1,000,000 bacteria (which are about 1/5000 inch in length and 1/25000 inch in diameter), if laid lengthwise, end to end, would extend to a distance of 16.66 feet; but, if laid side by side, they would be 3.33 feet long.

A gramme of street mud, which is equivalent to a small cube of earth having sides one-quarter inch in length, contains about 78,000,000 bacteria, which, if placed in a line, side by side, would cover a length of 259.74 feet, and a gramme of earth from a cultivated field will contain about 11,000,000 bacteria, which, if laid side by side, would extend a distance of 36.60 feet.

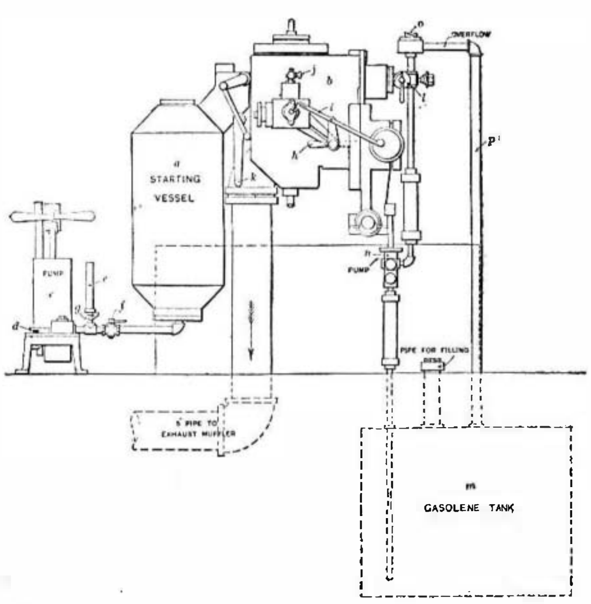
In the Alpine mountains, no bacteria were found in 10,000,000 cubic centimeters of air, which is equivalent in size to a cube of 7 feet sides; but in the air of the streets of Paris 55,000 were found in the same volume of air; while, in the rain-water in Paris, 33,800,000 bacteria were found in a cube having sides 7 feet in length. This is equivalent to about 57 bacteria to 1 cubic inch.—English Mechanic and World of Science.

STARTING GASOLINE ENGINES.*

THE AUTOMATIC STARTING DEVICE.

BY WALTER IRVING.

SMALL gas and gasoline engines may readily be started by turning the flywheel by hand, if the compression is reduced temporarily by opening a small relief cock, or by holding the exhaust valve open during part of the compression stroke. Large engines, after once being put in operation, usually are subsequently started by air compressed during the running of the engine by an air pump directly attached to or driven by the engine. The compressed air is stored in a tank until it is needed after the next succeeding shutdown, when it is admitted into the engine cylinder through a special valve whose operation is controlled by a sliding cam on the 2 to 1 shaft. During the first part of both suction and expansion strokes this valve admits compressed air to the cylinder, while another special cam holds the exhaust valve open during what otherwise would be the compression stroke. When the flywheel has attained sufficient momentum to establish the engine's regular cycle of operations the special cams are shifted out of action and the combustible mixture is admitted to the cylinder and exploded in the usual manner. As a rule, compressed air starters are applied to but one cylinder of a multicylinder engine, the other cylinders taking up their work after the engine has been run a few revolutions on compressed air.



DEVICE FOR STARTING GASOLINE ENGINES WITH A COMPRESSED CHARGE OF THE EXPLOSIVE MIXTURE.

The accompanying engraving shows a starter as applied to an Otto gasoline engine. It consists of a reservoir or starting vessel *a*, connected between the engine *b* and a hand pump *c*. A small quantity of gasoline is poured into the starting pump *c*, through the plug *d*, so that when the pump is operated a mixture of fuel and air passes through the reservoir *a* to the engine cylinder. Before attempting to ignite this mixture in the engine cylinder, it is customary to test it in the testing tube *e*. The cock *f*, between the hand pump *c* and the reservoir *a*, is closed, and the cock *g* at the foot of the testing tube *e* is opened; the upper end of the testing tube is covered with the hand and a few strokes are given to the pump to fill the tube with the mixture; then the cock *g* is closed, the hand removed from the mouth of the testing tube and the mixture quickly lighted with a burning candle or match. If the mixture is properly proportioned it will burn rapidly, giving a fairly sharp report as it burns down the tube, but if it burns slowly, giving a weak report, the mixture is not properly proportioned. The proportions of the mixture of air and gasoline may be changed by adjusting a brass set screw in the top of the starting pump barrel.

Having made the necessary adjustments to secure a good combustible mixture, the engine may be prepared for starting by turning the flywheel until the crank is in its starting position, slightly above the inner dead center, and with the piston at the beginning of the expansion stroke. To facilitate starting, the time of ignition is retarded by turning the handle *h*, so as to lower the igniter blade *i*. The cylinder relief cock *j* is opened, and by raising the hand lever *k* the starting valve between the reservoir *a* and the engine cylinder is also opened. With the cock *f* open and the cock *g* closed, about ten strokes are given to the hand pump to force into the cylinder enough of the mixture to drive out through the relief cock *j* any air or dead gases. The cock *j* is then closed, and after giving ten more strokes to the pump, the valve controlling the passage between the reservoir *a* and the engine cylinder is closed. The pressure within the reservoir is then increased by giving about twenty strokes to the pump, the lever arm of which is lengthened so as to increase its leverage.

When the switch of the igniting circuit is closed and the gasoline fuel valve *l* opened, the engine is ready for starting. Opening the valve operated by the lever *k* allows the high-pressure mixture to rush from the reservoir *a* into the cylinder, forcing the piston outward until it reaches the point at which ignition takes place, and the explosion produces a powerful impulse which imparts to the flywheel sufficient momentum to carry it over the next compression stroke. Immediately after the first explosion, the valve between the reservoir and the cylinder is closed by pushing down the lever *k*, so that the succeeding charge is drawn in, compressed and exploded in the regular way, and as the speed of the engine increases the time of ignition is advanced by turning the handle *h* so as to raise the igniter blade *i* until it occupies its normal position.

The required supply of gasoline is pumped from the tank *m* by a pump *n*, which is driven by an eccentric on the cam shaft and which lifts the gasoline to the cup *o*. From this cup the liquid flows to the gasoline inlet valve or spray nozzle at *l*, and the overflow returns through the pipe *p* to the underground supply tank *m* beneath the engine room floor.

* The Iron Age.

A NEW IDEA FOR AN INTERNAL-COMBUSTION ENGINE.

AN ingenious idea in the way of gas-engine design is embodied in the class of engine indicated by the accompanying illustrations. This type has been patented in England by H. Campbell, of Dumbarton, N. B., and was recently described in The Mechanical Engineer, of Manchester and London.

Fig. 1 is a sectional elevation of the cylinder of a single-acting engine, and Fig. 2 the cylinder of a double-acting engine, as they would be constructed in accordance with Mr. Campbell's patent. In the single-acting engine, *C* is an exhaust port fitted with a mechanically actuated valve *D*, and *E* is an admission port, located approximately midway of the stroke of the piston and provided with an admission valve *F*, which is closed by a spring *G*; *H* is a passage which communicates with a supply of mixture under pressure. In the illustration the piston *B* is shown in its bottom position, the top position being indicated in dotted lines, and it should be noted that the piston is sufficiently long to cover the admission port *E* when in its top position. In action, with the piston beginning to rise on a compression stroke, the exhaust valve *D* is held open until the cylinder has received a charge of mixture which will flow in past the admission valve *F*, the pressure in the supply passage *H* being sufficient to overcome the reduced pressure in the cylinder of the previously expanded charge and the resistance offered by the admission valve. The exhaust valve *D* is mechanically closed at an early period in the compression stroke of the piston, and the incoming charge is cut off by the automatic inlet valve *F* when the pressure within the cylinder is nearly in equilibrium with the pressure in the supply passage *H*. The charge is then compressed by the rising piston and subsequently ignited to produce the power stroke. When the power stroke is nearly completed, the exhaust valve *D* is opened to release the pressure in the cylinder, and when it has fallen below the pressure of supply the automatic valve *F* opens and a new charge flows into the cylinder, the charge being completed after the exhaust valve is closed.

In conjunction with this cycle of operations it will be noted that as the port *E* is situated at a distance above the head of the piston when it is down, during the compression stroke a portion of the charge, after partial compression has taken place, will be entrapped in the valve chamber and port opening *E* as the piston advances and remain trapped until the piston again passes the opening on its return or power stroke, when the entrapped charge will be ignited as it becomes exposed to the live charge and produce a supplementary power effort at a stage when the connecting rod is at effective angle with the crank.

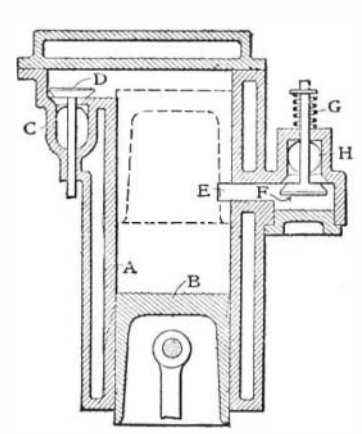


FIG. 1.

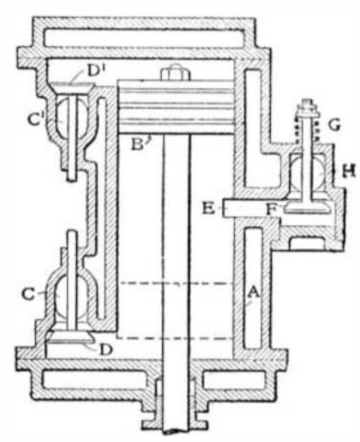


FIG. 2.

Referring to Fig. 2, in which the cylinder of a double-acting engine is illustrated, *C* and C^1 are end exhaust ports fitted with mechanically actuated valves $D\,D^1$, and *E* is the admission port, located approximately midway of the piston travel, as before. The port *E* is fitted with an automatic inlet valve *F*, and *H* is a passage which communicates with a supply of mixture under pressure, as in the previous case. In this form of construction, a comparatively short piston is employed. In action, with the piston in the position shown and beginning to descend on a compression stroke in the lower end of the cylinder, the exhaust valve *D* is held open until the lower end of cylinder has received a charge of mixture which will flow in past the valve *F* as in the cycle of the single-acting engine already described. The exhaust valve *D* closes in the initial movement of the piston, after which the charge will be compressed, and in the advance of the piston the admission port *E* will be brought into communication with the upper part of the cylinder where a power stroke is in progress. With this difference of operation the cycle of action is similar to that in the single-acting engine. The adjunct, however, differs in this case from that in the cycle of the single-acting engine, in that when the port or opening *E* is constructed to receive a portion of the charge in compression the entrapped charge is ignited during the same stroke by the live charge on the opposite side of the piston as the piston passes and uncovers the port.

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