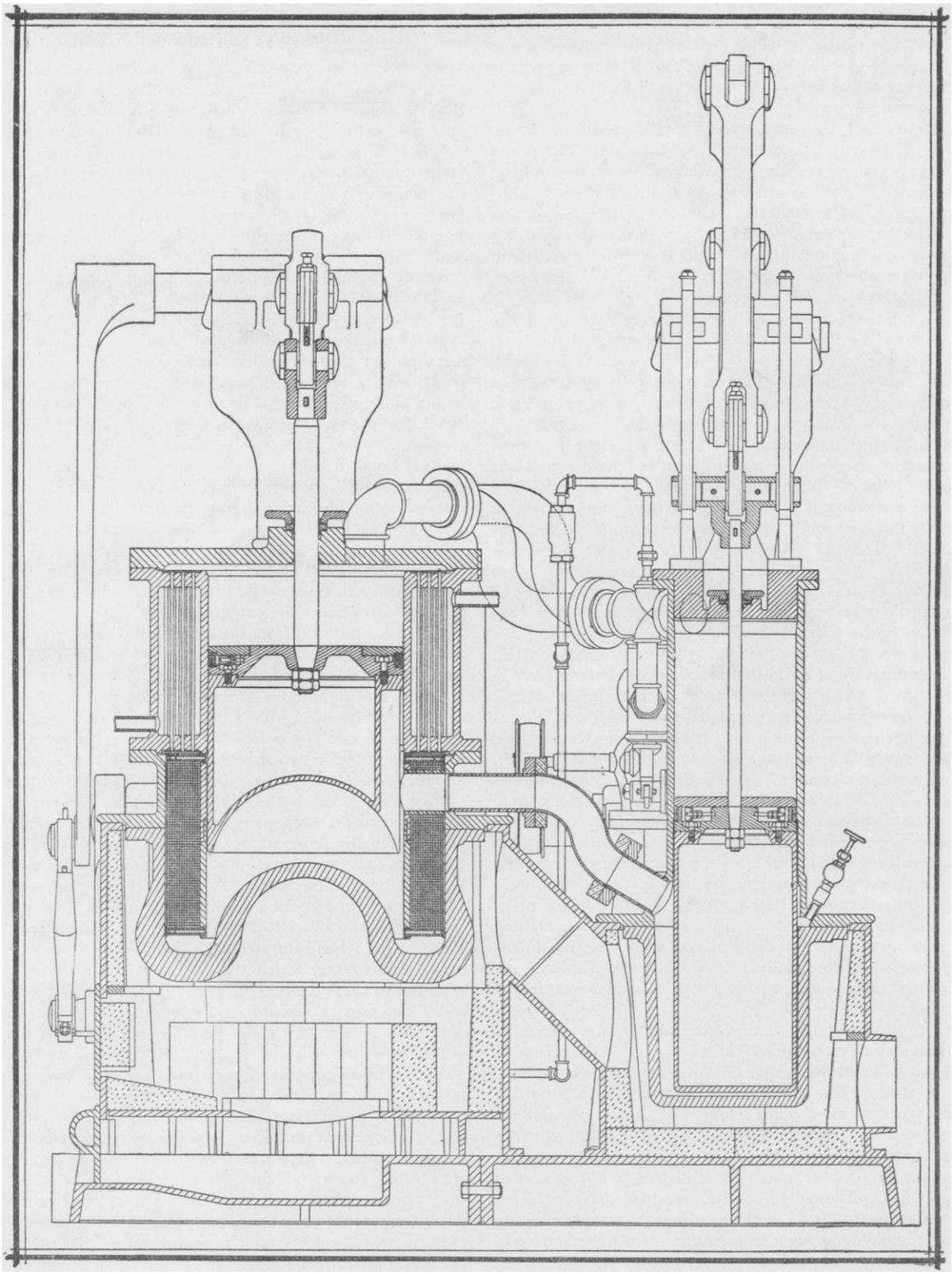
## AN IMPROVED AIR-ENGINE.

DURING the past ten or twelve years the firm of Woodbury, Merrill, Patten, & Woodbury, of Boston, Mass., have been steadily at work developing and perfecting an air-engine; and, as a result of their labors, they are now about to place on the market engines superior in durability and economy to any heretofore constructed. In a test made in South Boston in March last, the quantity of coke consumed was 1.54 pounds per indicated horse-power per hour. A representative of *Science*, on seeing the engine, was surprised at its general excellence and smoothness of movement.



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of their construction in sizes ranging from five to a hundred horse-power. A few experimental engines were built from time to time, as the inventors approached their ideals, and some of those engines are said to have done satisfactory work during a run of five years. But the engines as made at present are claimed to be much

The essential features of this engine are a heater, a regenerator, and a cooler, which three in combination are called a reverser. The engine illustrated is composed of two reversers and two double-acting cylinders, the cut being a section through one reverser and one cylinder. Each reverser is provided with a reverser heater, within a

furnace; a regenerator, composed of wire cloth of great superficial area, extending from the cooler to the bottom of the reverser heater; a cooler, composed of a large number of thin copper tubes, which are surrounded by water; and a displacer piston, having metallic packing rings, and adapted to reciprocate within the cooler. Each working cylinder is provided with a working piston having metallic packing rings. Each reverser is connected by means of pipes with the working cylinders, as follows: the hot chamber below the displacer piston is connected with the bottom of the working cylinder directly opposite, and the cold chamber above the displacer piston is connected with the top of the working cylinder diagonally opposite.

A small single-acting air-pump, having a leather-packed piston, is operated by an eccentric fastened to the main shaft. This pump is used, first, to compress the air to the initial pressure required; second, to maintain the initial pressure so attained, which is subjected to loss by leakage around the piston-rods. The regulation of the speed of the engine is obtained by a balanced equalizing valve of simple construction, placed in an equalizing pipe which connects the top of the working cylinders together, the valve being operated by a common centrifugal governor.

The power produced is due to the energy exerted upon the working pistons by the alternate raising and lowering of the temperature of the same mass of air within the reversers. The cooling medium used is any kind of water, or a blast of air circulated through the coolers. A very small quantity of water is required, and the same body of water may be used over and over again.

In operation, the alternate raising and lowering of the temperature of the same mass of air is accomplished as follows: in the upward stroke of the displacer piston, the mass of air in the cold chamber above the piston is forced through the cooling tubes, in its downward passage through which its temperature is not materially changed. The air then enters the regenerator, in its passage through which it absorbs heat which has been imparted to the regenerator. It next passes over the heated surface of the reverser heater, thereby becoming further heated, and enters the hot chamber below the displacer piston.

The temperature of the air in the cold chamber is about 120° F., and the temperature of the air in the hot chamber is about 600° F.

In the downward stroke of the displacer piston, the mass of air is forced into the regenerator, in its passage through which it deposits therein the greater portion of its heat. It then passes through the cooling tubes, where its temperature is reduced to about 120° F., and then into the cold chamber above the displacer piston. Therefore, at each upward and downward stroke of the displacer piston, the temperature of the same mass of air is alternately raised and lowered. The reversers being in duplicate, it is obvious that the same alternate raising and lowering of the temperature of the displaced air would take place in one reverser as in the other, but at opposite times; that is to say, both displacer pistons being operated by the reverser beam, whenever one displacer piston is making its upward stroke, the other displacer piston is making its downward stroke. It is therefore evident, that, when the displaced air in one reverser is being heated, the displacer air in the other reverser is being cooled.

The alternate raising and lowering of the temperature of the displaced air (in both reversers) generates a power in accordance with the well-known laws of the expansion of gases, which power is developed by the working cylinders, as follows: while one displacer piston is making its upward stroke, and is heating and expanding the displaced air, thereby producing a pressure which is exerted against the bottom of the piston of the working cylinder directly opposite the reverser, and against the top of the piston of the working cylinder diagonally opposite, the other displacer piston is making its downward stroke, and is cooling and contracting the displaced air, thereby reducing the pressure against the bottom of the piston of the working cylinder directly opposite the reverser, and the top of the piston of the working cylinder diagonally opposite. Thus each working piston is subjected to differential pressures, which are alternately reversed as the displaced air is alternately heated and cooled. Thus a power is exerted to cause the working pistons to have a reciprocating motion, which is changed to a rotary motion by means of the working-cylinder beam and its connected parts to the main shaft and the fly-wheel, from which the power may be taken off by a belt. A portion of the power developed is absorbed in the friction of the engine, and a portion is used to operate the displacer pistons. The engine is designed to run on an initial pressure of air of about forty-five pounds, at a speed of 115 revolutions per minute.

## PRODUCTION OF ESSENCE OF LEMON IN SICILY.

LEMONS in Sicily are divided into two classes, — the true lemon and the bastard lemon. The United States consul at Messina says that the true lemon is produced by the April and May blooms; the bastard, by the irregular blooms of February, March, June, and July, which depend upon the rainfall or regular irrigation, and the intensity of the heat during the summer and winter seasons. There are but three harvests of the true lemon. The first is the November, cut when the lemon is green in appearance, and not fully ripe. Lemons of this cut are the most highly prized: they possess remarkable qualities for keeping, and are admirably preserved in boxes or warehouses from November until March, and sometimes as late as May, and then shipped. The second cut occurs in December and January, and the third in March and April.

Bastard lemons present well-defined peculiarities in shape and appearance: their inner skin is fine, and adheres tenaciously to the fruit; they are hard, rich in acid, and seedless. The bastard lemon produced from the bloom of June is still green the following April, and ripens only towards the end of July. It remains on the tree over a year. The true lemon can be left on the tree until the end of May or the first week in June; but it interferes with the new crop, drops off from over-maturity, and is liable to be attacked by insects. The bastards, on the contrary, withstand bad weather and parasites, and they mature from June to October.

In obtaining the essence from the lemon, the following operations are performed by the Sicilian workman. He peels the fruit lengthwise with three strokes of a sharp knife, and lets the peel fall into a tub under the chopping-block. He then cuts the lemon in two, and throws it from his knife into a bucket. He works with wonderful rapidity, and fills from ten to twelve tubs with peel a day, and is paid about five cents a tub, weighing 77 pounds. His left hand and right index are protected with bands of osnaburgs or leather. Decayed fruit is not peeled. Fresh peel is soaked in water fifteen minutes before the essence is extracted. Peel that has stood a day or two should remain in soak from thirty to forty minutes, so that it may swell and offer a greater resistance to the sponge. The operative holds a small sponge in his left hand, against which he presses each piece of peel two or three times, — simple pressure followed by rotary pressure. The women employed in this work run a piece of cane through their sponges to enable them to hold them more firmly. The outside of the peel is pressed against the sponge, as the oil-glands are in the epicarp. The crushing of the oil-cells liberates the essence therein contained. The sponge, when saturated with the essence, is squeezed into an earthenware vessel which the operative holds in his lap. He is expected to press the peel so thoroughly as not to overlook a single cell. This is ascertained by holding the pressed peel to the flame of a candle. Should it neither crackle nor diminish the brilliancy of the flame, the cells are empty. This process yields, besides the essence, a small quantity of juice and dregs. The separation of the essence, juice, and dregs soon takes place if the vessels are not disturbed: the oil floats on the juice, and the dregs fall to the bottom. These three products derived from the peel have no affinity with each other. As the essence rises to the surface, it is skimmed off, bottled, and left to settle for a few days. It is then drawn off with a glass siphon into copper cans, which are hermetically sealed. After the essence has been expressed, a small quantity of juice is pressed from the peels, which are then either given as food to oxen and goats or thrown away.

The yield of essence is very variable, and the industry is carried on five months in the year. Immature fruit contains the most oil. From November to April, in the province of Messina, 1,000 lemons yield about 14 ounces of essence and 17 gallons of juice. An operative expresses three baskets of lemon-peel (weighing 190 pounds) a day, and is paid at the rate of about twenty cents a