983,206.

D. CLERK.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED DEC. 29, 1903.

Patented Jan. 31, 1911.

4 SHEETS—SHEET 1.

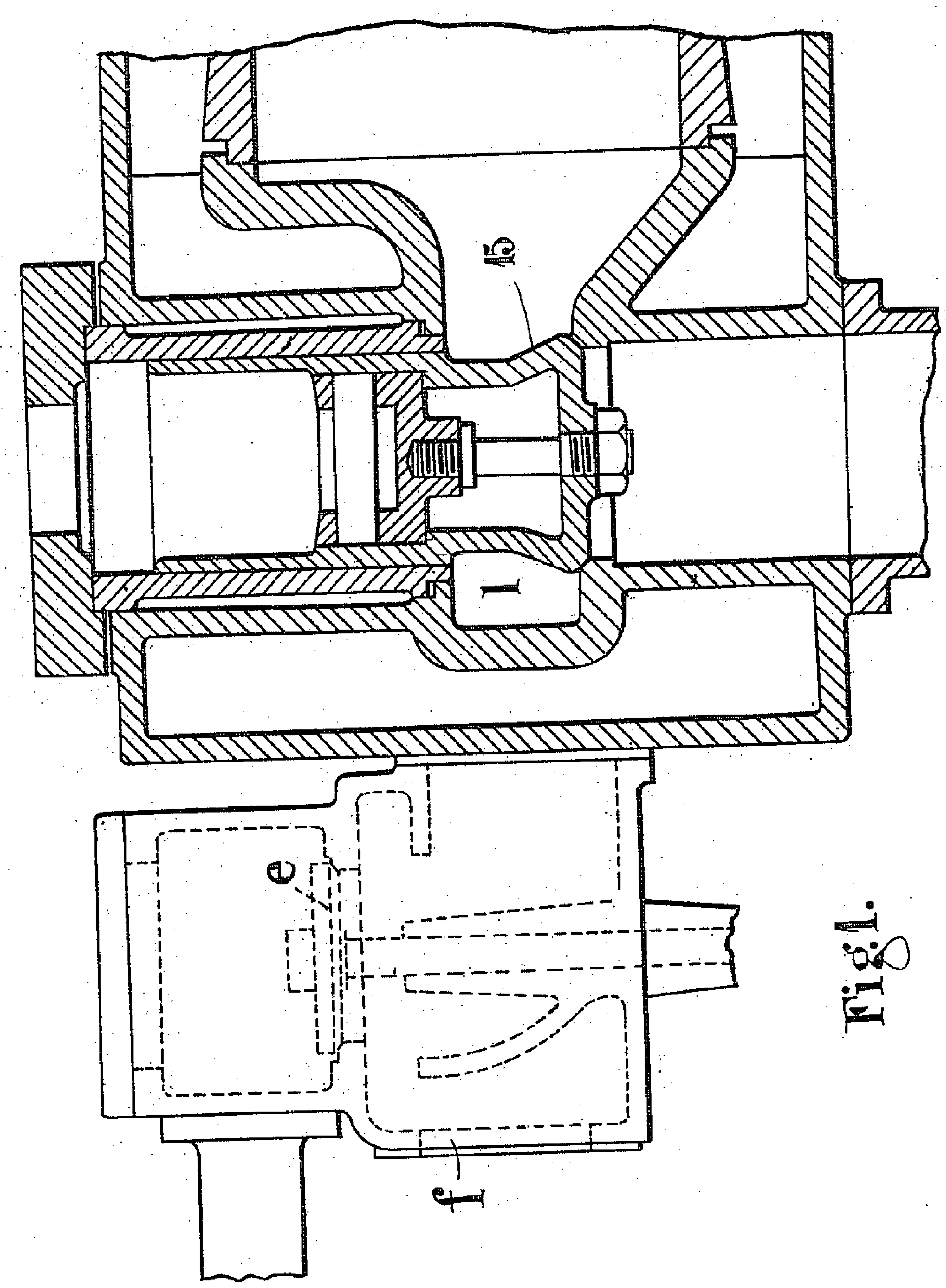

Fig. 1.

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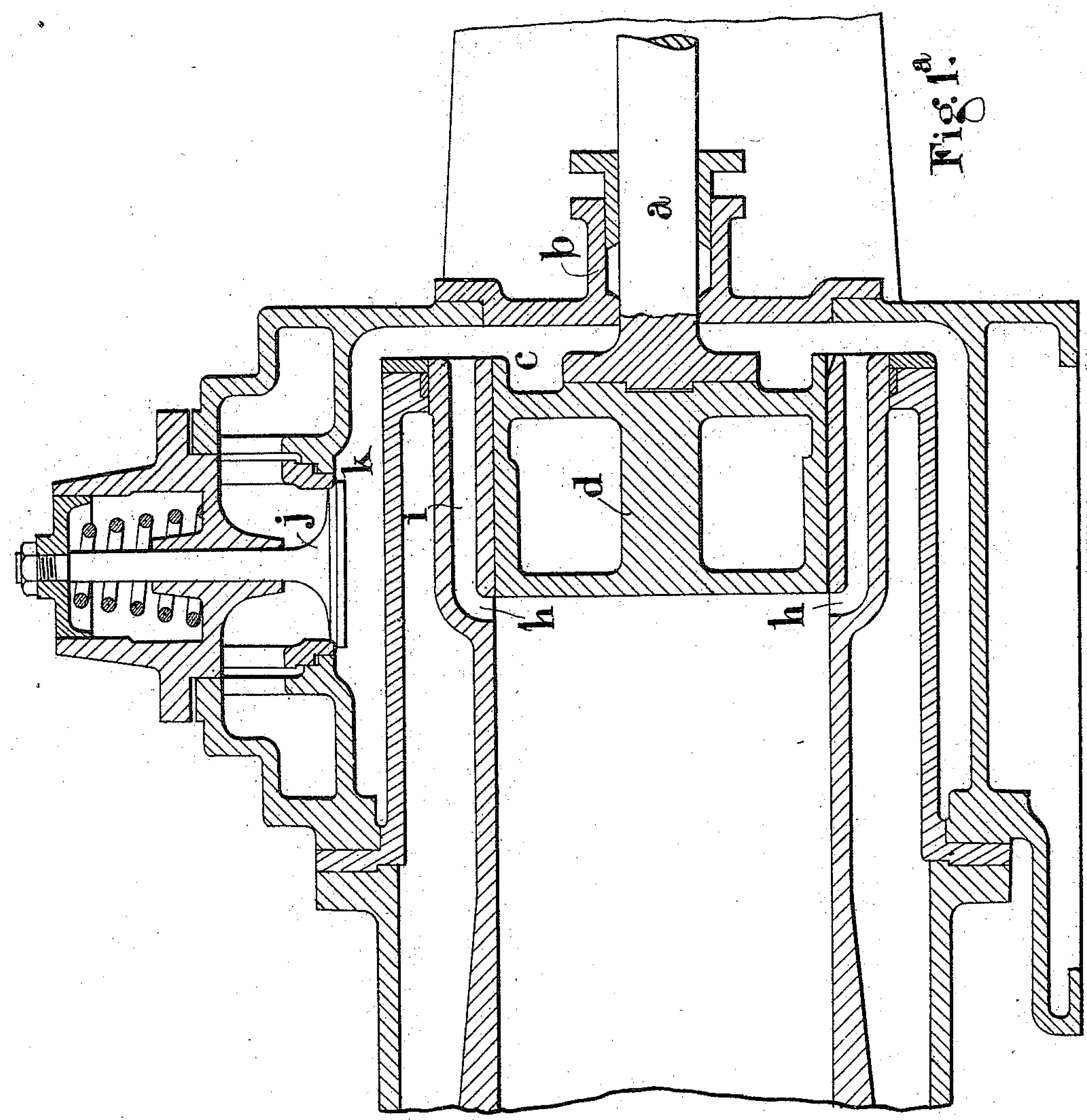

Fig. 1.[a]

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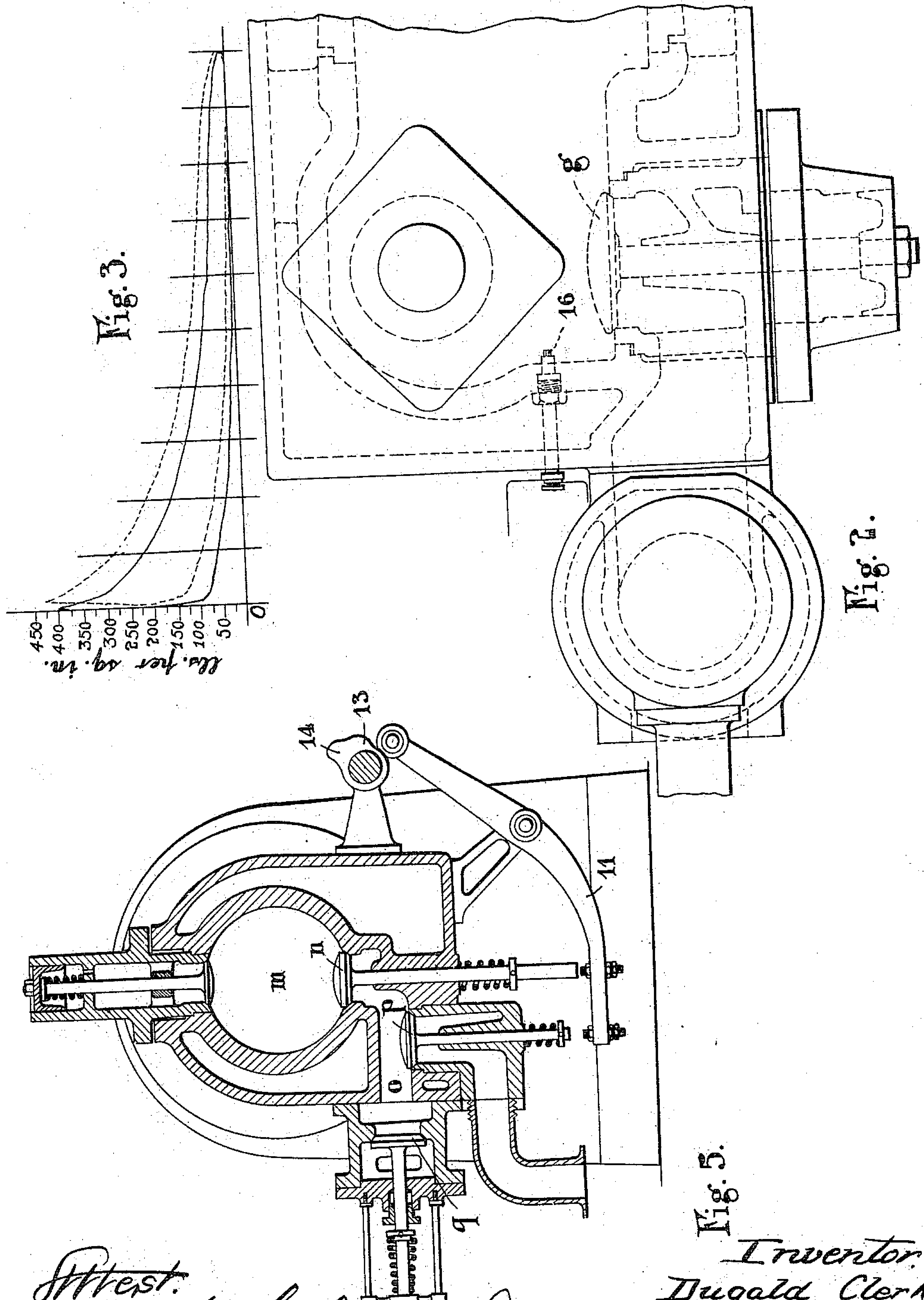

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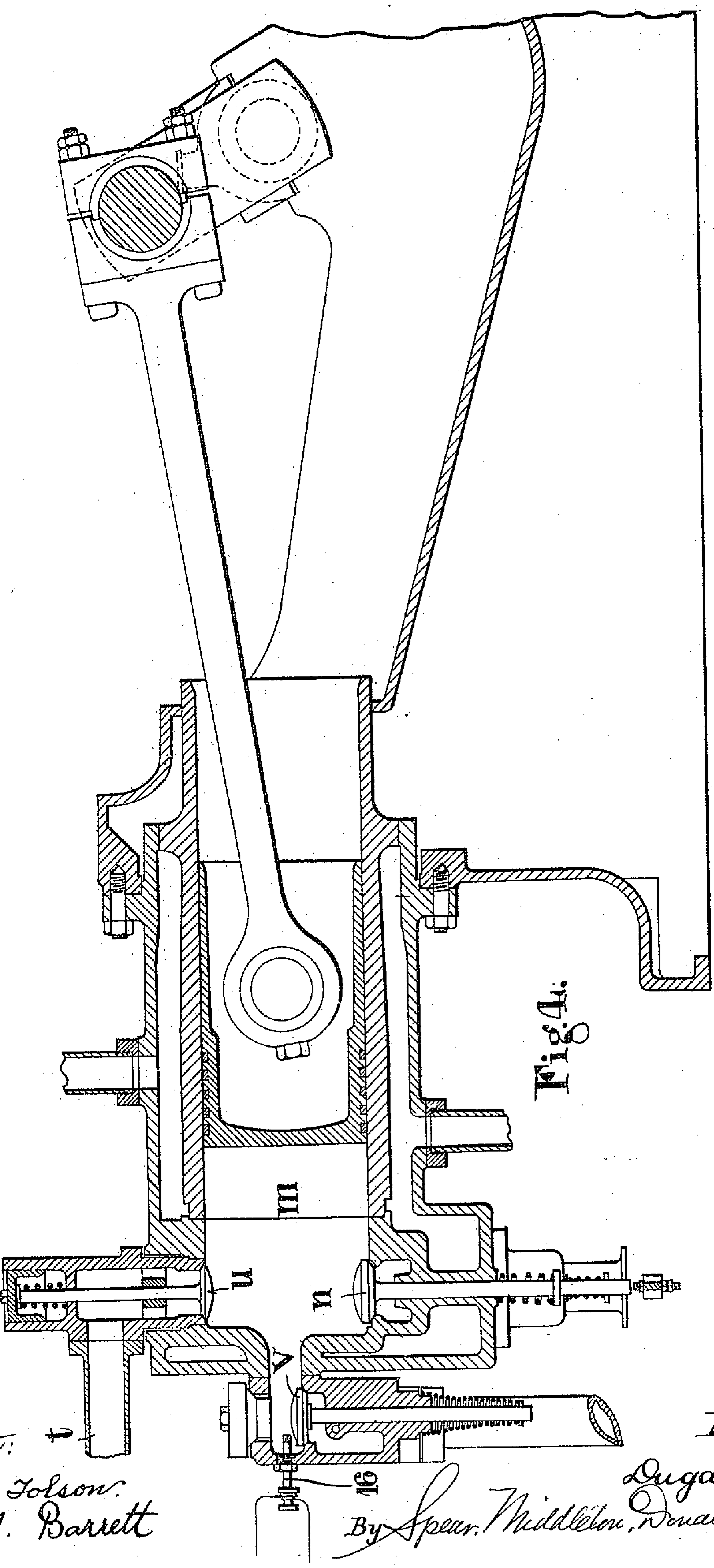

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UNITED STATES PATENT OFFICE.

DUGALD CLERK, OF EWHURST, ENGLAND.

INTERNAL-COMBUSTION ENGINE.

983,206. Specification of Letters Patent. Patented Jan. 31, 1911.

Application filed December 29, 1903. Serial No. 187,169.

To all whom it may concern:

Be it known that I, DUGALD CLERK, a subject of the King of Great Britain and Ireland, and residing at Little Woolpits, Ewhurst, in the county of Surrey, England, have invented certain new and useful Improvements in Internal-Combustion Engines, for which I have made application for Letters Patent in Great Britain, No. 28,827, bearing date December 30, 1902, and of which the following is a specification.

My invention relates to gas or other internal combustion engines, and it is particularly applicable to large engines.

In large engines as at present constructed, difficulties arise because of the high maximum temperature of gaseous explosion ordinarily used in such engines and the high mean temperature of the gases while expanding in the engine cylinder. Such difficulties, for example, as pre-ignition, are common in large engines, and unequal strains produced by the great heat flow through the sides of the cylinder and piston sometimes cause troublesome fractures. In many large engines the mean pressure is kept low for the purpose of reducing the mean temperature within the cylinder, and in this way some of the difficulties of pre-ignition and fracture are overcome, but this involves reduction of power for a given weight of engine.

My object is to reduce the mean temperature within the cylinder while maintaining a high average pressure.

My invention consists in a method of reducing or keeping down the temperature attained during combustion of the charge in an engine cylinder by adding a volume of elastic fluid, such as air, or products of combustion, to the charge before combustion. In every case the extra elastic fluid must be added in such a way as not to interfere with the portion of the charge in which the ignition is to be effected, and in the case of air being employed the presence of an excess of air over that required for normal combustion is involved. I find, for example, that when such a volume of air is added to the charge before combustion, the temperature attained in the cylinder is much reduced while the average pressures are increased and a great gain in economy attained.

Referring now to the accompanying sheets of drawings which illustrate various modes of carrying my invention into effect:—

Figures 1 and 1^A^ are two parts of the same view, viz. a sectional elevation (these figures together will represent the view referred to in the description by the words Fig. 1) and Fig. 2 is a plan of an "Otto" engine in which my invention is carried into effect by means of an added volume of air. Fig. 3 shows indicator diagrams from an engine of the above type with and without my invention. Figs. 4 and 5 shown in side and end sectional elevation respectively an "Otto" engine in which my invention is carried into effect by means of an added volume of cold exhaust products.

In most of the figures the valve operating mechanism has been omitted, as it does not form any part of my present invention; any mechanism may be used to perform the required function.

In carrying my invention into effect according to one modification, as applied, by way of example, in an "Otto" cycle engine using air for the additional volume of fluid (see Figs. 1 and 2), I provide the front end of the engine with a piston rod *a* passing through a stuffing gland *b*, and utilize the front side *c* of the piston *d* to act alternately for the purpose of supplying what I call the "super-compression" charge of air and supplying an air charge for scavenging. The piston *d* on its charging stroke takes in a charge of gas and air in the usual manner and proportions, say through gas inlet valve *e*, air inlet *f* and mixture valve *g*, and at the out end of the stroke the piston overruns ports *h* passing through the sides of the cylinder and leading by passages *i* into a reservoir *k* surrrounding the cylinder liner or connected to the cylinder. An additional charge of air which has already been compressed into the reservoir space then passes through the ports *h* overrun by the piston, and raises the pressure in the cylinder to a predetermined pressure above atmosphere. In some cases, the added charge may increase the pressure within the cylinder at the out end of the stroke as much as from one-half to one atmosphere. In this way, at a half atmosphere above atmospheric pressure, the cylinder is charged with one-and-a-half times the ordinary weight of gas-and-air charge. The piston then returns, compressing the charge into the compression space, and the compression rises to a higher point than in an ordinary gas engine with the same compression space. Ignition is effected by any suitable igniter, preferably the electric spark igniter, arranged near the passage *l*, by which the charge enters the cylinder. When ignition occurs, however, the maximum temperature attained is much less than that ordinarily attained in such an engine. In a given engine with a super-compression of half an atmosphere, the maximum temperature of explosion (with an ordinary gas charge) is about 1200° C. as against 1800° or 1900°, the usual explosion temperature. During the compression stroke the front end of the piston draws in a charge of air into the space *o* and reservoir *k* through a suitable valve *j*, and on the expansion stroke this air charge is compressed into the spaces *i* and *k*, or a portion of this charge may be discharged by the inlet valve *j*. Or, another valve may be provided for this purpose, so that, in some cases, no compression of this air charge begins until the piston has gone out a given portion of the stroke. Where the amount of compression in the front of the cylinder is desired to be varied, I may throttle the air inlet or mechanically operate the air inlet valve, and I prefer to so effect this that the air compression attained on the stroke to be used for scavenging is less than that attained on the stroke for super-compression, the operating cams being suitably arranged.

The exhaust valve of the engine is opened at an earlier period than is usual in the stroke of an "Otto" cycle engine, so that the pressure may fall to at or near atmosphere before the piston overruns the air ports. When the piston overruns the air ports, the air discharges from the reservoir under pressure, and it sweeps out a portion of the products of combustion from the engine cylinder through the exhaust valve. I preferably arrange to scavenge the engine cylinder in this way to the extent of about one half the piston stroke. By this arrangement I not only scavenge the cylinder, but I reduce the period of contact of hot gases with the piston, very materially. In an ordinary "Otto" cycle engine, for example, the hot gases are in contact with the piston during 360° of the crank path. In an engine constructed according to my invention, the hot gases are not in contact with the piston more than about 150° of the crank path. In an engine according to my invention, the hot gases are kept out of contact with the piston during the whole exhaust stroke by the volume of air equal to half a cylinder full discharged for the purpose of scavenging. The hot gases are also in contact with the other parts of the cylinder and combustion space for a shorter period than with the ordinary "Otto" cycle engine. During the exhaust stroke, the remainder of the exhaust gases are discharged through the exhaust valve 15, and the combustion space is filled with air—the scavenging charge—part of which passes through the space and out of the exhaust valve. During this stroke the piston has again drawn in another charge of air on the front side, and, on the return stroke,—the suction stroke, on the motor side—a fresh charge of air is compressed into the reservoir space surrounding or connected with the cylinder. The pressure in such reservoir space may rise to as much as twenty four pounds per square inch above atmosphere or even more. When the piston overruns the ports, the air is discharged into the cylinder and increases the pressure of the charge therein contained. By my invention an engine thus uses the front end of the piston to operate as an air pump—the one stroke for scavenging the cylinder, and the other stroke for super-compressing.

By my invention I reduce the mean temperature of the expanding gases in the engine cylinder, while I increase the mean effective pressure, obtaining thereby a considerable gain in economy. I also reduce the time of contact of the expanding gases with the piston and the sides of the cylinder, and by both means I am enabled to reduce the heat flow into the piston end and exhaust valve, so as to avoid the necessity for introducing water-jacketed pistons or water cooled exhaust valves in engines of comparatively large dimensions.

In Fig. 3 I have shown in full lines an ordinary indicator diagram from an engine of about 7″ cylinder diameter and 15″ stroke, and in dotted lines the diagram obtained from the same engine with a super-compression with air at about 9 lbs. per square inch above atmosphere. After deducting the work of compression of the air, this shows a gain in work of about 15% for exactly the same gas.

It will be seen that I may employ cooled products of combustion instead of air for the purpose of increasing the weight of charge and diminishing the temperature attained as above described. The cooled products of combustion may be obtained by causing the exhaust gases to discharge by way of cooling devices and a reservoir and suitable valves. One method of carrying this modification of my invention into effect in an "Otto" cycle engine is shown in Figs. 4 and 5. I discharge the gases from the engine cylinder *m* by the exhaust valve *n* into a space *o* closed by a second exhaust valve *p*. A check valve *q* opens from the space *o* to a reservoir. The valve *n* is opened, and the exhaust products discharge into the space between valves *n* and *p* pass into the reservoir through the check valve *q*. At a given point the second exhaust valve p is opened, and the exhaust stroke of the engine proceeds as usual. The exhaust gases so admitted to the reservoir are cooled by water jacketing the reservoir, or exposing cold surfaces in other ways, or by water spraying. The proper timing of the opening of the two valves n and p may be obtained by operating them from the same lever 11, moved in turn by a cam having two lifting surfaces 13 and 14, of different heights. The reservoir communicates again with the cylinder m through a pipe t and a valve u delivering cooled gases from the store under pressure to the engine cylinder. The engine piston completes its usual charging stroke taking in a mixture of air from the atmosphere and gas from any source in the ordinary manner. Toward the end of the charging stroke the ordinary inlet valve v is closed, and valve u opened to the exhaust gas reservoir. The exhaust gases are thus injected into the cylinder, preferably in such a manner as to mix with the contents already drawn in without disturbing the gases in the neighborhood of the igniter, and the pressure within the cylinder is raised to the desired point above atmosphere. The piston then compresses the total charge thus introduced, and ignition occurs in the usual manner, the igniter being placed preferably near the valve v, so as to ignite as nearly as possible a constant or nearly constant mixture. In an engine with an exhaust pressure of say about 40 lbs., I can readily obtain gases stored in a reservoir under a pressure of about 20 lbs. per square inch above atmosphere.

The ignition plugs 16 are arranged in proximity to the charge inlet valve (preferably as shown) in a position where readily combustible mixture will always be available for ignition, notwithstanding the admission of a large quantity of additional air or products of combustion.

Although I have throughout described my invention with regard to gas engines, it is equally applicable to engines using light or heavy oil, or other vapor, as the combustible, with the addition of the usual vaporizers or carbureters. Again, although I have described various forms of engines using supercompression by means of exhaust products, in addition to those using air, I have done so only to indicate the scope of the invention.

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

1. In internal combustion engines the method of reducing the maximum combustion temperature in the cylinder and increasing the available average pressure by charging a cylinder with gases mixed in the correct proportions for combustion and adding thereto before ignition a volume of inert elastic fluid at an increased pressure, said combustible gases remaining unmixed with the inert fluid in the neighborhood of the igniter to insure ignition and acting only to absorb some of the heat generated by combustion.

2. In internal combustion engines the method of keeping down the maximum combustion temperature in the cylinder and increasing the available average pressures consisting in charging a cylinder with gases mixed in the correct proportion for combustion and adding thereto before ignition a volume of air under pressure, said air being added at the end of the cylinder remote from the ignition point so as not to interfere with the ignition of said combustible mixture but to act only to absorb some of the heat generated by the combustion of same.

In witness wherof I have hereunto set my hand in presence of two witnesses.

DUGALD CLERK.

Witnesses:
T. MacGeoghy,
Caroline Brighton.