No. 789,554. PATENTED MAY 9, 1905.

C. LEMALE.

CONTINUOUS INTERNAL COMBUSTION TURBO-MOTOR.

APPLICATION FILED APR. 13, 1903.

3 SHEETS—SHEET 1.

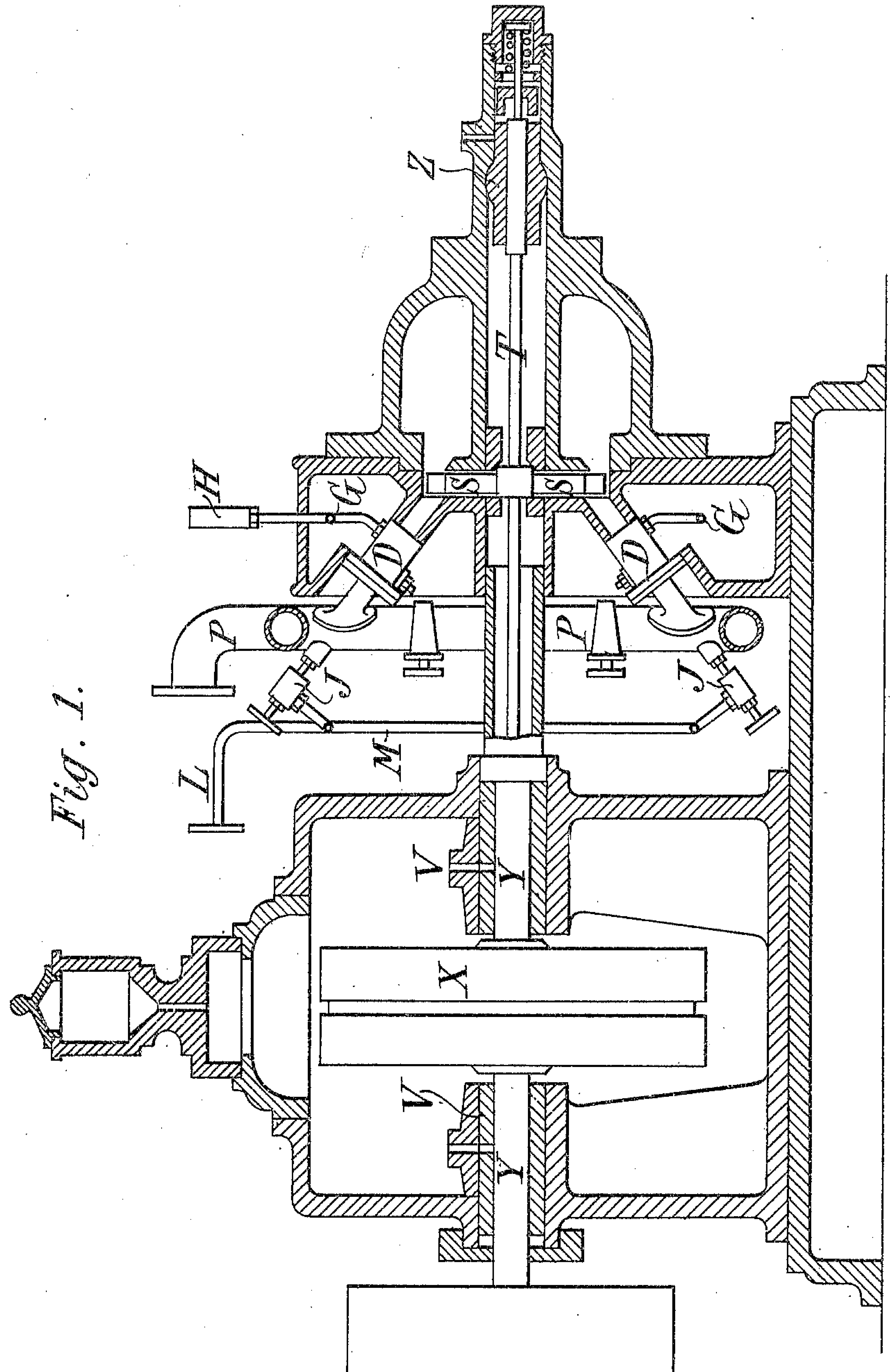

Fig. 1.

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Thomas J. Wallace

INVENTOR:

Charles Lemale,

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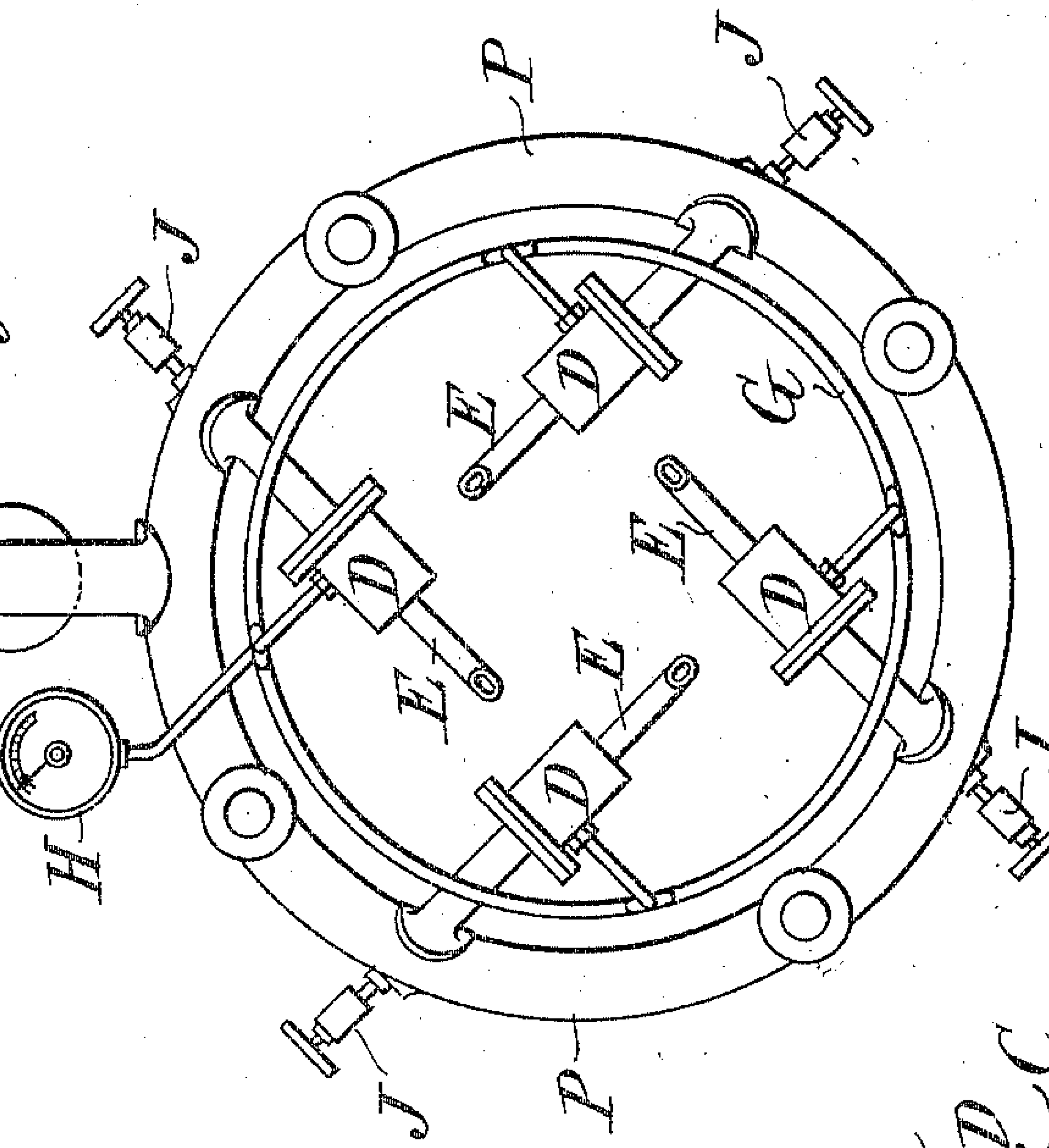

Fig. 2.

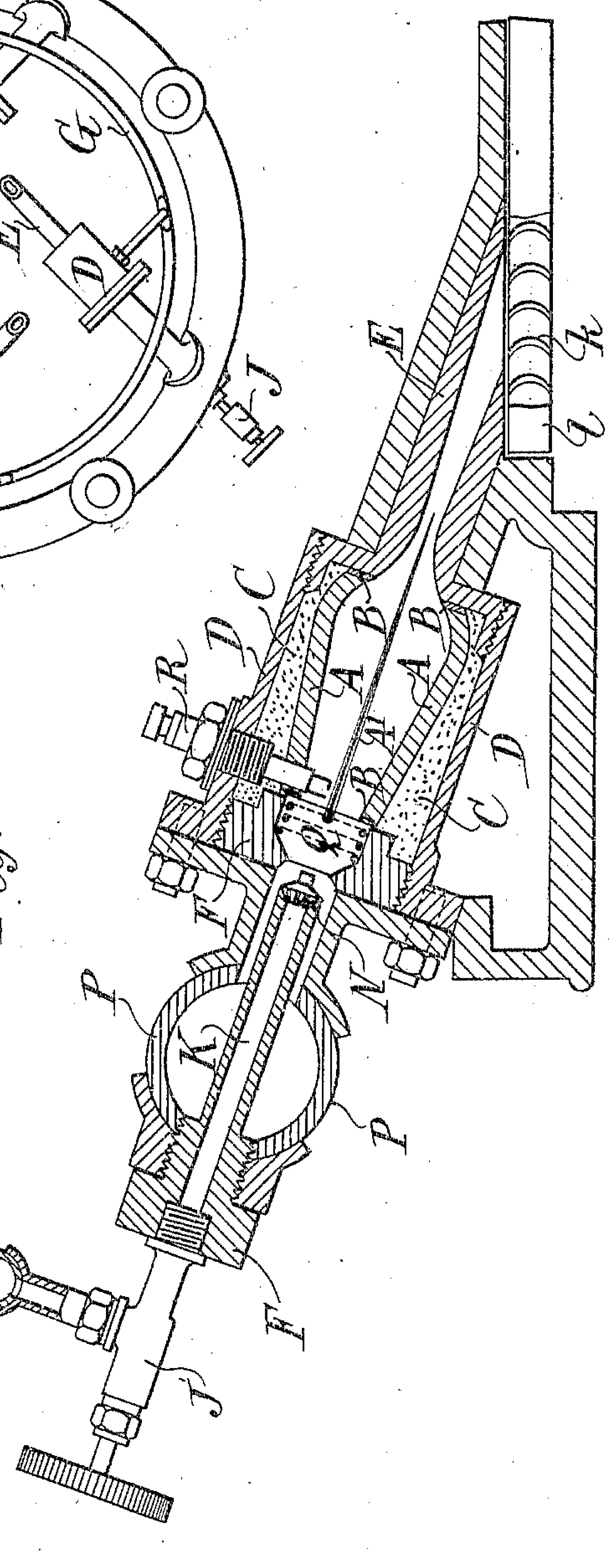

Fig. 3.

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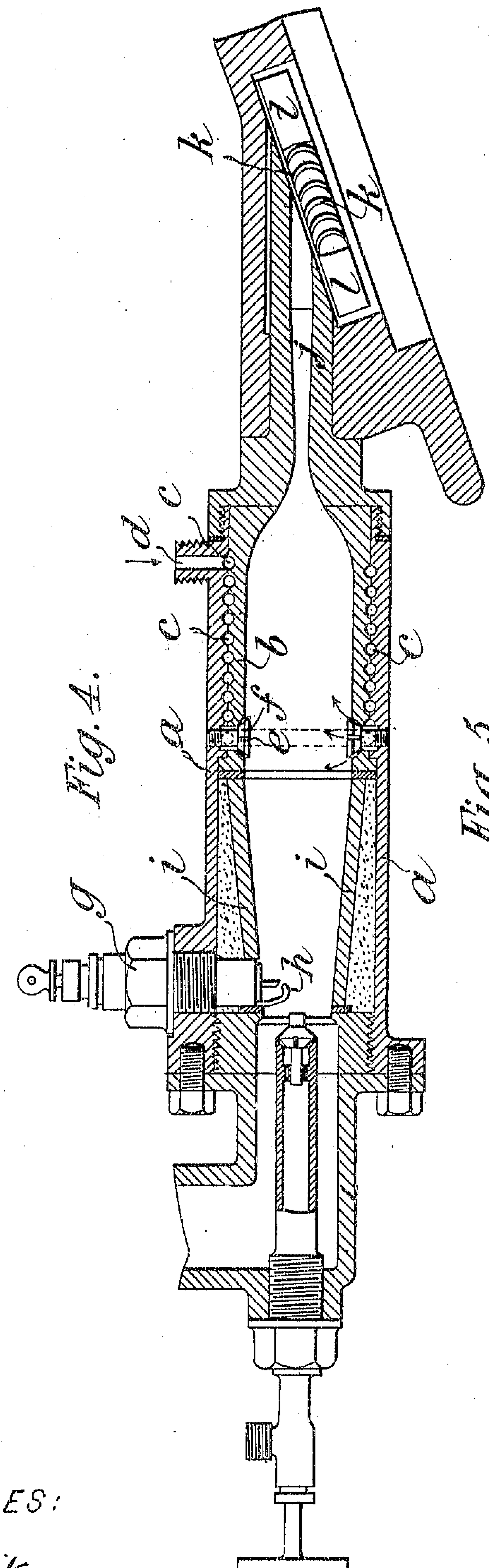

Fig. 4.

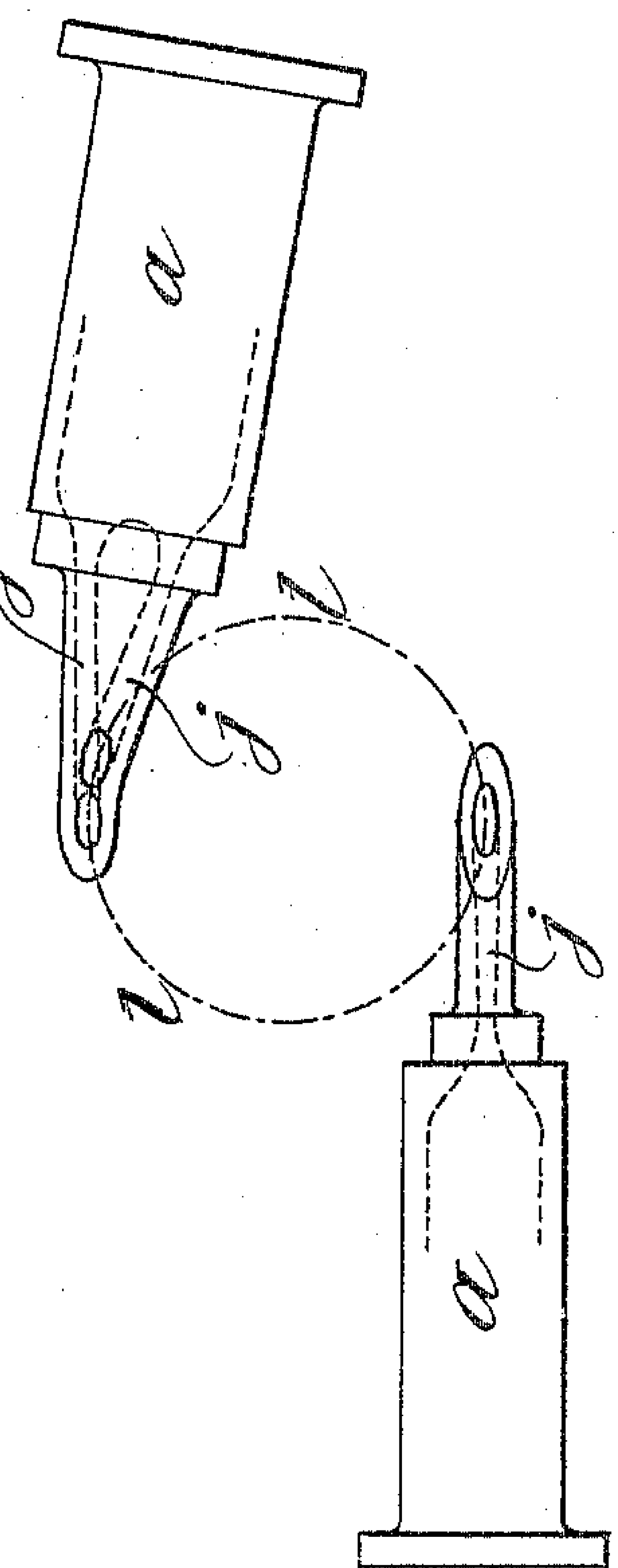

Fig. 5.

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UNITED STATES PATENT OFFICE.

CHARLES LEMALE, OF ALFORT, FRANCE.

CONTINUOUS INTERNAL-COMBUSTION TURBO-MOTOR.

SPECIFICATION forming part of Letters Patent No. 789,554, dated May 9, 1905.

Application filed April 13, 1903. Serial No. 152,366.

To all whom it may concern:

Be it known that I, CHARLES LEMALE, a citizen of the Republic of France, residing in Alfort, Seine, France, have invented certain new and useful Improvements in Continuous Internal-Combustion Turbo-Motors, of which the following is a specification.

The present application for patent has for its subject the improvements which I have made in the turbo-motor of my invention described in my English patent of February 28, 1903.

The objects of these improvements are, first, to permit of obtaining a practical and complete combustion of the gaseous mixture and of insuring the continuity of flow of the burned gases and, further, of avoiding losses of power due to the changes of direction which the gases had to undergo in the system described in the patent before mentioned.

The said improvements include, first, effecting the mixture of air and atomized combustible at the very moment when this mixture is on the point of penetrating into the combustion-chambers, and thus just at the entry to said chambers; second, making the combustion-chambers of such form that the internal walls thereof adapt themselves or correspond to the gaseous stream or current in proportion as its volume increases in consequence of the dilatation produced by the combustion; third, constructing the combustion-chambers in a refractory material which prevents losses of heat, and, fourth, introducing steam into the combustion-chambers, where it forms a mixture with the burned gases, the steam being preferably generated by the heat of combustion in said chambers. The ignition of the gaseous mixture is preferably effected by an electric spark, at least during starting of the motor; but I may arrange a platinum wire or wires in each of the combustion-chambers, which wires are maintained at a red heat by the combustion of said gaseous mixture and serve as igniters for the latter independently of the spark. Other means of igniting the mixture may obviously be employed.

The following description with reference to the annexed drawings will enable the details of the improvements which I have made in my system of turbo-motor to be well understood.

Figure 1 is a longitudinal section of the turbo-motor provided with all its distribution and transmission parts. Fig. 2 is an end view of the admission and distribution parts; and Fig. 3 is a section, on a larger scale, of one of the admission and distribution parts, clearly showing the conduits for air and liquid combustible, the combustion-chamber, and the pipe or nozzle in prolongation of the latter and which discharges onto the vanes of the turbine. Fig. 4 is a longitudinal section of the combustion-chamber provided with a chamber acting as a cooler and vaporizer and with the expansion pipe or nozzle for the gases. Fig. 5 represents two combustion-chambers provided with a pair of pipes or nozzles.

The turbo-motor, Figs. 1 and 2, is composed of a disk fitted with vanes or floats S, carried by a flexible shaft T, mounted on the one hand in a ball bush or bearing Z and on the other hand by its prolongation Y in two pedestals V V, between which is mounted the speed-reducing pinion X. All around the disk are symmetrically disposed the admission and distribution parts—that is to say, the circular pipes and conduits P and M for supplying the air and the liquid combustible, respectively, the combustion-chambers D, and the pipes or nozzles E, in which the motive fluid formed by the burned gases expands to act by its live force upon the vanes of the turbine. The combustion-chambers D—four, for example, in number—are formed of a chamber proper, of refractory material, A, insulated from all metallic parts by means of asbestos washers B, fitted at each edge. This refractory material is surrounded by a sufficiently thick layer of pressed wood-ashes C or any other material which is a bad conductor of heat. Around these ashes is disposed an envelop or casing D, of steel, closed at one end by the neck or nozzle E and at the other by a screw-plug F. The combustible under pressure is supplied through a bent pipe L, being already mixed with a portion of compressed air led by a special pipe or branch to the reservoir in which the combustible is contained. The combustible flows through the circular conduit M and enters the atomizers by the junctions or unions J. These atomizers are formed by conduits K, disposed in the axes of the combustion-chambers and provided at their ends with cones N, provided with grooves of very narrow section. Perpendicularly to the said conduits K opens the circular conduit P, in which circulates the air under pressure, this being of much larger section than that of the conduit M. The air under pressure passes through the annular orifice which surrounds the conduits K and mixes with the atomized combustible, and the gaseous mixture thus formed traverses a number of wire-gauze screens Q, where it becomes more perfect before passing into the combustion-chambers proper, A. The ignition may take place by means of an electric igniter R, disposed quite close to the wire-gauze screens Q, and the combustion of the gaseous mixture is effected completely, thus generating the gases, which expand through the nozzles onto the vanes of the turbine. These nozzles E are disposed at the extremity of the combustion-chambers and in the axis of same in order to avoid any change of direction which would lead to losses of power. In order to equilibrate the pressure in all the combustion-chambers D, these latter are connected together by a compensating conduit G, upon which is a pressure-gage H, which permits of ascertaining at any moment the pressure existing in the said chambers. The air which serves for the formation of the gaseous mixture can be previously heated by passing through a heater (not shown in the drawings) or by subjecting it to a preliminary compression. If desired, a certain quantity of water may be blown into it before it passes through the heater. The water is then transformed into steam and can serve to lower the temperature of the combustion and at the same time to increase the volume of the gases. In consequence of the combustion of the gaseous mixture the temperature will probably be sufficiently high to raise to red heat the refractory material of which the combustion-chambers are composed, and the ignition will then take place by simple contact of the said gaseous mixture with the wall of the combustion-chamber. However, to facilitate the continuous ignition a platinum wire A′ may be disposed in the axis of the combustion-chamber, which wire is raised to incandescence by the heat of the combustion of the gaseous mixture. The temperature of combustion of the gaseous mixture being about 2,000°, there might be reason to fear that notwithstanding the expansion of the burned gases these might still possess a very high temperature. In point of fact the temperature of the current of gas delivered onto the vanes of the turbine-disk should not exceed 350°. Above this temperature the strength of the metal of the disk is no longer the same, as will be readily understood, and in consequence of the high speeds at which the turbine-disks rotate it is important that the strength of the metal shall not be diminished, since otherwise one might be exposed to breakage of the disk and all the consequences of such an accident.

In order to keep the temperature of the gaseous current below the maximum limit just indicated, I have devised a modification of combustion-chamber described above with reference to Fig. 3, which is prolonged by a second chamber the metal walls of which are provided with a water circulation in a coil or serpentine, Fig. 4. This serpentine, in which the water is transformed into superheated steam, discharges through orifices at the extremity of the combustion-chamber, from which openings the steam escapes and mixes with the burned gases and cools them.

The water-vaporizing chamber is composed of the exterior envelop or casing *a*, in which is fitted the internal piece *b*. These two pieces have each a helical groove *c* cut or formed in their body and forming a vaporizing coil or serpentine. The water under pressure enters by the junction or union *d*, circulates through the coil, and passes in the condition of steam into the combustion-chamber at the extremity of the latter by the small orifices or channels *e*, formed on the cone *f*, and thus dividing the steam into a number of small jets, which mix more readily with the gases.

The igniter may be of any suitable construction—as, for instance, that shown at R′ in Fig. 4. To guard the spark from the violent current of the gases, a platinum protector *h* may be fixed at the lower part of the igniter R′. This platinum protector has, further, the advantage that soon after starting it becomes incandescent and then suffices to produce continuous and automatic ignition of the mixture without it being necessary to pass the spark.

The operation of the motor is in accordance with the description filed in my English patent of February 28, 1903. Combustion of the gases takes place in their passage through the refractory casing *i*, and the burned gases heat the metallic casing *b*, thus producing vaporization of the water which circulates in the coil. The mixture of gas and steam expands in the pipe or nozzle *j*, which delivers the jet onto the vanes *k* of the turbine *l*. An intense heat is conserved in the combustion-chamber by reason of its non-conducting walls, so as to insure a complete combustion of the heaviest oils, and it is only at the end of the chamber after such complete combustion has been effected that a portion of the heat is permitted to be radiated through the metal wall of the prolongation to the water in the heating-coil. Likewise it is only after such complete combustion, and preferably immediately thereafter at the end of the combustion-chamber where the gases are hottest and at the very beginning of their passage as complete combustion gases to the turbine, that the cooling-steam is admitted, so that there is no retarding of combustion, but a thorough admixture of steam with the gases.

Each combustion-chamber may comprise one or several expansion pipes or nozzles—two, for example, as shown is Fig. 5. In this case the point of delivery of each nozzle is contiguous, so as to distribute or deliver a single stream of gas by the junction of the different jets.

I claim as my invention and my exclusive property—

1. In a continuous internal-combustion turbo-motor, the combination of combustion-chambers, a circular air-conduit of relatively large section leading into said chambers, a circular liquid-combustible conduit of relatively smaller section, and branches discharging liquid combustible and air from said conduits into the combustion-chambers.

2. In a continuous internal-combustion turbo-motor, the combination of combustion-chambers, a circular air-conduit of relatively large section leading into said chambers, a circular liquid-combustible conduit of relatively smaller section, branches from the liquid-combustible conduit traversing the air-conduit and passing through an annular space therein, an atomizing-nozzle at the end of said branch, said branch and said annular space discharging liquid combustible and air into the combustion-chambers.

3. In a continuous internal-combustion turbo-motor, the combination of combustion-chambers, a circular air-conduit of relatively large section leading into said chambers, a circular liquid-combustible conduit of relatively smaller section, branches discharging liquid combustible and air from said conduits into the combustion-chambers, and mixing-screens disposed at the entrance of the combustion-chambers and through which the air and combustible pass.

4. In a continuous internal-combustion turbo-motor, the combination of a combustion-chamber proper A of refractory material of an increasing cross-section to correspond with the expansion of the gaseous stream during combustion, and a steel casing D surrounding said refractory material, a space between the casing and the refractory material being filled by a thick layer C of non-conducting material so as to avoid loss of heat by conduction, and the ends of the refractory material being insulated by means of insulating-washers.

5. In a continuous internal-combustion turbo-motor, the combination of a turbine adapted to rotate at high speed, a non-conducting combustion-chamber in which are formed highly-heated gases of combustion and which is adapted to conserve the heat and insure a high temperature therein and consequent complete combustion, a nozzle for directing the gases upon said turbine, a prolongation of said chamber between the chamber and the nozzle for conducting the gases of combustion to said nozzle, and means for converting water into steam and introducing the steam into said gases in said prolongation while highly heated at the point at which said combustion-chamber ends to lower their temperature to the point at which they may be led to the turbine.

6. In a continuous internal-combustion turbo-motor, the combination of a turbine adapted to rotate at high speed, a combustion-chamber in which are formed highly-heated gases of combustion, and a prolongation thereof inclosing the highly-heated gases of combustion and comprising a metal casing carrying a water-circulating coil around the prolongation adapted to be connected at one end to a water-supply, and discharging at its other end into the prolongation at the point at which the combustion-chamber ends, whereby steam is generated in said coil and is discharged into said prolongation and mixes with the gases of combustion so as to lower their temperature to the point at which they may be led to the turbine.

7. In a continuous internal-combustion turbo-motor, a chamber inclosing the highly-heated gases of combustion, and composed of an exterior envelop *a* and an internal member *b*, said envelop and member being grooved to form a coil *c* adapted to be connected at one end to a supply of water and discharging through a number of small jets into the interior of the chamber, whereby the water in said coil is converted into steam and is introduced in jets into said chamber to mix with the gases therein and lower their temperature.

8. In a continuous internal-combustion turbo-motor, the combination of a turbine adapted to rotate at high speed, a non-conducting combustion-chamber in which are formed highly-heated gases of combustion and which is adapted to conserve the heat and insure a high temperature therein and consequent complete combustion, said combustion-chamber being formed of a cross-section increased beyond the point of admission of the fuel to correspond with the increased volume of the gaseous stream after combustion, a nozzle for directing the gases of combustion upon said turbine, a prolongation of said chamber having substantially the same cross-section as that of the end of said chamber for conducting the gases of combustion to said nozzle, and means for converting water into steam and introducing the steam into said gases in said prolongation while highly heated at the point at which said combustion-chamber ends to lower their temperature to the point at which they may be led to the turbine.

9. In a continuous internal-combustion turbo-motor, the combination of a turbine adapted to rotate at high speed, a non-conducting combustion-chamber adapted to conserve the heat and insure a high temperature therein and consequent complete combustion, a nozzle for directing the gases upon said turbine, a prolongation of said chamber between the chamber and the nozzle for conducting the gases of combustion to the nozzle, means for applying the heat of the gases in said prolongation to water to convert it into steam, and means for introducing such steam into said gases in said prolongation while highly heated at the point at which said combustion-chamber ends to lower their temperature to the point at which they may be led to the turbine.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

CHARLES LEMALE.

Witnesses:
ARMENGAUD, Jeune,
MARCEL ARMENGAUD, Jeune.