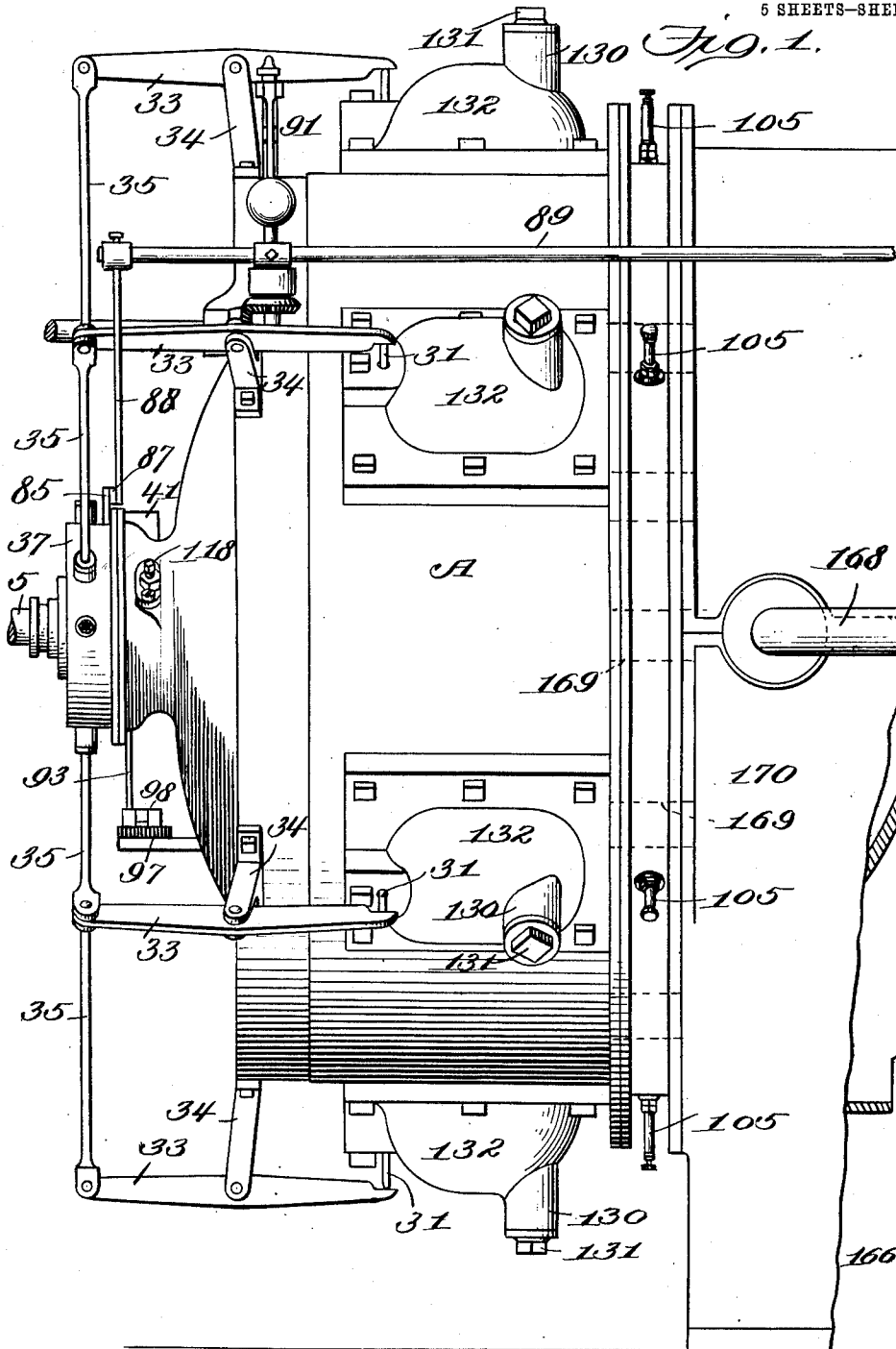


L. A. HAINES.
THERMODYNAMIC MOTOR.
APPLICATION FILED FEB. 25, 1910.

1,025,869.

Patented May 7, 1912.

5 SHEETS—SHEET 1.



Witnesses:
C. H. Haines
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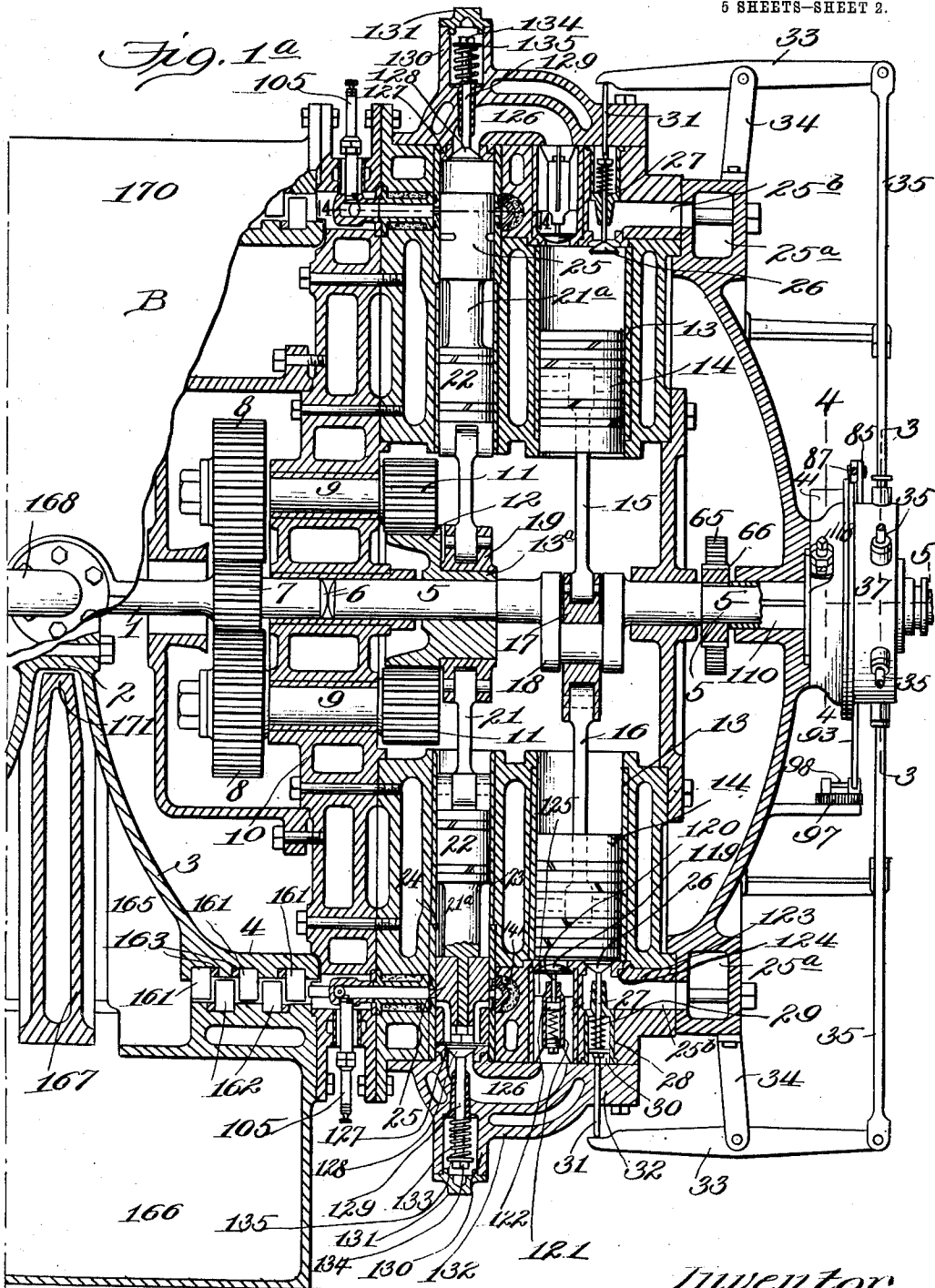
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5 SHEETS-SHEET 2.



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5 SHEETS—SHEET 3.

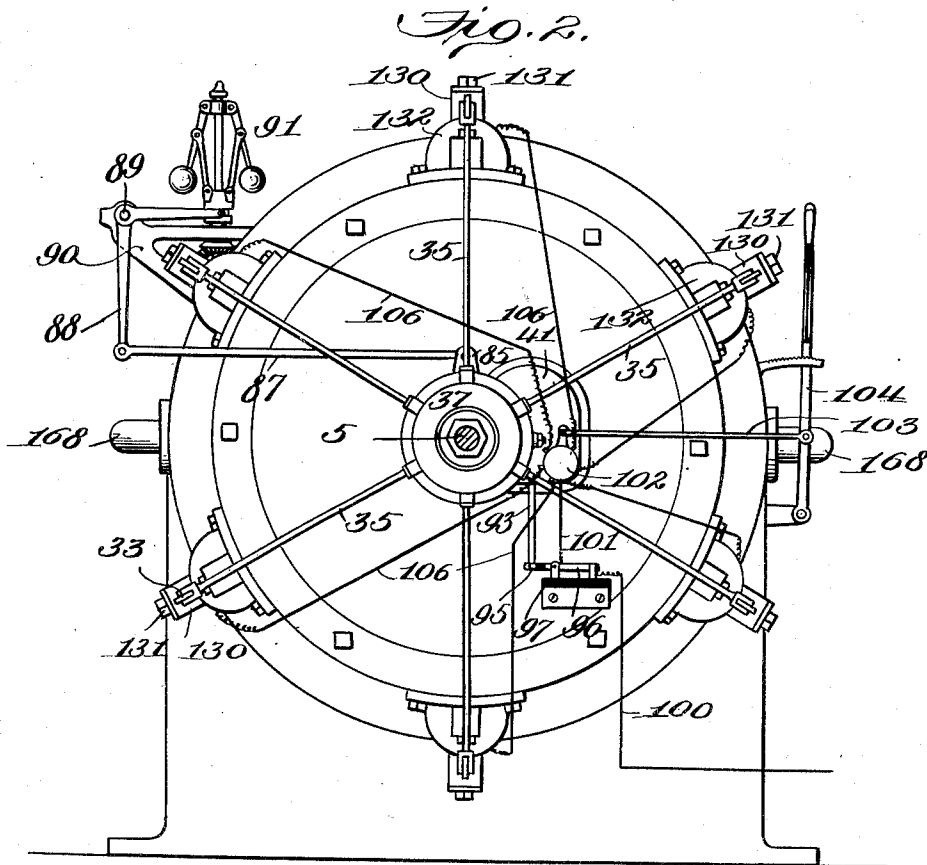


Fig. 16.

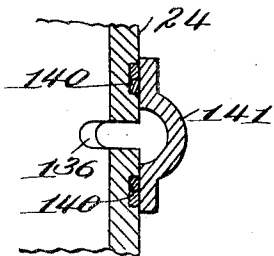
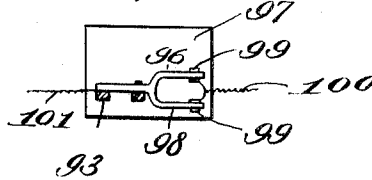


Fig. 15.



Witnesses:
Ed. Kessler
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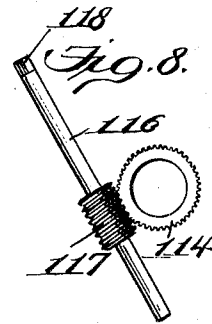
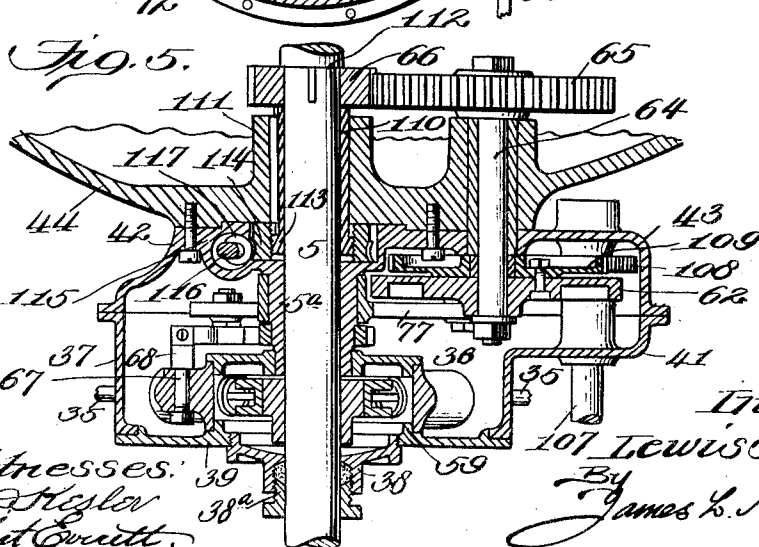
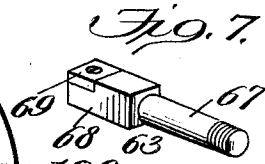
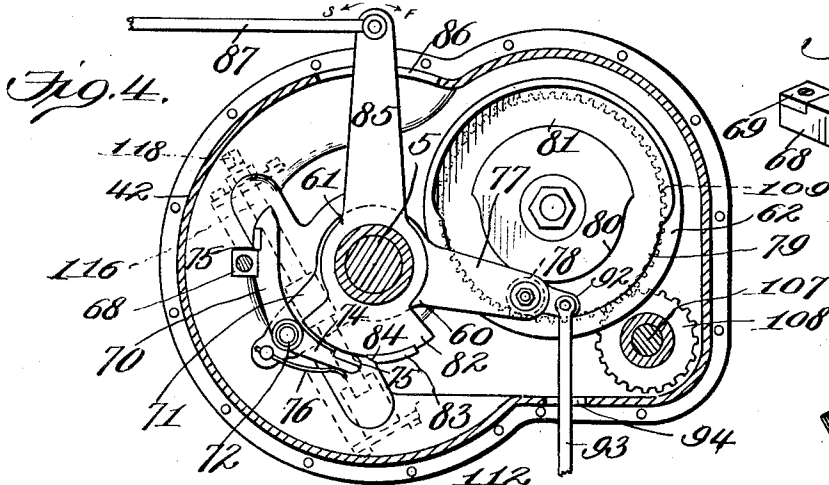
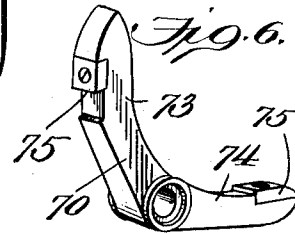
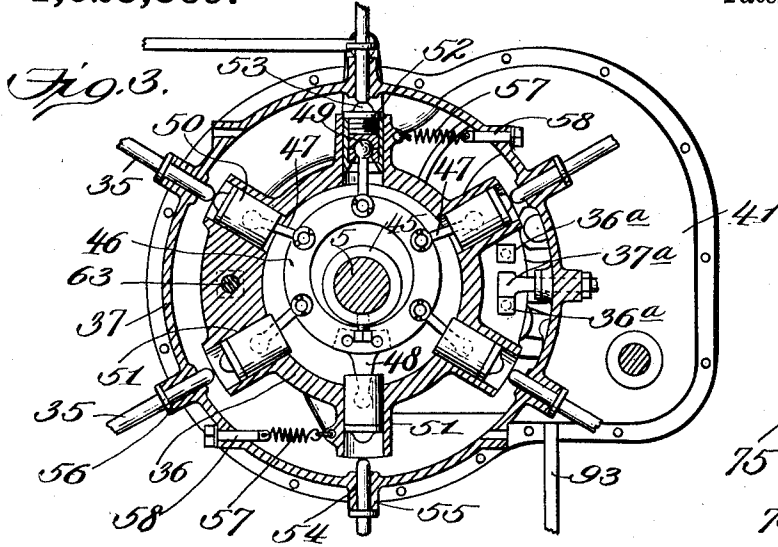
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1,025,869.

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5 SHEETS—SHEET 4.



Witnesses:
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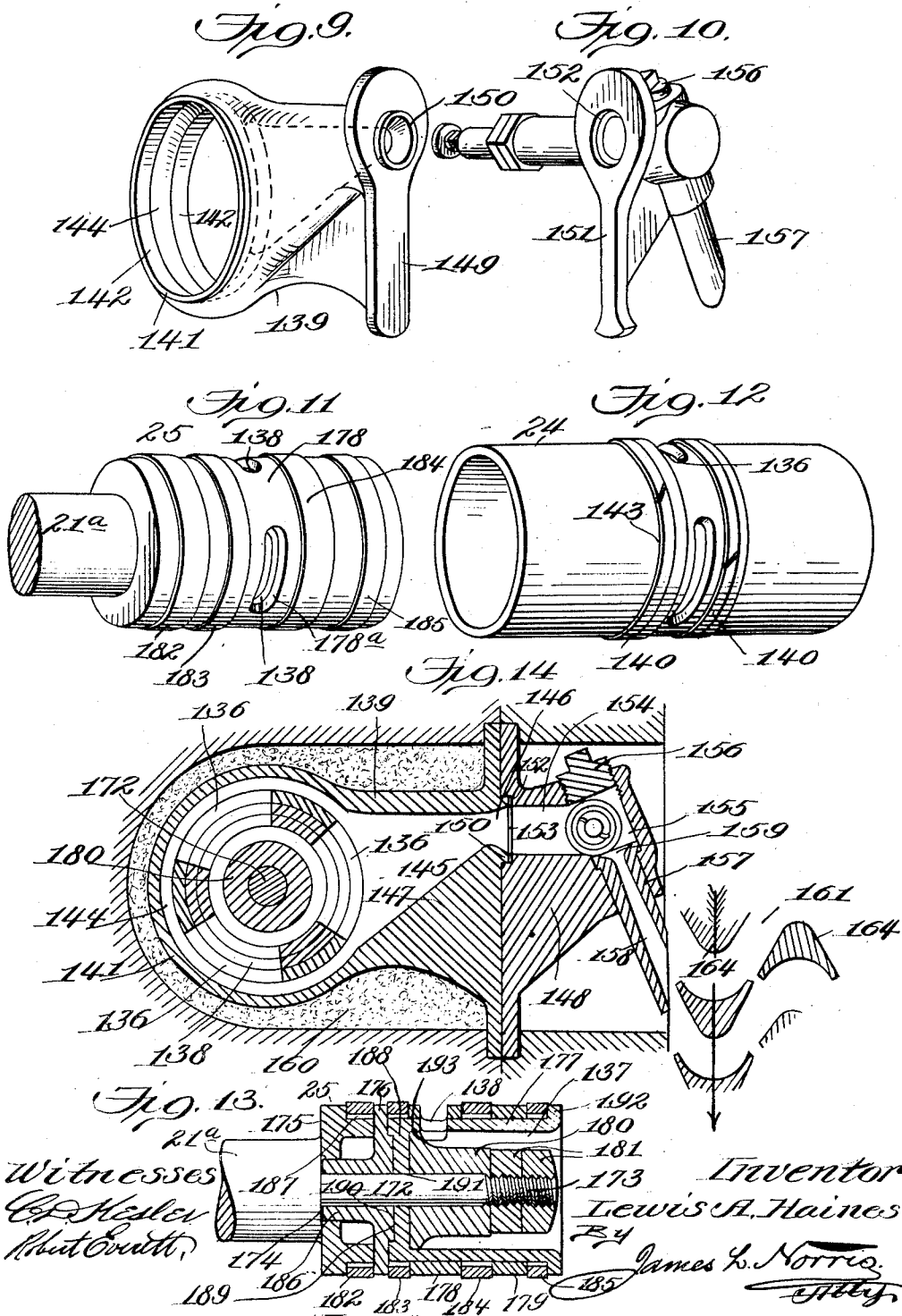
Inventor
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APPLICATION FILED FEB. 25, 1910.

1,025,869.

Patented May 7, 1912.

5 SHEETS-SHEET 5.



UNITED STATES PATENT OFFICE.

LEWIS A. HAINES, OF COLUMBUS, OHIO.

THERMODYNAMIC MOTOR.

1,025,869.

Specification of Letters Patent.

Patented May 7, 1912.

Application filed February 25, 1910. Serial No. 545,818.

To all whom it may concern:

Be it known that I, LEWIS A. HAINES, a citizen of the United States, residing at Columbus, in the county of Franklin and State of Ohio, have invented new and useful Improvements in Thermodynamic Motors, of which the following is a specification.

This invention relates to a thermodynamic motor and is preferably embodied in that class of engines known as turbines of the internal combustion type, though equally well applicable to other classes of engines or motors wherein it may be found desirable at intervals to permit a part of the working organization to cool down without affecting the driving power of such engines.

In engines of the turbine class using an explosive motive agent a highly heated condition of the driving elements ensues and it is essential that the temperature of said elements be controlled to reduce as much as possible structural deterioration of the driving means with which the highly heated exploded motive agent comes in contact.

The present invention embodies improvements of a material nature of the construction and general organization disclosed by my pending application filed August 3, 1908, Serial Number 446,640. The same alternating application and cut-off of the heated or exploded motive agent to different portions of the turbine organization included in the power generating means is preserved in the present improvement in a manner substantially similar to the motor disclosed by the aforesaid application.

One of the essential features of improvement is the ignition of the motive agent exteriorly of the compression chambers instead of in the latter to maintain the compressing device or valve in balance and prevent back fire in the compression chambers and undue thrust and shock on the compression mechanism generally. A further advantage of this particular feature of improvement is that the compressed explosive medium or agent is practically all released from the compression chambers prior to the explosion or ignition of said medium or agent, thereby clearing each compression chamber and preventing the retention and deposit of a deleterious residuum therein. A still further advantage of this particular feature of improvement is that the motive agent is exploded or fired nearer the dis-

charge outlet or nozzle and a greater percentage of heat units is thus converted into effective energy.

The present invention also embodies means or mechanism for controlling or regulating the supply of a motive agent to one or more cycling combustion chambers included in a series of the latter and having a cycling movement and the instant ignition of said agent when liberated from the compression means or chambers, and also for controlling and regulating the explosion of a motive agent in one or more combustion chambers in proportion to the load on the motor with material advantages in the economic use of the motive agent and in operating or driving certain classes of machines that may be lightened up at intervals relative to the maximum horse power utilized in operating said machines in performing full work.

Other features of improvement will be more fully hereinafter specified, and in the drawings a preferred embodiment of the invention is shown applied to a thermodynamic motor of the internal combustion type for the purpose of demonstrating one practical application of the improved essential features of the invention, but it will be understood that the invention is not limited in the least to the form of the machine shown in the drawings or to the specific structural features which will hereinafter be particularly explained.

In the drawings: Figure 1 is a view showing one-half of the motor or engine in elevation, broken away in part and in section, and embodying improved features of the invention. Fig. 1^a is a longitudinal vertical section of a greater portion of the remaining half of the improved motor or engine, parts of the latter being shown in elevation. Fig. 2 is an end elevation of the improved motor or engine. Fig. 3 is a transverse vertical section on the line 3—3, Fig. 1^a. Fig. 4 is a transverse vertical section on the line 4—4, Fig. 1^a. Fig. 5 is a horizontal section on the line 5—5, Fig. 1^a. Figs. 6, 7 and 8 are detail views of parts of the mechanism as particularly shown by Figs. 3, 4 and 5. Figs. 9 and 10 illustrate perspective views of one of the expansion chambers and ignition or sparking attachments, respectively, both devices constituting a combustion chamber provided with igniting means. Figs. 11 and 12 illustrate perspective views of a compressing plunger or valve

and compressing cylinder or chamber respectively which cooperate to compress and liberate the motive agent into the combustion chamber associated therewith. Fig. 13 is a longitudinal section through the plunger or valve shown by Fig. 11. Fig. 14 is a horizontal section taken in the plane of the line 14—14, Fig. 1^a. Fig. 15 is a detail plan view of a switch means cooperating with the electric circuit of the sparking plugs to control the action of the latter. Fig. 16 is a detail sectional view of part of one of the compression chambers or cylinders and explosion chambers and particularly illustrating the receiving ring or member of the latter in its relation to the compression chamber or cylinder and the manner of instituting a tight joint to prevent leakage and insure a positive engagement of the said receiving ring or member and the compression cylinder or chamber.

Similar characters of reference are employed to indicate corresponding parts in the several views.

The numeral 1 designates a turbine or main driving shaft projecting from an intermediate hub 2 fixed thereto or forming a part thereof and to which inwardly dished turbine supports 3 are secured and have outer flanged extremities 4 on which the turbine elements are disposed, two sets or series of turbine elements being used in the present instance and spaced for conjoint operation with duplex motive agent and supply means or controlling mechanism which will be presently explained. The one motive agent controlling supply means and including combustion devices is designated by the reference character A and the other by B, and each includes a set of pumps and a corresponding number of compression plungers of duplicate construction and operatively connected to opposite extremities of the main or turbine shaft 1, and embody inter-related mechanisms for mechanically controlling explosion and delivery of the motive agent to the turbine driving elements at intervals in alternation, and as the motive agent controlling supply means A and B are exact duplicates in construction and operation it will suffice to specifically describe one of the same. Each motive agent controlling supply means has a central shaft 5 in longitudinal alinement with the main or turbine shaft 1, but operatively independent of the latter, the inner terminal of each shaft 5 and the outer terminals of the shaft 1 being adjacent and separated by hard steel thrust disks 6. The object of this separate shaft organization is to permit the main or turbine shaft 1 to run freely at a predetermined high rate of speed and the shafts 5 at a correspondingly low rate of speed so as to effect a regular and practical operation of the dual mechanisms for controlling

explosion and delivery of the motive agent to the turbine driving elements and insure constancy in the accumulation of potential energy and delivery of kinetic energy to the turbine driving elements, and also avoid resistance to the substantial free running of the turbine or main shaft 1 and an impractical operation of the motive agent supply controlling means which would result if the shafts 5 were rotated at the same high rate of speed as the main or turbine shaft 1. On each extremity of the main or turbine shaft 1 a pinion 7 is secured and continually meshes with transmitting gears 8 carried on gear shafts 9 parallel with each shaft 5 and having bearing in a portion of the frame 10 which serves also to give bearing to the extremities of the shafts 1 and 5. On the extremities of the shafts 9 opposite those carrying the gears 8 are pinions 11, one on each shaft, the said pinions 11 exactly corresponding in dimensions and number of teeth to the pinions 7. The pinions 11 are held in continual mesh with gears 12 formed with eccentric sleeves 13^a keyed to the shafts 5 and of the same dimensions as the gears 8.

The gearing just described may be properly termed a compensating means or gearing, and though the speed of rotation of each shaft 5 relatively to the main or turbine shaft 1 may be varied in turbines constructed in accordance with the invention, it has been found that the most beneficial practical proportions or ratio of speed are four to one, or four revolutions of the main or turbine shaft 1 will give one revolution of the shaft 5.

Radially arranged around each shaft 5 is a plurality of pumps which in the present instance are shown as six in number, and each embodies a cylinder 13, a piston 14, and a corresponding number of piston rods 15 and 16, the piston rod 16 slightly differing in its connections from the remaining piston rods 15. Each of the piston rods 15 is movably attached at its inner extremity to an eccentric disk 17 and at its outer extremity likewise connected within the piston 14, the said eccentric disk 17 being held by or engaging a crank 18 forming part of the shaft 5. The outer extremity of the piston rod 16 is movably connected to its piston 14 in a manner similar to the connection of the piston rods 15 to their corresponding pistons, but the inner extremity of said piston rod 16 is fixed to the disk 17 to maintain the latter in proper position against wobbling or irregular movement, or to insure a positive operation of said disk relatively to the crank 18. It will therefore be understood that the piston rod 16 acts as a holding leg for the disk 17, but in the performance of this function the piston rod 16 will not be in the least restricted in its reciprocating and oscillating movements. A part 19 is

mounted on the sleeve 13^a, the latter eccentrically engaging and secured to the shaft 5 and the part 19 operating as an eccentric strap. To this eccentric strap 19 a plurality of radially arranged plungers 22 is movably connected by rods or equivalent devices 21, the plungers being reciprocatingly mounted in radial chambers 23 continuous at their outer portions with compression chambers 24 having compression valves or pistons mounted therein and connected to the said plungers. The eccentric embodying the sleeve 13^a and strap 19 is so set relatively to the disk 17 and crank 18 as to operate a little later than the latter, or in other words the disk 17 and crank 18 operate in advance of the eccentric including the sleeve 13^a and strap 19 so that the compression chambers 24 will be sufficiently charged with the motive agent prior to the beginning of the outstroke of the compression valves or pistons 25 and by this means a degree of compression will be exerted on each charge of the motive agent desired to effect a practical potential energy prior to the liberation of each charge of the motive agent into coöperating combustion chambers which will be presently described.

Each motive agent controlling supply means including combustion devices, or each section or organization for the purposes mentioned and designated by A and B, is provided at the outer extremity with an annular mixing chamber 25^a to which suitable carbureting mechanism may be exteriorly connected, and communicating with this mixing chamber at intervals are inlet passages 25^b corresponding in number to the number of pump cylinders 13 and opening into the outer extremities of the latter. The communication of each pump cylinder 13 with its passage 25^b is controlled by a mechanically operated inwardly opening valve 26 having a stem 27 movably projecting outwardly through a part of the frame or inclosure of the motor as at 28 and having a closing spring 29 operating therewith and seated in a recess 30. All of the valves 26 are regularly operated by mechanical means to open them and establish communication between the pump cylinders and the passages 25^b, and the stress of the springs 29 is such as to prevent the several valves from being opened by the pressure of the motive agent passing from the mixing chamber 25^a into the passages 25^b. The advantage of this mechanical control of the several valves 26 is that a practical successive operation of the pump cylinders at predetermined intervals is obtained without liability of the disadvantages that might result from a supply of the motive agent entering pump cylinders at the time undesirable to be active in charging the compression and combustion mechanism and which is apt to ensue where

valves are used and arranged to be opened by the incoming motive agent. Furthermore, by having the valves 26 mechanically controlled, the use of intermediate valves between the mixing chamber 25^a and the passages 25^b is unnecessary. The preferred mechanical means for operating the several valves 26 at predetermined times or intervals consists of a plurality of push pins or rods 31 slidably mounted in the inclosure or frame of the motor as at 32 and having their inner ends continually in contact with the outer ends of the stems or valve rods 27. The push pins or rods 31 are disposed in longitudinal alinement with relation to the valve stems or rods 27, and their outer extremities, which are always exterior of the motor inclosure, are engaged by actuating levers 33 held by intermediate fulcrum projections or supports 34 secured to the part of the motor inclosure or frame adjacent to the mixing chamber 25^a. The inner ends of the actuating levers 33 loosely bear on the outer ends of the push pins or rods 31, and the outer ends of said levers have connecting rods 35 movably attached thereto and projecting inwardly in radial relation to the outer extremity of the shaft 5 and coöperating with a controlling mechanism or controller, more clearly shown by Figs. 3, 4 and 5.

The controlling mechanism or controller regulates the supply of motive agent to one or more compression and expansion or combustion chambers and the explosion of the said motive agent in one or more combustion chambers in proportion to the load on the motor, and so operates that in the event of excessive speed a portion of the motive agent supply means or pumps, compression chambers and corresponding combustion chambers will be instantly cut out or shut off until the motor resumes its normal speed or the full load has been imposed on the motor and under which latter conditions all of the supply means or pumps, compression and combustion chambers will regularly and successively operate.

As hereinbefore intimated, a certain specific number of motive agent supply means or pumps, compression and combustion chambers are used and disclosed in the drawings to demonstrate one practical form of the motor, and, moreover, the motor as shown has opposite alternately acting groups of supply means or pumps, compression and combustion chambers, but it will be understood that the principle of operation involving the automatic cut-out of a portion of said mechanism or the regulation of explosion of the motive agent in a number of combustion chambers in proportion to the load on the motor or in the event of excessive speed is not dependent upon the number of supply means or pumps, compression

and combustion chambers nor upon a duplex organization of said devices and it is intended to adopt this principle of operation in any motor where it may be applicable.

5 In the preferred form of this controlling or regulating mechanism, as shown particularly by Figs. 2, 3, 4 and 5, an inner approximately circular frame 36 is used and shiftably disposed or oscillatable on a bearing

10 hub 5^a of shaft 5 within an outer fixed inclosure or shell 37 having a bearing sleeve 38 extending from an inclosing head 39 and provided with a stuffing box 38^a to prevent

15 shaft 5 rotatably extending through the said sleeve and stuffing box. The shell 37 has a lateral extension 41 secured to a correspondingly shaped shell 42 and extension 43

20 for the prime controller or regulator actuating means. The two shells 37 and 42 and the extensions of the latter fully open into each other, and the shell 42 and its extension 43 are applied to the center of the end

25 inclosing head 44 of the motor. This controlling or regulating mechanism is duplicated at opposite ends of the motor, both organizations being of the same structure

30 but primarily arranged to have a reverse operation or so that when one is actuated to permit the motive agent to enter the supply

35 means or pumps, compression and combustion chambers on one side, the other will be actuated to cut off the supply of motive agent to the adjacent pumps, compression and combustion chambers.

Within the approximately circular frame 36 an eccentric 45 is keyed on the shaft 5 and engaged by an eccentric strap 46 to which is attached a plurality of piston rods

40 47 and 48, the piston rods 47 being movably secured to the strap and the piston rod 48 fixed thereto and serving as a holding leg to maintain the eccentric strap in proper

45 working position at all times without detracting from its desired function. Each of the piston rods 47 and 48 is connected at its outer end by a ball and socket joint 49 to a piston 50, the pistons 50 being disposed in

50 radial seats formed therefor in the frame 36 as at 51, each of the pistons being provided with a head 52 with a central striking projection 53. The inner ends of the connecting

55 rods 35 extend through radially arranged openings 54 having outwardly extending cooperating bearing collars 55 formed at intervals in the shell 37, the openings 54 and collars 55 being in alinement

60 with the pistons 50 when the frame 36 is in normal working position; and the ends of the connecting rods 35 are so disposed as to be regularly engaged by the striking projections 53 of the piston heads 52. The connecting rods 35 are provided with stops 56,

65 one on each, to limit the inward movement of the inner ends of the connecting rods 35

relatively to the openings 54 and collars 55. These rods 35 when in normal position are held with their inner extremities projected through the openings 54 into the shell 37, as shown by Fig. 3, by the springs 29 surrounding the stems 27 engaging the push pins or rods 31, the latter in turn transmitting the resilient effect of said springs to the levers 33 having the said rods 35 connected thereto. The pistons 50 will be regularly forced

70 outwardly in their seats 51 by the movement of the eccentric strap 46 due to the operation of the eccentric 45 carried by the hub 5^a on the outer portion of the shaft 5, and the projections 53 of said pistons will successively engage the inner terminals of the rods 35 and open the valves 26 in timed

75 sequence. Cooperating with diametrically opposite portions of the frame 36 are retractile springs 57 secured at their inner ends to reverse portions of diametrically

80 opposed seats 51 and at their outer ends attached to bolts or adjusting rods 58 having their outer headed ends exposed through the exterior portion of the shell 37. The frame

85 36, as hereinbefore indicated, is shiftable or oscillatable and engages a flange or annular bearing 59 on the inner portion of the head 39, see Fig. 5, and when the said frame is free for shifting movement in a manner

90 which will be hereinafter explained.

The shifting mechanism or actuating means for the controller or regulator is disposed in the shell 42 and extension 43, as heretofore specified, in intimate relation to the means for actuating the rods 35 as just explained. This shifting mechanism essentially includes a latch or dog operating member 60, a trip member 61, a cam 62 and a projection or catch block 63. The latch or dog carrying member 60 and the trip member 61 are loosely mounted on the bearing hub 5^a of the shaft 5 and the cam 62 is fixed on the end of an auxiliary shaft 64 extending into the extension 43 of the shell 42

100 and having bearing in the adjacent head 44 of the motor. On the inner end of the auxiliary shaft 64 is secured a gear 65 held in continual mesh with a pinion 66 keyed on the shaft 5, the object of this intermeshing

105 gearing being to slow down or decrease the rotation of the cam 62 relatively to the speed of rotation of the shaft 5 to obtain a proper timed operation of the rods 35 by the pistons or plungers 50. The catch block 63 is

110 secured to the shiftable frame 36 by means of a threaded stem 67, see Fig. 7, and the head 68 of the block is preferably angular in cross section and provided with a hardened contact piece 69 which is held in the

115 path of movement of a dog 70 intermediately fulcrumed on a short projecting arm 71 of the member 60, the said dog 70 being intermediately fulcrumed as at 72 and simulating a bell-crank having upper and lower

120 125 130

arms 73 and 74 at an angle to each other. The upper arm 73 is formed with an outer shoulder and hardened contact block as at 75 and the lower arm of the said dog has an upper terminal contact piece 75 of suitable hardened material. The lower arm 74 of the dog 70 is engaged by a flat spring or other analogous resilient means 76 which is free to move thereover or does not interfere with the rocking movement of the dog, and this spring tends to normally throw the upper arm 73 outwardly relatively to the shaft 5 or in position under certain conditions to engage the enlarged extremity or head 68 of the catch block 63. The member 60 also has a longer arm 77 projecting over the one face of the cam 62 and carries a roller 78 which is continually held in a cam groove 79 of the said cam. The cam groove or race 79 comprises a portion 80 of less radius than a portion 81 continuous therewith. In other words, a part of the cam groove or race 79 is nearer the center of the cam than the remaining portion, and this formation of the cam groove or race imparts to the arm 77 at intervals an oscillating or shifting movement and the dog 70 carried by the shorter arm 71 partakes of such movement or is oscillated to a degree corresponding to the oscillation of the arm 77 so that at regular intervals during the normal operation of the motor the shoulder 74 of the dog 70 will rise and the enlargement or head 68 of the block 63 will move vertically therewith owing to the relaxation of the downward stress of the dog on the catch block, such movement of the dog and catch block ensuing instantly when the roller 78 on the arm 77 enters the portion 81 of the cam groove or race having the greater radius relatively to the center of the cam 62. The upward movement of the catch block 63 is caused by the springs 57 which have been held under expanded resistance by the lowered normal position of the said catch block, but it will be seen that as soon as the downward pressure or stress of the dog is relaxed as just explained, the said springs 57 will act and throw the frame around its axis a limited distance controlled by stops 36^a and 37^a respectively on the frame 36 and shell 37, as shown by Fig. 3, and thereby dispose the projections 53 out of alinement with relation to the inwardly projecting ends of the connecting rods 35. In this latter shifted position of the frame 36 the pistons or plungers 50 continue to regularly reciprocate, but the rods 35 are inactive or idle by reason of the fact that their actuating devices are out of alinement with relation thereto, and hence the supply means or pumps, compression and combustion chambers with which the said inactive connecting rods are operatively associated will for an interval of time remain without driving function relative to

their turbine elements, though the latter and the pumps and compression and combustion chambers will continue to operate in timed relation while the opposite or duplex similar pumps, compression and combustion chambers and turbine elements are operating as power generating means. The moment that the roller 78 again enters the portion 80 of the cam groove or race, the arm 77 is drawn inwardly toward the center of the cam and the arm 71 thrown downwardly, thereby correspondingly lowering the dog 70 and causing the catch block 73 to be drawn downwardly and the frame 36 shifted in an opposite direction against the resistance of the springs 57 to dispose the projections 53 of the plungers or pistons 50 in alinement with the inwardly projecting ends of the rods 35 and under which latter conditions the said rods 35 will regularly operate in succession to admit the motive agent or medium to the successive pumps through the valves 26.

There is always a possibility of the motor racing or operating under excessive speed and which may occur under normal conditions or when the load on the motor is temporarily reduced, and to insure economy in the utilization of the motive agent, avoid strain and injury to the operating parts, and to automatically control the speed of the motor and its power relatively to the load thereon it is necessary to provide means for regulating the supply of the motive medium and the operation of a proportionate number of pumps, compression and combustion chambers. For this purpose the trip member 61 is used in operative association with the dog 70, said trip member having a segment 82 carrying a shoe 83 with an inclined nose or terminal 84 to ride over the contact piece 75 and tilt or oscillate the dog 70 against the resistance of the spring 76 to effect a disengagement of the shoulder 75 from the catch block and permit the latter to move upwardly by reason of the springs 57 shifting the released frame 36 and throw the projections 53 out of alinement with relation to the inner ends of the connecting rods 35 and thus cause a cessation of feeding operation of the pumps directly controlled by the said rods. The movement of the segment 82 and shoe 83 as just explained is effected through an arm 85 projecting upwardly through a slot 86 in the top of the shell 42, a rod 87 being movably attached to the upper end of the arm 85 and also movably attached to the depending arm of a bell-crank 88 secured on a shaft 89 extending fully across the motor and held in suitable brackets 90 secured to the motor frame. The shaft 89 has a rocking movement imparted thereto by a governor 91 through the medium of the upper arm of the bell-crank 88, as clearly shown by Fig. 2,

there being but one governor 91 used but a duplicate connection between the shaft 89 and each arm 85 of the controlling and regulating mechanisms at the opposite ends of the motor of a similar character in all particulars so that no matter which side of the motor is operated as the power generating means the governor will automatically restore the normal speed of the entire motor or compensate for a variation of load on the motor. The release of the dog 70 from the catch block 63 may be effected when the roller 78 on the arm 77 is at any point in the portions 80 and 81 of the cam groove or race of the cam 62 of either controlling or regulating mechanism, and the dog 70 will be held disengaged from the catch block 63 just as long as the motor is running under abnormal or excessive speed. If the dog 70 has been thrown out of engagement relatively to the catch block or device 63 when the roller 78 on the arm 77 reaches the portion 81 of the cam groove or race having the greater radius, the dog will be raised as in the previously described operation but ride past or clear the catch block, and likewise if the disengagement of the dog is maintained until the roller 78 again reaches the cam groove or race 80 the said dog will be drawn downwardly and clear the catch block or device 63. As soon, however, as the normal speed of the motor has been resumed by the latter, the rod 87 exerts a pull on the arm 85 in a direction reverse to that which accomplished the disengagement of the dog 70 from the catch block or device 63, and this reverse movement of the arm 85 will throw the shoe 83 out of engagement with the lower arm 74 of the dog 70 and immediately the spring 76 throws the said lower arm inwardly and the upper arm 73 outwardly so that the shoulder 74 will engage the enlargement or head 68 of the catch block or device 63 and restore the frame 36 to proper position to continue the operation of the pump and compression and combustion chambers with which its rods 35 are associated. At the time that the shoe 83 is in engagement with the lower arm 74 of the dog 70, the shifting movement or oscillation of the arms 77, 71 and the dog 70 when the roller 78 passes from the portion 80 to the portion 81 of the groove or race of the cam 62, will not affect such engagement as the shoe is long enough to compensate for the oscillating movement, and by this means no interference with the desired inactivity of the pumps and compression and combustion chambers, or the cut-off of the supply of motive agent will ensue.

When the pumps, compression and combustion chambers are regularly working, or the motor is running under normal speed and load, it is obvious that the igniting

means in the combustion chambers should be regularly cut out or deenergized when the supply of the motive agent to one section of the motor is cut off by the corresponding controller or regulator and also that when the section A or B has its mechanism thrown into activity by the corresponding controller or regulator, the igniting means in the combustion chambers should be instantly energized so that there will be no misfire and waste of motive agent. To accomplish this result the arm 77 of the member 60 is provided with a terminal projection 92 having a switch rod 93 movably depending therefrom through a slot 94 in the bottom of the extension 43 of the shell 42. This rod 93 is connected to the inner end of the arm 95 of a yoke switch 96 mounted on a suitable support 97 held on the adjacent portion of the head 44 of the motor frame, as clearly shown by Fig. 2. The yoke 98 of the switch 96, as shown by Fig. 15, is adapted to engage blade contacts 99, the latter and the yoke arm 95 being included in an electrical circuit comprising wires 100 and 101, a well known form of timer 102 being included in the circuit and provided with an operating rod 103 and lever 104 to set the same or to control the operation of a plurality of sparkers or sparking plugs 105 cooperating with the outlets of the combustion chambers and exteriorly projected, as shown by Fig. 1^a. This circuit also includes wires 106 running from the timer 102 to the sparking plugs 105 as well as a suitable source of electrical generation, such as a battery, not shown, the electrical source of generation connected up in the ordinary manner and well understood in the art.

The particular mode of connecting up the electrical source of generation and the sparking plugs as well as the timer forms no part of the invention, the novelty residing in the arrangement of the rod 93 and its connection to the arm 95 of the yoke switch to open and close the latter at regular intervals. The rod 93, as hereinbefore specified, is connected to the inner end of the yoke arm 95, and this switch is intermediately fulcrumed so that a downward pressure exerted on the yoke arm 95 will throw the yoke 98 out of engagement with relation to the blade contacts 99, and conversely an upward pull on the rod 93 and arm 95 will close the switch. Therefore, it will be understood that when the roller 78 is in the portion 80 of the groove or race of the cam 62, an upward pull will be exerted on the arm 95 to maintain the yoke switch in closed relation to its blades 99, but as soon as the roller 78 reaches the portion 81 of the cam groove or race a downward stress will be exerted on the arm 95 and throw the switch out of contact or disengage the yoke 98 from the blade contacts 99.

It will be understood that the timer 102 may be readily adjusted to regulate the sparking of the several plugs as may be desired and found necessary, and the said timer is operated by a shaft 107 projecting into the extension 43 of the shell 42 below the auxiliary shaft 64 and having a pinion 108 thereon which meshes with a gear 109 secured to the back of the cam 62, see Fig. 5. The gear 109 uniformly rotates with the cam 62 and shaft 64 or has one-half the speed of rotation of the shaft 5. The pinion 108 is of such dimensions as to rotate the shaft 107 at a rate of speed similar to the speed of the shaft 5 so that the timer 102 will be operated in proper timed relation to the actuation of the connecting rods 35 and successive opening of the valves 26 or relatively to the supply, compression and combustion of the motive agent to the several pumps and compression and combustion chambers. Each shaft 5 is also provided with adjustable means for obviating end thrust and consisting of a sleeve 110, see Fig. 5, mounted on the shaft and extending through the end head 44 of the motor frame, said sleeve being prevented from having rotational movement though free to longitudinally slide through the medium of an elongated key and slot 111 in the respective engaging parts. The pinion 66 is applied on the shaft 5 against a shoulder 112, and the inner end of the sleeve 110 engages the said pinion. The outer end of the sleeve 110 has a screw-threaded head 113 on which is applied an annular worm gear 114 having interior threads to cooperate with the threads of the outer head 113 of the sleeve 110. A suitable supplemental frame 115 is formed as a part of or secured to the inner side of the shell 42 and extends diagonally with relation to said shell. Within this supplemental frame 115 a shaft 116 is mounted and has thereon a worm 117 at an intermediate point. The worm 117 is held in continual mesh with the worm gear 114 which projects laterally into the supplemental frame 115. The upper end of the shaft 116 projects above the frame 115 and is formed with an annular head 118 for engagement therewith of a key, wrench or other analogous implement for rotating the shaft 116 and actuating the worm 117 and worm wheel 114 to shift the sleeve 110. It will be seen that each shaft 5 being similarly equipped with this end thrust taking up means will be maintained in proper working position relatively to the parts subsidiary thereto or depending thereon for operation.

Each pump cylinder 13 has an outlet valve 119 provided with a stem 120 movable in a cylinder or casing 121 having a slidable head or analogous device 122 working against a spring 123 in a tube 124 concentric with the said cylinder or casing.

The cylinder or casing 121 with the parts just explained therein is suitably fitted within the frame of the motor, and the particular valve organization specified is duplicated in connection with each pump cylinder, each valve 119 opening outwardly with relation to its cylinder and in contradistinction to the valve 26 which opens inwardly in relation to the cylinder. The valves 26 and 119, together with their stems and cooperating spring devices, are arranged in a section 123 suitably constructed for this purpose, said section also having the passages or inlet ports 25^b formed therein and extending fully around the series of pumps or applied adjacent to the pump cylinders, as particularly shown by Fig. 1^a. Between the casing 121 and the passage or inlet port 25^b the section 123 is projected as at 124 to fit over the outer end and form an outer closure for each pump cylinder, and in this outer closure the seats are formed for the respective valves 26 and 119. Between each casing 121 and the seat with the valve 119 a chamber 125 is formed and has fully open communication with a channel or conduit 126 opening at its inner extremity through a valve seat 127 in the outer extremity of the compression cylinder or chamber 24. An inwardly opening valve 128 cooperates with the seat 127 and has an outwardly extending stem 129 movable in a tubular head 130 closed by a plug 131. The head 130 forms a part of a section 132, the latter also having the channel or conduit 126 formed therein. A spring 133 cooperates with the stem 129 of the valve 128 to normally hold the said valve to its seat, and said latter spring has a tension which is sufficient to resist a certain predetermined pressure of the motive agent within the channel or conduit 126 and which resistance may be regulated at will and as found necessary by removing the plug 131 and tightening up or loosening a nut 134 on the outer end of the stem 129 and bearing against a follower 135 with which one extremity of the spring 133 has engagement. The motive agent is accumulated within the channel or conduit 126 by successive operations of the corresponding plunger 14 in the cylinder 13 having cooperation with said channel or conduit, the valve 26 controlling the inlet of the motive agent to each pump cylinder or chamber 13 being closed by the compressing stroke of the piston 14 in said cylinder and the valve 119 opened by the same stroke of the piston, and in view of the fact that the capacity of the cylinder is greater than that of the channel or conduit 126, the compression of the motive agent in the said channel or conduit will be in excess of the compression or pressure of the motive agent in the cylinder 13 and especially after a repeated

operation of the piston 14 prior to compression movement of the valve or plunger 25 in the compression cylinder or chamber 24. When the motive agent accumulated in the channel or conduit 126 has a pressure greater than the resistance to opening movement of the valve 128 set up by the spring 133, the said valve 128 will be forced open and the motive agent under pressure will enter the compression cylinder or chamber just at the instant that the plunger or valve 25 reaches the innermost limit of its stroke or is about to begin its outstroke. At the instant that the plunger 25 begins its outstroke the valve 128 is closed and the motive agent is compressed to a degree in accordance with the limit of the outstroke of the valve or plunger 25 and which degree of compression will be determined when the several elements or components of the motor are organized. The compression cylinder or chamber 24 has outlet ports or slots 136 at an intermediate point extending in a circumferential direction therearound, there being three of these elongated ports or slots in the present construction as shown by Fig. 14. The valve or plunger 25 has an annular chamber 137 fully opening through the bottom thereof and communicating at its upper terminal with elongated outlet ports or slots 138 which are adapted to register with the ports or slots 136 of the cylinder 24 when the valve or plunger 25 shall have reached a certain point during its outstroke and which will be at a time when the motive agent will have been compressed to a predetermined extent or when sufficient potential energy will have been generated to render the motive agent in a condition to quickly escape through the said ports 136 into a combustion chamber 139 where it is converted into kinetic energy under the most favorable circumstances relatively to the utilization of the greatest number of heat units in the propulsion of the adjacent turbine.

At equal distances above and below the ports 136 in the cylinder or chamber 24 eccentric packing rings 140 are disposed and engaging the said packing rings is a semitubular ring or extension 141 forming part of the combustion chamber 139, as clearly shown by Figs. 9 and 16, the semitubular ring or extension 141 having inner suitably dressed faces 142 above and below the horizontal central plane of the said ring or extension 141 to snugly and firmly engage the packing rings 140 so as to provide a tight joint and remove all possibility of leakage. The packing rings 140 are disposed in circumferential grooves 143 in the cylinder or chamber 24 and have such strong spring action as to always maintain a tight engagement with the faces 142 of the ring or extension 141. The eccentric formation of the

packing rings 140 not only insures a tight engagement thereof with the faces 142, but also facilitates the application of the said packing rings to the cylinder or chamber 24.

As shown by Fig. 14, the ports 136 and 138 when in registration not only communicate with the intermediate channel 144 of the ring or extension 141, but a part of the same open directly into the passage 145 of the combustion chamber 139, the channel 144 also continuing into the said passage and the latter converging toward a throat 146. The combustion chamber is preferably composed of two sections, one serving as a receiver 147 and the other as an ignition means 148. The section 147 carrying the ring or extension 141 is first disposed in place in a suitable opening provided therefor in the motor frame and has a joint flange or face 149 extending transversely thereof from which a coupling boss or annulus 150 projects around the outlet of the throat 146. The section 148 also has a joint flange 151 extending transversely there across similar in contour to and adapted to be held closely against the joint flange or face 149, the joint flange 151 having a seat 152 formed therein adjacent to one extremity to receive the boss or annulus 150, a suitable asbestos packing ring 153 being interposed between the boss or annulus 150 and the inner wall of the seat 152 to effect a tight joint between the sections at this point to obviate leakage.

It will be seen that when the section 147 is disposed in the motor frame it is necessary to move the same outwardly in the opening provided therefor as far as possible or at least sufficiently to permit the section 148 to clear the boss or annulus 150 when the said section 148 is positioned in the motor frame so that its joint flange 151 will align with the joint flange 149. The opening in the motor frame will be primarily made large enough to permit outward movement of the section 147 far enough for the purpose just specified and after both sections are in place the cylinder or chamber 24 is then vertically inserted through the ring or extension 141 and operates to draw the section 147 into place and effect a tight jointure or positive engagement of the flanges 149 and 151 and a reliable insertion and retention of the boss or annulus 150 in the seat 152. The seat 152 forms the inlet to a contracted or reduced passage 154 extending to a sparking or ignition chamber 155 at the inner side of the section 148 and into which the inner active extremity of the sparking plug 105 projects, the outer wall of the said chamber 155 being provided with a removable plug 156. The throat 146 and passage or channel 154 operate to concentrate the motive agent under pressure relatively to the inner active extremity of the sparking plug 105

located in the sparking or ignition chamber 155. Extending laterally inward from the sparking chamber 155 at an angle to the passage or channel 154 is a delivery spout 157 inserted in place through the opening closed by plug 156, and has a gradually diverging bore 158 starting from an outwardly flared entrance throat 159, the purpose of said throat being to insure a quick exit of the exploded motive agent, and the divergent bore 158 operating to deliver said exploded agent or the kinetic energy to the adjacent turbine in the most effective manner. Each spout 157 stands at a tangent relatively to its turbine and the inner maximum flare or divergence of the bore 158 results in the most economic distribution or application of the exploded motive agent to the turbine elements, such as the buckets or vanes.

After the sections 147 and 148 have been positively associated by the insertion of the cylinder or chamber 24 through the ring or extension 141, the opening or space between the outer portions of the sections and the adjacent walls of the openings in the motor frame is filled with a suitable non-conducting material or composition of material as at 160. The liberation of the compressed motive agent from the compression cylinder or chamber 24 into the combustion chamber 139 is effected instantly, as hereinbefore specified, and the valve 25 will have moved inwardly far enough to close the ports 136 prior to the explosion of each charge of the compressed motive agent when the motor as a whole is running regularly, and under such conditions it will be readily seen that when the explosion takes place the compression cylinder and valve therein, together with the parts cooperating therewith, will not be in the least affected by back-pressure or vibration in view of the fact that the explosion takes place practically against a blank or closed wall, or in other words, the combustion chamber is completely cut off from communication with the compression cylinder or chamber when the explosion of each charge ensues under normal running or operation of the motor. This is one of the important features of the improvement and the advantages incident thereto are chiefly the obstruction to strain on the working parts and the practical escape or outflow of all of the motive agent from the compressing cylinder or chamber and the consequent elimination of deleterious residuum in the said compressing cylinder or chamber. Another advantage incident to the explosion of the motive agent exteriorly of the compressing cylinder or chamber in a combustion chamber and causing said explosion to ensue adjacent to the inner end of the delivery spout is the utilization of a greater number of heat units without loss as in the

class of motors having long conducting conduits or channels for the liberation of the exploded motive agent to the turbine elements. It will be seen that in the present improvement the exploded motive agent under the most favorable heat conditions is almost instantly delivered to the turbine elements, and by such mode of delivery there is no appreciable loss of heat units with well understood advantages in operating internal combustion or thermodynamic motors.

On the flanges or flanged extremities 4 of the supports 3 of the turbines, a plurality of turbine elements, preferably in the form of rings or annular sections, are disposed. Some of these rings are movable and intersected by stationary similar devices which serve as guiding means for the discharged exploded motive agent passing from the several spouts 157. The movable turbine elements or rings 161 are three in number and separated by fixed elements or rings 162, and between the movable and fixed elements or rings, suitable packing rings 163 are introduced to form tight joints. The buckets 164 forming part of the elements or rings 161 and 162 are preferably of the form shown by Fig. 14 and are disposed at such angle with relation to each other on the said rings or elements as to be most efficient in rotating the turbine and in fully utilizing the driving force of the exploded motive agent delivered thereto from the spouts 157. The turbine is well balanced and continuously driven when the motor is in operation by the impact of the exploded motive agent against either one or the other of the sets or series of turbine elements or rings engaging the flanged extremities 4, and adjacent to the discharge spouts 157 a movable ring or element 161 is arranged, and the movable and fixed elements alternate toward the innermost movable element from which the motive agent after expending its energy passes into an exhaust chamber 165 common to both sets of turbine elements and completely extending around the turbine between the supports 3 and having an enlarged outlet 166 at its lower portion, as shown by Figs. 1 and 1^a. By locating the exhaust chamber 165 within the center of the motor and providing said chamber with an enlarged ventage or outlet, the turbine movement is not in the least affected by the exhaust, and the continual exhaust of the expended motive agent into said chamber 165 is free to take place entirely around the opposite similar operating portions of the turbine elements without the least restriction or any tendency to backing up or obstructively accumulating in the exhaust chamber 165.

The entire motor organization and particularly the working parts including the pump cylinders, valves, compression and

combustion chambers and the several conduits, ducts and passages, are double-walled or enveloped with chambers which are all intercommunicating for the free circulating of water therethrough to maintain the several mechanisms in cool condition, the water being fed into one end of the motor and discharged at the opposite extremity, as in my former motor. Furthermore, all of the gearing and eccentrics, together with the shafts, will run in oil so as to thoroughly lubricate the same and maintain them in such sensitive operating condition. The frame or supporting structure of the several parts of the motor has not been particularly described, only such portions thereof being specifically referred to in the foregoing description as found necessary in illustrating and describing the position and formation of the valve supports and operating means and to define the walls of the several ducts, passages, channels or conduits. It will therefore be understood that the frame may be modified at will to adapt it to the essential features of construction and arrangement of the valves and channels or conduits.

One of the most effective features of the present construction and which was also embodied in my former motor is a cooling medium introduced in the exhaust chamber 165 and consisting of an annular hollow partition 167 having water supply connections 168 at opposite portions, said connections being also in communication with the chambers surrounding the remaining mechanisms and devices so that a circulation of water is continually maintained in the intermediate cooling medium or partition 167 to lower the temperature of the latter. The exhaust is thrown against the cooling partition 167 and rapidly reduced in temperature and also lowering the temperature of the exhaust chamber 165 to a comparatively low degree and materially assisting in maintaining the entire motor organization in cool condition, especially the turbine elements heretofore explained and which are continually subjected in alternation to a high degree of heat. The degree of heat of the turbine elements will be increased by the rapid rotation of the turbine as a whole, but the cooling partition acting to lower the degree of heat of the exhaust and other means which will now be explained result in the reduction of temperature of the turbine elements with advantages in the durability of the latter. Between the supports 3 and the adjacent cooling partition 167, the exhaust chamber 165 is formed as hereinbefore specified, and this exhaust chamber also serves as an air receiving chamber by the ingress of air thereto from the exterior of the motor through openings 169 formed in the heads of the outer inclosing casing

170. These air ingress openings are so disposed as to cause the air from the exterior of the motor to pass over and between the turbine elements or buckets while the latter are operating, the air being separated from the motive agent passing through the said elements or buckets and flowing into the exhaust chamber 165 and escaping with the exhaust. The casing 170 is removable to give access to the turbine and adjacent parts. By providing the air circulating or cooling means as just explained, the turbine elements are caused to rotate in an air or cooling zone without interfering with the action of the motive agent on the turbine elements, and the air being rapidly drawn out with the exhaust after passing into the combined exhaust and air receiving chamber 165 has a tendency to draw the air inwardly with sufficient force to create a circulation of the air and will result in a continuous displacement of the heated air in the exhaust chamber by incoming cooler air, and thereby maintain a degree of temperature of the air within the casing and adjacent to the turbine elements comparatively low and highly beneficial in reducing the tendency of the turbine elements to become heated to an excessive injurious degree, and when the turbine elements are alternately inactive as driving means or have the motive agent cut off therefrom, the inactive elements will be more rapidly cooled down in the air zone provided by the inflowing air as explained. In the present improvement the cooling partition 167 at its upper extremity 171 does not directly bear or have contact with the intermediate portion of the hub 2, but is projected upwardly close to the said hub as shown by Fig. 1^a so that in the event of sagging or breakdown of the main or turbine shaft 1 the depression of the latter will be reduced to a minimum by the hub coming into contact with the inner portion of the cooling partition encircling the said hub and turbine shaft. In this provision care will be taken, however, in the preliminary structure to provide communication through the partition 167 between the two portions of the exhaust chamber 165 divided by the said cooling partition.

The valve or compressing plunger 25 working in each compression cylinder or chamber 24 may be of any preferred structure adapted for the purpose so long as the annular chamber 137 opening through the bottom thereof and communicating at the opposite portion with the ports 138 has the same relative area as the said latter ports or is of such dimensions as to provide for a rapid clearance or quick outflow of the compressed motive agent through the ports 138 when the latter are in registration with the ports 136 of the cylinder or chamber 24. To facilitate the association of the several parts

of this valve or compressing plunger 25, however, a particularly advantageous construction has been adopted. A rod or stem 21^a is continued from the plunger 22 in the chamber 23 to the valve 25, and the outer end of the said rod is reduced as at 172 and terminally screw-threaded as at 173. By reducing the outer extremity of the rod or stem 21^a a shoulder 174 is formed between the main portion of the rod or stem and its reduced extremity, as clearly shown by Fig. 13. The valve includes in its organization a number of separable parts consisting of a cup 175, a space disk 176, a cylinder 177 which forms the wall of the annular chamber 137, port or bull ring 178 and space ring 179, a securing thimble 180, nuts 181 to engage the screw-threaded extremity 173, and packing rings 182, 183, 184 and 185. The cup 175 and disk 176 are first threaded on the reduced extremity 172, the disk 176 having a sleeve 186 over which the cup is fitted and both the cup and terminal of the sleeve bear against the shoulder 174. A circumferential groove 187 is formed in the cup 175 and is closed at one extremity by the disk 176, the ring 182 being disposed in the said groove. The cylinder 177 has a closed head 188 with a recess 189 in the side thereof adjacent to the disk 176 to receive a boss 190 formed as a part of the disk 176 and operating to center the cylinder, the head 188 of the cylinder also being formed with a central opening 191 to permit the same to be readily applied over the reduced extremity 172. The extremity of the cylinder 177 opposite that having the head 188 is formed with an outwardly projecting circumferential foot flange or shoulder 192, and thereagainst is first placed the packing ring 185 which is held in place by the space ring 179, and following the latter is the packing ring 184 held in place by the port ring 178 and between the said latter port ring and the disk 176 the packing ring 183 is disposed on the cylinder. By this arrangement of the packing, space and port rings are provided for readily replacing the packing rings in event of wear, and, furthermore, said rings may be applied and reliably held without requiring the formation of grooves in the body of the cylinder 177. The packing ring 182 may also be readily applied and replaced, and it will be observed that a tight joint will be at all times preserved between the valve or compressing plunger 25 and the wall of the cylinder or compressing chamber 24, and the rectification of any irregularity due to an impositive action of the packing rings may be readily accomplished. After the cylinder 177 with the rings applied thereto as specified has been threaded over the reduced extremity 172, the securing thimble 180 is also applied over said extremity and the nuts 181 then turned on the screw-threaded

end 173 to tightly associate all of the parts by forcing the inner end of the said thimble against the head 188 of the cylinder 177. The inner end of the thimble 180 is flared and provided with an outwardly curved wall as at 193 which registers with the inner terminals of the ports or elongated outlet slots 138 to insure an unretarded release of the compressed motive agent. The port ring 178 is circumferentially slotted as at 178^a, see Fig. 11, to register with the ports 138 and 136 respectively formed in the cylinder 177 and chamber or cylinder 24, said port ring in practice being of harder material or more durable than the cylinder 177 and also capable of adjustment or shifting movement on said cylinder to modify the dimensions of the ports 138 to compensate for the pressure to which the motive agent is subjected and thereby permit the use of different motive agents without materially affecting the valve structure. The port or bull ring 178 may also be replaced at any time found necessary by a similar device with advantageous economy in the use of the compressing valves or plungers.

The packing rings used in connection with the several mechanisms, particularly where the latter are subjected to a high degree of temperature, will be of the most approved type and are preferably what are known as eccentric rings or those having the inner and outer circumferences eccentrically arranged so as to accommodate considerable expansion and contraction of the parts with which said rings are used without liability of leakage.

The circular frame 36 is inclosed within the shell 37 by the means hereinbefore explained and the eccentric 45, eccentric strap 46, piston rods 47 and 48 and pistons 50 are all lubricated under the splash system by oil introduced within the frame and prevented from leaking by the stuffing box 38^a hereinbefore described in the sleeve 38. By this means the said movable parts are rendered sensitive in their operation or will not become dry by reason of lack of lubrication. It is also proposed to introduce at points found necessary sound deadening means, and as one particular instance of this, the stops 36^a will be provided with a suitable buffing material such as leather, and the projection or abutment 37^a will be likewise equipped so as to reduce wear on the stops and relieve the latter of pounding action or noise. Furthermore the stops 36^a are so positioned relatively to the projection or abutment 37^a that the frame 36 will be shifted around when released by the dog 70 through the medium of the springs 57 just far enough to effect a clearance with relation to the dog but in a position to effect an instant engagement of the dog with the block 63 without the least lost motion and thereby insure a continuance of the cycle of com-

pression and explosion of the motive agent in either group of compression and explosion chambers at the point where a cessation of such operations ensued when the frame was released and shifted.

Another special advantage of the foregoing construction is the disposition of the eccentric rings 140 on the chamber 24 at opposite points relatively to the ports 136 and the engagement of said rings with the faces 142 of the ring or extension 141 and whereby leakage of the motive agent is completely obstructed irrespective of the expansion of the ring or extension 141. These eccentric rings are of a highly resilient character and automatically expand through the medium of their resiliency to compensate for any modification of the expansion of the said ring or extension 141 and likewise resume a normal position when the said ring or extension contracts.

From the foregoing the operation of the motor will be readily understood, but to summarize the same in its broadest aspect, the pumps, compression and combustion chambers of the two sections A and B alternately coact in delivering the motive agent in exploded and highly heated condition tangentially through the spouts 157 to the respective turbine elements nearest to the sections, and while one section and its turbine elements are inactive as driving means and cooling down, the other section and its turbine elements are regularly working except when the motor races or attains an excessive speed, but under normal conditions the desired speed is maintained to rotate the two shafts 5 which may be projected any suitable distance outwardly from the opposite ends of the motor and provided with transmitting means for driving electrical generators or other mechanisms, and by such operation the degree of efficiency of motors of this type or of any other class of engines to which the same principle is applicable will be materially increased, not only from a standpoint of constancy in high speed and driving power, but also in preventing deterioration of the structural parts of the motor and thus materially reduce the cost of maintaining high speed turbines in commercially practical condition.

The governor 91 used in connection with the motor as hereinbefore explained is the well known form of centrifugally acting ball governor, and likewise the timer 102 is well known in the art of motors of the internal combustion type embodying sparking plugs. These two mechanisms may be replaced by any other similar devices having a different construction, the successful operation of the motor not being dependent upon any particular type of governor or timer. The use of six pumps and the corresponding number of compression and combustion

chambers is not imperative and it is proposed to modify the number of these mechanisms as may be desired and in proportion to the general dimensions of the motor and the maximum horse power that may be required.

What is claimed as new is:

1. A motor of the class described having potential and kinetic energy generating means, distinct rotor devices with which portions of the generating means cooperate independently and mechanism controlling the delivery of a motive agent to different portions of the generating means, said means comprising compression and combustion chambers, the latter being exterior of the compression chamber and provided with means for igniting the motive agent subsequent to closure of the compression chamber and causing an explosion against a closed wall of said compression chamber.

2. A motor of the class described having potential and kinetic energy generating means, distinct rotor devices with which portions of the generating means cooperate independently and mechanism controlling the delivery of a motive agent to different portions of the generating means, said means comprising a compression means having communication with a combustion chamber provided with firing means, the motive agent being expanded under pressure in the combustion chamber and exploded subsequent to closure of the compression means.

3. A motor of the class described having potential and kinetic energy generating means, distinct rotor devices with which portions of the generating means cooperate independently, mechanism controlling the delivery of a motive agent to said generating means, said generating means comprising a motive agent compressing means, and a combustion chamber adjacent to and having communication at intervals with the compressing means, the motive agent being exploded in said combustion chamber subsequently to its liberation from the compressing means.

4. A motor of the class described having potential and kinetic energy generating means, distinct rotor devices with which portions of the generating means cooperate independently, mechanism controlling the delivery of a motive agent to said generating means, said generating means comprising a motive agent compressing means, and a combustion chamber adjacent to and communicating at intervals with the compressing means and provided with igniting means in close relation to the generating means for igniting a charge of the explosive medium subsequently to its liberation from the compressing means and delivering it in highly heated condition to the generating means.

5. A motor of the class described having

potential and kinetic energy generating means, distinct rotor devices with which portions of the generating means cooperate independently, mechanism controlling the delivery of a motive agent to different portions of the generating means, said latter means comprising compressing means, and means for igniting a charge of the motive agent under pressure subsequent to its liberation from said compressing means.

6. A motor of the class described having potential and kinetic energy generating means, distinct rotor devices with which portions of the generating means cooperate independently, said generating means comprising compression means for a motive agent, and a combustion chamber adjacent to and exterior of the compression means into which the motive agent under pressure is expanded and fired.

7. A motor of the class described having structurally independent rotor means, motive agent compression means, and combustion means having interval communication with the compression means and provided with igniting means in proximity to the said rotor means, the combustion means being arranged to alternately operate with the structurally independent rotor means.

8. In a motor of the class described, structurally independent rotor means cycling potential and kinetic energy generating means having portions arranged for alternate activity and inactivity, said means comprising mechanism for controlling the supply of motive agent to different portions of the said generating means in alternation and including compression means, and combustion means exterior of and having interval communication with the compression means and provided with igniting means in proximity to the cycling power generating means.

9. In a motor of the class described, structurally independent rotor means cycling potential and kinetic energy generating means, the latter comprising motive agent compression means, and a combustion means exterior of and having interval communication with the latter and provided with firing means, the motive agent being expanded under pressure in the combustion means and exploded subsequent to the closure of the compression means relatively to the combustion means.

10. A thermodynamic motor having a means for igniting a charge of explosive motive agent subsequent to the liberation of the said agent from a compressing means, and distinct rotor devices alternately operated by the compressing and igniting means.

11. A thermodynamic motor having motive agent compression means, and combustion means exterior of and having interval communication with the compression means,

and distinct rotor devices alternately operated by the compressing and igniting means.

12. A thermodynamic motor having motive agent compression means, combustion chambers into which the motive agent from the compression means is expanded under pressure and ignited subsequent to closure of the compression means with relation to said chamber to prevent back fire in the compression means and undue thrust and shock on the latter, and distinct rotor devices which alternately receive the ignited motive agent from the combustion chambers.

13. A thermodynamic motor having distinct motive agent compression and combustion means whereby the motive agent is exploded exteriorly of the compression means, and structurally independent rotor devices with which the compression and combustion means alternately cooperate.

14. A thermodynamic motor having distinct rotor means, motive agent combustion means adjacent and alternately operating in relation to the distinct rotor means, and a motive agent compression means arranged to communicate at intervals with the combustion means.

15. A motor of the class described having distinct rotor means, mechanism controlling the delivery of a motive agent to different portions of the same and including compression and combustion means, the combustion means being exterior of the compression means, and means for automatically shutting off and applying the motive agent from and to the said rotor means and said controlling mechanism to permit different distinct rotor means to become alternately inactive and active and respectively cool down at intervals.

16. A thermodynamic motor having distinct rotor organizations, means controlling the supply of motive agent to said organizations in alternation including compression means provided with combustion means in exterior relation thereto, and means for automatically and successively shutting off the supply of motive agent to the organizations at intervals to cool said organizations.

17. A thermodynamic motor having distinct rotor devices and motive agent supply means including independent compression and combustion means having mechanism for rendering said means alternately active and inactive as to delivery of kinetic energy to said distinct rotor devices to reduce the heated condition of either one of said distinct rotor devices.

18. A thermodynamic motor having driving elements, means for supplying a motive agent to said elements in alternation and including compression chambers and independent combustion chambers, the combustion chambers having igniting devices therein, and means for automatically shutting

off the supply of motive agent to the said elements and compression and combustion chambers and simultaneously rendering the igniting devices inoperative.

5 19. A thermodynamic motor having distinct rotor devices, a series of combustion chambers coöperating with the distinct rotor devices and into which a motive agent under pressure is liberated, and mechanism for controlling the supply of the motive agent to one or more of the combustion chambers and the ignition of said agent when liberated into said chambers.

10 20. A thermodynamic motor having distinct rotor devices, a series of cycling combustion chambers into which a motive agent is liberated and exploded, and mechanism for automatically controlling the supply of the motive agent to one or more of said combustion chambers and either of the distinct rotor devices.

15 21. A thermodynamic motor having distinct rotor devices, independent series of compression chambers having a cycling operation to successively receive a motive agent and having expansion chambers exterior thereof and in communication with the compression chambers at intervals, means in the expansion chambers for igniting the charges of motive agent, and means for controlling the supply of the motive agent to one or more of the compression and expansion chambers.

20 22. A thermodynamic motor having distinct rotor devices, combustion chambers in proximity to and alternately operating with relation to said distinct rotor devices and adapted to receive a motive agent, and mechanism for controlling the explosion of the motive agent in one or more of the combustion chambers.

25 23. A thermodynamic motor having distinct rotor devices, a series of combustion chambers to which a motive agent is supplied and from portions of which kinetic energy is delivered in alternation to the distinct rotor devices, and mechanism for controlling the explosion of the motive agent in one or more of the combustion chambers during a cycle of the latter.

30 24. A thermodynamic motor having distinct rotor means, a series of combustion chambers having motive agent supply means, and mechanism for controlling the explosion of the motive agent in a number of the combustion chambers in alternation relatively to the distinct rotor means in proportion to the load on the motor.

35 25. A thermodynamic motor having means to control the explosion of the motive agent in proportion to the load on the motor, and distinct rotor organizations to which the exploded motive agent is alternately delivered.

40 26. A thermodynamic motor having distinct rotor organizations, motive agent com-

pression and combustion means, and mechanism for controlling the activity of the compression and combustion means alternately in relation to the distinct rotor organizations proportionate to the load on the motor.

70 27. A thermodynamic motor having distinct rotor organizations, motive agent compression and combustion means having a cycling operation, and mechanism for controlling the supply of the motive agent in the said means and for instantly igniting the said agent in the combustion means in timed relation to the cycling operation of the compression and combustion means to deliver an exploded motive agent from different portions of the said means alternately to the distinct rotor organizations.

75 28. A thermodynamic motor comprising distinct rotor devices, means to impose kinetic energy established by the explosion of a motive agent on said rotor devices in alternation, and automatically operating means for regulating the imposition of said energy on the rotor devices in proportion to the load on the motor.

80 29. A thermodynamic motor having distinct rotor devices, means for giving a motive agent potential energy and for converting the latter into kinetic energy and delivering the said kinetic energy alternately to the rotor devices, and means automatically controlling the generation of the potential and kinetic energies in proportion to the load on the motor.

85 30. A thermodynamic motor having distinct rotor devices, motive agent compression and combustion means grouped to cause independent groups thereof to operate in alternation with relation to the distinct rotor devices, speed governing means, and automatically operating mechanism for controlling the activity of the compression and combustion means proportionate to the speed of the motor.

90 31. A thermodynamic motor having distinct rotor devices actuated by the explosion of the motive agent, and mechanism for controlling the explosion of the motive agent and delivery of the latter in alternation to the distinct rotor devices in proportion to the speed of the motor and also the load on the motor.

95 32. A thermodynamic motor having distinct rotor devices, automatically operating motive agent supply, compression and combustion means, and automatically operating mechanism for controlling the inlet of the motive agent through the supply means and delivery to the distinct rotor devices in alternation proportionate to the speed of the motor and also the load on the motor.

100 33. A thermodynamic motor having distinct rotor devices, a motive agent supply means having valves, motive agent compression and combustion means having interval

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communication with the supply means, and mechanism for controlling the activity of the supply, compression and combustion means relatively to the distinct rotor devices and proportionate to the speed of the motor and also to the load on the latter.

34. A thermodynamic motor having distinct rotor devices, motive agent supply means having valves opened at intervals, motive agent compression and combustion means, speed governing means, and mechanism operated by the speed governing means for controlling the activity of the supply, compression and combustion means relatively to the distinct rotor devices in alternation.

35. A thermodynamic motor having distinct rotor devices, mechanism for controlling the supply of motive agent to the rotor devices in alternation, speed governing means, and means controlled by the speed governing means for regulating the admission of the motive agent to the supply mechanism in accordance with the speed of the motor.

36. A thermodynamic motor having distinct rotor devices, motive agent supply means having a cycling operation and provided with valves, means for opening the valves in sequence, compression and combustion means associated with the supply means and having a cycling operation and delivering the motive agent in alternation to the distinct rotor devices, and mechanism for controlling the actuation of the said valve opening means proportionate to the speed of the motor and the load on the latter.

37. In a motor of the class described, duplicate rotor organizations, governor means cooperating with the rotor organizations, and automatically operating mechanism controlling the admission of motive agent to the rotor organizations in alternation and having devices operatively associated with the governor means to regulate the quantity of motive agent admitted and the activity of the rotor organizations in proportion to the speed of the motor and the load on the latter.

38. In a motor of the class described, rotor organizations, means for applying and shutting off a motive agent in alternation relatively thereto and having a cycling operation, and mechanism for automatically cutting off and continuing the supply of motive agent to said means in quantities proportionate to the excessive speed of the motor and variation of the load on the latter.

39. In a motor of the class described, potential and kinetic energy generating means including means for applying and shutting off a motive agent thereto and power shafts which extend from different portions of the said generating means, governor means and mechanism mounted on and operated

by the power shafts to regularly supply the motive agent to the generating means and including devices connected to the governor means for shifting the said supply regulating mechanism to cut out portions of the generating means in the event of excessive speed of the motor and variation of load on the latter.

40. In a motor of the class described, potential and kinetic energy generating means including means for applying and shutting off a motive agent thereto, the generating means having portions operating in alternation and provided with independent power shafts, governor means, shiftable mechanism mounted on each power shaft and controlling the regular supply of the motive agent to the portions of the generating means operating in alternation, and devices loosely disposed on the power shafts and connected to the governor means and also to said shiftable mechanism for regulating the operation of the generating means in accordance with the speed of the motor and the load on the latter and automatically continuing the regular operation of the motor on the normal resumption of speed without checking the timed actuation of the several parts of the generating means.

41. In a motor of the class described, potential and kinetic energy generating means including means for applying and shutting off a motive agent thereto in alternation relatively to different portions of said generating means, the generating means being also provided with independent power shafts, governor means uniformly influenced from both power shafts, shiftable mechanism mounted on and actuated by each power shaft and controlling the regular supply of the motive agent to different portions of the generating means in alternation, and devices loosely disposed on the power shafts and connected to the governor means and also to said shiftable mechanism for controlling the supply of the motive agent to portions of the generating means in alternation under normal conditions and also operating to regulate the supply of the motive agent to the generating means in accordance with the speed of the motor and the load on the latter.

42. In a motor of the class described, structurally independent rotor organizations, means for applying and shutting off a motive agent to the rotor organizations in alternation, and automatically operating mechanism for controlling the quantity of the motive agent supplied to the different portions of the rotor organizations under normal speed conditions and for automatically shutting off the supply of motive agent to either of the rotor organizations in the event of excessive speed of the motor and variation of load on the motor without

checking the timed actuation of the rotor organizations.

43. In a motor of the class described, structurally independent rotor organizations, means for applying and shutting off a motive agent to the rotor organizations different portions thereof in alternation, electrical devices for exploding the motive agent and including a timer in circuit therewith, and mechanism for controlling the regular supply of the motive agent to the rotor organizations under normal speed conditions and actuating the said timer relative to the regular supply of the motive agent and also for automatically shutting off the supply of motive agent to either of the rotor organizations in the event of excessive speed of the motor in alternation.

44. In a motor of the class described, potential and kinetic energy generating means including means for applying and shutting off a motive agent to different portions thereof in alternation and for regularly resolving the said agent into kinetic energy, and mechanism operated by and in timed relation to the generating means and for controlling the regular supply of the motive agent to the different portions of the generating means under normal speed conditions and for automatically shutting off the supply of motive agent to a part of or all of the different portions of the generating means in the event of excessive speed of the motor.

45. In a motor of the class described, potential and kinetic energy generating means including means for applying and shutting off a motive agent to different portions of the generating means in alternation, and mechanism operated by and in timed relation to the generating means for controlling the regular supply of the motive agent to different portions of the generating means under normal speed conditions and including means for automatically releasing a part of said mechanism to shut off the supply of motive agent to a part or all of the different portions of the generating means in the event of excessive speed of the motor.

46. In a motor of the class described, potential and kinetic energy generating means including means for applying a motive agent to different portions thereof in alternation and also provided with power shafts, and a controller mounted on each shaft and consisting of a frame having reciprocating devices for regularly operating the inlet means for the motive agent and actuated by and automatically shiftable on the shaft, and means loosely carried by the shaft and provided with a device for separably engaging a part of the frame to draw the latter into normal position to regularly feed the motive agent to the generating means.

47. In a motor of the class described, po-

tential and kinetic energy generating means including means for applying a motive agent to different portions of the same and provided with power shafts, and means for preventing end-thrust of the shafts and consisting of a sleeve slidably mounted on each shaft and having one terminal engaging a projecting means on the shaft, the opposite terminal of the sleeve having a screw-threaded head, an annular worm gear engaging the screw-threaded head of the sleeve, and a shaft having an intermediate worm held in continual mesh with the worm gear.

48. In a motor of the class described, potential and kinetic energy generating means including motive agent compression and combustion means, the combustion means consisting of two sections, one of the sections being provided with a terminal spout at its inner extremity and an igniting device in a contracted passage thereof, and the other section provided with an expansion chamber and an annular extension continuing into said chamber, and the compression means having a body which is inserted through the said annular extension and provided with a plunger or valve controlling communication of the compression means with the combustion means, the sections of the combustion means being forced into tight engagement by the insertion of the body of the compression means through the annular extension of one of the sections.

49. In a motor of the class described, potential and kinetic energy generating means including a motive agent compression and combustion means, the combustion means being composed of sections which are separately inserted in the motor in incomplete association, and the compression means having a body which is inserted through one of the sections of the combustion means to draw both sections in close assembled relation.

50. In a motor of the class described, potential and kinetic energy generating means including a turbine and motive agent compression and combustion means, the combustion means being structurally independent of the compression means and having a part of the latter inserted therethrough to dispose the said combustion means in operative relation to the turbine.

51. In a motor of the class described, potential and kinetic energy generating means including a turbine and motive agent compression and combustion means, the combustion means being structurally independent of the compression means and comprising an expansion chamber, a contracted passage, an outlet spout at an angle to the passage, and an igniting device in the inner terminal of the passage close to the inlet extremity of the spout.

52. In a motor of the class described, potential and kinetic energy generating means including a turbine and motive agent compression and combustion means, the compression and combustion means being structurally independent and a portion of the compression means inserted through a part of the combustion means and having ports communicating with the latter, and a reciprocating valve having compressing operation in the compression means and alternately opening and closing communication between the compression and combustion means.

53. In a motor of the class described, potential and kinetic energy generating means including a motive agent compression and combustion means, the compression means having a reciprocating compressing valve mounted therein and embodying a stem, a cup, a disk with a sleeve applied to the cup, a cylindrical body associated with the disk, alternately arranged packing and space rings removably applied over the outer surface of the cylindrical body, a packing ring between the disk and cup, a thimble applied over the stem against the inner extremity of the cylindrical body, the latter having ports formed therein, and means removably engaging the outer extremity of the stem for securing the thimble against the cylindrical body and tightly associating all the parts of the valve, the valve having an annular chamber formed therein around the thimble and securing means and opening fully through the outer end of the cylindrical body and also fully communicating with the said ports.

54. A thermodynamic motor having a plurality of combustion means arranged in alternating cycling groups, and means to automatically shut off the motive agent relatively to a part or the whole of each group as the load may require.

55. A thermodynamic motor involving a plurality of compression means having combustion means exterior thereof, the compression and combustion means arranged in groups and having an alternating cycling operation, and means automatically operating to shut off the motive agent from one or more of the groups of the compression and combustion means as the load may require.

56. A thermodynamic motor having controlling and governor means, the controlling means comprising a plurality of plungers radially arranged in an automatically shiftable frame, a mixing chamber, a plurality of pumps having inlet and outlet valves, means actuated by the plungers of the controlling means for opening the inlet valves, compression and combustion means, and turbine devices, the controlling means

regulating the amount of motive agent that flows from the mixing chamber into the pumps and compression and combustion means as the load on the motor may require.

57. A thermodynamic motor having distinct rotor devices, groups of combustion chambers into which a motive agent is liberated and exploded and from which the exploded motive agent is delivered in alternation to the rotor devices, and mechanism for controlling the supply of motive agent to one or more of said combustion chambers of each group to economize in the use of the motive agent relatively to the load on the motor.

58. A thermodynamic motor having distinct rotor device, groups of combustion chambers to which a motive agent is supplied and from which said agent is delivered to the distinct rotor devices, and mechanism for controlling the explosion of the motive agent in one or more of the combustion chambers of each group during a cycle of the latter to economize in the use of the motive agent in accordance with the speed of the motor and the load on the latter.

59. A thermodynamic motor having potential and kinetic energy generating means, a combustion chamber having an extension, a compression chamber having ports at intermediate points and fitted in the extension of the combustion chamber, and means interposed between the portions of the said extension and the compression chamber on opposite sides of the ports in the latter chamber to compensate for expansion and contraction and obviate leakage of the motive agent.

60. A thermodynamic motor having potential and kinetic energy generating means, a combustion chamber, a compression chamber fitted in a part of the combustion chamber and having ports communicating with the latter, and means interposed between the engaged portions of the combustion and compression chambers to compensate for expansion and contraction.

61. In a thermodynamic motor, means for compressing and exploding a motive agent, and means for controlling the supply of motive agent to the compressing and exploding means and involving an inclosing casing having a sleeve projecting therefrom with a stuffing box therein, a shaft extending through said sleeve and stuffing box, and a frame shiftable around said shaft and provided with a plurality of movable devices, the frame and movable devices running in oil and operating under the splash system.

62. In a thermodynamic motor, a plurality of compression chambers each having a compressing valve reciprocatingly mounted therein, each chamber and its valve hav-

ing outlet ports and the valve provided with
a port ring having slots therein to register
with the ports and shiftable to change the
dimensions of the ports, and means for sup-
5 plying the compression chambers with a
motive agent.

In testimony whereof I have hereunto set

my hand in presence of two subscribing wit-
nesses.

LEWIS A. HAINES.

Witnesses:

CHAS. S. HYER,
SADIE E. WHITE.