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4 Sheets—Sheet 1.

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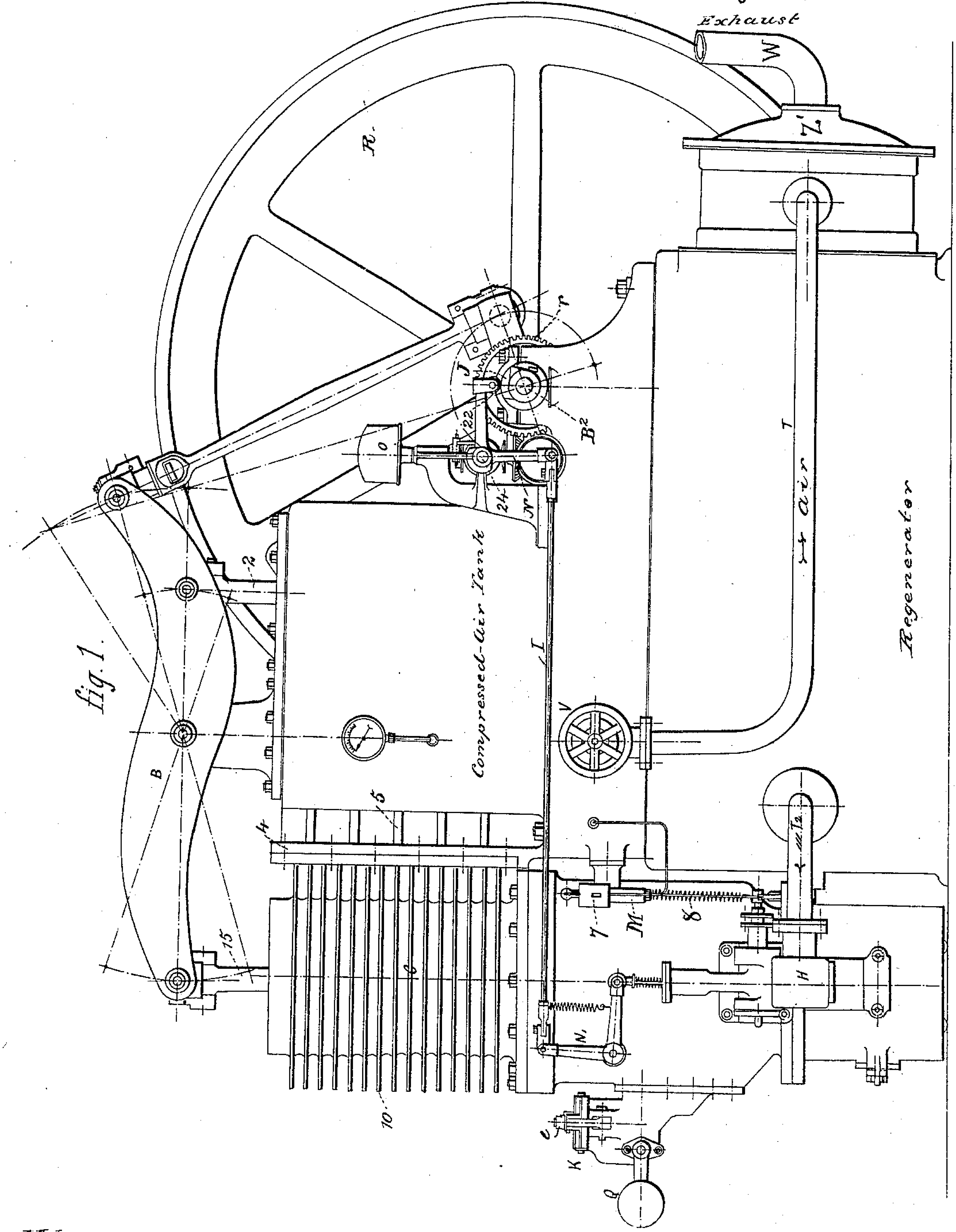
HOT AIR ENGINE OR AEROTHERMIC MOTOR.

No. 387,063. Patented July 31, 1888.



Witnesses,
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(No Model.) 4 Sheets—Sheet 2.

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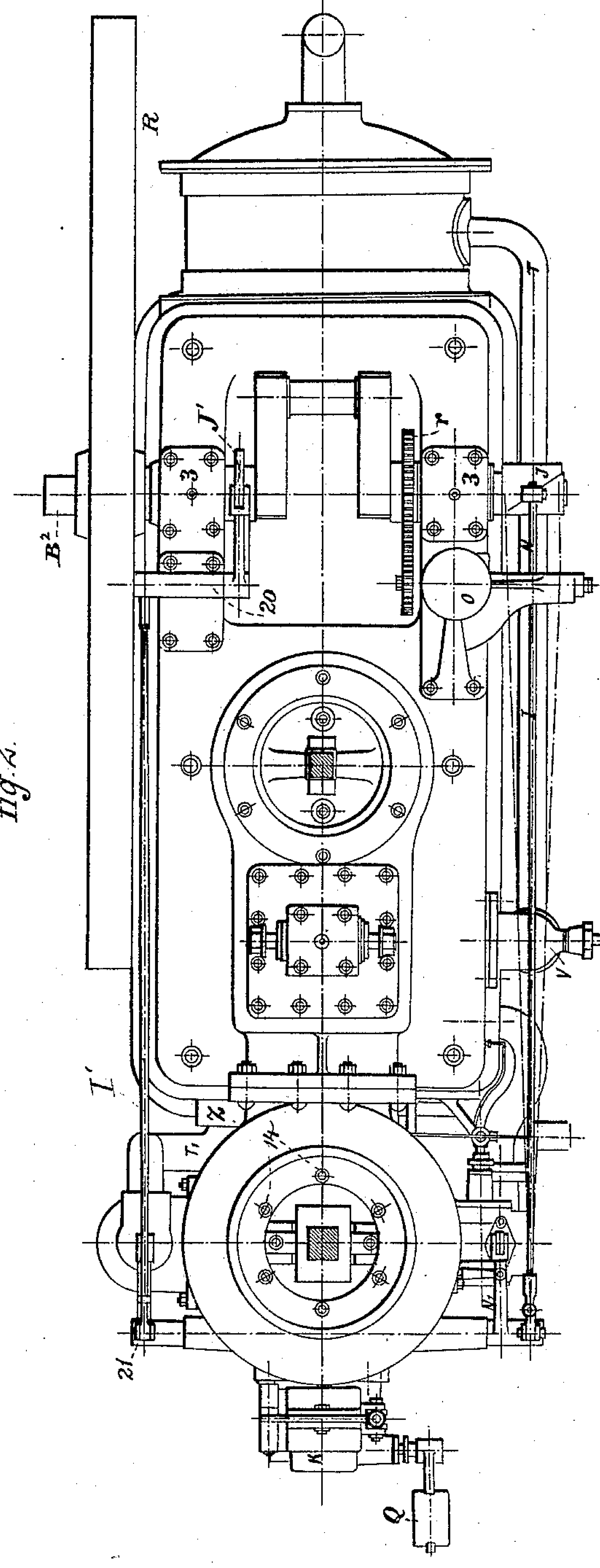

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(No Model.) 4 Sheets—Sheet 3.

L. GENTY.

HOT AIR ENGINE OR AEROTHERMIC MOTOR.

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fig. 3.

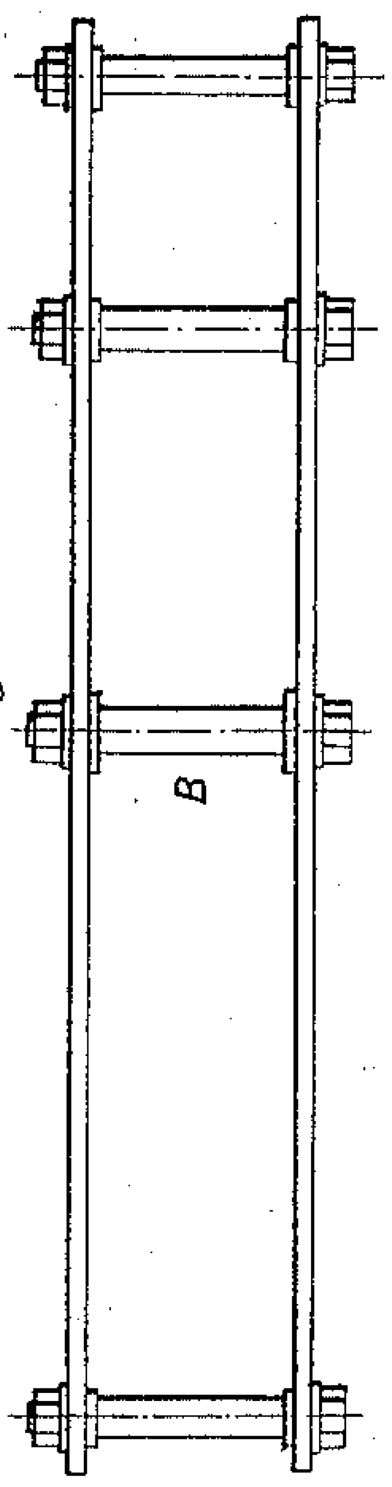


fig. 6.

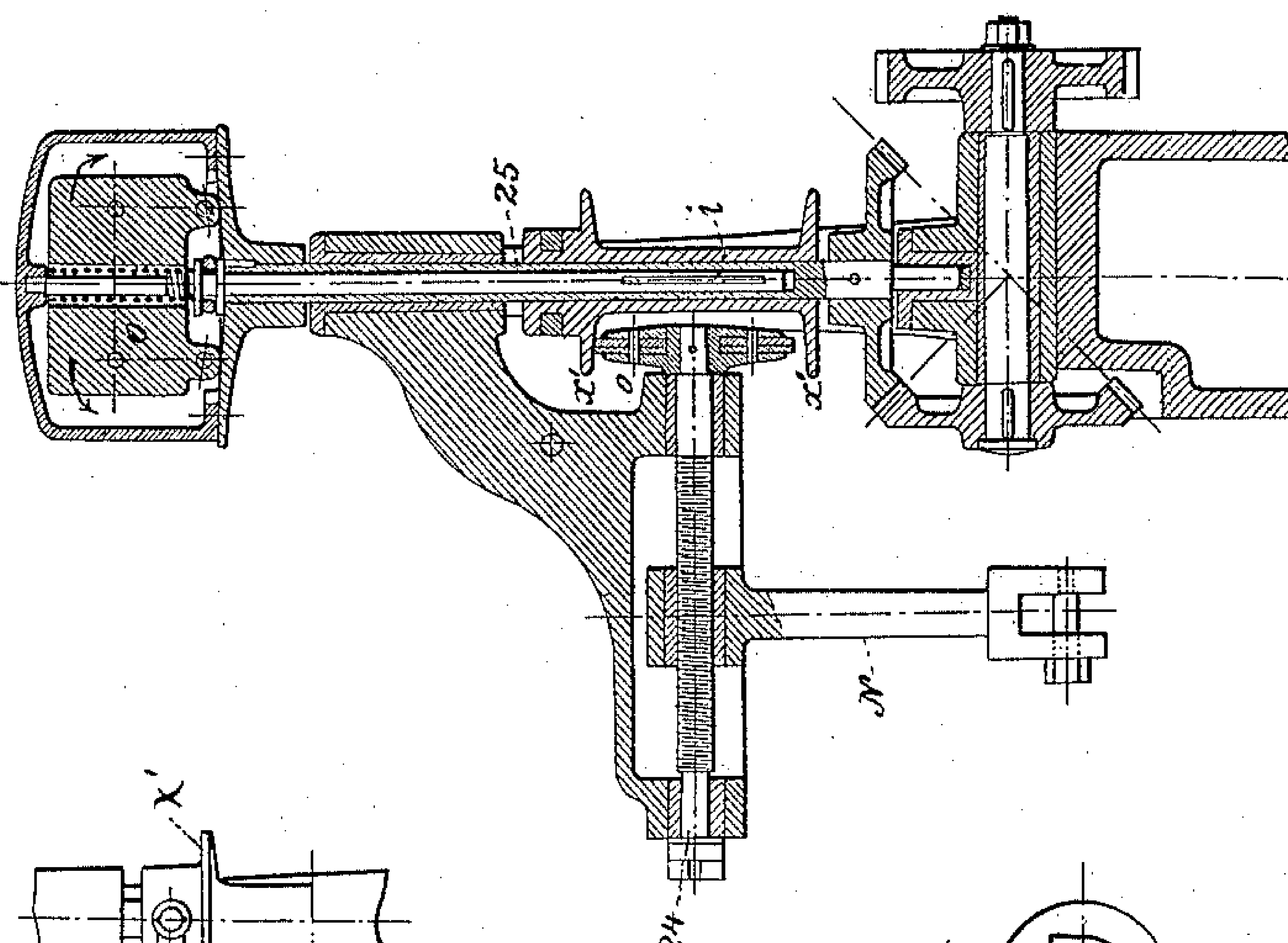


fig. 7.

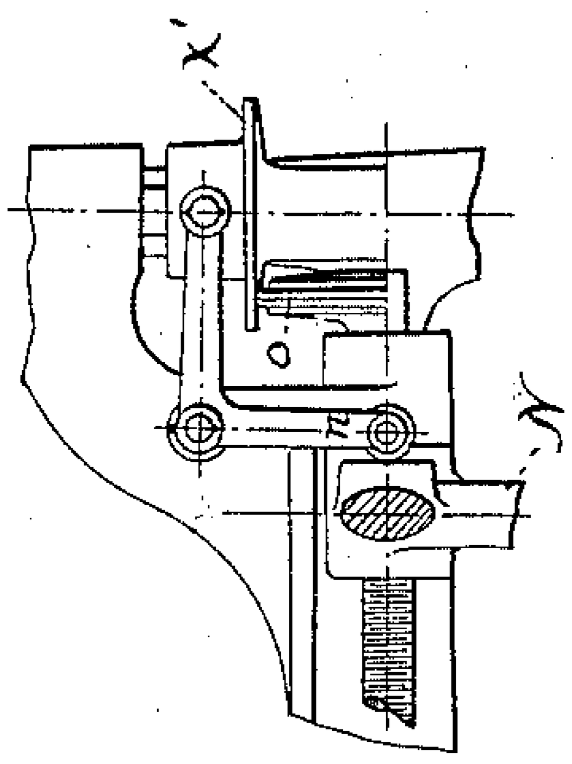


fig. 8.

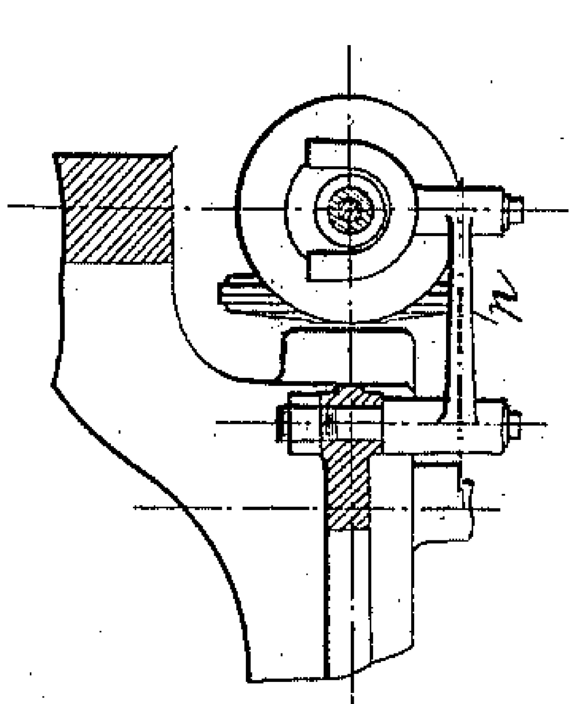
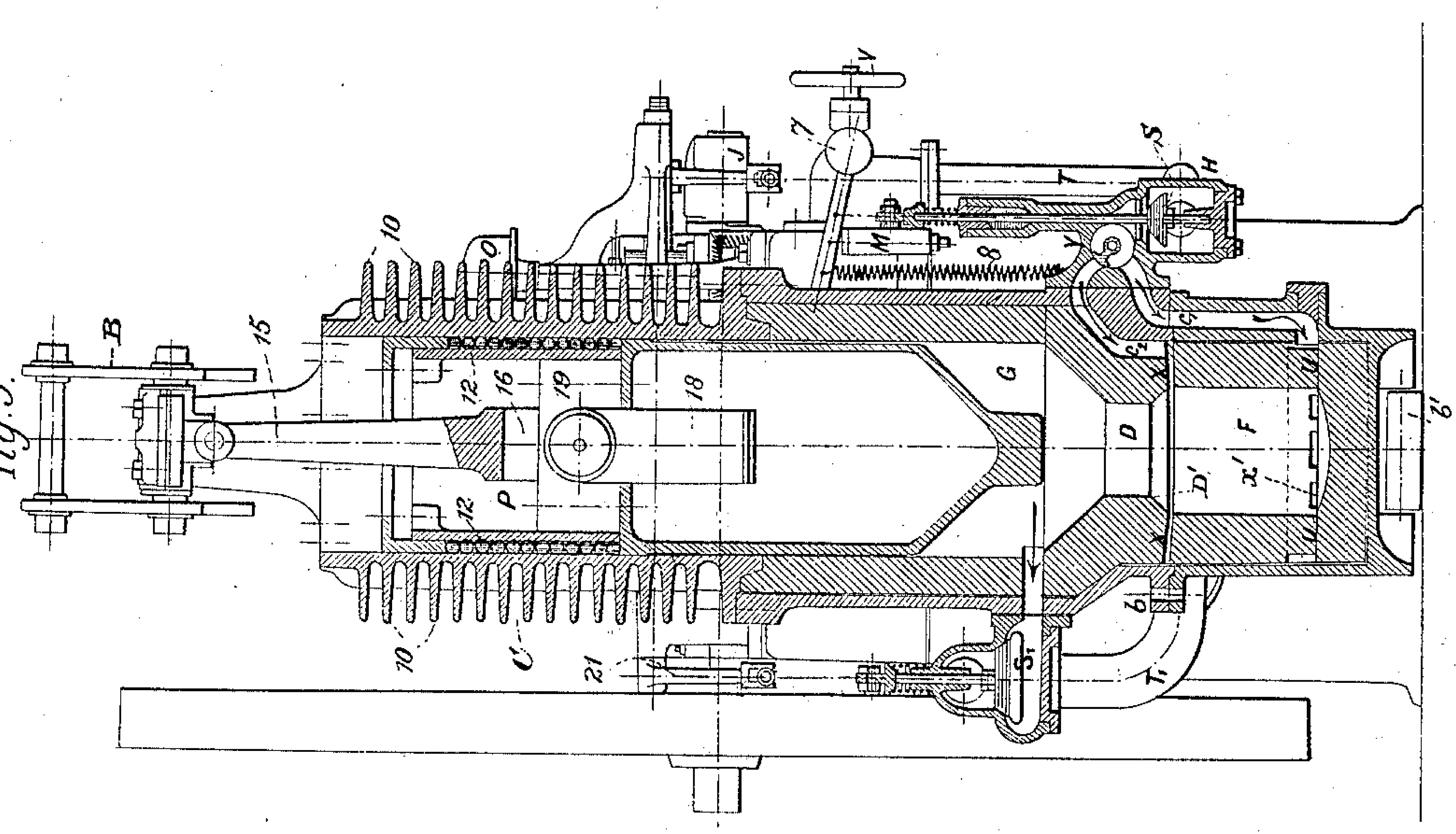


fig. 5.



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(No Model.) 4 Sheets—Sheet 4.

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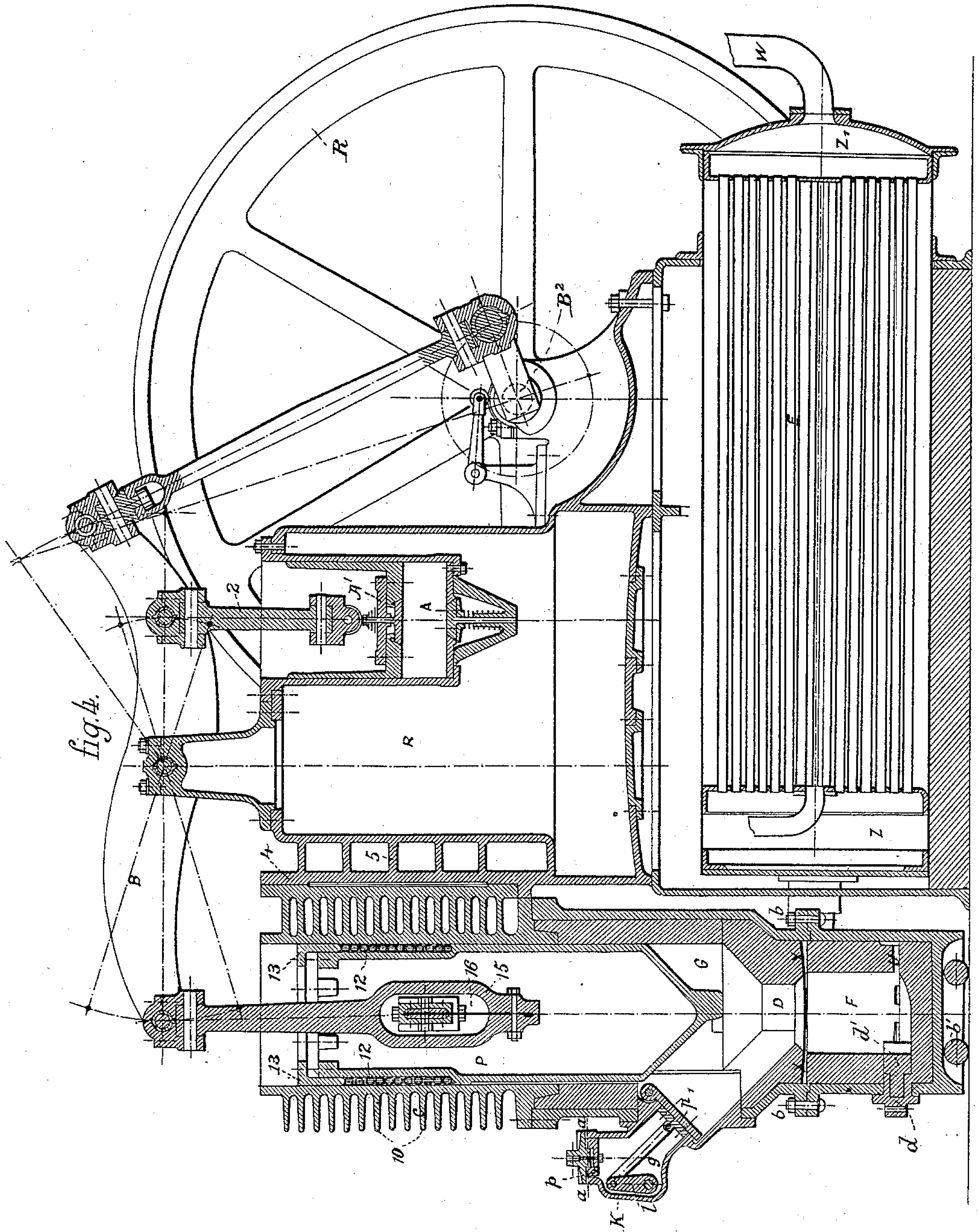

fig. 4.

Witnesses,

Inventor.

Lucien Genty

UNITED STATES PATENT OFFICE.

LUCIEN GENTY, OF TOURS, FRANCE.

HOT-AIR ENGINE OR AEROTHERMIC MOTOR.

SPECIFICATION forming part of Letters Patent No. 387,063, dated July 31, 1888.

Application filed February 1, 1888. Serial No. 262,609. (No model.)

To all whom it may concern:

Be it known that I, LUCIEN GENTY, a citizen of France, residing at Tours, in the Department of Indre-et-Loire, have invented a new and useful Improvement in Hot-Air Engines or Aerothermic Motors, of which the following is a specification.

This invention relates to a new or improved hot-air engine or aerothermic motor arranged and operating as hereinafter described with reference to the accompanying drawings.

Figure 1 is a general view showing a side elevation of an aerothermic motor constructed according to the invention. Fig. 2 shows the motor in plan, the beam and connecting-rod being removed. Fig. 3 is a plan of the beam. Fig. 4 represents a longitudinal section of the motor. Fig. 5 is a vertical section taken through the cylinder and valves. Fig. 6 represents the centrifugal governor in vertical section. Figs. 7 and 8 represent the small stop-lever of the governor in elevation and plan, respectively.

The working of the motor is as follows: Air from the atmosphere is compressed in a reservoir or chamber communicating with an exchanger or heater, which delivers it in the furnace at a temperature as near as desired to that of the escaping or exhaust gases. This air, whose temperature is raised by the heat of the escaping gases, is distributed in a furnace or combustion-chamber, whence it issues at an elevated temperature, varying according to the action of the engine. It then enters the cylinder, where it acts first under constant pressure and afterward by expansion, which is produced by the excess of heat taken up in the combustion-chamber, being subsequently discharged or exhausted at atmospheric pressure into the exchanger or heater hereinbefore referred to, whence it ultimately escapes into the atmosphere.

This hot-air engine or aerothermic motor, as illustrated in the drawings, is constructed with a feed-pump, A, connected to a compression-chamber, R, Fig. 4, by means of a flange and bolts. The valves are flat and packed with leather, being of such a shape or form that the waste or inactive space beneath the piston A′ is limited to that reserved at the end of the stroke between the piston and the end of the cylinder. The connecting-rod 2, attached to the piston A′, is made with two joints having their axes arranged at right angles, so that the piston never binds or strikes in the cylinder however irregularly the beam B may be centered. The cast-iron compression-chamber R forms part of a support or bed-plate, one end of which carries the two plumber-blocks 3 of the crank or driving shaft B^2, the other end presenting a broad plate, 4, connected to the compression-chamber by webs 5, and to which the driving-cylinder C is bolted.

The compression-chamber R communicates with a heater, E, through a tube, T, and starting-valve V. This heater or exchanger of temperature is constructed similarly to the body of a circular boiler. In this heater the air is heated to a temperature more nearly approaching that of the exhaust, according to the area of surface presented by the tubes. This heated air enters a tube, T^2, Fig. 1, passing through the side of the bed-plate and leading to an admission-valve, H, Figs. 1 and 5. The admission-valve box is shown in section at H, Fig. 5, and contains a valve, S, formed by a number of superposed sheets of asbestus paper or fabric, or by a disk formed of a truncated cone of compressed asbestus tightly fixed between two disks of metal. This valve closes the passage perfectly at an elevated temperature and can be easily repaired by renewing the asbestus when required.

The compressed and heated air admitted by the valve S enters a distribution-box, Y, where it is divided into two streams of different volumes according to the position of the distribution-valve. One portion of the air passes along a passage, C, leading to an annular passage, V, formed around the fire-bricks at the lower part of a combustion-chamber, F, whence the air is delivered through a series of horizontal tuyeres, x', in the thickness of the bricks to fuel placed in the combustion-chamber, and consisting of coke, for example. This coke is maintained at a bright red or even white heat by means of the fire-proof and heat-retaining casing by which it is inclosed. Combustion producing carbonic acid takes place at first, after which a partial decomposition occurs, and a flame composed of nitrogen, carbonic acid, and carbonic oxide escapes from the upper surface of the fuel. This flame meets a thin stream of hot air delivered by an annular tuyere or opening, x, formed between the upper bricks of the combustion-chamber and the lower bricks of an expansion-chamber, G, and communicating with a passage, C^2, which receives the second portion of the air delivered from the distribution-valve.

The mixture resulting from the meeting of the two gaseous streams effects the complete combustion of the carbonic oxide contained in the flame. This combustion is promoted or assisted by a throat or contraction, D′, which reverberates and concentrates the heat near the upper tuyere, and at the same time partly prevents radiation of heat from the red-hot coke against the sides of the expansion-chamber. The mixing continues in a cylindrical passage, D, connecting the combustion-chamber F with the expansion-chamber G, which is supplied with a gaseous mass under pressure, and at an elevated temperature regulated by the position of the distribution-valve at Y.

The distribution-valve is connected with a small piston loaded by a weight, 7, and by a spring, 8, and working in a cylinder, M, connected by a small tube with the chamber or reservoir R. Each degree of pressure between certain fixed limits corresponds with a different position in which the piston in the cylinder M is in equilibrium. When the pressure falls in the reservoir R, the piston, yielding to the action of the counter-weight and spring, tends to descend and alter the position of the distributer Y in such a manner as to increase the proportion of air which passes through the fuel, and thus raises the working temperature. The reverse action takes place when the pressure approaches the maximum limit assigned to it. After the valve S has closed the air introduced into the expansion-chamber G and that contained in the combustion-chamber F increase in volume, continuing to force up the motor-piston, and thus perform work by expansion at the expense of their internal heat and of the heat generated in the fuel. At the end of the upward stroke of the piston an exhaust-valve, S′, similarly arranged to the admission-valve S, opens, and the air in the expansion-chamber falls to atmospheric pressure and is expelled, being driven into the heater by the descent of the piston. The air thus expelled proceeds from the box of the exhaust-valve S′ to a head or chamber, Z, in the heater through a bent tube, T′, Figs. 2 and 5, at a temperature more or less elevated, according to the working of the engine.

At the farther extremity of the heater the exhaust-gases, which have been cooled to about 210° centigrade, are collected in a chamber, Z′, whence they are discharged into the atmosphere through a pipe or chimney, W.

The metal casing of the combustion-chamber F can be detached from the expansion-chamber by unscrewing bolts b. The combustion-chamber then rests upon small wheels or rollers b', upon which it may be moved. At its lower part this chamber is provided with an opening closed by a tight-fitting door, d, to facilitate lighting and cleaning. This door is provided on its inner side with a fire-brick, d', which fits into and fills the hole in the lining of the combustion-chamber. An apparatus for the introduction of fuel during the working is provided in the side of the expansion-chamber G farthest from the support. This apparatus is illustrated at k, Figs. 1, 2, and 4. It consists of a chamber communicating with the atmosphere through an outer door, p, and with the expansion-chamber through an inner door, p'. These doors are of metal and packed with asbestus paper. The outer door, p, is in the form of a flap hinged on an axis, a a, being pressed against the orifice of the chamber when closed by means of screws e, Fig. 1, or other suitable device. The inner door or flap, p', Fig. 4, is operated by two flat bars, g, connected to levers l and working against the sides of the feed-chamber. These bars and levers may work in contact with the fuel or they may be protected or inclosed by a casing or covering of sheet metal suitably arranged. The levers l are fixed on a shaft passing to the exterior through an asbestus packing, and having a weighted lever, Q, fixed on its outer end. This weighted lever serves to maintain the door normally closed.

In order to introduce a charge of fresh fuel into the combustion-chamber by means of this apparatus, the outer door, p, is first opened and fuel is thrown into the chamber L, after which the door p is closed. It then suffices to raise the weighted lever Q in order to open the inner door or flap, p', and allow the fuel to fall down the inclined passage which conducts it to the combustion-chamber.

The expansion-chamber G is arranged above the combustion-chamber and is connected at its upper part with the base of a working-cylinder, C. The said expansion-chamber is formed by a metallic casing lined with fire-bricks to protect the metal from the action of the flame and diminish the loss of heat.

The working or motor cylinder C is provided externally with ribs or projections 10, which serve to conduct or throw off into the atmosphere the heat which it receives from the expansion chamber. This cylinder is attached to the body or base of the engine by the broad plate 4, hereinbefore referred to. In this cylinder works a hollow motor-piston, P, provided at its upper part with a packing, 12, of asbestus and plumbagine, forming a trunk working in the turned portion of the cylinder. Figs. 4 and 5 illustrate a packing of this description formed by means of a rope of asbestus covered with plumbagine and coiled in a helix around the upper part of the piston P, which is somewhat reduced in diameter for this purpose. A ring, 13, which can be adjusted by means of nuts 14, enables this packing to be compressed and expanded so as to compensate for wear.

The connecting-rod 15, through which the motor-piston P acts on the beam, is attached to the piston by a flexible blade or spring, 18, of metal. One extremity of this blade 18 is secured to the lower end of the connecting-rod 15, and the other extremity is attached to a cross-bar, 19, bolted to two projections cast on the inside of the piston-trunk and passing through an eye or opening, 16, formed in the connecting-rod 15. This mode of connection presents the following advantages: It obviates the friction, wear, and necessity for lubrication in a place inconvenient of access and exposed to an elevated temperature. The connecting-rod terminates at its upper extremity in a bearing, which is attached to it in such a manner that the connection between the connecting-rod and the beam presents two axes at right angles to one another. This arrangement is adopted in all the joints of the other connecting-rods in the motor, the object being to allow for the distortion arising from unequal expansion and contraction of the supports and moving parts and obviate the straining of the connections and disturbing of the fitting, that would otherwise be produced by this cause.

The crank-shaft B^2 carries the following parts, viz: a fly-wheel, R, an exhaust-cam, J′, an admission-cam, J, and a toothed wheel, *r*, driving a centrifugal governor, O. The exhaust-cam J′ operates the corresponding valve, S′, through the intervention of a bell-crank lever, 20, and a connecting-rod, I′, working a second bell-crank lever, 21, Fig. 2.

The admission-cam J, Figs. 1, 2, and 5, is so arranged as to enable the admission of air to the combustion-chamber F to be regulated or controlled in such manner as to maintain a uniform speed, notwithstanding variations in the load or work performed. The lifting part of the cam J is formed along a generating-line of the cylinder, forming the cam, so that the valve S is invariably opened when the crank-shaft is in a certain position. The drop of the cam, on the other hand, is in the form of a portion of a helix, so that the length of the period of admission varies according to the relative position of the cam, and a small roller, 22, at the end of a lever, N, operating the valve S by the intervention of a rod, I, and a lever, N′.

The speed of the engine is maintained between certain predetermined limits by the action of a centrifugal governor, O, which automatically increases or diminishes the period of admission according to the requirements of the motor by shifting the admission-lever N along the cam J. The axis of this lever N is formed by a screw, 24, Fig. 6, which works in the lever as in a nut. This screw is provided at one extremity with a friction-disk, *o*, placed between two plates, *x*′, connected together. These two plates rotate with the governor-spindle 25, and are capable of sliding longitudinally thereon when acted on by a rod, *i*, connected to the governor balls or weights. So long as the speed keeps within the prescribed limits, these plates are held out of contact with the disk *o*; but when, on the contrary, the speed attains the higher or lower limit, the disk on the screw *o* is caused to engage with one or the other of the plates *x*′, and the screw rotates on its axis so as to displace the admission-lever N in the direction required to restore the normal action of the engine.

When from any cause whatever the engine running below the fixed limit would be liable to cause the lever N to be screwed hard up at the end of the screwed axis, this inconvenience is prevented by a small stop-lever, *n*, which, being acted on by the admission-lever N, raises the plates *x*′ and throws them out of gear with the disk *o*.

Having now fully described my said invention, what I claim is—

1. The improved hot-air engine or aerothermic motor composed of the compression-chamber provided with the shaft-bearings at one end, the working-cylinder, motor-piston, and expansion-chamber at the opposite end of said chamber, the feed-pump supported by flanges in said chamber and having its cylinder in communication therewith, the beam mounted on said chamber, the crank-shaft mounted in said bearings, and the connection-rods between the said beam and the motor-piston, the pump-piston, and the crank-shaft, respectively, in combination with the combustion-chamber placed under and communicating with the expansion-chamber, and the heater interposed between the compression and the combustion chambers and heated by the waste gases from the expansion-chamber, substantially as described.

2. The combination, with the working-cylinder and motor-piston, the combustion and expansion chambers under said working-cylinder, the heater receiving the waste gases from the said chambers, and the feed-pump for compressing the air into said heater, of the admission-valve placed in the passage leading from the said heater into said combustion-chamber and mechanically operated by connections with the mechanism driven by said motor-piston, substantially as described.

3. The combination, with the machine-frame, of a working-cylinder and an expansion-chamber fastened to said frame, so as to be supported thereby independently of the combustion-chamber, and a removable combustion-chamber arranged under and detachably connected with said expansion-chamber, substantially as described.

4. In combination with the working-cylinder, the motor-piston, and the expansion-chamber, the combustion-chamber arranged under the said expansion-chamber and provided at the top with a contracted throat, through which it is in direct communication with said expansion-chamber, said combustion-chamber being, moreover, provided with passages leading one to the lower part of said chamber and the other to its upper part below the contracted portion or throat, substantially as described.

5. The combination, with the working cylinder, the expansion-chamber, and the combustion-chamber, of the hollow motor-piston, the connection-rod, and the means inside said motor-piston for connecting the inner end of the said rod with the said motor-piston, said means consisting in a flexible blade or metal spring fastened at one end to the said rod and at the other to a cross-piece of said motor-piston, substantially as described.

6. The combination, with the combustion-chamber, the expansion-chamber, the working-cylinder, the motor-piston, the feed-pump, and the crank-shaft, of the beam and the connection-rods provided with double joints having axes at right angles to each other and to the length of the rods, substantially as described.

7. The working-cylinder provided externally with ribs or projections, in combination with a machine-frame provided with a plate to which said cylinder is bolted, said plate being connected with said frame by webs, substantially as described.

8. The combination, with the combustion-chamber, the expansion-chamber, the working-cylinder, the motor-piston, and mechanism operated by said piston, of the admission-valve, the elongated admission-cam or the crank-shaft having a helical incline for closing said valve, the lever for operating the valve from said cam, the centrifugal governor, and the regulating mechanism, whereby said governor shifts said lever lengthwise of said cam and causes it to be operated by different parts of the cam-surface, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

LUCIEN GENTY.

Witnesses:
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A. ROUSSEL.