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N. A. OTTO.

MOTOR ENGINE WORKED BY OIL VAPOR.

No. 433,807. Patented Aug. 5, 1890.

Fig. 6

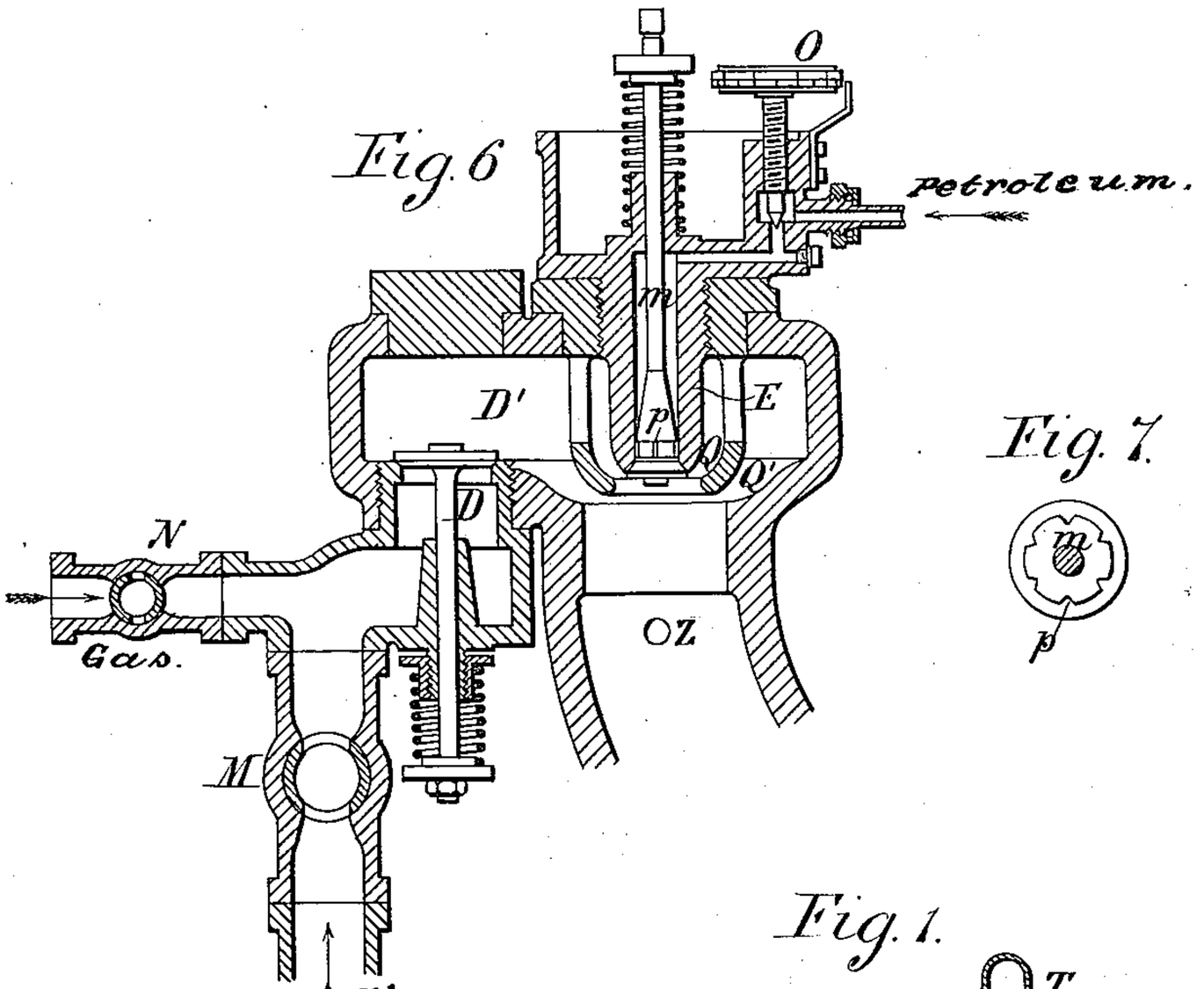

Fig. 7.

Fig. 1.

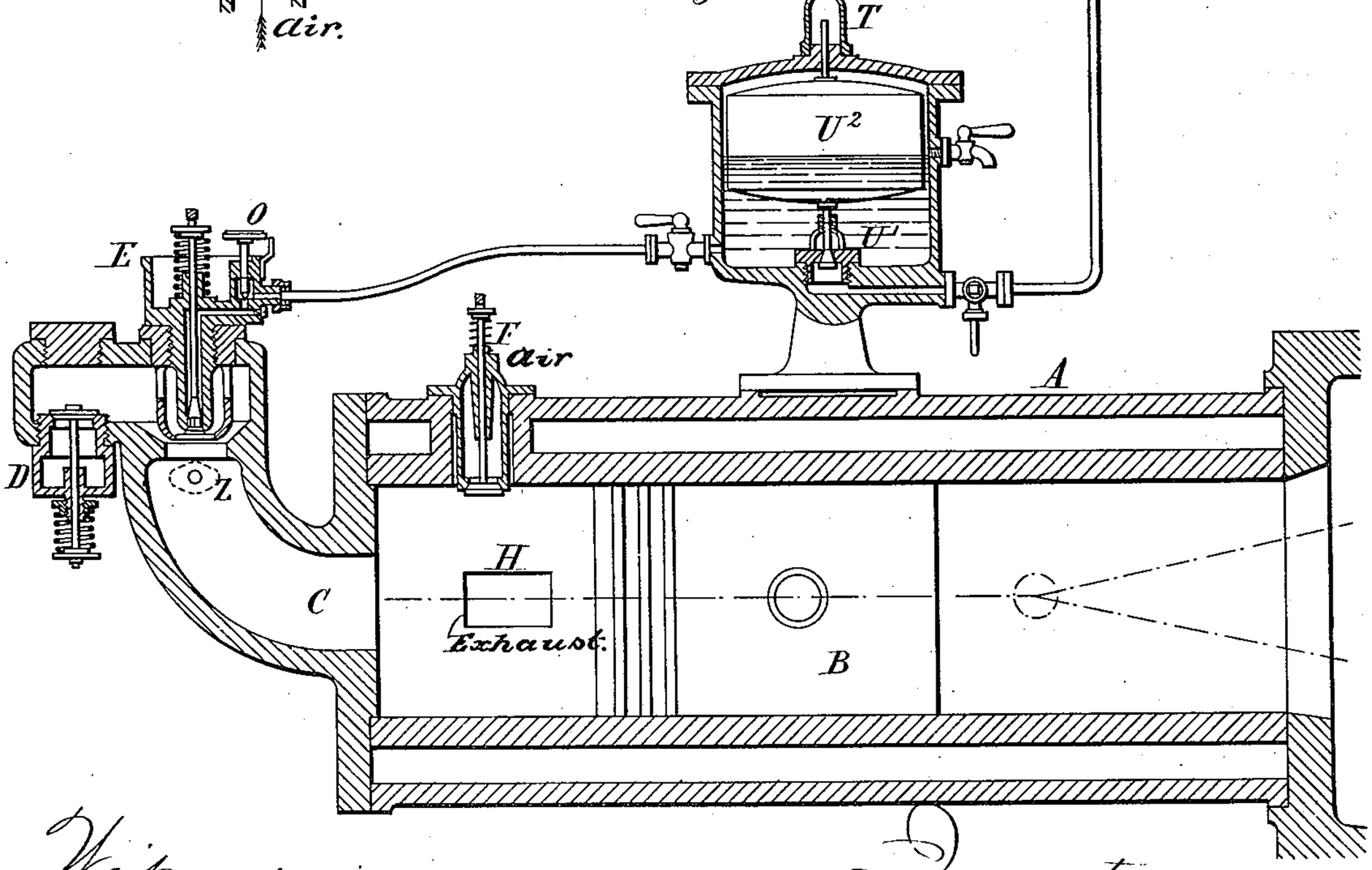

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Fig. 4.

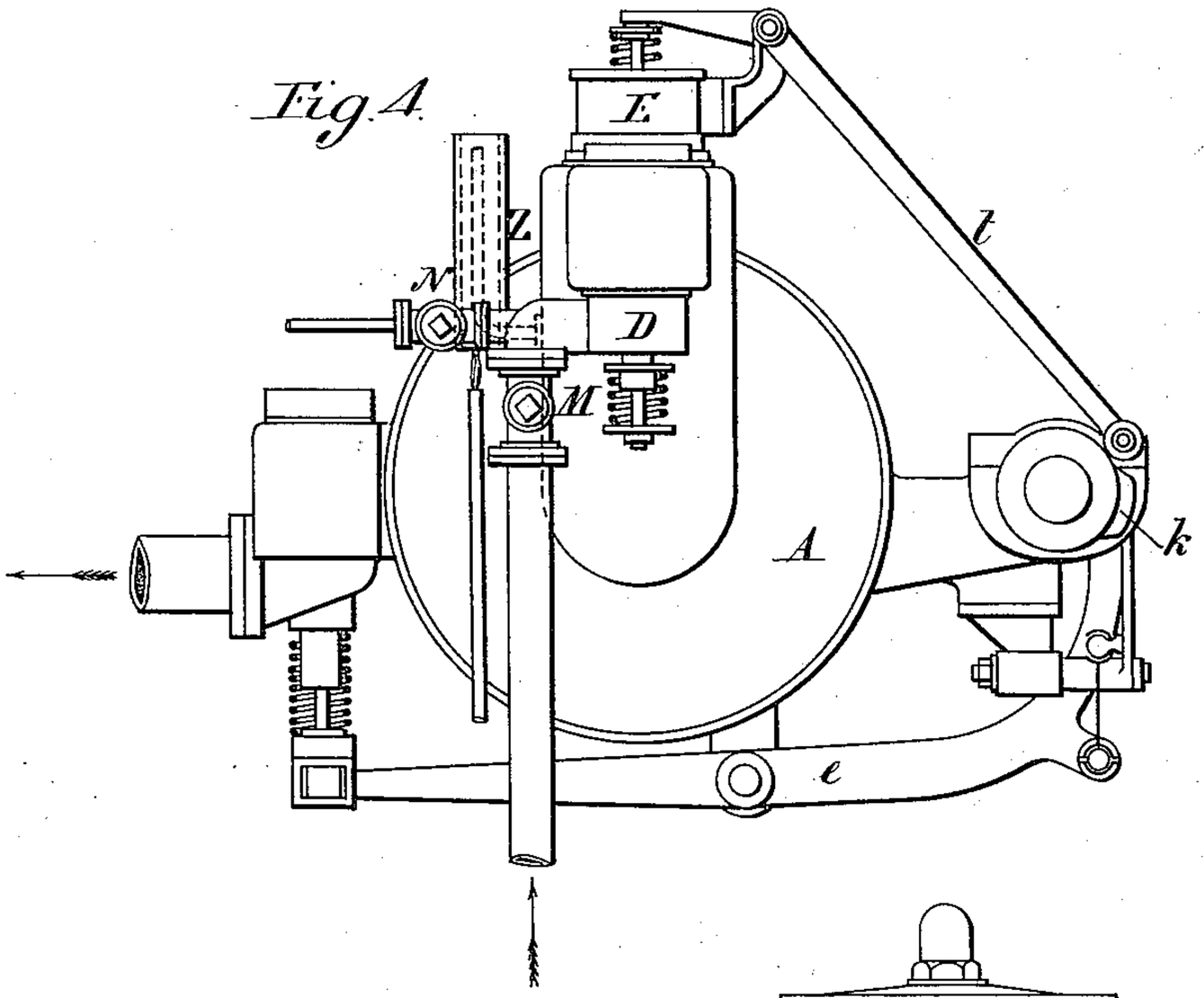

Fig. 2.

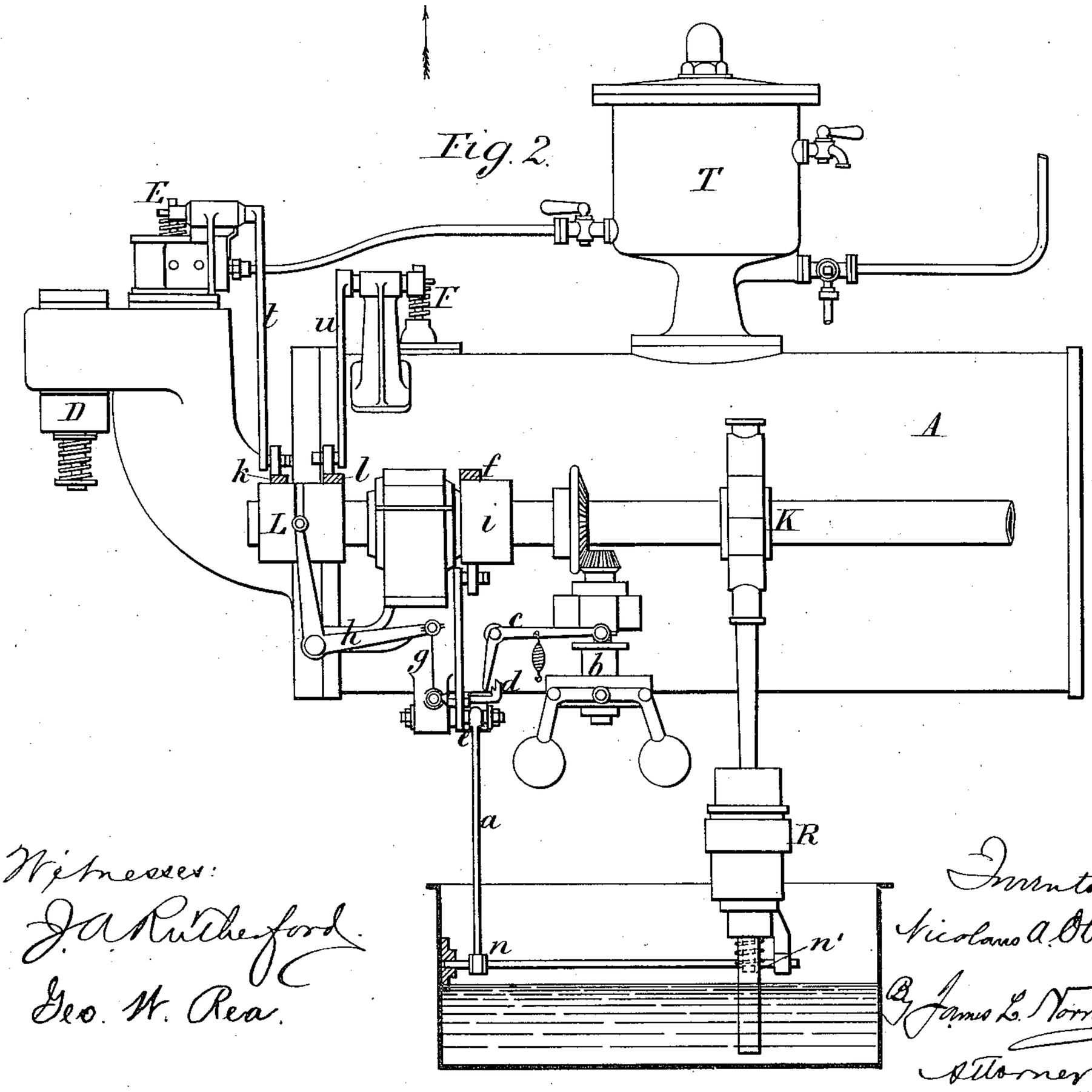

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Fig. 5.

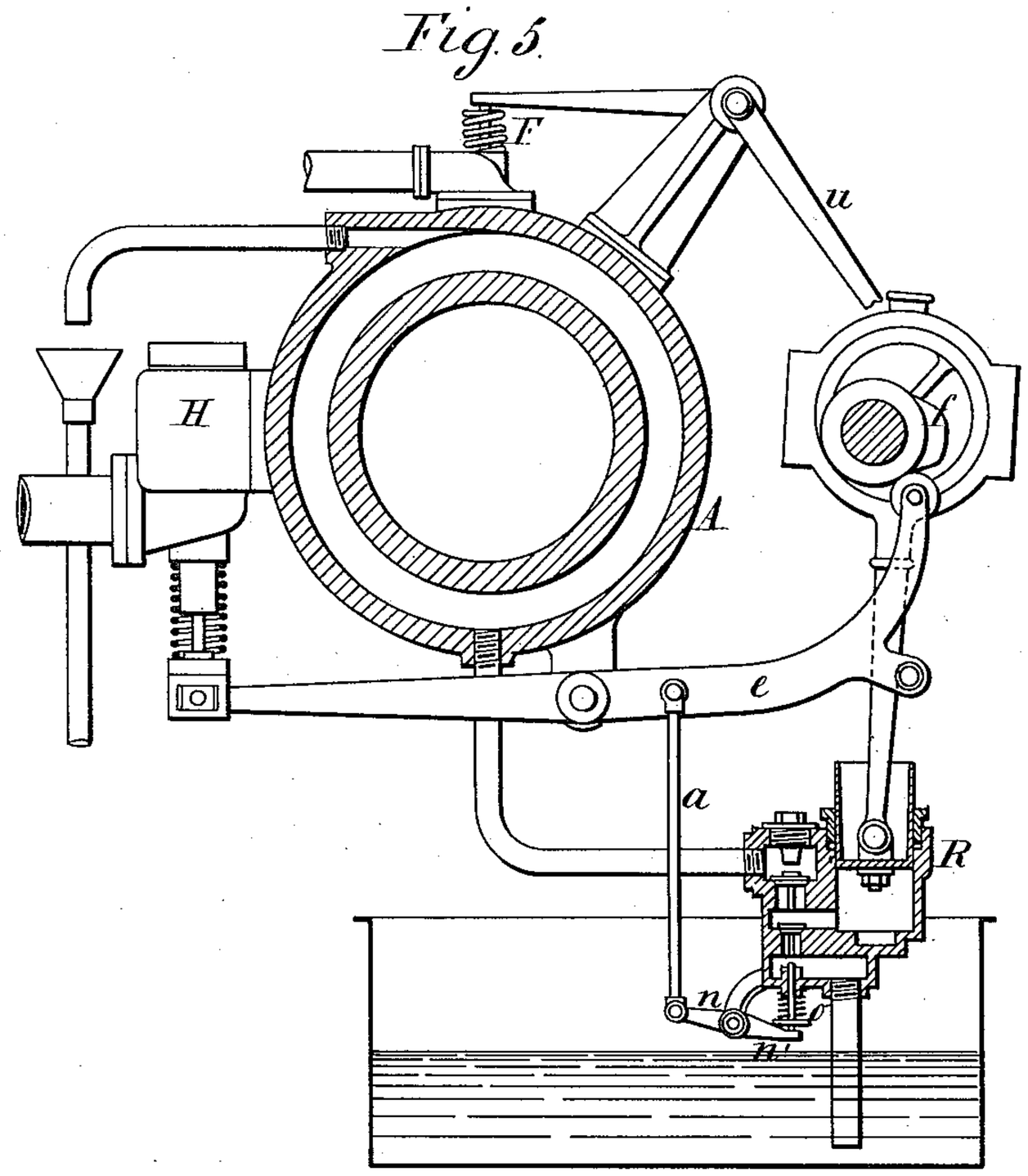

Fig. 3.

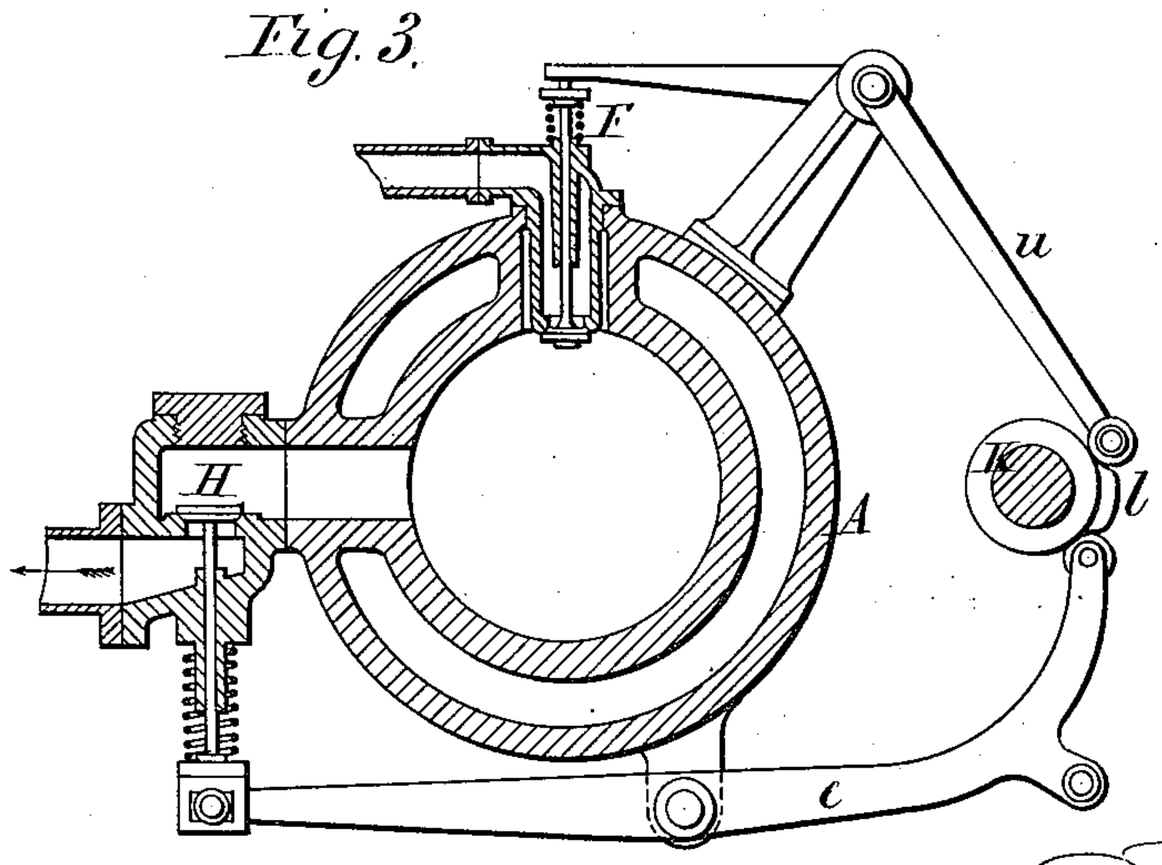

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Fig. 9.

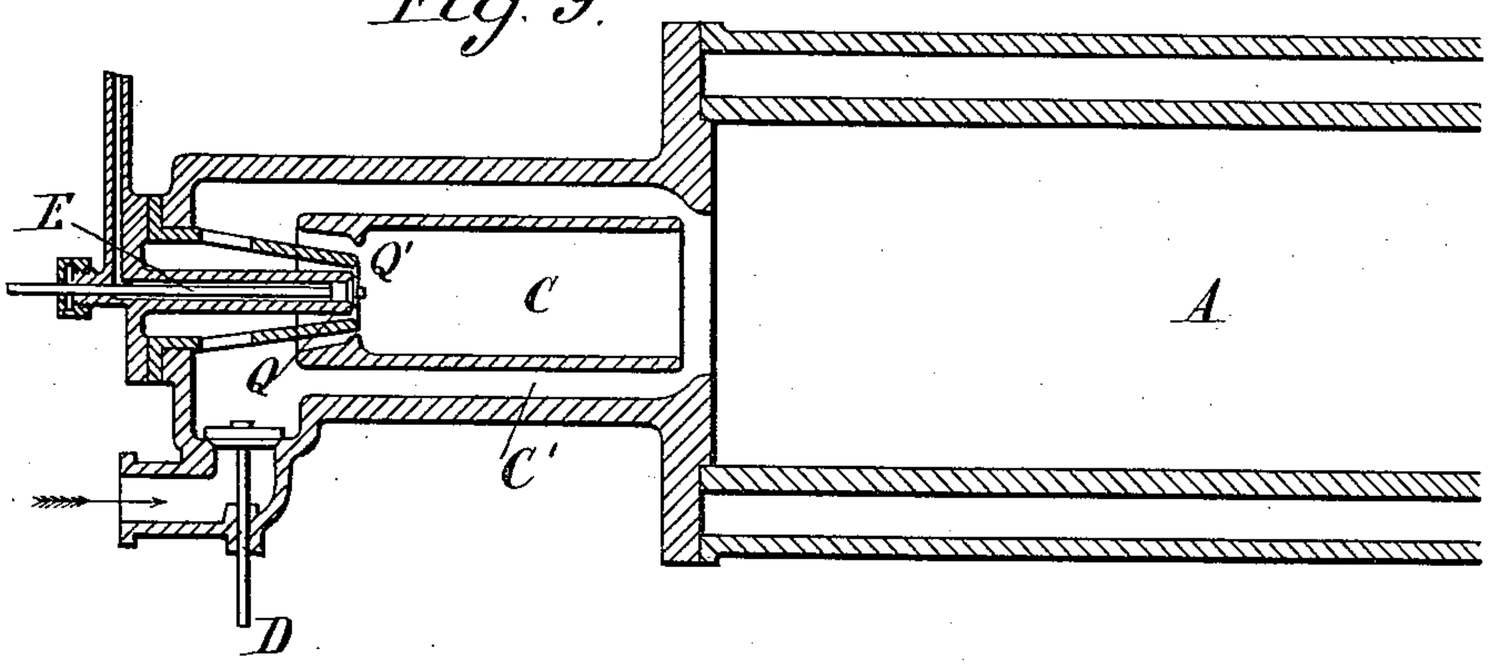
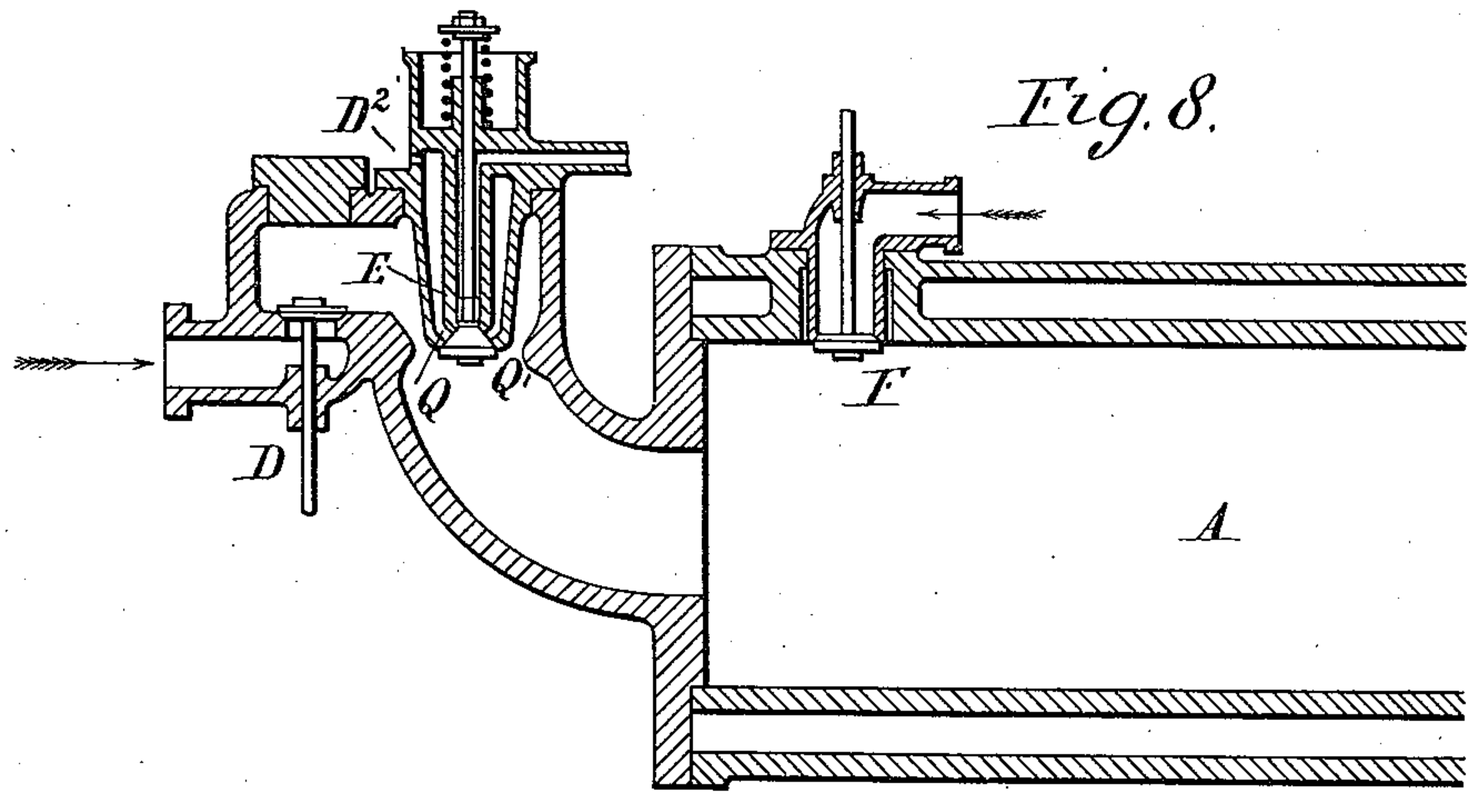


Fig. 8.



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UNITED STATES PATENT OFFICE.

NICOLAUS AUGUST OTTO, OF COLOGNE, ASSIGNOR TO THE GAS-MOTOREN-FABRIK-DEUTZ, OF KÖLN-DEUTZ, GERMANY.

MOTOR-ENGINE WORKED BY OIL-VAPOR.

SPECIFICATION forming part of Letters Patent No. 433,807, dated August 5, 1890.

Application filed March 1, 1890. Serial No. 342,198. (No model.) Patented in Belgium February 5, 1890, No. 89,416; in Switzerland February 8, 1890, No. 1,874, and in Italy February 25, 1890, LII, 479.

To all whom it may concern:

Be it known that I, NICOLAUS AUGUST OTTO, a citizen of Prussia, residing at Cologne, in the German Empire, have invented new and useful Improvements in Motor-Engines Worked by Oil-Vapor, (for which I have obtained patents in Belgium, dated February 5, 1890, No. 89,416; in Italy, dated February 25, 1890, Vol. LII, 479, and in Switzerland, dated February 8, 1890, No. 1,874,) of which the following is a specification.

This invention relates to that description of four-stroke-cycle petroleum-motor engines constructed by me, in which a spray or vapor of petroleum mixed with air to form an explosive compound is introduced through a long heated passage into the working-cylinder, such explosive charge after compression being ignited by suitable means in the said passage. The charge, which may be introduced either under pressure or by forming a partial vacuum in the cylinder during the suction-stroke, and which may be formed either in the heated passage itself or before entering the same, effects the clearance of the passage from the residual products of combustion of the previous charge, which are retained in the cylinder, and leaves the passage filled with explosive compound suitable for ignition. In the arrangement of such engines heretofore employed by me the whole of the air-supply required for the perfect combustion of the explosive charge was introduced through the long passage, whereby the ignition was rendered more or less uncertain. According to the present invention I obviate this disadvantage by introducing into the passage at the point where the petroleum spray or vapor is introduced only a portion of the air required for the complete combustion, the remaining portion being introduced either directly into the cylinder itself or into the end of the long passage, which adjoins the cylinder. By this means the passage remains filled with rich explosive mixture, which will ignite with certainty.

The accompanying drawings show the construction of a motor-engine operating in the above-described manner.

Figure 1 shows a longitudinal section; Fig. 2, a side view; Fig. 3, a cross-section through the air-valve F and escape-valve H; Fig. 4, an end view; Fig. 5, a section showing the circulating-pump; Figs. 6 and 7, enlarged details of the oil spraying and mixing apparatus. Fig. 8 is a detail sectional view showing a modification of the oil and air inlets. Fig. 9 is a similar view showing another modification of the same.

A is the cylinder, whose piston B, when in its backward or inward position, leaves a charging or compressing space, with which the uncooled supply and igniting passage C communicates. The charging-space also communicates with the escape-valve H, Fig. 3, and with the air-supply valve F. The curved passage C has an opening at Z for the introduction of a suitable igniting device, such as a heated tube. At its extremity is the valve E for the admission in the form of spray of the oil or other combustible liquid, (shown to a larger scale at Fig. 6,) as also the self-acting air-valve D. The air-supply is admitted to this valve through the regulating-cock M, either immediately from the surrounding atmosphere or through a suitable appliance for lessening noise. There is also provided a gas-supply cock N for admitting ordinary combustible gas on starting the engine. A pressure-regulator T is provided on the top of the cylinder for supplying the oil under constant pressure to the valve E, the regulator being charged with oil from the upper reservoir S through the pipe U and inlet U′, controlled by a float U^2.

Fig. 2 shows a side elevation of the cylinder, showing the valve-gear and governing apparatus. These mechanisms are worked by the way-shaft K, which revolves at half the speed of the engine-shaft.

Fig. 3 shows a cross-section of the cylinder, and Fig. 5 the construction of a pump for the cooling-water, with special arrangement for regulating the supply of the cooling-water.

The mode of working the engine (shown at Figs. 1 to 6) and the mechanisms combined therewith are as follows: The oil passing from the tank S and pipe U to the pressure-regu-

lator T and regulating screw-valve O is in the first instance subjected to a preparatory heating in the space above the spraying-valve E. As soon as the air-valve D opens automatically against the pressure of its spring at the commencement of the suction-stroke, and the valve-stem *m* is pressed down by the cam *k* and lever *t*, the oil is distributed in the small channels *p* in the enlarged part of the stem *m*, (shown more clearly in the enlarged plan, Fig. 7,) and is further divided on contact with the valve-seat, and is then converted into spray by the jet of air entering through valve D into chamber D′ and issuing with considerable velocity from the annular nozzle Q. The petroleum spray thus formed mixes with another supply of air issuing through the nozzle Q′, forming an easily-inflammable mixture, and passes through the heated passage C into the cylinder A, where it mixes with the residual products of combustion. During the suction-stroke the air-valve F is opened by the cam *t* and lever *u*, thereby admitting to the charge in the cylinder a quantity of fresh air for the above-described purpose. On the return-stroke of the piston the charge is compressed, and the compressed charge is then fired in the passage C, effecting the working-out stroke by the consequent expansion. On the following return-stroke the products of combustion are expelled through the escape-valve H, which is opened by means of the lever *e* and cam *f*.

The annular nozzles Q and Q′ are formed with such restricted area that when the piston B commences its suction-stroke a partial vacuum will be formed in the cylinder, thus enabling the external atmospheric pressure to force the air through the nozzles Q and Q′ with considerable velocity, and thus produce, first, the effectual spraying of the oil, and, secondly, the intimate and uniform admixture thereof with the air to form the combustible charge entering the cylinder.

The formation of an easily-inflammable mixture is effected by regulating the oil-supply by means of the regulative device O, and the air-supply by the cock M. The air-supply drawn directly into the cylinder A can be regulated either by an earlier or later opening of the valve or by more or less restricting the passage. The valve F can therefore be made to open automatically against the action of a spring, and the valve D may be worked by a lever and cam instead of automatically. The ignition is effected as nearly as possible at the end of the charging-passage C—such as at the point Z—by means of any suitable igniting appliance. In the drawings, Fig. 4, an incandescent igniting-tube is supposed to be employed for this purpose.

Fig. 8 shows a modified construction of the inlet devices for oil and air, in which the air required for spraying the oil is drawn in through an opening D^2, the air required for mixing with the spray through nozzle Q′ being alone admitted through the valve D. In this case the oil-valve E at the same time serves to close the nozzle Q, through which the air from D^2 enters.

Fig. 9 shows another modification, in which the passage C, which in this case is formed straight, has an annular passage C′ surrounding it; or it may be a series of separate passages, through which a portion of the air admitted through the valve D is made to pass, so as to mix with the explosive charge passing through C as both enter the cylinder, the separate air-valve F of the former arrangements being in this case dispensed with.

The regulation of the engine is effected in such a manner that when, owing to a reduction of the work performed, the engine tends to run at higher speed than the normal the oil-supply is cut off, so that no explosions take place, while at the same time the escape-valve H is held open, so that the hot products of combustion that are expelled during the expelling-stroke are drawn in again from the discharge-flues during the following suction-stroke, whereby any detrimental cooling of the cylinder-sides is prevented.

For the above purpose the regulating-sleeve L, which is moved to and fro by means of the lever *e*, that works the escape-valve, and by the link *g* and lever *h*, is held in its one end position, corresponding to the opening of the escape-valve H, by the action of the governor *b*, lever *c*, and notch *d*, so that the cams *k* and *l* revolve out of gear with the levers *t* and *u*, in consequence of which the oil-valve E and the air-valve F are kept closed in a similar manner to that described in the previous application, Serial No. 338,115, filed January 25, 1890. This method of regulation can also be applied to the supply of cooling-water to the cylinder-jacket for the purpose of economizing such water, as shown at Fig. 5. For this purpose the lever *e* is arranged to force open the suction-valve by means of the rod *a*, levers *n n′*, and stem *o*, which passes through the suction-valve casing and is held down by a spring, such forcing open being effected during the time that the lever *e* is being acted upon by its cam—that is to say, during about one-fourth of a revolution of the way-shaft. As the pump-eccentric is so placed on the way-shaft relatively to the escape-valve cam *f* that the said lifting of the suction-valve corresponds to the automatic upward motion of the valve during the suction-stroke of the pump, it will be seen that when the engine is working at the normal speed the said action of the stem *o* will not affect the working of the pump; but as soon as, owing to an increase of speed above the normal, the governor causes the escape-valve to be kept open in the above-described manner the suction-valve of the pump will also be kept open, and consequently no water will be supplied to the cylinder-jacket during the time that the supply of oil spray through valve E and of air through valve F is cut off. This mode of regulating the supply of cooling-water has the effect of

maintaining the temperature of the engine-cylinder as constant as possible.

If the cooling-water is supplied from a service pressure-pipe, the arm of the escape-valve lever *e* is made to act directly upon a check-valve in the supply-pipe opening downward and held closed by a spring, so that as long as the escape-valve of the engine is closed the lever holds the check-valve open and water flows to the cylinder-jacket; but as soon as the escape-valve is held open by the lever *e* through regulating mechanism, as above described, the check-valve is closed by means of its spring and by the pressure exerted upon it by the water in the main, so that during such time the water-supply will be stopped.

I do not herein claim the method described of insuring the ignition and complete combustion of the charge, as this method is claimed in my application filed March 1, 1890, Serial No. 342,197.

Having thus described the nature of my invention and the best means I know for carrying the same into practical effect, I claim—

1. In a four-stroke-cycle petroleum-motor engine, the combination of an ignition or explosion chamber of restricted area at the end of the cylinder, communicating at the front end freely with the cylinder and having an inlet-valve for oil, an inlet-valve for air, and an igniting device, and a second valve for the introduction of air situated in the cylinder beyond the explosion-chamber, substantially as described.

2. In a four-stroke-cycle petroleum-motor engine, a passage opening at one end into the engine-cylinder and having at the other end a chamber communicating with the said passage through two concentric orifices or nozzles, an oil-inlet valve situated centrally within the inner annular orifice, and an air-inlet valve opening into the said chamber, from which the air issues through the said annular orifices into the passage, substantially as herein described.

3. In a four-stroke-cycle petroleum-motor engine, a passage opening at one end into the engine-cylinder and having at the other end a chamber communicating with the said passage through two concentric annular orifices or nozzles, an oil-inlet valve situated centrally within the inner annular orifice and having grooves in its stem for dividing the oil-supply, an air-inlet valve opening into the said chamber, from which the air issues into the passage, an igniting device in the said passage for igniting the combustible charges, and a second air-inlet valve situated in the engine-cylinder or near the mouth of the said passage, substantially as and for the purposes set forth.

4. In a four-stroke-cycle petroleum-motor engine, the combination of an ignition or explosion chamber opening at one end into the cylinder and having valvular appliances for admitting explosive mixtures at the other end, an igniting device in the said chamber for igniting the said charges, and means for admitting a further supply of air into the cylinder at a point beyond the explosion-chamber, substantially as set forth.

5. In a four-stroke-cycle petroleum-motor engine, the combination of a passage opening at one end into the engine-cylinder and having at the other end valvular appliances for admitting explosive mixtures of petroleum spray and air into it, a valve for admitting a further supply of air into the cylinder, levers for opening the said valves and the last-named air-valve, cams for actuating the said levers mounted on a sleeve sliding upon a way-shaft of the engine, a connection between the said sleeve and the lever that works the escape-valve, whereby the sleeve and cams have a to-and-fro motion imparted to them, and a lever actuated by the governor that retains the escape-valve lever and the cams in a position in which they cannot act upon the oil and air valve levers when the engine is running too fast, substantially as and for the purposes set forth.

6. In combination with the water-supply pump for the cooling-jacket of a four-stroke-cycle petroleum-motor engine, a stem passing into the suction-valve box beneath the suction-valve and connected with the lever that works the escape-valve of the engine, so as to partake of the motion of such lever, and a lever actuated by the governor that retains the escape-valve lever in the open position when the engine runs too fast, whereby the stem connected to the escape-valve lever is also held in such a position as to keep the suction-valve of the pump open, substantially as and for the purposes set forth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 12th day of February, A. D. 1890.

NICOLAUS AUGUST OTTO.

Witnesses:

PET. LANGEN,

WILH. SPIECKER.