(No Model.) 2 Sheets—Sheet 1.

W. L. SAUNDERS.

METHOD OF INCREASING THE EFFICIENCY OF MOTOR FLUIDS.

No. 486,411. Patented Nov. 15, 1892.

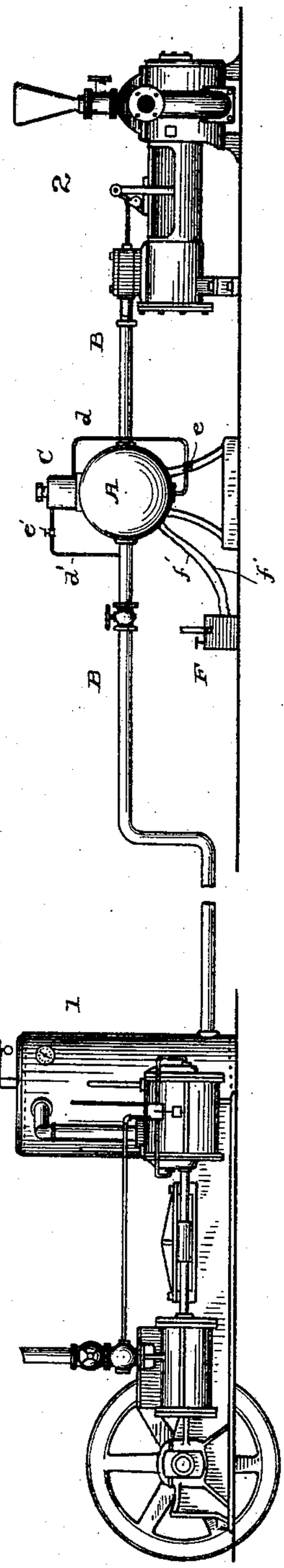

Fig. 1.

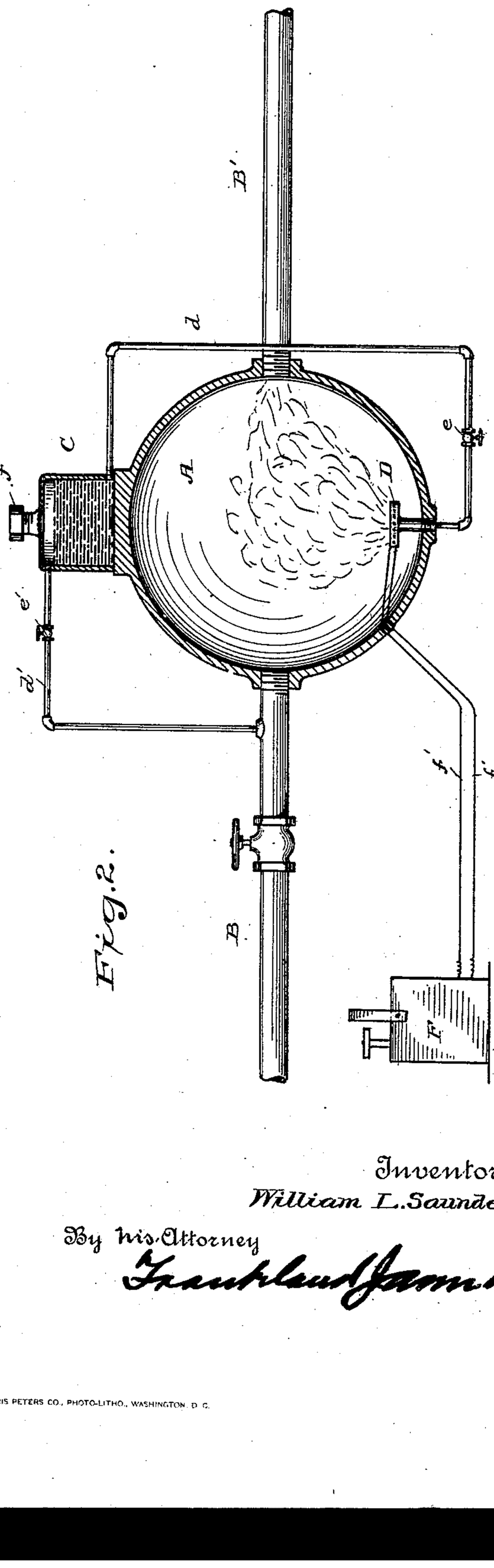

Fig. 2.

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(No Model.) 2 Sheets—Sheet 2.

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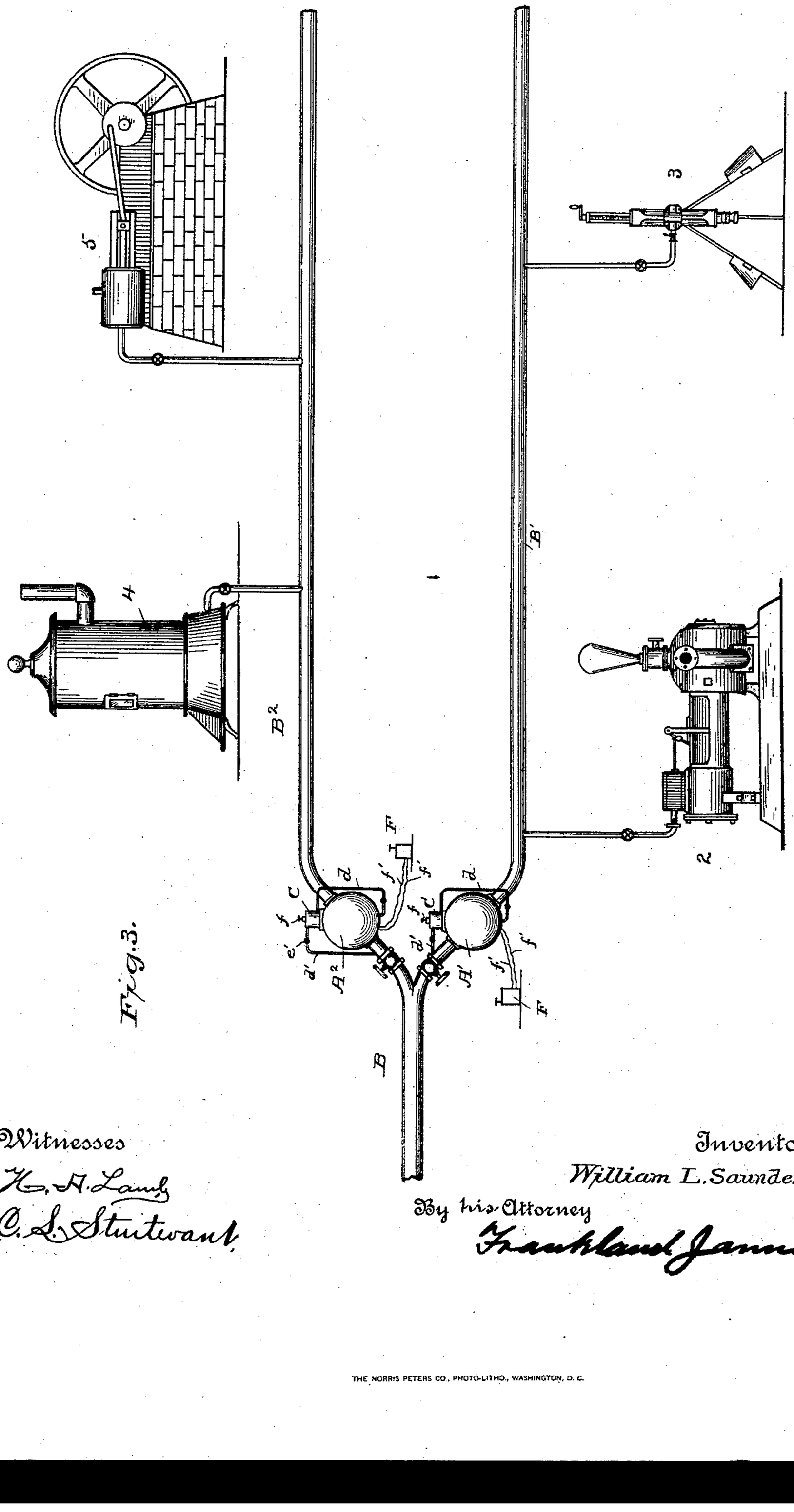

Fig. 3.

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UNITED STATES PATENT OFFICE.

WILLIAM L. SAUNDERS, OF NORTH PLAINFIELD, NEW JERSEY, ASSIGNOR OF ONE-HALF TO THE INGERSOLL SERGEANT DRILL COMPANY, OF NEW YORK, N. Y.

METHOD OF INCREASING THE EFFICIENCY OF MOTOR FLUIDS.

SPECIFICATION forming part of Letters Patent No. 486,411, dated November 15, 1892.

Application filed June 13, 1889. Serial No. 314,107. (No specimens.)

To all whom it may concern:

Be it known that I, WILLIAM L. SAUNDERS, a citizen of the United States, residing at North Plainfield, in the county of Somerset and State of New Jersey, have invented certain new and useful Improvements in Methods of Increasing the Efficiency of Motor Fluids, of which the following is a description, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon.

My invention has reference to a method for increasing the efficiency of compressed air as a motor fluid, and has for its object to restore to the compressed air the full measure of heat which it has lost through compression and transmission, and, furthermore, to so increase the temperature of the compressed air as applied to an engine that when it is expanded and exhausted in the cylinders and valves its temperature will not be reduced below the freezing-point, thus obviating the difficulty previously experienced through the freezing of the moisture in the air.

In carrying out my invention I subject the compressed air to the direct action of a flame within a closed chamber, desirably forming a portion of the system of pipes by which the motor fluid is transmitted to the point of consumption. I preferably use for the purpose of heating the air a flame produced by the combustion of a fluid containing hydrocarbon—such, for example, as gasoline. I find that by varying the quantity of hydrocarbon furnished to the combustion-chamber I can at will produce as a resultant heated carbonic-acid gas or similarly-heated carbonic-oxide gas. In the former the flame, not being inflammable, is used where the effect of expansion alone is desired, whereas the latter, being inflammable, may be used for any of the purposes to which it is applicable—for example, as an illuminant, for producing heat in cooking-stoves or other burners, or when mixed with a suitable portion of air for the operation of explosion-engines usually termed "gas-engines," and for various other kindred purposes, which will in themselves be obvious.

An additional feature of my invention resides in the method of igniting the charge within the closed chamber, since I find that the mixture resulting from the introduction of volatile hydrocarbon fluid or its equivalent into the chamber containing compressed air will, on account of the excess of oxygen, be highly inflammable and that therefore by producing a spark between two terminals of an electric circuit, or even by heating a filament or thin section forming a part of said circuit to incandescence, I can readily ignite the mixture, combustion being then sustained so long as the hydrocarbon is supplied.

The chief obstacle to the use of compressed air as a motive power is its cost. A further difficulty ensues from the formation of ice in the ports of the compressed-air engine.

It is well known to pneumatic engineers that when atmospheric air is compressed a degree of heat is produced in proportion to the tension. If this compressed air is cooled or allowed to cool to the temperature of the surrounding atmosphere and then used to drive the piston of an engine, when in the performance of this duty it is expanded and reaches the normal pressure of the atmosphere heat is lost or cold is produced in exactly the same proportion as when the compression took place. A double source of loss is therefore experienced because in the compressing-engine the production of heating acts expansibly on the air, thus resisting compression, and, whether this heat is absorbed directly at the compressor or allowed to radiate before the air is used, the result is power lost, for each unit of heat represents power. Then, again, in the compressed-air engine the reduction of temperature is accomplished by a contraction of volume and pressure, which shrinkage of the motive fluid reduces the efficiency of the engine.

Various means have been devised for reheating compressed air, principally with a view of preventing its freezing in exhaust-ports of engines. Such means have been through external application of heat by surrounding the air-pipes with steam, hot water, or by passing the pipes through the flue of a furnace. Experiments have also been made

to this end by passing compressed air through hot water for the purpose of increasing its temperature; but in all the devices previously employed the addition of heat is too expensive to materially reduce the cost of compressed air. In all cases of external application of heat, if it is done thoroughly, it must be done at considerable loss in caloric, inasmuch as a large part of the heat is lost through the chimney, and, besides, these devices involve coils of pipe which add to the friction of transmission. My system of internal heating is subject to none of these objections in that every heat-unit produces its best result in power through its expansive effect upon the air.

A form of apparatus embodying the invention is shown in the accompanying drawings, and will be hereinafter fully described, and referred to in the appended claims.

In said drawings, Figure 1 is a view showing an arrangement of apparatus adapted to carry out my invention, and Fig. 2 is an enlarged sectional detail view showing more clearly how the heating of the air may be effected. Fig. 3 is a diagrammatic view illustrating the application of the invention to a number of different purposes for which it is adapted.

In the form of apparatus adapted to carry out my improved method and shown in the drawings the internal arrangement of the heating apparatus is most clearly seen in Fig. 2, in which is indicated the compressor 1, connected by a pipe B to one side of a retort, drum, or receiver A, suitably mounted and supported, and from the opposite side of which extends a delivery-pipe B′, leading to the engine 2 to be driven. The drum A is desirably located near to the engine or engines to be operated by the heated air or gas. Upon the top of the receiver A is mounted a tank or retort C, adapted to contain oil, gas, or any other suitable inflammable fluid, and closed at its top by a cap *f*, enabling the replenishment of the oil. A burner D, preferably similar in construction to a gasoline-burner, is located in the lower part of the chamber of the receiver and with said burner connects the tube *d*, leading from the tank C, said tube being adapted to supply oil to said burner in quantities controlled by the valve *e*, interposed in said tube. A second tube *d′* taps the pipe B adjacent to its connection with the receiver and has its other end communicating with the upper part of tank C, the air-pressure exerted within said tank being controlled by a valve *e′*. F is an electric battery, from the poles of which extend wires *f′ f′*, having their terminals or a thin strip or filament attached thereto located over the burner D. The character of the battery and of the circuit leading therefrom is immaterial, so long as it admits of the generation of a spark or heating the filament to incandescence above the burner D to start the flame when required. In the air under pressure there will be an overcharge of carbon, which will readily unite with the oxygen in the oil, and a spark being generated the mixture will readily ignite and produce a flame. This abundance of oxygen will maintain a high combustion in the chamber A, converting a portion of the oxygen into carbonic acid, which, together with the compressed air, is conveyed through pipe B′ to the engine. By means of the valve *e* the flow of oil can be regulated, as previously stated, and hence the intensity of the combustion is controlled.

The reaction which takes place in the compressed-air chamber through my system of burning is represented as follows: $C+O_2=CO_2$. Where C represents an atom of carbon which combines with two atoms of oxygen, the result is the production of carbonic-acid gas. This is accomplished by no loss in volume through what might be termed "burning" of the air.

Thomas Box, in his treatise on heat, says, pages 66 and 67, paragraph 78: "When oxygen and carbon combine, the volume of the carbonic-acid gas formed is nearly the same as that of the oxygen consumed. When, therefore, a combustible contains carbon only, the volume of gas in the chimney is the same as that of the air entering the fire, expanded, of course, to the volume due to the increased temperature, the oxygen consumed having been replaced by the same volume of carbonic-acid gas. The nitrogen in the air is passive, passing through the fire without chemical alteration." It being therefore established that a flame burning in compressed air does not reduce the volume through combustion, the increase of volume through expansion due to heat will be readily understood by reference to the tabulated statement contained in the work of Box, previously mentioned.

In the case of oil or common gasoline, which I find to be adapted to the present purpose, I have hydrogen to deal with, the gasoline being a hydrocarbon. The direct influence of the hydrocarbon is to still further increase the volume of the resultant, in that two atoms of hydrogen from the oil will combine with one atom of oxygen from the air, producing H_2O, or water. This water, on account of the high temperature, will be in a state of vapor. It is well understood by pneumatic engineers that thermal vapor is much more susceptible to expansion through heat than dry air. I do not propose in all cases to use the air at a very high temperature, but in any case the gain in heating will be important as affecting increased volume and reduced liability to freezing.

In carrying out my invention I have found that the method of internal heating can be used for the generation of an inflammable gas suitable for heating and cooking purposes and which can be piped to the point of consumption. The reaction which takes place

when the flame burns in atmospheric air is a combination of carbon and oxygen. If that combination is complete, as is the case of the Bunsen burner, CO_2 is produced, or carbonic-acid gas; but where the supply of carbon exceeds that of the oxygen CO is produced, or carbonic-oxide gas. Now carbonic-acid gas is not inflammable, while carbonic-oxide gas is. In the compressed-air chamber the supply of carbon and oxygen could relatively be controlled, so that carbonic-oxide gas would be produced, which, going along with the oxygen in the air, would form a very useful gas for heating or cooking, as stated. Inasmuch as the full value of each atom of carbon is represented in the product which is contained in the pipe the production of this gas will be an economical one.

It will be understood from the foregoing description of the combinations, nature, and some of the results of my invention that by varying the amount of hydrocarbon furnished to the burner in the retort A a resultant is produced which is either inflammable or not, as desired, and I contemplate utilizing such capability to its fullest extent.

Where the supply of hydrocarbon to the retort A is such as to produce carbonic-acid gas the same may be piped to heating-stoves or the like, or may be supplied to explosion-engines, commonly known as "gas-engines" or caloric engines, and with this end in view a convenient means of securing a variety of results from a single air-compressing plant is indicated in the diagram Fig. 3, in which the main air-supply pipe B is bifurcated and the branches B^1 B^2 are furnished with separate retorts A^1 A^2, each of which may be supplied with a proper quantity of hydrocarbon to produce a resultant gas having the necessary qualifications for the desired use. The branch B′, as indicated, supplies carbonic-acid gas to any kind of engines—for example, a pumping-engine 2 and a drilling-engine 3—while the branch B^2 is arranged to be supplied with carbonic-oxide gas which may be utilized for power or heat as indicated by the stove 4 and gas-engine 5 in connection therewith.

I am well aware that the exhaust from a drilling or other engine supplied with heated carbonic-acid gas according to my invention would, if in a confined space, so vitiate the atmosphere as to render the same extremely unwholesome and productive of injurious results to the attendant workman, and I therefore do not contemplate the operation of engines in confined spaces without the addition of means for preventing deleterious results—as, for instance, by leading off escaping carbonic-acid gas through an exhaust-pipe communicating with the open air or by passing the exhaust from an engine so operated through or combining the same with substances or agents which would neutralize the objectionable effects of the carbonic-acid gas. The products of the cumbustion of the carbonic-oxide gas are disposed of in any usual or convenient manner.

I have hereinbefore referred to my improved method as being fully accomplished in a single chamber and by once subjecting the air to the action of a flame. It must be understood, however, that in some instances—as, for example, when the air being treated is under very high pressure—good results may be secured by employing a number of retorts or chambers connected in series, supplying each with a flame, and subjecting the air successively to their action. The use of a number of retorts, each supplied with a small flame, would reduce the possibility of explosion of the mixture, and this I claim as an obvious modification of the herein-described method, since it may in practice be found to be more economical, safe, and satisfactory to provide a plurality of small chambers or retorts A than a single one of sufficient capacity to produce the desired results.

I do not confine myself to the use of oil, gas, or any particular combustible, nor do I limit myself to any special form of apparatus in which the heating or burning of the air takes place.

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

1. The method of increasing the efficiency of compressed air for use as a motive power at a distance from the compressor, the same consisting in delivering compressed air to a line-pipe, conveying said air through the line-pipe to a point near the point of consumption, whereby the heat of compression is dissipated, then applying heat to said cooled air by direct contact therewith within the pipe, and then supplying the heated air to a translating device or devices.

2. The method of increasing the efficiency of compressed air for use as a motive power at a distance from the compressor, the same consisting in delivering compressed air to a line-pipe, conveying said air through the line-pipe to a point near the point of consumption, whereby the heat of compression is dissipated, then bringing said cooled air in contact with a flame within the line-pipe, and then supplying the heated air to a translating device or devices.

3. The method of increasing the efficiency of compressed air for motive purposes, the same consisting in delivering the compressed air to a line-pipe, conveying said air through the line-pipe to a point near the point of consumption, then bringing the said air in contact with a flame contained within the line-pipe at a point adjacent to the point of consumption, and then supplying the heated air to the translating device.

4. The method of increasing the efficiency

of compressed air for motive purposes, the same consisting in delivering the compressed air to a line-pipe at a point distant from the source of supply, conveying said air through the line-pipe from the compressor to a point near the point of consumption, then bringing the said air in contact with a flame contained within a chamber forming part of the line-pipe, and then supplying the heated air from said chamber to the translating device.

In testimony whereof I hereto affix my signature in presence of two witnesses.

WM. L. SAUNDERS.

Witnesses:

JOHN STANDFAST,

HUNTINGTON PAGE.