No. 727,455. PATENTED MAY 5, 1903.

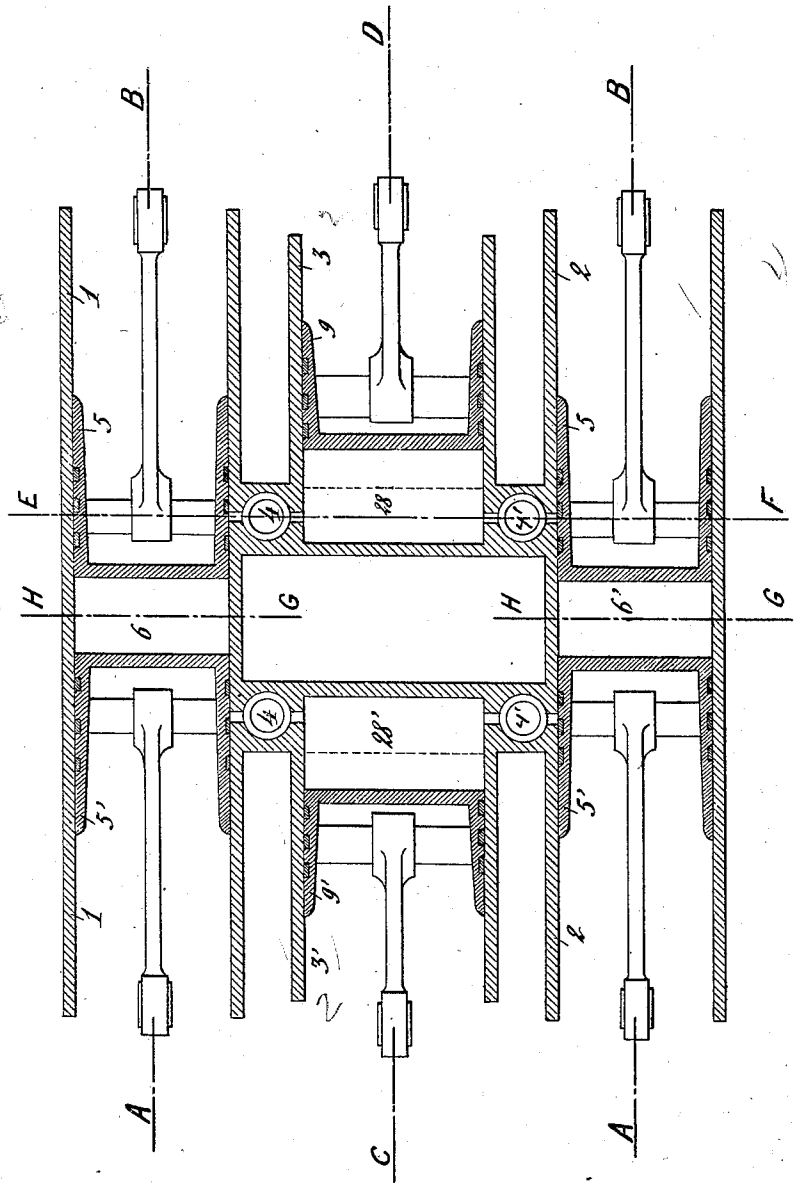
M. H. RUMPF.

EXPLOSION ENGINE.

APPLICATION FILED OCT. 25, 1901.

NO MODEL. 5 SHEETS—SHEET 1.

Fig. 1.



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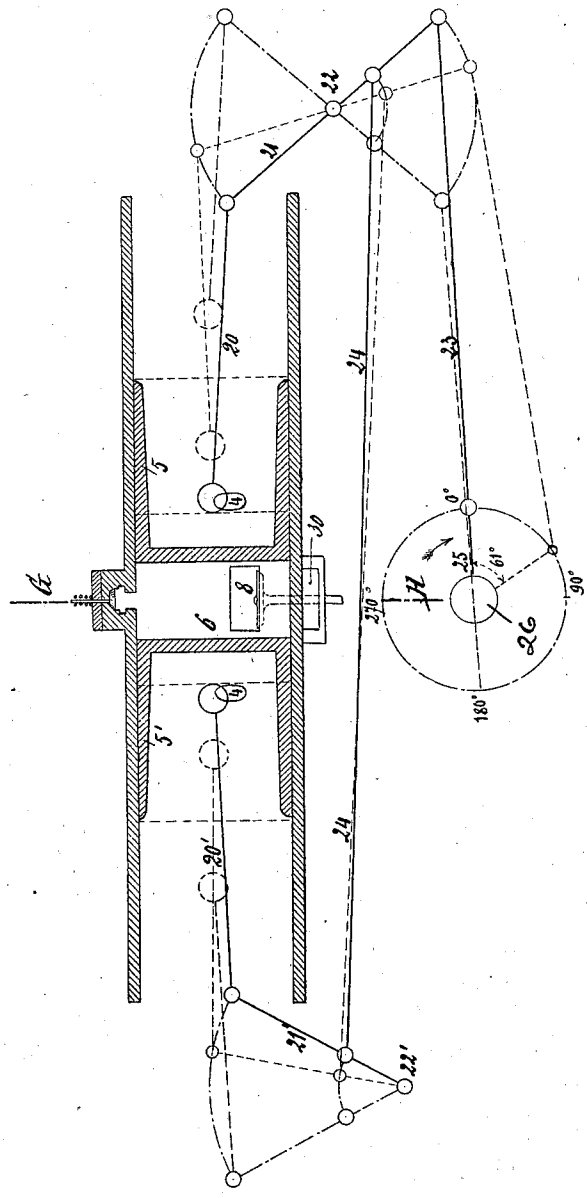
NO MODEL. 5 SHEETS—SHEET 2.

Fig. 2.



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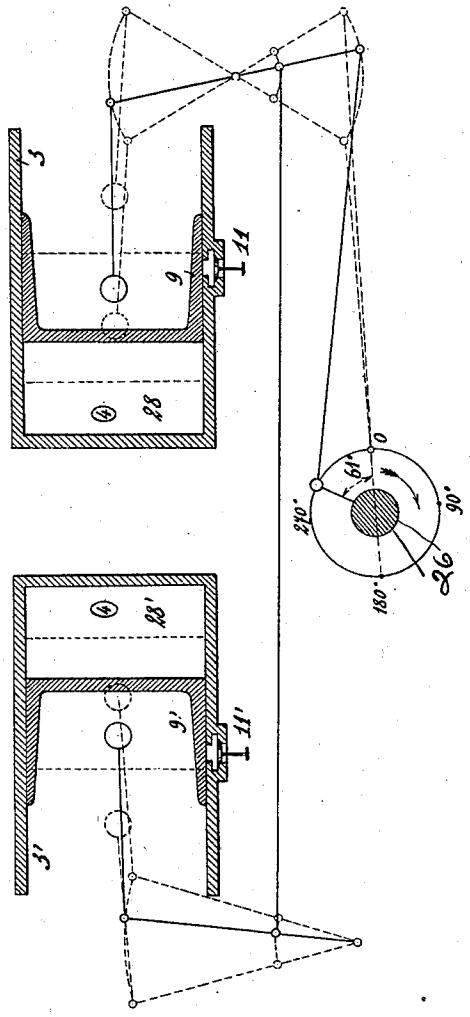
NO MODEL. 5 SHEETS—SHEET 3.

Fig. 3.



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NO MODEL. 5 SHEETS—SHEET 4.

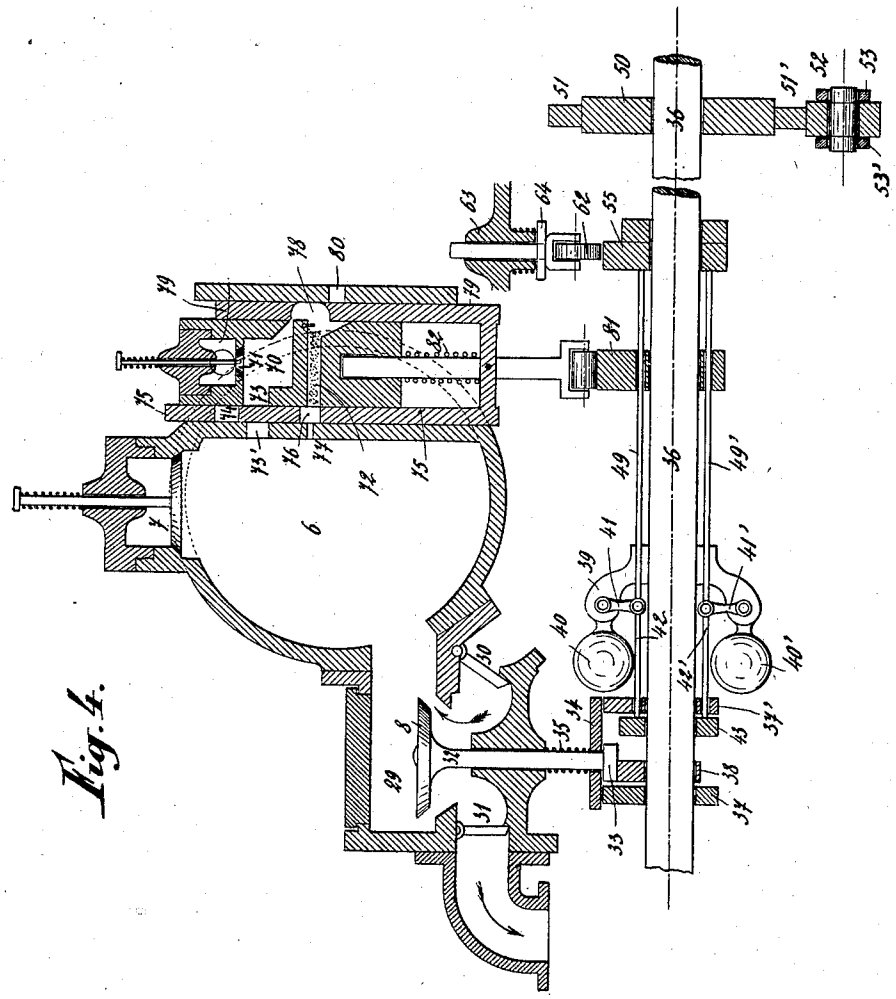

Fig. 4.

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APPLICATION FILED OCT. 25, 1901.

NO MODEL. 5 SHEETS—SHEET 5.

Fig. 7.

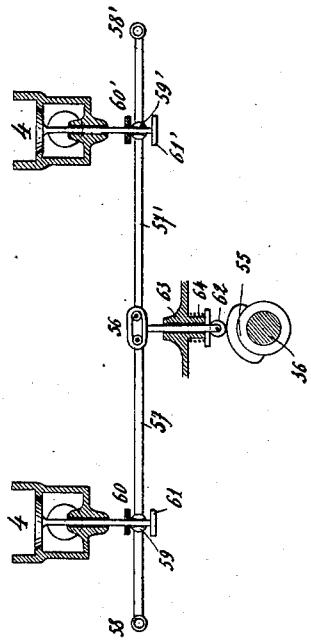


Fig. 8.

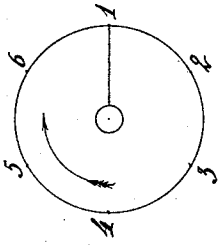


Fig. 8bis.

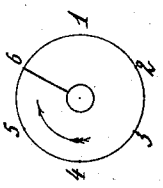


Fig. 5.

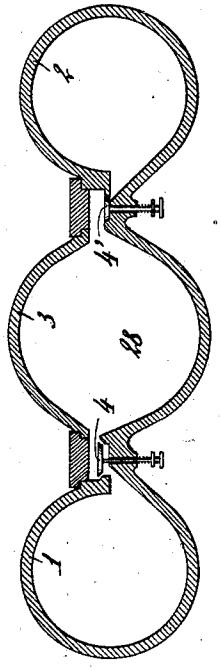
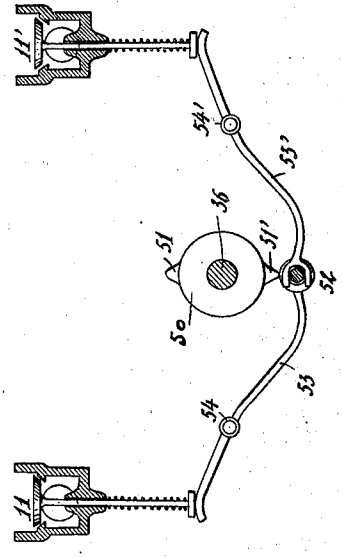


Fig. 6.



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No. 727,455. Patented May 5, 1903.

UNITED STATES PATENT OFFICE.

MARTIN HENRI RUMPF, OF PARIS, FRANCE.

EXPLOSION-ENGINE.

SPECIFICATION forming part of Letters Patent No. 727,455, dated May 5, 1903.

Application filed October 25, 1901. Serial No. 79,989. (No model.)

To all whom it may concern:

Be it known that I, MARTIN HENRI RUMPF, manufacturer, a citizen of Brazil, residing at Paris, in the French Republic, have invented certain new and useful Improvements in Explosion-Engines, of which the following is a specification.

This invention relates to explosion-engines, and provides for an engine having a plurality of cylinders, one or more of which are working as four-stroke engines and are acting also at the proper moment as pumps for one or more other cylinders in order to inject a certain quantity of the aspired mixture into the said other cylinders and also to ignite that quantity of mixture.

Referring to the annexed drawings, Figure 1 is a horizontal section through the cylinders of a motor constructed according to my invention. Fig. 2 is a vertical section taken on line A B, Fig. 1, showing diagrammatically the shaft-actuating gear of the motor. Fig. 3 is a similar vertical section taken on line C D, Fig. 1. Fig. 4 is a transverse section through the compression-chamber 6, taken on line G H, Figs. 1, 2, showing the valves 8 and 7, the igniting device, and a part of the cam-shaft, with the centrifugal governor of the engine. Fig. 5 is a transverse section taken on line E F, Fig. 1. Fig. 6 shows diagrammatically the cam-shaft and levers acting on the exhaust-valves 11 and 11′ of cylinders 3 and 3′. Fig. 7 shows diagrammatically the same cam-shaft and levers acting on the valves 4 4 and 4′ 4′, located in the channels through which the several cylinders are intercommunicating with one another. Figs. 8 and 8^{bis} show the relative positions of the cranks on the driving-shaft.

As shown in Fig. 1, the motor comprises four cylinders 1, 2, 3, and 3′. In each of the two cylinders 1 and 2 move two pistons 5 and 5′, between which are located compression-chambers 6 6′. When the explosion takes place, the two pistons 5 and 5′ are thrown away from one another. The two cylinders 3 and 3′ are each provided with a single piston 9 and 9′, and the compression-chambers 28 and 28′ are communicating with each of the two piston-cylinders 1 and 2 through four channels 4 4 and 4′ 4′, provided with valves, two of which are shown in section, Figs. 5 and 7. The two channels 4 4 communicate with cylinder 1 and the two channels 4′ 4′ with cylinder 2. The location of the channels 4 4 4′ 4′ in the cylinders 1 and 2 depends upon the quantity of mixture which it is intended to compress in the said cylinders, and as it is a condition that these channels open in the compression-chambers of cylinders 3 and 3′ the cranks of the pistons moving in cylinders 1 and 2 must be keyed with respect to the cranks of the pistons moving in the cylinders 3 and 3′ in such a manner that when the pistons of cylinders 1 and 2 in their forward stroke disclose the channels 4 the pistons of cylinders 3 and 3′ must pass their rear dead-point.

The cylinders 1 and 2 work on the four-stroke cycle, and cylinders 3 and 3′, which may be of greater diameter and less stroke, work on the two-stroke cycle.

When the motor is running normally, the communication of cylinders 1 and 2 with cylinders 3 and 3′ is alternative. In other words, the working stroke of one of cylinders 1 or 2 takes place on the moment of the sucking stroke of the other.

The combustion of the mixture takes place in the four cylinders; but cylinders 1 and 2 only are provided with an igniting device, which may be electrical or of any other suitable construction. I, however, prefer to make use of the special construction hereinafter described.

As shown in Fig. 2, the pistons 5 and 5′ of cylinders 1 and 2 are provided with rods 20 and 20′. Rod 20 of piston 5 is connected with a swing-lever 21, pivoted at 22. The other end of the said swing-lever is connected with a rod 23, actuating directly the crank 25 of the shaft 26. Rod 20′ of piston 5′ is connected with a swing-lever 21′, pivoted at 22′. A rod 24 connects the two swing-levers 21 and 21′ in such a manner that the two pistons 5 and 5′ necessitate only one crank in order to rotate continuously the shaft 26. As already stated, 6 is the compression-chamber, 7 is the inlet-valve for the mixture, and 8 is a valve adapted to be used at the proper moment as an air-inlet valve or as exhaust-valve.

Fig. 3 is a section through the axis of cylinders 3 and 3′ and shows that the pistons of the said cylinders are connected with the

shaft 26 similarly to pistons 5 and 5′ in such a manner that the said shaft requires only three cranks for the six pistons of the motor. 11 and 11′ are the exhaust-valves of cylinders 3 and 3′ and are located somewhat before the forward-stroke dead-point.

Referring now to Fig. 4, which shows a transverse section of cylinder 1, (or 2,) it will be seen that valve 8 (which is shown in its open position for the sake of clearness) is located in a chamber 29 and opens in the compression-chamber 6 of cylinder 1. Chamber 29 is provided with clack-valves 30 31, one of which, 30, allows the entry of air and the other, 31, the escape of the burned gas. Rod 32 of valve 8 is fitted at its end with a collar 33, on which rests a ring 34, loosely mounted on rod 32 and pressed against the collar 33 by aid of a spring 35. The valve is actuated by means of cams keyed on a cam-shaft 36, rotating at half the speed of shaft 26. The two cams 37 and 37′ are similar and work on ring 34. Cam 38 actuates the valve-rod 32. The bosses of cams 37 and 37′ are combined in such a manner that during the explosion period the ring 34 is lifted so as to compress the spring, which in this position has no action on the valve, the said valve consequeutly being able to rise under atmospheric pressure. The ring 34 is held in this position by the bosses until after the escape period. Consequently when the boss of cam 38 acts upon the rod of valve 8 the action of the spring is released and the valve is lifted with facility. At the end of the escape period the bosses of the three cams have no action whatever on the ring 34 and collar 33, and spring 35 acts consequently again and the valve closes. The centrifugal governor 39, mounted on the cam-shaft 36, acts upon the escape-valve 8. The balls 40 and 40′ of the said governor are connected together by aid of a spiral spring in a well-known manner and are mounted on two levers 41 41′ at right angle, pivoted at the apex of the right angle and connected through rods 42 42′ with a disk 43, adapted to slide longitudinally on the shaft 36.

When the running of the motor is abnormal or when the speed increases above the normal, the centrifugal force throws the balls apart from each other, surmounting the reaction of the spring, and the movement is transformed through levers 41 and 41′ in a sliding movement along the shaft, the said movement being transmitted by means of rods 42 42′ to the disk 43, which during the escape period may be placed under the collar 33 of rod 32. The valve 8 consequently remains open and the cylinders (1 and 2) are only filled with air. No explosive mixture consequently is admitted in the cylinder so long as the speed of the motor is above the normal speed. When the speed decreases and the motor returns to its normal running, the balls come back to their original position, withdrawing the disk 43 from under the collar 33, and the ordinary cycle takes place again. The air drawn in the cylinders may naturally pass through the jackets (not shown on the drawings) of the cylinders.

Referring now to Fig. 6, which shows the actuating device of the escape-valves 11 and 11′ of cylinders 3 and 3′, it will be observed that the said valves must open at each revolution of the motor-shaft, and as the cam-shaft 36, carrying the cam 50, actuating the said valves, rotates only at half the speed of the motor-shaft cam 50 is provided with two fingers 51 and 51′ opposite one another. A roller 52, pressed against the cam, is embraced on each of its faces by the forks of two curved levers 53 53′, pivoted, respectively, at 54 and 54′, the free ends of which bear on the end of the rods of valves 11 and 11′. At the moment where one of the cam-fingers acts on the roller 52 the forks are lowered, and consequently the free ends of the levers pressed on the valve-rods, which are thus lifted. When the finger has passed the roller, the valve-springs close the valves, and acting on the free ends of levers 53 53′ hold the roller in contact with the cam.

Fig. 7 shows separately the actuating device of the valves located in channels 4 4 and 4′ 4′. On cam-shaft 36 is keyed a cam 55, having a boss corresponding to three-eighths of the circumference of the said cam and adapted to compress during the compression-stroke and a part of the explosion-stroke the valve-springs with the same object in view as described with reference to valve 8. A rod 62, guided in a socket 63, is held by spring 64 against cam 55. The said rod 62 ends in the form of a link 56, in which are engaged pivot-pins on the extremities of two levers 57 57′, pivoted at 58 58′ and acting, by means of supporting-balls 59 59′, on disks 60 60′, loosely mounted on the valve-rods. When the boss of cam 55 raises the rod 62, the two levers 57 57′ are raised and the balls 59 push the disks 60 60′ (which are under the springs on the valve-rods) upward in such a manner that the action of the springs on the valves is released and that the said valves may open easily. When the boss of the cam has passed the rod 62, the springs assume again their action and the levers come to rest on abutments 61 61′.

As hereinbefore described, the cylinders 1 and 2 only are provided with an igniting device, the construction of which is shown in Fig. 4. This device comprises an igniting-chamber 70, fitted with a little inlet-valve 71, and a channel or chimney 72, filled with platinum moss and platinum wire. Chamber 70 is in communication through openings 73 73′ and a hole 74 in a slide 75 with the interior of the compression-chamber 6, and chimney 72 is in communication with the said compression-chamber 6 through a hole 76 in slide 75 and a port 77 in the wall of the cylinder. Chimney 72 may be in communication with chamber 70 through a passage 78 in a slide

79 or may be separated therefrom and in this case in communication through passage 78 with opening 80, leading to the atmosphere. This igniting device acts as follows: A cam 81, mounted on the cam-shaft, acts upon the slides 75 and 79 and brings them into the position shown during the compression-stroke. The compressed mixture enters with force through the port 77 into the chimney 72, where it is ignited when passing over the platinum moss, igniting at the same time the mixture in chamber 70 and bringing (mixture continuing to enter) the flame from atmospheric pressure to the pressure of the compressed mixture in the compression-chamber. When, then, the piston reaches the dead-point, the action of cam 81 is released and the spring 82 brings the slides 75 and 79 in their former position. The communication of chamber 70 with the cylinder is established through opening 74 and the charge ignited in the compression-chamber. The downward movement of the slides 75 and 79 shuts the communication between the chimney 72 and chamber 70 and between the said chimney and the cylinder and sets the chimney 72 in communication with the atmosphere through passage 78 and opening 80, and as the slides remain in this position during the explosion, escape, and suction strokes the contents of chimney 72 is during the said strokes in contact with the atmospheric air and the platinum may regenerate its condensing power. During the escape-stroke the burned gas may not enter into the chimney, but only in chamber 70, out of which they are expelled during the suction-stroke by means of the fresh mixture which is admitted simultaneously through the inlet-valve 7 and the little valve 71, connected to the carbureter by means of a little pipe. Thus when the compression-stroke begins and when the slides are brought in the position shown chamber 70 is filled with mixture at atmospheric pressure.

Having thus described the essential parts of my improved motor, I will now explain its operation, taking as an example the construction shown in the drawings, in which the cranks are keyed to each other in such a manner that the crank corresponding to the pistons 3 and 3′ stands at sixty-one degrees in the rear of the cranks corresponding to the pistons of cylinders 1 and 2, Fig. 2. As this angle corresponds to one-third of the stroke of pistons in cylinders 1 and 2, channels 4 and 4′ must open in the said cylinders at one-third before the rear dead-point. Now be it assumed that the pistons of cylinder 1 are at the beginning of the explosion-stroke and the pistons of cylinder 2 at the beginning of the suction-stroke. Referring to Fig. 8 for cylinders 1 and 2 and to Fig. 8bis for cylinders 3 and 3′, the following cycle takes place: Cylinder 1: When the crank is at 1, (corresponding to the rear dead-point,) the explosion takes place and the pistons are thrown ahead. When the crank passes at 2, the valves of channels 4 open, as hereinbefore described, and the burning gas enters as a dart in the cylinders 3 and 3′, igniting the mixture. Then the crank passes from 2 to 4, and if during this stroke the expansion is such as to create a certain vacuum in the cylinder valve 8 opens and air is sucked in cylinder 1. The crank then returns from 4 to 1, the pistons expelling the burned gas and the air sucked in through the valve, passing the rear dead-point and beginning the suction-stroke, the cycle being then identical to that described with reference to cylinder 2. Cylinder 2: The crank passes from 1 to 4, the pistons sucking explosive mixture in the cylinder. On the return stroke from 4 to 1 the mixture is compressed and forced back through the valves of channels 4 into the cylinders 3 and 3′ until the pistons pass again the channels. From this moment the mixture is compressed and a part thereof forced through the port 77, communicating with the chimney or tube 72, and through the opening in the igniting-chamber 70. The rest of the mixture in the cylinder being compressed, the pistons arrive at the rear dead-point. At this moment the explosion takes place and the cycle proceeds as described with reference to cylinder 1. Cylinders 3 and 3′: The crank passes from 6 to 1, Fig. 8bis, the pistons compressing the charge. When passing the rear dead-point, the burning gas from cylinder 1 entering as a dart through the channels 4 in the compression-chambers the charge is ignited and the pistons are thrown ahead from 1 to 4, their forward dead-point. The channels are closed automatically as soon as the pressure of the gas ignited in cylinders 3 and 3′ overcomes the pressure in the other cylinders. A little time before the pistons are passing the forward dead-point the valves 11 and 11′ open and remain open the necessary time in order to allow the escape of a certain quantity of burned gas and to make place for the fresh mixture which the pistons of cylinder 2 are forcing through the channels 4′ 4′. When the crank passes at 6, the hereinbefore-described cycle takes place again.

It will be observed that when during the abnormal running of the motor the governor 39 acts on valve 8, as hereinbefore described, in such a manner that the working of one of cylinders 1 or 2—say, for instance, of cylinder 1—is suppressed cylinders 3 and 3′ are working also on the four-stroke cycle, for the reason that cylinder 2 works only at each two revolutions of the shaft during a part of the compression-stroke as a pump forcing the explosive mixture into cylinders 3 and 3′. Thus the power of the engine is reduced more than half the normal power. In order that at this moment the cylinders 3 and 3′ may not be set in communication with cylinder 1, the valves of channels 4 are conveniently pressed upon their seats by the fact that the governor 39

when throwing its balls 40 away displaces the cam 55, which is connected through rods 49 49′ with the arms 41 41′ of the governor in such a manner that rod 62, actuating the valves of channels 4, cannot be acted upon by the boss of cam 55.

It must be understood that I do not limit myself to the special arrangements or details of the motor hereinbefore described and that the said details may be varied in order to obtain the best result possible from my system without departing from the spirit of my invention.

What I claim is—

1. In an explosion-motor comprising a plurality of cylinders, one or more cylinders working as four-stroke engines, one or more cylinders working normally as two-stroke engines, channels between said cylinders, the said channels opening in the compression-chambers of the two-stroke cylinders and, in the four-stroke cylinders, at a place depending upon the quantity of mixture which is to be compressed in the said cylinders, a part of this mixture being injected in the two-stroke cylinders and ignited therein through the burning gas of the four-stroke cylinders.

2. In an explosion-motor, in combination two cylinders having each two pistons moving in opposite directions, two cylinders having each a single piston and channels between the two-piston cylinders and the single-piston cylinders in such a manner that each of the two-piston cylinders injects alternatively a part of its charge in one of the single-piston cylinders, the said charge being ignited in the single-piston cylinders through the burning gas of the two-piston cylinders substantially as described.

3. In an explosion-motor, in combination: two cylinders having each two pistons moving in opposite directions and working as four-stroke engines, two cylinders having each a single piston and working normally as two-stroke engines, channels between the two-piston cylinders and the single-piston cylinders, the said channels opening in the two-piston cylinders at a point depending upon the quantity of mixture which is to be compressed in the said cylinders and in the compression-chambers of the single-piston cylinders in such a manner that the pistons of the two-piston cylinders in their compression-stroke may inject a part of their charge in the single-piston cylinders, this mixture, being ignited through the burning gas of the two-piston cylinders at the moment the pistons of the single-piston cylinders pass the rear dead-point after having compressed their charges, substantially as described.

4. In an explosion-motor, in combination two cylinders having each two pistons moving in opposite directions and working as four-stroke engines, two cylinders having each a single piston and working normally as two-stroke engines, channels between the two-piston and the single-piston cylinders, inlet and escape valves for the two-piston cylinders and valves in the single-piston cylinders near the forward dead-point the said valves opening a little time before the pistons of the single-piston cylinders pass the forward dead-point in order to allow the escape of a portion of the burned gas and to make place for fresh mixture injected in the single-piston cylinders by one of the two-piston cylinders substantially as described.

5. In an explosion-motor in combination two cylinders having each two pistons moving in opposite directions, two cylinders having each a single piston, channels between the two-piston and single-piston cylinders, an inlet-valve for each two-piston cylinders, a valve adapted to act as inlet or exhaust valve in the said cylinders a spring holding the said valve normally upon its seat, means whereby the action of this spring may be released in such a manner that the said valve may open easily in case of a certain vacuum taking place in one of the two-piston cylinders and a cam to open the said valve during the exhaust-stroke and valves in the single-piston cylinders near the forward dead-point, substantially as described.

6. In an explosion-motor in combination two cylinders having each two pistons moving in opposite directions, two cylinders having each a single piston, channels between the two-piston and single-piston cylinders, valves in the said channels, springs acting on the said valves, means for releasing the action of the said springs, mixture-inlet valves, exhaust-valves adapted to act also as air-inlet valves for the two-piston cylinders, springs acting upon the said exhaust-valves, means for releasing the action of the said springs and exhaust-valves in the single-piston cylinders near the forward dead-point thereof, substantially as described.

7. In an explosion-motor in combination, two cylinders having each two pistons moving in opposite directions, two cylinders having each a single piston, channels between the two-piston and single-piston cylinders, valves in the said channels, springs acting on the said valves, inlet and exhaust valves for the two-piston cylinders, springs acting upon the said exhaust-valves, exhaust-valves in each of the single-piston cylinders, a cam-shaft, a governor on the said cam-shaft and a disk 43 subjected to the action of the said governor and acting on the exhaust-valve 8 to hold it open and a cam 55 also subjected to the action of the governor in such a way that the boss of said cam, when displaced through the governor, cannot act upon the springs of the valves which are held on their seats by the said springs substantially as described.

8. In an explosion-motor comprising a number of cylinders having each pistons moving in opposite directions, the combination with each piston of a rod connected to a swing-lever, a connection between the two swing-le-

vers and a rod transmitting the movement of one of the swing-levers to a single crank in such a manner that the two pistons require only one crank substantially as described.

9. In an explosion-motor comprising two cylinders having each two pistons moving in opposite directions and two cylinders having each a single piston, all arranged substantially as described, in combination, pivoted swing-levers connected each to a piston-rod, connecting-rods between the swing-levers always actuated by two opposite pistons and three rods transmitting the movement of the swing-levers to three cranks for six pistons on the motor-shaft, substantially as described.

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

MARTIN HENRI RUMPF.

Witnesses:
GEORGE BEDE,
GREGORY PHELAN.