A.D. 1857 N° 1655

SPECIFICATION

OF

EUGENE BARSANTI

AND

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APPARATUS FOR OBTAINING MOTIVE POWER

LONDON
PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY
PUBLISHED AT THE GREAT SEAL PATENT OFFICE
25 SOUTHAMPTON BUILDINGS HOLBORN
1857

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Apparatus for Obtaining Motive Power.

LETTERS PATENT to Eugène Barsanti, Professor of Physics and Mathematics, and Felix Matteucci, Gentleman, both of Florence, in the Grand Duchy of Tuscany, for the Invention of "IMPROVED APPARATUS FOR OBTAINING MOTIVE POWER FROM GASES".

Sealed the 1st December 1857, and dated the 12th June 1857.

PROVISIONAL SPECIFICATION left by the said Eugène Barsanti and Felix Matteucci at the office of the Commissioners of Patents, with their Petition, on the 12th june 1857.

We, EUGENE BARSANTI, Professor of Physics and Mathematics in the Institute Ximeniano, and FELIX MATTEUCCI, Gentleman, both of Florence, in the Grand Duchy of Tuscany, do hereby declare the nature of the said Invention for "IMPROVED APPARATUS FOR OBTAINING MOTIVE POWER FROM GASES" to be as follows:

This invention of improved apparatus for obtaining motive power from gases relates to the means of obtaining motive power derived from the explosive force of a mixture of atmospheric air and hydrogen, or any other inflammable gas. The explosion of the mixed gases is effected by means of an electric spark applied to the under part of a piston working in a cylinder.

The following are the two plans we prefer to employ for carrying out our Invention, although the same may be variously modified according to the circumstances.

According to the first plan we avail ourselves of the vacuum produced underneath the piston by the explosion, and in this case it is simply atmospheric pressure acting upon the outer surface of the working piston, which communicates the requisite motion thereto in one direction, the return stroke being effected by the piston rod, which is specially arranged and constructed for the purpose. When this mode of actuating the pistons is adopted it is preferred to employ two cylinders in which the pistons are made to operate alternately by exploding gases in the two cylinders alternately.

According to the second arrangement the force of the explosion and the vacuum produced are both utilized, the one force being made to act on one side of the piston, and the other force on the opposite side. In this case the pistons and their cylinders differ but slightly from those ordinarily employed in steam engines as regards their construction and the mode of operating them.

In both these arrangements the mixture of the gases is effected inside the cylinder by means of a suitable arrangement of apparatus, the air being introduced direct from the atmosphere, and the gas from a gasometer at a given pressure.

It will of course be understood that after every discharge or explosion of the mixed gases in the cylinder the products generated by the explosion must be disposed of so as to prevent the apparatus from clogging up.

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Eugene Barsanti and Felix Matteucci in the Great Seal Patent Office on the 12th December 1857.

TO ALL TO WHOM THESE PRESENTS SHALL COME, we, EUGENE BARSANTI, Professor of Physics and Mathematics, and FELIX MATTEUCCI, Gentleman, both of Florence, in the Grand Duchy of Tuscany, send greeting.

WHEREAS …….

NOW KNOW YE, that we, the said Eugène Barsanti and Felix Matteucci, do hereby declare the nature of our said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement, reference being had to the Drawings hereunto annexed, and to the letters and figures marked thereon (that is to say):

This Invention of improved apparatus for obtaining motive power from gases relates to the means of obtaining motive power from the explosive force of a mixture of atmospheric air and hydrogen, or any other inflammable gas. The explosion of the mixed gases is effected by means of an electric spark applied to the under part of a piston working in a cylinder.

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The several Figures in the accompanying Drawings represent various views of the principal working parts of an engine constructed according to the first arrangement above referred to, the framing and the other well-known parts being omitted. Fig. 1 is a plan or bird's-eye view of the apparatus; Fig. 2 represents a section taken in the line 1…2, of Fig. 1; Fig. 3 is a sectional view of a portion of Fig. 2 drawn to a scale of twice the size; Fig. 4 is a front or end view of the cylinder; Fig. 5 represents the apparatus for producing the electric spark; similar letters indicate like parts in all these Figures.

A, B, C, D, indicate one of the cylinders of the engine, which is generally intended to have two. This cylinder is open to one end, as seen in Fig. 2, and is closed at the other by a cover A, B, bolted

thereto, and which is provided with two valves *a a* opening outwards. This cylinder is devided into two unequal parts, the smallest of which *u, v, s, x* (Fig. 2), is intended for the working of the piston. This chamber is surrounded with a jacket filled with water for the purpose of preventing it from attaining too high a temperature. P is a large elastic piston, the rod P* of which has a rack formed on it, and has a crosshead at its outer extremity for the purpose of guiding its motion, and stopping it when the piston has arrived at the end of its stroke. R (Figs. 2 and 4) is a toothed wheel taking into the rack on the piston rod P*. This wheel R is mounted loosely on the shaft E, F, and turns freely thereon during the down stroke of the piston; but the wheel R carries a click which takes into the teeth of a ratchet wheel R^{II} (Fig. 2), keyed on the shaft E, F, by which means this latter will be caused to rotate during the return stroke of the piston. P^{II} is a small piston, the office of which is to draw in the charge of gas which is to be exploded, and also to clear the small chamber of the products of combustion; this piston will in the following description be distinguished by the name of the "counter piston".

The apparatus intended for the production of the electric spark which is to fire the charge is represented at Fig. 5. It is composed of a small cylindrical circuit braker E^{I}, which is caused to turn continuously, and rub against the end of a steel spring when the engine is in operation by means of an endless band or cord *b** passing from a pulley on the shaft E, F, to another pulley on the shaft of the cylinder E^{I}. To the outer extremity of this shaft (which is insulated) is attached one of the poles of a Bunsen's battery, furnished with a De la Rive's multiplier; the other pole of the battery must only be brought into communication with the cylinder when the electric spark is required to set fire to the explosive mixture. *b* is a slide valve adapted to the small chamber of the cylinder, for the purpose of regulating the introduction of the atmospheric air and of hydrogen, or other inflammable gas, which is drawn from a gasometer, maintained at a determined pressure. This slide valve box is made to communicate with the chamber by three openings or ways *d*, *e*, *i* (see the enlarged view, Fig. 3), and the cover of the valve is provided with two other openings *o*, *u*, the first of which *o* serves to draw in the air, and the second *u* serves for the introduction of the gas; it is provided with a metallic pipe communicating with the gasometer by means of an india-rubber or flexible pipe. L, M, (Fig. 1) is a cross bar or crosshead, to which a reciprocating motion is communicated by means of the two connecting rods L^{I}, M^{I}, driven by the two excentrics, which receive their motion from two toothed wheels L^{II}, M^{II}, that are driven by pinion *l*, *m*, mounted on the shaft E, F. Through the crosshead L, M, passes the rod of the counter piston P^{II}, to which it communicates motion, after making at the commencement of each stroke an independent movement equal to about one-third of its useful motion. These movements are so timed that the return stroke of the counter piston cannot take place until the piston P has arrived at its starting point. b^{I} is a rod attached at right angles to the counter piston rod, and serves to actuate the slide valve *b*, and also to close the electric circuit when the charge is introduced, for which purpose it is made to bear upon a piece soldered to one of the poles of the battery.

The operation of the engine is as follows: --Suppose the main piston P to be at rest, and the counter piston P^{II} nearly in contact with it, the opening of the slide valve opposite the opening *o* of the valve box cover, and the opening or way *i*, open as shown in Fig. 2 and 3, on communicating motion to the fly wheel of the main shaft E, F, the crosshead L, M, will descend and carry with it (after the first independent motion above mentioned) the counter piston P^{II}, which will draw in atmospheric air until the arm b^{I} of the piston rod acting upon the slide valve closes the air-way *o* and opens the way *u* for the introduction of the gas, which rushes in until the slide valve by passing

onwards closes that passage and opens the way *d* below. When the slide valve has reached this point the electric circuit will be closed or completed by the arm b^{I}, and a series of electric sparks will be produced which will effect the explosion of the mixture of gases contained in the cylinder, and by this means the piston P will be driven forward with a force equivalent to the power of the explosive force to overcome the pressure of atmosphere; when the explosive force is expended the atmospheric pressure will act upon the back of the piston in a contrary direction; and in consequence of the vacuum formed in the cylinder by the explosion the shaft E, F, and its accessories again receiving motion during the return stroke (but remaining stationary during the forward stroke), the counter piston P^{II} being then again set in action, will force out the products of combustion through the exit openings until it closes the opening *e*, the arm b^{I} will then again act upon the slide valve until it assumes its starting position, and during this movement a small portion of the products of combustion, which had remained between the two pistons, is driven out into the atmosphere through the passages *i* and *o*. The return stroke of the piston now again takes place, a fresh charge is drawn in above the counter piston, and the products of combustion which remained behind it are compressed and driven off through the valves *a*, *a*, at the bottom. The introduction of the charges and their explosion and discharge thus take place successively, and if the fly wheel be of suitable size and weight the engine will soon acquire a uniform motion, even although provided with but one cylinder; but in order to obtain a continuous and powerful motion it would be found necessary to employ two cylinders and pistons, the racks on the rods of which should act alternately upon the same shaft.

The Figures in Sheet II, represent another arrangement, which possesses the advantage of greater simplicity of construction and rapidity of action, for which reason it is more especially adapted to single cylinder engines. Fig. 6 is a longitudinal section, taken through the cylinder; Fig. 7, an outside view, taken at right angles to Fig. 6; Fig. 8 is a detached view of the slide valve arrangement; and Fig. 9 an end view of the cylinder and its accessories. The piston and its rack, and the wheel which gears therewith the ratchet wheel and the electric apparatus, only differ from the former arrangement inasmuch as the piston is not arrested below the chamber, but continues its course to the end of the cylinder, in order to drive out the products of combustion on its return stroke, and also to draw in the charge of inflammable gases during its forward course, thus dispensing with the counter piston and its appendages. These effects are produced by the following arrangement of parts: -- The rack of the piston rod is provided with two tappets *m*, *n* (Fig. 6), and the shaft E carries a cam *k*, which, when the piston has arrived nearly at the end of the cylinder, acts upon the tappet *m* and drives the piston home. A toothed wheel R, mounted on the same shaft as the cam *k*, and revolving therewith, gears into another wheel R^{I} of equal diameter, and which carries another cam k^{I}; this latter revolves therefore in a contrary direction to that of the cam *k*.

The position of these cams is so arranged, that when the cam *k* leaves the tappet *m*, the cam k^{I} will drive the piston in a contrary direction by means of the tappet *n*; a fresh charge of the explosive gases will then be drawn in and set fire to during the last movement of the slide valve. In this arrangement the slide valve, instead of being a D valve, is made straight, with two openings corresponding to those in the valve box and cylinder. When the piston during its return stroke has closed the opening *e* for the introduction of the gas, The slide valve will begin to act in the same direction, and after the first opening of the slide valve has passed beyond the opening *e*, it opens the exit apertures for the escape of the products of combustion; the piston then opens the way *e*, and the opening in the slide valve again coming opposite to it, gas is drawn in until the apertures are closed. All these movements of the slide valve are operated by means of two cams *c*, c^{I} (shewn by red lines

in Fig. 6), mounted upon the same shafts as those above mentioned, and which act upon tappets *s*, *t*, mounted upon a rod working in guides, and to which the slide valve rod is attached.

In this arrangement the electric circuit is closed by the end of the valve rod coming in contact with a piece soldered to one of the poles of the battery.

In a double cylinder engine the above arrangement may be modified by substituting for the shafts which carry the cams *k* a beam which has its fulcrum between the two cylinders, and has motion communicated to it by the pistons alternately, so that one piston in descending shall raise the other one which has just descended to the bottom of the cylinder, thus dispensing with the cams k^{1}. In this case the valve rods would be worked by the arms of the beam.

In all these arrangements the power of the engine may be regulated in the same manner as that of a steam engine, by means of a cock adapted to the supply pipe leading from the gasometer; and in the case of a stationary engine we adapt thereto a regulator acting upon the supply valve.

When applying this Invention to a locomotive engine, as it is intended to supply the place of two double action (or high-pressure) cylinders, four cylinders must be employed, one on each of two pairs of driving wheels, the main shafts being made to drive these wheels by means of connecting rods or gearing combined in such a manner as to change the direction of rotation by means of clutches.

In order to supply gas to the locomotive, a reservoir is adapted to the tender, which is supplied from gasometers situate at the several stations with a sufficient quantity of gas (at a pressure of several atmospheres) to last until the end of the journey, or until the engine arrives at the next station; the gas before being supplied to work the engine passes through a gasometer placed between the reservoir and the feed pipe, by which means it is supplied to the cylinders at a uniform pressure of one atmosphere. This gasometer, which we call a *regulator*, communicates with the gas reservoir by means of a metal pipe, and on the other side with the engine by means of an india-rubber pipe. On the upper part of the gasometer is placed a small cylinder, open at both ends, in which a piston works, the rod of which is connected to one end of a lever arm, the other arm of which works a slide valve, which cuts off communication with the reservoir when the pressure of the gas diminishes. The pressure of the gas in the gasometer is increased or diminished by means of a small weight, which causes an increase or diminution of pressure, according to whether it be placed on the piston rod or the valve rod.

By slightly modifying this improved engine, the direct action of the explosion may be utilized for various useful purposes where a percussive force is required. It it be desired, for instance, to break stones for excavating a tunnel, or to work a forge hammer, the chisel or hammer may be adapted to the extremity of the piston rod, or any other suitable tool may be applied thereto according to the nature of the work required to be performed. In this case the only office which the rotating shaft of the engine will have to perform will be to work the supply of the mixed gases to the cylinder, and the discharge there-from of the products of combustion.

Having now described our invention of improved apparatus for obtaining motive power from gases, and having explained the manner of carrying the same into effect, we would observe, that we do not mean or intend to confine ourselves rigidly to the precise arrangement or construction of parts herein, shown and described, as they may doubtless be varied without departing from the nature and object of our Invention.

In conclusion, we claim as the Invention which we desire to secure to ourselves by Letters Patent, as aforesaid, the mode or modes herein shown and described, or any mere modification thereof, for obtaining motive power from gases.

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