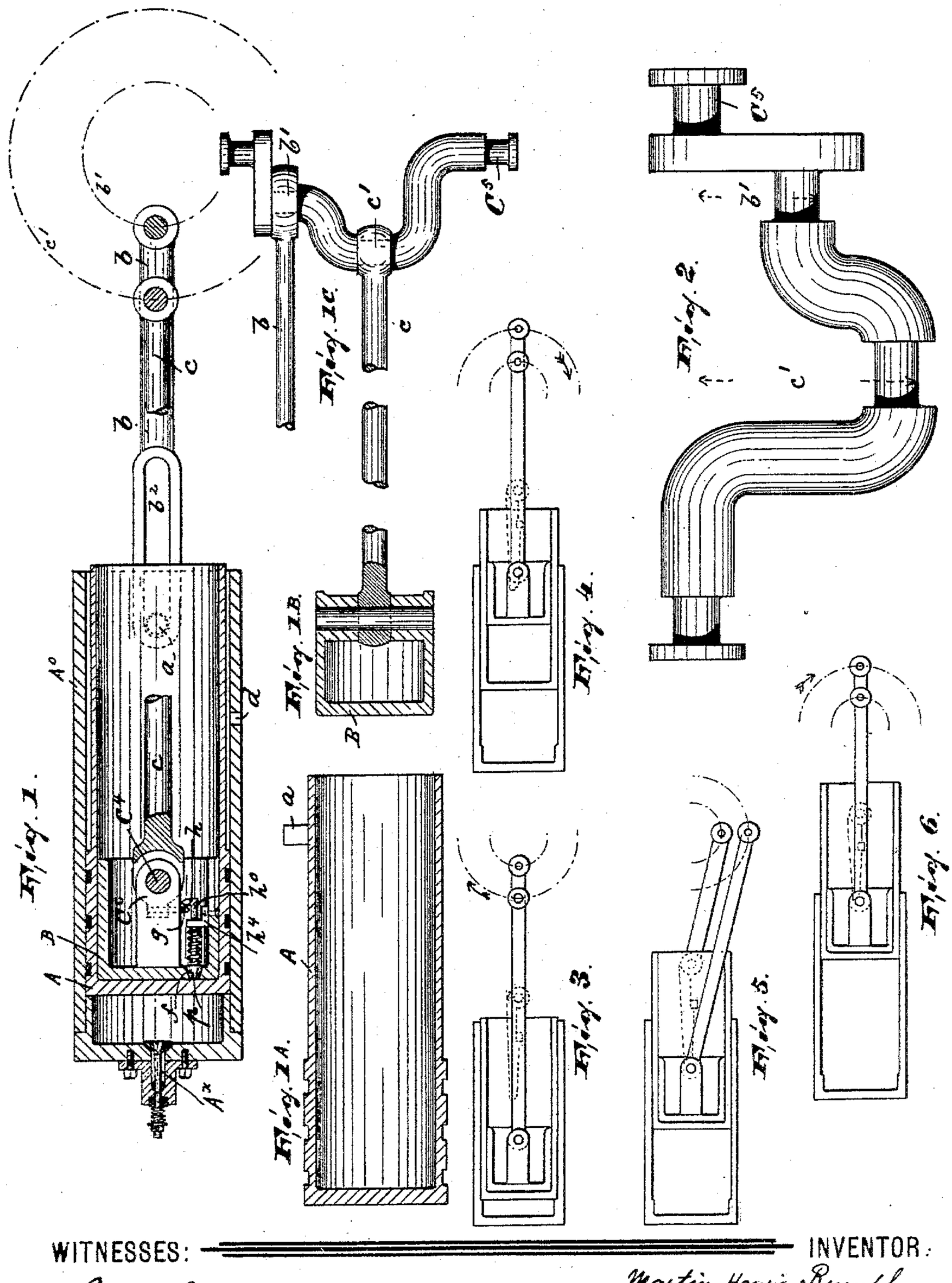
(No Model.) 3 Sheets—Sheet 1.

M. H. RUMPF.

HYDROCARBON MOTOR.

No. 584,097. Patented June 8, 1897.



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Duncan M. Robertson.

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(No Model.) 3 Sheets—Sheet 2.

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Fig. 7.

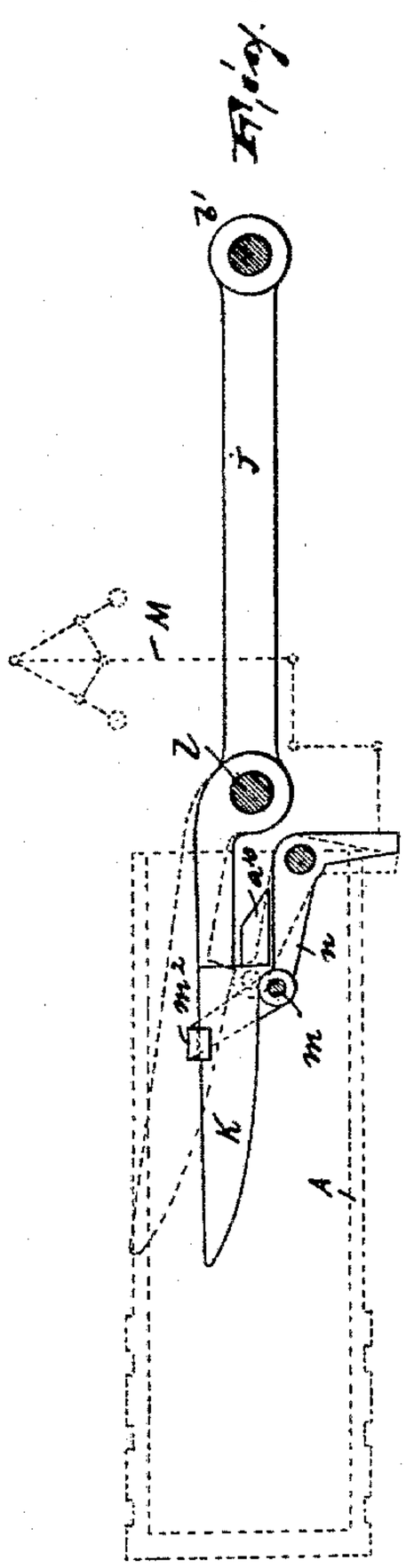

Fig. 8.

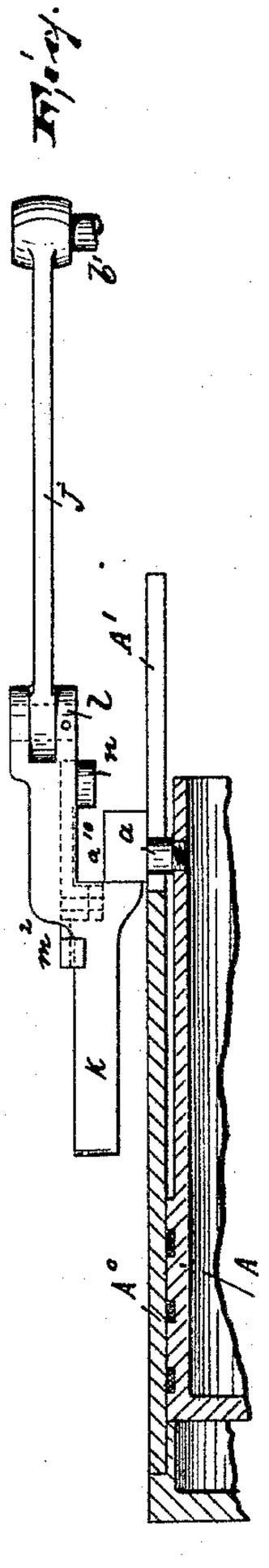

Fig. 10.

Fig. 9.

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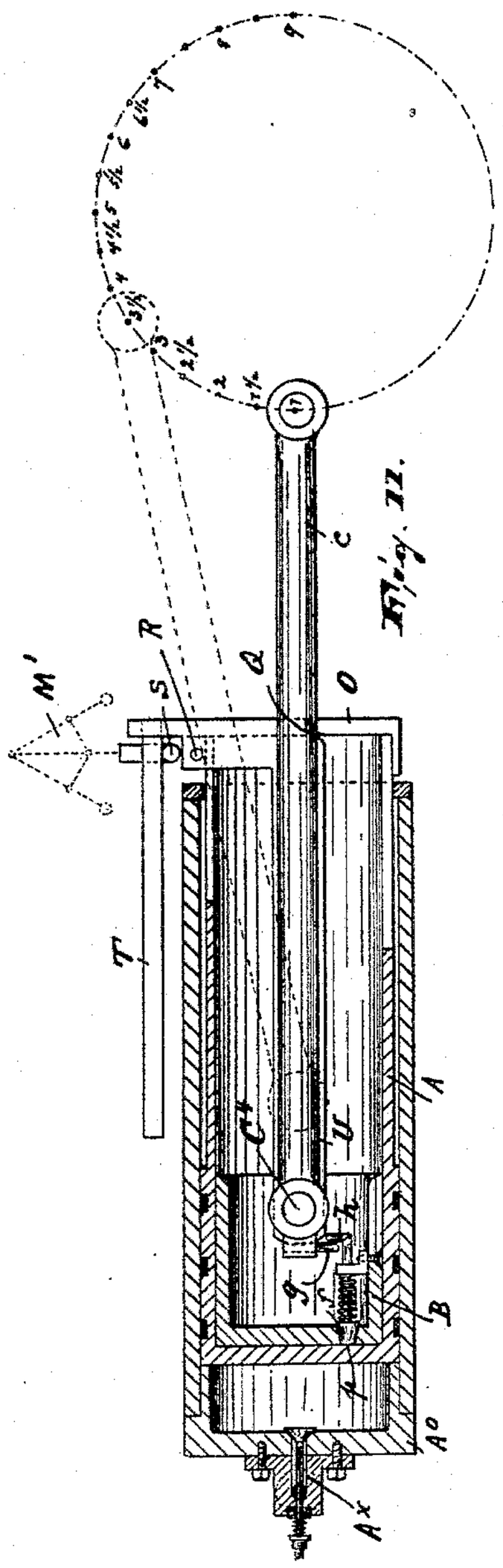

Fig. 11.

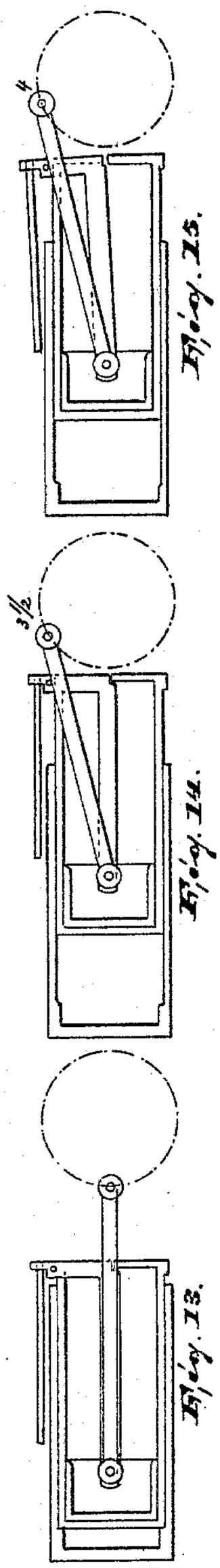

Fig. 15.

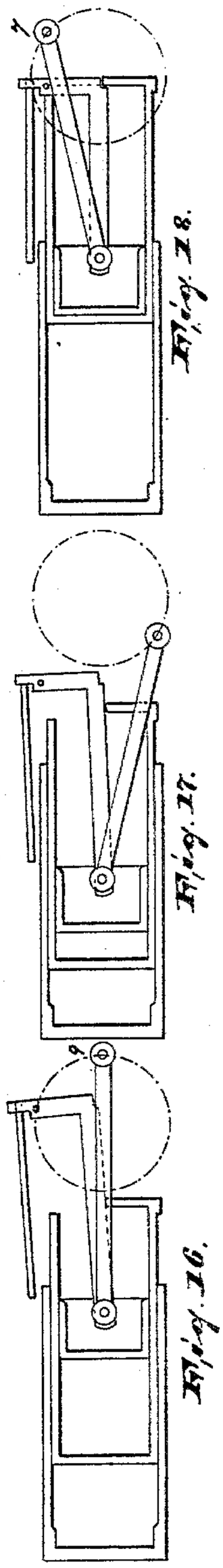

Fig. 18.

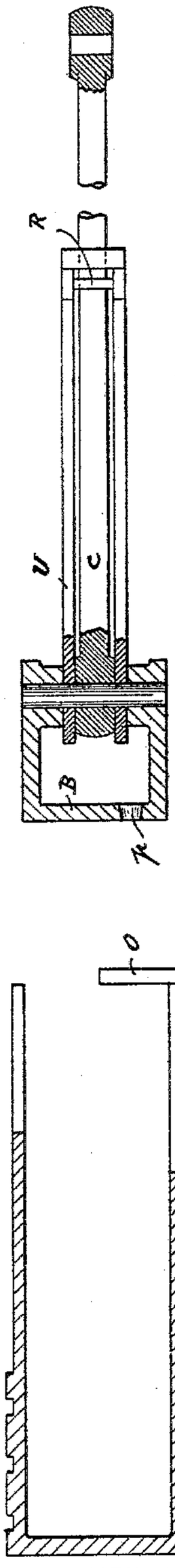

Fig. 12.

Fig. 14.

Fig. 17.

Fig. 13.

Fig. 16.

Fig. 11a.

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UNITED STATES PATENT OFFICE.

MARTIN HENRI RUMPF, OF BRUSSELS, BELGIUM.

HYDROCARBON-MOTOR.

SPECIFICATION forming part of Letters Patent No. 584,097, dated June 8, 1897.

Application filed September 9, 1896. Serial No. 605,221. (No model.)

To all whom it may concern:

Be it known that I, MARTIN HENRI RUMPF, a citizen of Brazil, residing in Brussels, Belgium, have invented certain new and useful Improvements in Hydrocarburet-Motors; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters and figures of reference marked thereon, which form a part of this specification.

The object of this invention is to provide a hydrocarbon-motor of simple, strong, and durable construction, reliable in operation, and by means of which, first, a complete expansion of the combustible gases is effected; second, a strong back pressure on the return of the piston is avoided; third, the expulsion of the products of combustion is insured; fourth, a partial vacuum in the cylinder behind the piston is established, and, fifth, the action of the atmospheric pressure during the return of the piston is utilized.

The invention consists in the improved hydrocarbon-motor, its piston, composed of two concentric independent parts, in the means for transmitting the desired movements to the two parts of said piston, in the means for regulating the movements of said two parts and for the interposition at the right moment of a cushion of air between said two parts, in the means for insuring a complete exhaustion of the burned gases and for obtaining a partial vacuum behind the piston, and in the combination and arrangement of the various parts substantially as will be hereinafter more fully described and finally embodied in the clauses of the claim.

In the accompanying drawings, Figure 1 is a longitudinal section of my improved hydrocarbon-motor, certain portions being removed or broken away to better illustrate the nature of my said invention. Figs. 1^{A} and 1^{B} are detail sectional views of the outer and inner piston, respectively; Fig. 1^{C}, a detail view of the fly-wheel-carrying crank-shaft and the piston-rods connected therewith, only a portion of the latter being shown; Fig. 2, a view similar to Fig. 1^{C}, but on an enlarged scale and having the piston-rods removed; Figs. 3, 4, 5, and 6, diagrammatic views illustrating the respective positions of the outer and inner pistons during a cycle corresponding with two revolutions of the crank-shaft; Figs. 7 and 8, a side and top plan view, respectively, of means to be employed in connection with the motor for regulating its speed; Fig. 9, a sectional view of a pump used in connection with my improved motor for the purpose of facilitating the exhaustion of the consumed gases; Fig. 10, a detail top plan view of the head of the spindle controlling the valve-opening between the motor-cylinder and the said pump; Fig. 11, a longitudinal section of my improved motor, illustrating a modified form for transmitting the desired movements to the two parts of the piston and for regulating the speed of the motor; Fig. 11^{a}, a detail view of the outer piston, as illustrated in Fig. 11; Fig. 12, a detail sectional view of the inner piston, its rod, and the controlling and regulating lever, as used in connection with the construction in Fig. 11; and Figs. 13, 14, 15, 16, 17, and 18, diagrammatic views illustrating the respective positions of the inner and outer piston and the regulating-lever during a cycle corresponding with two revolutions of the crank-shaft.

In said drawings, Figs. 1 to 10, A^{0} represents a cylinder open at one end and provided in its other end with the opening $A^{\times}$, serving as inlet for the explosive mixture, and at one side with an air-inlet *d*, Fig. 1, and with an elongated slot A′, Fig. 8, through which latter the lug *a* projects, which lug forms a part of the cup or outer part A of the piston arranged within the cylinder A^{0}. Within said cup is placed the inner part B of the piston, provided at its bottom with an opening *f*, controlled by the valve *p*, which latter is arranged at the inner end of the stem or rod h^{0}, guided in the bracket h^{4} and having its forward or outer end bent at an angle, as at *h*, adapted to be engaged by the pin *g*, projecting at substantially right angles from the rear portion C^{0} of the piston-rod *c*. Said piston-rod is fulcrumed on the transverse pin or axis C^{4}, secured to the inner part B of the piston and with its forward end to the elbow *c*′ of the crank-shaft C^{5}, supported in bearings and carrying the fly-wheel, as in ordinary con-

struction, and not illustrated in the drawings. The stem or rod h^0 is surrounded by a spiral spring bearing with one end against the valve p and with its other end against the bracket h^4, as clearly shown in Fig. 1 of the drawings. The lug a of the outer part A of the piston is adapted to be engaged by the elongated slot b^2, arranged in the rear end of the piston-rod b, the forward end of which is connected with the elbow b' of the crank-shaft C^5. The elbows b' and c' of the crank-shaft C^5 are of different length, and the slot b^2 is calculated in such a manner that at the dead-center the bottom of this slot comes behind the lug a, (during the stage of admission of the explosive mixture into the cylinder A^0,) while at all other times the cup A is entirely independent of the movements of the piston-rod b.

Figs. 1 or 3, 4, 5, and 6 of the drawings show the relative positions of the two parts of the piston during the four operations, which are repeated periodically, as follows:

First. On the entry of the explosive mixture the two parts A and B of the piston touch each other and are at the end of the return stroke, and their respective piston-rods b and c are in the positions shown in Figs. 1 and 3. The inner part B of the piston, connected by its piston-rod c to the larger elbow c' of the crank-shaft, advances rapidly, and the cup A, connected with the smaller elbow b' by the piston-rod b, the rear of which (at the dead-center) comes behind the lug a, advances more slowly under the pull of this piston-rod b. Consequently when the crank-shaft has made half a revolution the inner part B of the piston is in advance of the cup A in proportion to the difference of radius between the two elbows on the crank-shaft, and the explosive mixture has only entered into the space afforded by the movement of the cup A, that is, according to Fig. 4, in a space corresponding to one-half of the stroke effected by the inner part B of the piston during a half-revolution of the fly-wheel.

Second. During the time of return and compression the cup A, the snug a of which is free and slides in the slot b^2 in the piston-rod b, Fig. 1, remains stationary until the inner part B, in returning, catches it up and pushes it backward from the position Fig. 5 to the position Fig. 3, thus causing the compression of the explosive mixture.

Third. During the third stage, corresponding to the explosion of the mixture and to its expansion, the cup A, which is free to move forward, pushes forward the inner part B of the piston by pressing against it during the whole of the working stroke. (See Fig. 6.) Toward the end of this stroke, when the pressure of the exploded or burned gases has fallen below atmospheric pressure and when the exhaust-valve for the escapement of the burned gases opens, the bottom of the cup A passes beyond the opening d in the cylinder-wall, (see Fig. 1,) and a current of fresh air then enters the cylinder.

Fourth. Finally, during the fourth stage of the cycle, the piston returning backward drives out the burned gases, (see Fig. 3,) and the same operations as above described are repeated indefinitely. In thus causing a complete expansion of the gases, as hereinbefore described, their discharge into the atmosphere takes place without back pressure—that is, without loss of work. Consequently all employable heat is utilized. This form of constructing a piston in two parts has, moreover, the advantage that the expansion of the burned gases can be completed before the end of the forward stroke, so that the pressure behind the piston will fall below the atmospheric pressure. To attain this result, it is sufficient to make the two elbows of the crank-shaft proportionate to the desired strokes. In this case the smaller elbow of the crank-shaft will have a smaller radius than that shown in the drawings, and accordingly during the stage of admission the cup A will advance less than shown in the accompanying drawings. As a matter of fact, if proportions were given to the elbows c' and b' of the crank-shaft which would permit the expansion to be so prolonged that before the end of the stroke of the piston the pressure of the burned gases fell below the atmospheric pressure then the piston would only continue to advance under the action of the energy of motion stored up in it; but in that case the atmospheric pressure, being greater than the pressure behind the piston, would cause on the return stroke a pressure on the latter and provide a motive power until the moment when the pressure of the burned gases compressed behind the piston became equal to that of the atmosphere, and from that moment the burned gases would be expelled by the returning piston. It will be understood that in this way the force of the explosive mixture could be utilized during the advance of the piston and the atmospheric pressure during its return.

In Figs. 7 and 8 is illustrated an arrangement to be used in connection with the construction hereinbefore described for the purpose of regulating the speed of the motor. The piston-rod b is replaced by a connecting-rod which consists of the rail j, jointed on the small elbow b', and of a piece or arm k in the form of a pawl and oscillating on the axis l of said rail j. Said axis l slides in a guide on the framework of the machine, and the pawl k rests on the friction-roller m, carried by the bell-crank lever n, which is pivoted on the framework and which is connected and controlled by an ordinary ball-governor M, as indicated in dotted lines in Fig. 7 of the drawings. The pawl k is provided at its under side with a notch k^{10}, adapted, when the speed of the motor is as desired, to remain behind the ridge a^{10}, projecting from the lug a. As long as the number of revolutions of the crank-shaft is less than or equal to that for which the motor is regulated then the pawl k of the

connecting-rod comes behind the ridge a^{10} at the dead-center point at the commencement of the forward stroke and forces the cup A to follow the forward movement transmitted by the small elbow b' to the connecting-rod j. When the speed exceeds the normal rate, the arm of the regulator presses against the bell-crank lever n and forces up the pawl k sufficiently to clear the ridge a^{10}, so that the rod j is disconnected from the cup A, which latter then remains at the bottom of the cylinder, so that the explosive mixture is no longer admitted. As soon as the speed resumes its normal rate the pawl k, being no longer lifted by the regulator, returns at the dead-center behind the ridge a^{10} and again pulls the cup A, thus producing a vacuum which sucks in a fresh charge of the explosive mixture. To keep the pawl k in the proper position, a bracket m^2 is fixed to the bell-crank lever n, which prevents the pawl k from leaving the roller m.

To produce means for exhausting the burned or consumed gases and to clear the cylinder of all impurity arising from the combination therein and to increase the vacuum in the cylinder after the complete expansion of the gases generated by the explosion, a small pump is employed, which is arranged on one side of the cylinder, reference being made to Figs. 9 and 10 of the drawings. The pump consists of the cylinder 10, open at its rear and provided about midway with an elongated slot 7 and at its forward end with the spring-controlled valve 11. The piston 9 of said pump is mounted on the piston-rod 8, the forward end of which is connected to the lug a', projecting from the cup A, while its rearwardly-extending portion 5 is curved and adapted to operate the head 4 of the spring-controlled spindle 2. Said spindle carries at its lower end the plug or valve 3, adapted to open and close the inlet-opening of the channel 13, which latter connects the rear end of the cylinder A^0 with the forward end of the cylinder 10, as clearly shown in the drawings. It will be seen that the pump works under the action of the movement of the cup A.

The position of the parts in Fig. 9 corresponds to the end of the stage of explosion. Consequently the cup A is represented at the end of its forward stroke. On the return of this cup the rearwardly-projecting portion or plate 5 of the piston of the pump presses on the head 4 of the spring-valve 3, which latter is thus opened, and the consumed gases are drawn in by the pump, which communicates with the bottom of the cylinder by means of the channel 13 and the valve 3, as hereinbefore described. This drawing in is continued until the moment when the head 4 of the valve comes in the groove 6, arranged in the plate 5, when the valve automatically closes under the action of its spring, and, as will be seen by the drawings, at the same moment the piston 9 passes the opening 7 in the body 10 of the pump, which said opening puts the consumed gases in communication with the outside air during the remainder of the back stroke. During the following forward stroke the gases contained in the pump are expelled first through the opening 7 and subsequently through the spring-valve 11, arranged in the cover of the pump.

From the foregoing description it follows that during the stages of admission and compression and the first half of the explosive stroke the head 4 of the valve continues to slide in the groove 6 of the plate 5, and the valve remains closed, but during the second half of the explosive stroke it would open again under the action of the projecting plate 5, while it should, on the contrary, remain closed. In order to avoid this inconvenience, the head 4 is arranged to pivot on the spindle 2 of the valve and is only maintained in its normal position by means of the spring-plate 15 and a stop 14, as seen in Fig. 10. On the other hand, the plate 5 is furnished with a ledge 6', which, when it catches the head 4, causes it to turn on the spindle 2 of the valve and brings it into a position where its projecting part is no longer pressed by the plate 5. The valve is therefore closed during the second part of the explosive stroke, while at the end of this period the head 4 is free, when the spring 15 returns it to its normal position, so that the plate 5 can open the valve from the commencement of the stage of the exhaustion.

In Figs. 11 to 18 is illustrated my improved motor provided with other means for transmitting the desired movements to the two parts of the piston and for regulating the speed of the motor. On the transverse pin or axis C^4, on which is fulcrumed the piston-rod c, is also pivoted the slotted angle-lever U, provided at its forward portion with the notch Q, adapted to engage the projecting lug O, secured to the cup A. At or near the upper portion of the angle-lever U is arranged the pin R, adapted to be engaged by the piston-rod c when the latter is in its forward movement. From the upper portion of said lever U projects rearward the rod or tube T, parallel with the longer arm of said angle-lever and adapted to rest on the roller S, which latter is connected and controlled, in a vertical motion, by the ball-governor M' by any well-known means, and not illustrated in the drawings. In this arrangement, to allow for the admission of the explosive mixture the cup is pushed forward by the bent lever U, which is pivoted on the trunnion of the piston-rod c and which at this moment strikes with the shoulder Q against the snug O of the said cup A, so that when the pin of the crank causes the rod c to advance the cup A, pushed by the shoulder Q on the lever U, advances at the same time as the part B and that just at the moment when the pin R of the lever U meets the piston-rod c. This meeting is brought about by the inclination which the piston-rod takes during its movements, and it will

be seen in Fig. 14 that this meeting takes place when the pin of the crank reaches the point marked $3\frac{1}{2}$ in Figs. 11 and 14. When the head of the piston-rod reaches the point marked 4, (see Fig. 15,) it has raised the lever U several millimeters, and the latter is thus disengaged from the snug O, so that the cup A, being no longer moved, remains then in the position that it occupied at that moment, while the lever U, on the contrary, continues to follow the movements of the piston-rod *c*. Finally, when this rod *c* reaches the point $6\frac{1}{2}$, Fig. 11, it passes away from under the pin R of the lever U, the lower side of which then rests on the edge of the snug O of the cup A, on which it slides first forward and then backward, until the moment when the inner part B of the piston again meets the bottom of the cup A. The shoulder Q on the lever U returns behind the snug O, and the two parts A and B of the piston finish their return stroke together, corresponding with the compression of the explosive mixture.

During the stage of explosion the two parts of the piston are still connected with each other by the contact of the shoulder Q with the snug O, but it is no longer the lever U which pushes the cup forward, but the pressure of the burned gases, and said cup A acts on the part B of the piston, thus supplying the motive power. To insure that before the end of the forward stroke the pressure behind the piston shall fall below the atmospheric pressure, the volume of the explosive mixture introduced into the cylinder must be reduced. For this purpose it is only necessary to lower the pin R of the lever U so that it meets the piston-rod *c* when the latter is at the point marked 3 in Fig. 11, or even before that point, so that the driving-lever U leaves the cup A sooner, and in consequence reduces its forward stroke and determines the volume of the explosive mixture admitted to the cylinder. Finally, it is important that the cup A, after being abandoned by the lever U, cannot fall back of its own accord, even, for example, under the action of the vacuum produced behind it. The parts are therefore so arranged that the shoulder Q of this lever U can, after having released the snug O during the stage of explosion, replace itself quickly enough behind the said snug O, so that the two parts of the piston are connected together when they finish their forward stroke as well as their backward stroke.

In order that the inner part of the piston B shall not meet the cup A abruptly during the stage of compression of the explosive mixture, this piston B is so arranged that during its return stroke and before it touches the cup the air contained between the two parts is compressed and forms a cushion or spring to prevent them striking. For this purpose the opening *p*, arranged at the bottom of the piston B and serving for the entrance and exit of the air between the two parts A and B, as shown in Fig. 11, is furnished with a spring-valve *f*, fixed at the extremity of a rod h^0, the other bent extremity of which is subject to the action of a flange or projection *g*, fixed at the end of the piston-rod *c*. In this way during the forward stroke the flange or projection *g* of the piston-rod *c*, on account of the inclination taken by the latter during the forward stroke, causes a pressure against the rod h^0 of the valve *f* and opens the latter, thus allowing the air to enter freely between the parts A and B. but during the back stroke, the piston-rod taking an opposite inclination, the flange or projection *g* does not act on the rod h^0 of the valve, and the latter closes under the action of its spring. The air contained between the two parts of the piston is compressed to a degree determined by the force given to the spring of this valve *f*. This air serves as a cushion or spring between the two parts A and B until the resistance of the explosive mixture which is behind the cup A becomes sufficiently strong to overcome the action of the spring of the valve and forces it to open and to allow an escape for the air, thus allowing the inner part of the piston to meet the cup without shock. These two parts of the piston should finish their backward stroke together, thus determining the compression of the explosive mixture.

It is, moreover, to be understood that the invention is not limited to the particular forms and arrangements which have been described and illustrated in the drawings, as these may be considerably modified to adapt them in any desirable manner to carry out the practical realization of the various principles above described and on which the invention is based.

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

1. In a hydrocarbon-motor, the combination with the cylinder, of a piston consisting of two independent parts, the outer part of which being adapted to operate in the cylinder, while the inner part is adapted to operate in the outer part of said piston, and means for giving each of said parts the desired movement, substantially as and for the purposes described.

2. In a hydrocarbon-motor, the combination with the cylinder, of a piston in said cylinder and consisting of two independent parts working on and within each other, a rod for each of said parts of the piston, and a crank provided with a longer and a shorter elbow respectively connected with the rod of the outer and inner part of the piston, substantially as and for the purposes described.

3. In a hydrocarbon-motor, the combination with the cylinder, of a piston arranged in said cylinder and consisting of two independent parts working on and within each other, a valve-controlled opening arranged in the inner part of the piston and communicat-

ing with the outer part thereof, a spring-controlled stem connected with said valve, a crank-shaft having a longer and a shorter elbow, a rod connecting the outer part of the piston with the longer elbow, a rod connecting the inner part of the piston with the shorter elbow, and means carried by said second rod for operating the spring-controlled stem carrying the valve, all said parts, substantially as and for the purposes described.

4. In a hydrocarbon-motor, the combination with the cylinder, of a piston consisting of two independent parts, the outer one of which being adapted to operate in the cylinder, while the inner one is adapted to operate in the outer part, means for giving each of said parts the desired movement, and means for regulating the said movements, substantially as described.

5. In a hydrocarbon-motor, the combination with the cylinder, of a two-part piston in said cylinder, a pump on one side of said cylinder, a valve-controlled channel connecting the forward part of said pump with the rear part of said cylinder, a piston in said pump, a rod connecting the pump-piston with the outer part of the piston in the cylinder, and means carried by the piston of the pump to operate the valve controlling the channel, all said parts, substantially as and for the purposes described.

6. In a hydrocarbon-motor, the combination with the cylinder, of a two-part piston in said cylinder, a pump on one side of said cylinder, a valve-controlled channel connecting the forward part of said pump with the rear part of said cylinder, a piston in said pump, a rod connecting the pump-piston with the outer part of the piston in the cylinder, a plate, having a curved end and on its under side a longitudinally-arranged recess, carried by the piston-rod of the pump, a spindle connected to the valve controlling the channel, a head pivotally secured to the said spindle and adapted to be operated by the curved end of the plate, and means for throwing said head out of operative engagement with the said plate, substantially as and for the purposes described.

7. In a hydrocarbon-motor, the combination with the cylinder, of the piston arranged in said cylinder and consisting of two independent parts arranged on and within each other, a rod pivotally connected to the inner part of said piston, an angle-lever arranged on the pivot of said rod, and provided at its forward end with a notch, a projection on the outer part of the piston and adapted to be engaged by said notch, and a pin carried by the free arm of said angle-lever and adapted to be engaged by the piston-rod, all said parts, substantially as and for the purposes described.

8. In a hydrocarbon-motor, the combination with the cylinder, of the piston arranged in said cylinder and consisting of two independent parts arranged on and within each other, a rod pivotally connected to the inner part of said piston, an angle-lever arranged on the pivot of said rod, and provided at its forward end with a notch, a projection on the outer part of the piston and adapted to be engaged by said notch, a pin carried by the free arm of said angle-lever and adapted to be engaged by the piston-rod, and means for raising the angle-lever out of engagement with the outer part of the piston, to thus regulate its speed, substantially as described.

9. In a hydrocarburet-motor, the combination with the cylinder, of a piston arranged in said cylinder and consisting of two independent parts working on and within each other, a valve-controlled opening arranged in the inner part of the piston and communicating with the outer part thereof, a spring-controlled stem connected with said valve and provided at its free end with an upward projection substantially at right angles to the stem, a crank-shaft having a longer and a shorter elbow, a rod connecting the outer part of the piston with the longer elbow, a rod connecting the inner part of the piston with the shorter elbow, a pin arranged on the rearwardly-projecting end of the second rod and adapted to engage the projection on the free end of the spring-controlled valve, substantially as described.

In testimony whereof I have hereto set my hand in the presence of the two undersigned witnesses.

MARTIN HENRI RUMPF.

Witnesses:
ALFRED WUNDERLICH,
GREGORY PHELAN.