No. 670,311.

Patented Mar. 19, 1901.

E. COURVOISIER.

EXPLOSIVE ENGINE.

(Application filed June 10, 1899.)

(No Model.)

2 Sheets—Sheet 1.

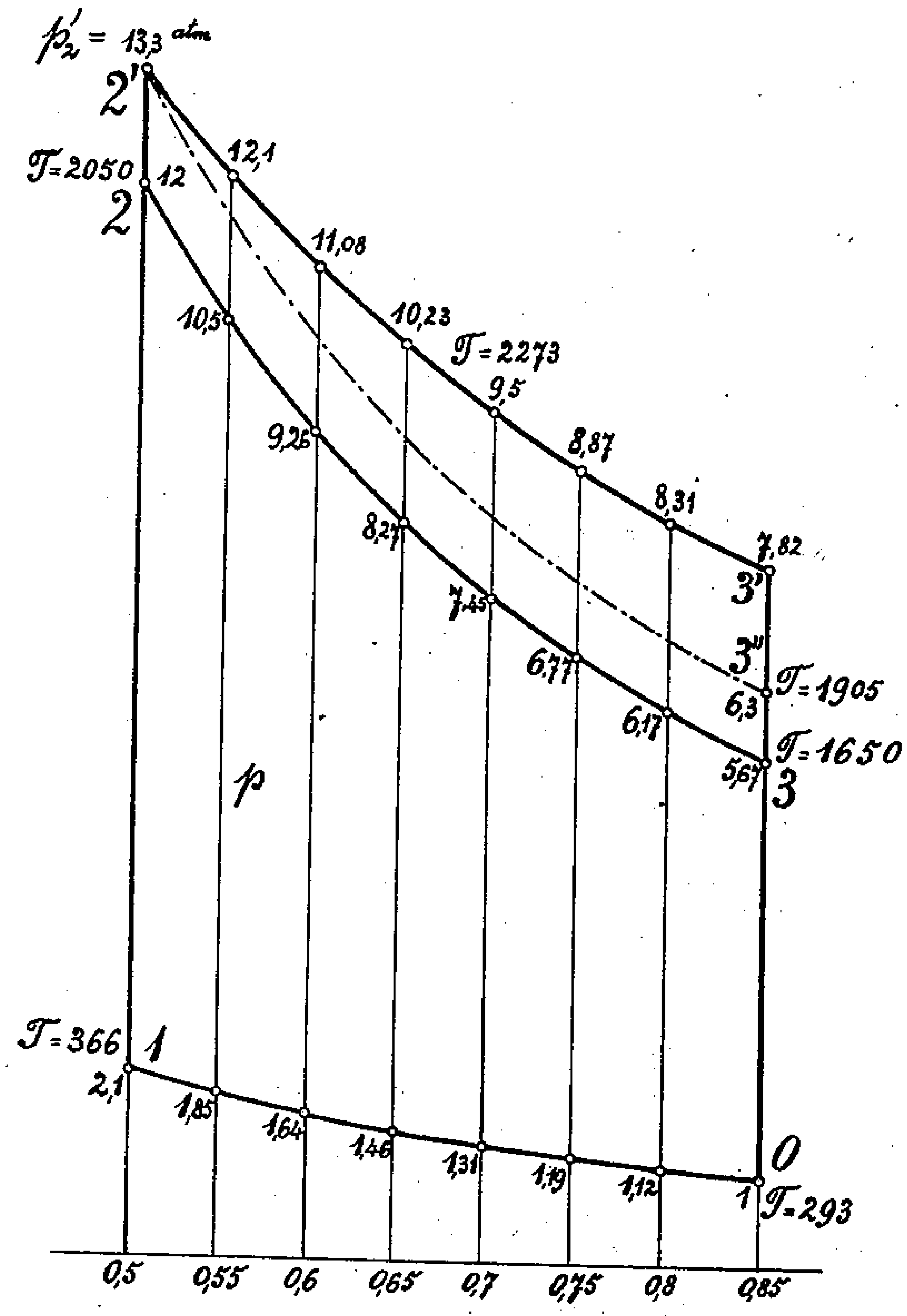

Fig. 1.

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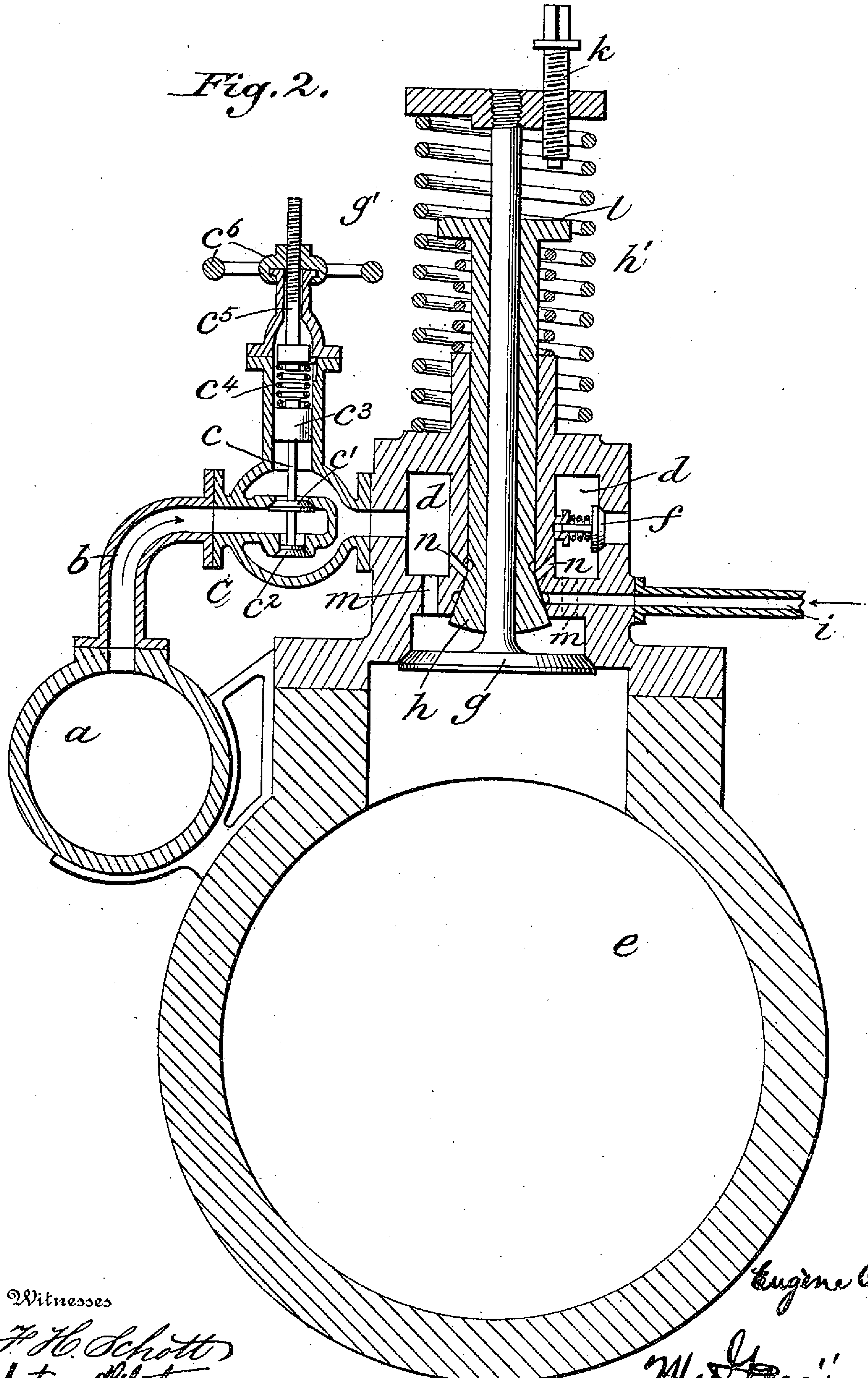
Fig. 2.



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UNITED STATES PATENT OFFICE.

EUGÈNE COURVOISIER, OF BIENNE, SWITZERLAND.

EXPLOSIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 670,311, dated March 19, 1901.

Application filed June 10, 1899. Serial No. 720,032. (No model.)

To all whom it may concern:

Be it known that I, EUGÈNE COURVOISIER, a citizen of Switzerland, residing at Bienne, Switzerland, have invented certain new and useful Improvements in Explosive-Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improvements in explosive-engines, and in particular to such explosive-engines as are used for the propulsion of vehicles.

It is well known that the power required to propel a vehicle under ordinary conditions is much less than is necessary to start such a vehicle from a condition of rest or to drive it up hills or over portions of the roadway which are rougher than usual. Hence it is usual in equipping a vehicle with an explosive-engine for propelling it to proportion the engine, so that it is capable of developing the maximum amount of power which will at any time be required from it. As the demand on the engine for such maximum amount of power is made usually only at infrequent intervals, the engine is employed during a large part of the time of its operation in supplying but a portion of its maximum power, and consequently the engine is larger than necessary for its ordinary or usual work. Being larger it is also heavier, and as a result is compelled to furnish the additional power required to propel its surplus weight at such times.

It is the object of my invention to avoid the above-mentioned disadvantages by enabling the engine to be proportioned as to size and weight so that under ordinary conditions it will be working at its usual full capacity, and yet when the occasion demands it this full capacity may be temporarily increased up to what might be termed an "abnormal" capacity.

With this general object in view an apparatus embodying my invention consists in an explosive-engine arranged to operate in the usual manner by the repeated explosions of any ordinary mixture of atmospheric air and gas or other fuel and having in addition means for supplying oxygen or the like to the air and gas mixture, whereby the energy of the mixture is increased to such an extent that by its use the engine will give an abnormal power.

While I have particularly pointed out hereinabove the disadvantages of the usual explosive-engines for driving vehicles, it will be obvious that corresponding disadvantages result even with other explosive-engines where the same are expected to supply at intervals a maximum power in excess of the amount usually required. Consequently under such circumstances also my invention is applicable with advantage.

As is well known, the ordinary explosive-engine is operated by the ignition in its cylinder of a mixture composed of a hydrocarbon and atmospheric air, the latter serving as an oxidizer of the hydrocarbon. In an engine of a given size the power can be varied from zero to a certain maximum amount by the admission of more or less of the air and hydrocarbon mixture to the cylinder or by a variation in the proportion of hydrocarbon supplied to a given quantity of air; but the maximum amount of hydrocarbon, and thereby also the maximum power of the engine, is limited by the size of the engine-cylinder, because the maximum amount of air which the cylinder will receive can oxidize completely only a fixed maximum amount of hydrocarbon. If a greater quantity of hydrocarbon than this maximum be fed to the cylinder, the surplus will not be burned and adds nothing to the power of the engine. It is well-known that in the atmospheric air supplied to the cylinder only the oxygen which it contains—viz., about 0.2356 parts, by weight—serves in the combustion of the hydrocarbon, the remainder—viz., 0.7644, which is nitrogen—being inert. If now instead of a certain weight of ordinary atmospheric air the same weight of a mixture of air and oxygen be fed to the cylinder with the hydrocarbon, a greater weight of the latter can be oxidized completely than by the use of the ordinary air, since such a mixture of air and oxygen contains more than 0.2356 parts, by weight, of oxidizing material. Hence by an increase in the quantity of oxygen in the oxidizing mixture it becomes possible to increase the power of the engine within certain limits, so that the same engine will give a greater maximum power than it can with the use of ordinary air alone as the oxidizing agent. Consequently by the provision of means for permitting an increase in the oxidizing effect of the oxidizing mixture it becomes possible to proportion the engine so that when doing its normal work it will be running at its maximum capacity, with ordinary air as the oxidizing agent, and when the demand occurs for an increase of power the means for permitting an increase in the oxidizing effect of the air may be brought into use, and thereby the power of the engine increased to meet such demand.

My invention will now be more specifically described in connection with the accompanying drawings and then particularly pointed out in the claims.

In the drawings, Figure 1 represents a theoretical indicator-diagram based upon the use of one kilogram of a combustible mixture, which diagram will be more fully explained hereinafter. Fig. 2 is a transverse section of one form of explosive-engine embodying my invention.

Referring to Fig. 1, it will be assumed first that the engine is working with ordinary atmospheric air. The combustible mixture of air and hydrocarbon is assumed to be drawn into the cylinder at 20° centigrade (293° absolute) and at atmospheric pressure. It is thereupon compressed adiabatically to 2.1 atmospheres, whereby the temperature rises to 93° centigrade, (366° absolute.) Then the mixture is ignited, whereupon the pressure rises to twelve atmospheres and the temperature to 1,777° centigrade, (2,050° absolute.) In this explanation it is also assumed that the hydrocarbon is such that twenty kilograms of ordinary air are required for the complete combustion of one kilogram of hydrocarbon and that its heating value is six thousand calories per kilogram. The adiabatic compression is indicated by the line 0 1, Fig. 1. The burned mixture now expands adiabatically, as indicated by the line 2 3, Fig. 1. Hence the work done is represented by the area 0 1 2 3 0, which also represents the maximum power of the engine under the conditions above assumed. If now instead of using ordinary air as the oxidizing means a quantity of air charged with such an amount of oxygen is employed that the oxygen forms 0.4712 parts, by weight, of the oxidizing mixture instead of 0.2356 parts, as with the ordinary air, then with this mixture one-tenth kilogram of hydrocarbon can be completely oxidized, instead of only one-twentieth kilogram, which was oxidized by the air alone in the first-mentioned example. With this increase of hydrocarbon there will be an increase in temperature at the time of the ignition of the explosive mixture, and in the absence of other modifying causes the temperature would rise to 3,284° centigrade, (3,557° absolute,) while the pressure would rise to about 20.8 atmospheres; but as a matter of fact the temperature will scarcely rise above 2,000° centigrade, (2,273° absolute,) because above 2,000° centigrade the constituent parts of the explosive mixture cannot unite chemically, and instead at first only so much of the hydrocarbon will be oxidized as is necessary to produce the dissociation temperature of 2,000° centigrade. Therefore the pressure will be raised to 13.3 atmospheres, as indicated on Fig. 1 by the point 2'. Upon the forward movement of the piston expansion takes place, this tending to produce a cooling effect, which causes the previously-uncombined hydrocarbon to unite with the remaining oxygen, this chemical action progressing with the expansion, so that the temperature is maintained at 2,000° centigrade, and an isothermal expansion results. This action is indicated by the isothermal line 2' 3', Fig. 1, which line of course is above the line 2 3, and the area between the said two lines indicates the increase in work done. The total work done by the enriched oxidizing mixture is indicated by the area 0 1 2' 3' 0, which is about twenty-two per cent. greater than the area 0 1 2 3 0.

If an oxidizing mixture is used containing about 0.2618 parts, by weight, of oxygen, then about one-eighteenth kilogram of hydrocarbon can be completely oxidized. The temperature at ignition will rise to 2,000° centigrade, (2,273° absolute,) and the expansion will proceed adiabatically, as indicated by the dot-and-dash line 2' 3'' in Fig. 1. The temperature at the end of the expansion will be about 1,557° centigrade, (1,830° absolute,) and the work produced will be indicated by the area 0 1 2' 3'' 0, Fig. 1.

As is well known to those skilled in the art, some of the combustible materials may be consumed by substances other that oxygen—for example, the halogens—so that such halogens as chlorin or bromin may be mixed with air to increase the output of the engine, instead of using oxygen, as hereinbefore described.

The oxygen (or its equivalent) may be kept under pressure in a separate receiver, from which it may be fed to the combustion-chamber of the engine, preferably in such a manner as to be well mixed with the hydrocarbon and air. The oxidizing material is introduced at the right moment—for example, during the suction-stroke of the piston—by an inlet-valve operated by the engine, while by a regulating-valve operated either by hand or by a governing device the quantity of the oxidizing material to be admitted at the desired moment may be controlled.

In Fig. 2 I have shown an apparatus embodying my invention. In this view, *a* indicates a receiver for the oxygen or like enriching material, from which receiver a conductor *b* leads to a suction-chamber *d* through an inlet or reducing valve C. The suction-chamber is provided with an air-inlet valve *f*, which when open permits the entrance of atmospheric air to the suction-chamber. The suction-chamber *d* communicates with a cylinder *e* through passages *m m*, this communication being controlled by a valve *g*, which is automatically opened during the suction period of the piston owing to the reduction in pressure produced in the cylinder at that time. The spindle of the valve *g* extends through and is movable within the hollow spindle of the hydrocarbon inlet-valve *h*, which controls the supply of hydrocarbon conducted to the engine through the conduit *i*. The stem of the valve *g* carries an adjusting-screw *k* at its upper end, which strikes the head *l* of the hollow spindle of the valve *h*, and thereby causes the said valve *h* to open. The said valves *g* and *h* are provided with springs *g' h'*, as shown, in order to close the same. The atmospheric air which enters the chamber *d* through the valve *f* passes through openings *m* and *n*, formed in the walls of the said chamber *d*, as shown, and thus enters the cylinder *e*. That part of the air which passes the openings *n* takes up and carries with itself the hydrocarbon admitted by the opening of the valve *h* from the tube *i* and then mingles with that part of the air which passes through the openings *m*.

In the ordinary operation of the engine the above usual operation is all that takes place in charging the cylinder with explosive mixture.

In order to prevent the admission of the oxygen or other suitable enriching material to the suction-chamber *d* during this above-mentioned ordinary operation and to allow such enriching material to be admitted at will and in varying quantities when a demand is made upon the engine for a power greater than usual, a suitable valve device is placed between the receptacle *a* and the suction-chamber *d*. In Fig. 2 I have shown a convenient form of such valve device, in which *c* is a valve-stem carrying two valves c' c^2, of different areas, as shown, and arranged to be received in corresponding valve-seats formed on opposite sides of an inward extension of the valve-body, which extension is in communication with the conduit *b*. The upper end of the valve-stem *c* carries a piston c^3, movable in a cylindrical extension of the valve-body, a helical spring c^4 being connected to the top of the said piston and to the bottom of a head formed on the lower end of a screw-threaded rod c^5, projecting outside the valve-casing and adjustable in and out by means of a hand-wheel nut c^6, located outside the valve-casing. The head of the rod c^5 is splined to the cylindrical extension of the valve-casing in order to prevent its rotation, while at the same time allowing a longitudinal movement of the rod c^5. When the hand-wheel nut c^6 is screwed up, the tension on the spring c^4 is increased, and thereby the pressure of the oxygen or similar material in the receptacle *a* is enabled to hold the valves c' c^2 closed for the reason that the valve c', which opens inward, exposes a larger area to the pressure of the oxidizing or enriching material than does the valve c^2, which opens outward. Hence in this condition no enriching material will be supplied to the suction-chamber *d* and the engine will operate in the ordinary manner of such engines. When, however, a demand is made upon the engine for a greater power than the maximum it can furnish with air and hydrocarbon mixture, the hand-wheel nut c^6 is unscrewed to move the rod c^5 inward, whereby the tension on the spring c^4 is relaxed. In this condition when the suction-stroke of the engine occurs the piston c^3 will be forced inward by the pressure of the external air, which is free to act on the outer surface of said piston c^3 owing to the fact that the screw-threaded rod is not packed where it passes through the upper end of the cylindrical extension of the valve-body. Therefore at each suction-stroke of the engine-piston a certain amount of oxygen or the like will be admitted from the receptacle *a* into the suction-chamber *d*, where it will unite with the atmospheric air entering through the air-inlet valve *f*, the mixture of air and oxygen then passing to the engine-cylinder, as before, taking up the hydrocarbon on the way. It will be seen that the extent to which oxygen or the like will be admitted depends upon the tension of the spring c^4, which is controlled by the hand-wheel nut c^6.

The ignition and exhaustion of the explosive mixture and the transmission of power from the piston need not be described, as these steps take place in the usual manner.

I am aware that the idea of using oxygen, chlorin, and the like as oxidizing agents for use with hydrogen or hydrocarbons in the production of power or of employing oxygen, chlorin, or the like mixed with atmospheric air for like purposes is not new; but in all the disclosures known to me of such use the employment of oxygen or the like, either alone or with air, as an oxidizing mixture has been suggested as a continuous one, so that great expense would attach to the ordinary operation of an engine constructed in accordance with such disclosures, this great expense being due to the continuous use of such oxygen, chlorin, or the like.

In my invention the ordinary operation of the engine takes place, as usual, by the employment of the ordinary air as an oxidizer, while only at intervals is the oxygen or the like employed, the expense of which intermittent use is not excessive and is more than counterbalanced by the other considerable advantages obtained, which have been explained hereinbefore. Hence my invention may be considered as consisting in the combination, with an explosive-engine having means for using ordinary atmospheric air and a suitable fuel as an explosive mixture, of auxiliary means for supplying a richer combining material for the fuel when a power greater than the maximum obtained under usual conditions is desired. By the term "richer combining material" for the fuel I mean a material which will unite with the fuel and liberate heat to a greater extent than will the ordinary air. For example, the ordinary air when provided with additional oxygen or with a quantity of a halogen will be such a richer combining material, and so also would be the pure oxygen or halogen.

Having thus fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination with an explosive-engine having means for employing ordinary air and suitable fuel as an explosive mixture, of auxiliary means for supplying a richer combining material for the fuel.

2. The combination with an explosive-engine having means for employing ordinary air and suitable fuel as an explosive mixture, of auxiliary means for supplying to the said mixture a richer combining material for the fuel.

3. The combination with an explosive-engine having means for employing ordinary air and suitable fuel as an explosive mixture, of an auxiliary receptacle to contain a richer combining material for the fuel, and connections between said receptacle and the engine whereby the contents of said receptacle may be delivered to the engine-cylinder when required.

4. The combination with an explosive-engine having means for employing ordinary air and suitable fuel as an explosive mixture, of an auxiliary receptacle to contain a richer combining material for the fuel, connections between said receptacle and the engine, whereby the contents of said receptacle may be delivered to the engine-cylinder, and means for varying the amount thus delivered.

In testimony whereof I have affixed my signature in presence of two witnesses.

EUGÈNE COURVOISIER.

Witnesses:

ADOLPHE FEDERER,
PAUL SCHNEIDER.