L. A. HAINES.

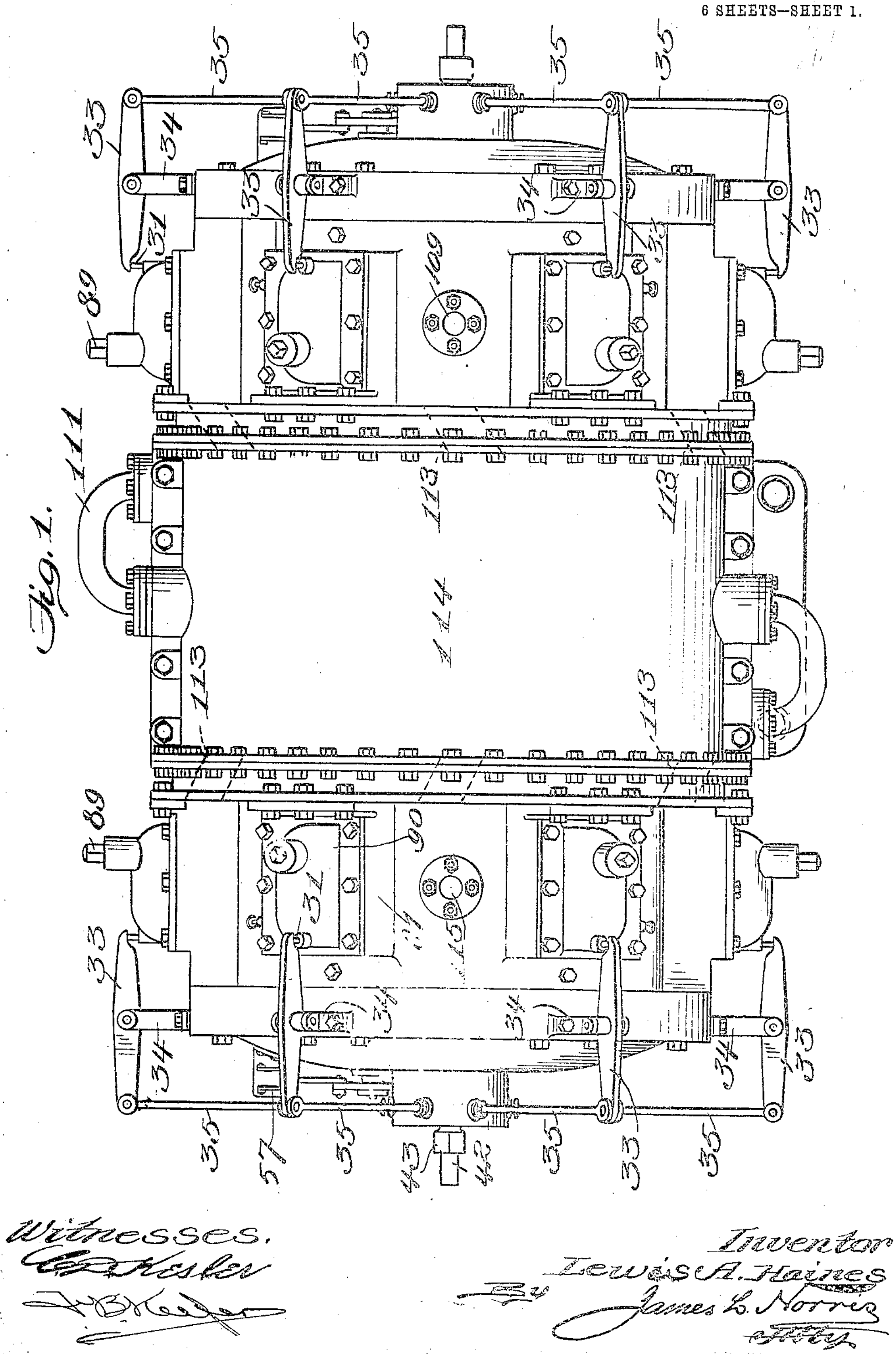
THERMODYNAMIC MOTOR.

APPLICATION FILED AUG. 3, 1908.

1,037,757.

Patented Sept. 3, 1912.

6 SHEETS—SHEET 1.



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6 SHEETS—SHEET 2.

Fig. 4.

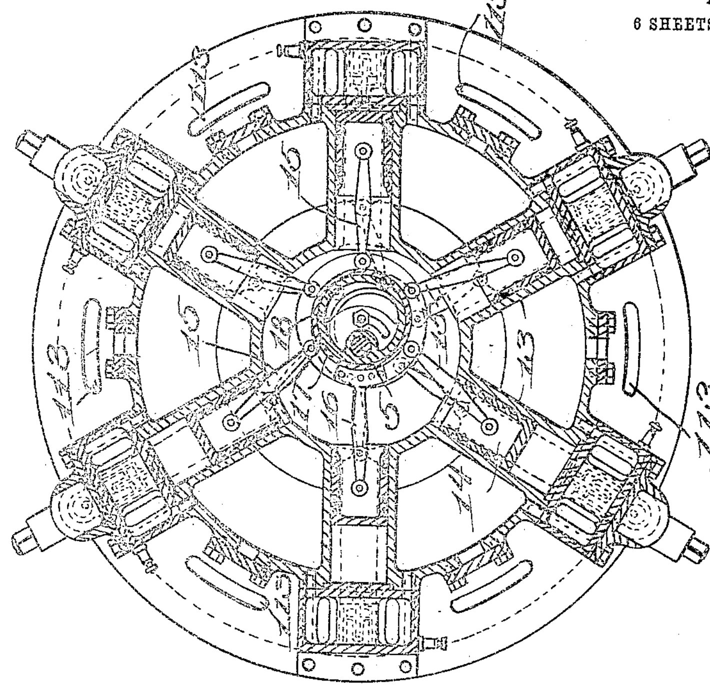
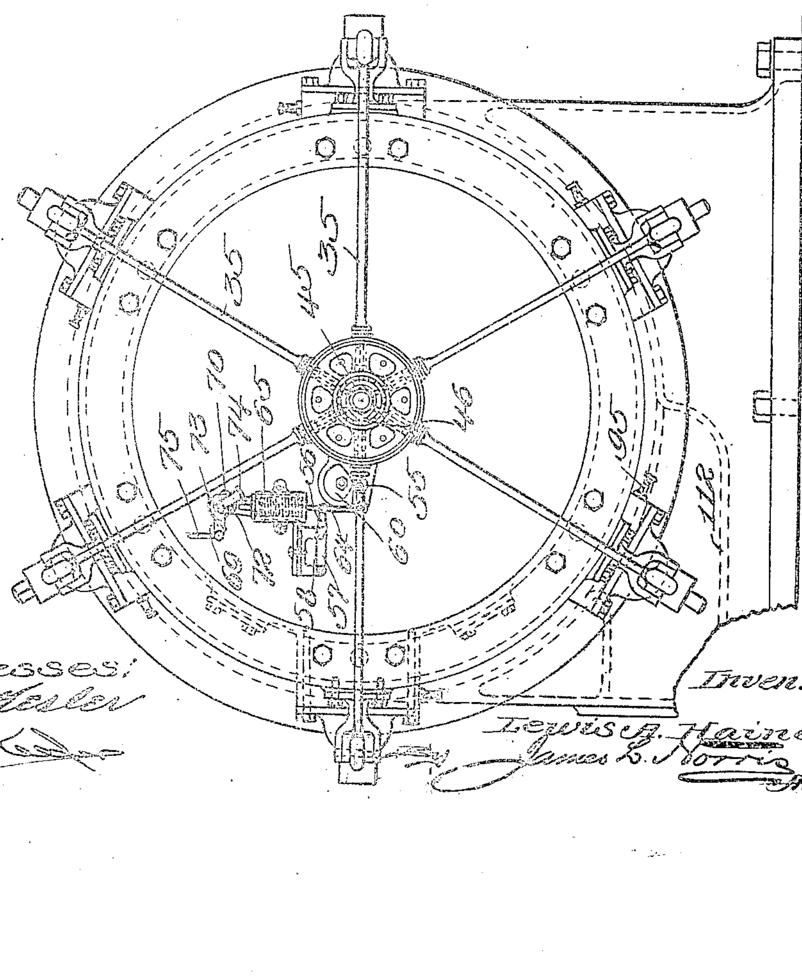


Fig. 2.



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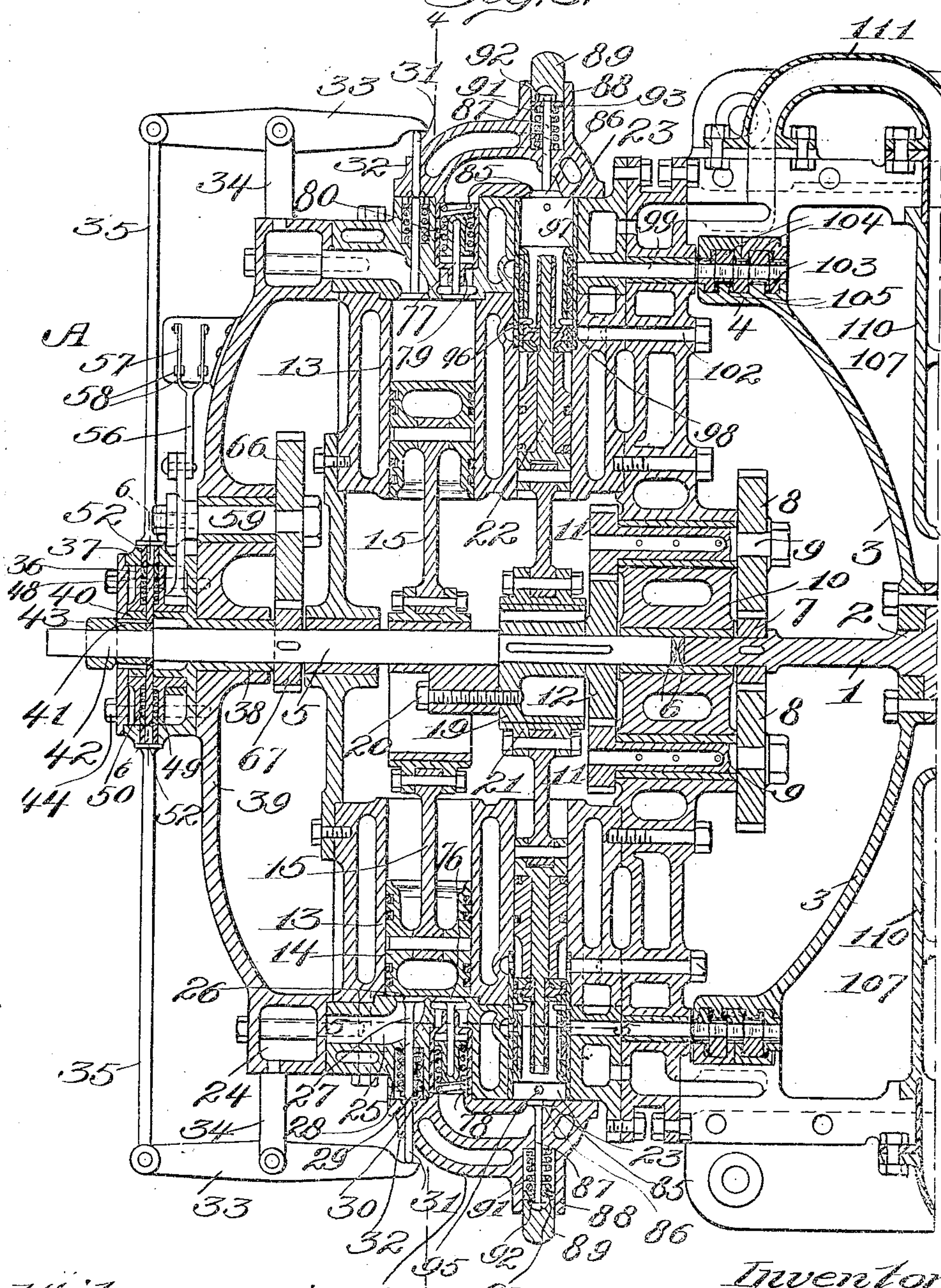
6 SHEETS—SHEET 3.

Fig. 3.



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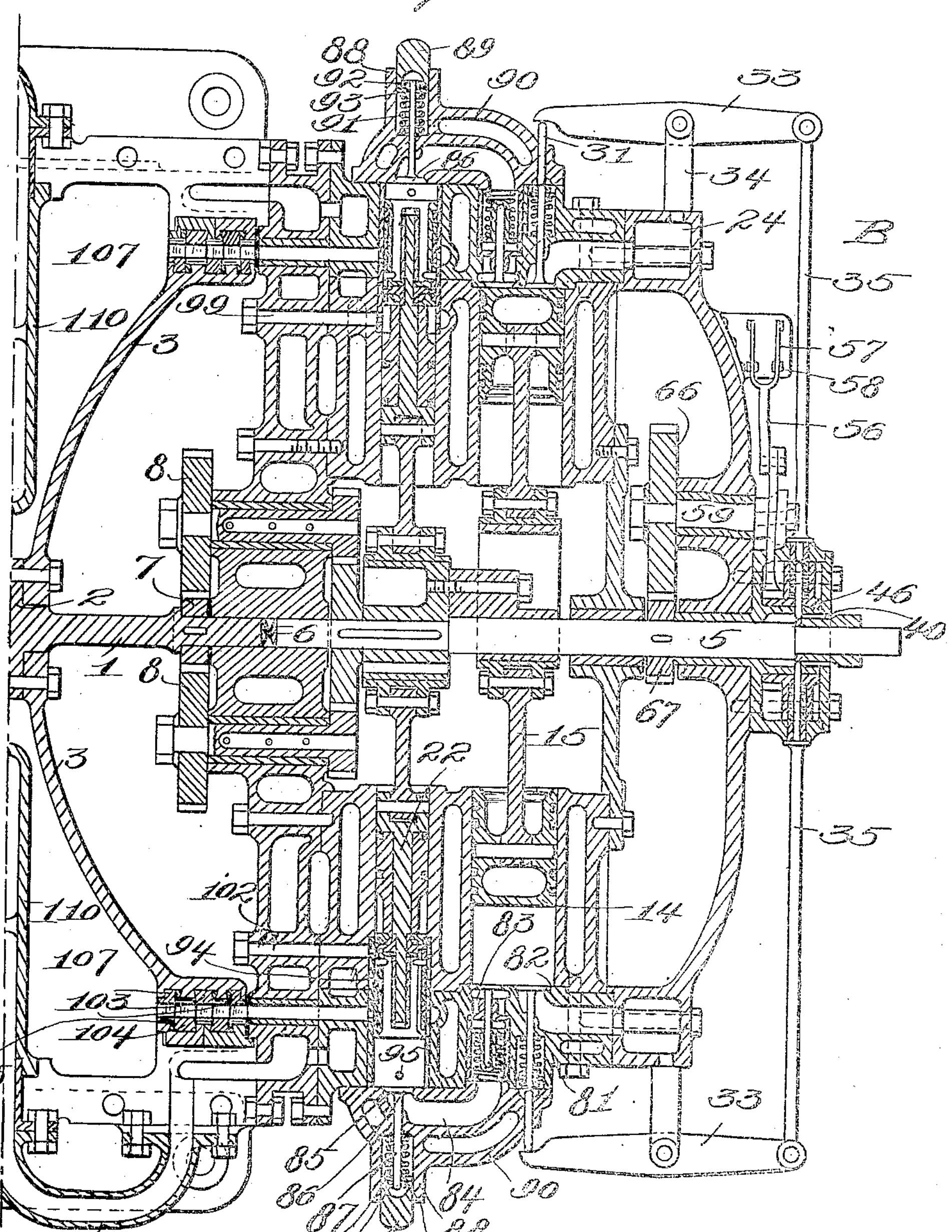
6 SHEETS—SHEET 4.

Fig. 3a



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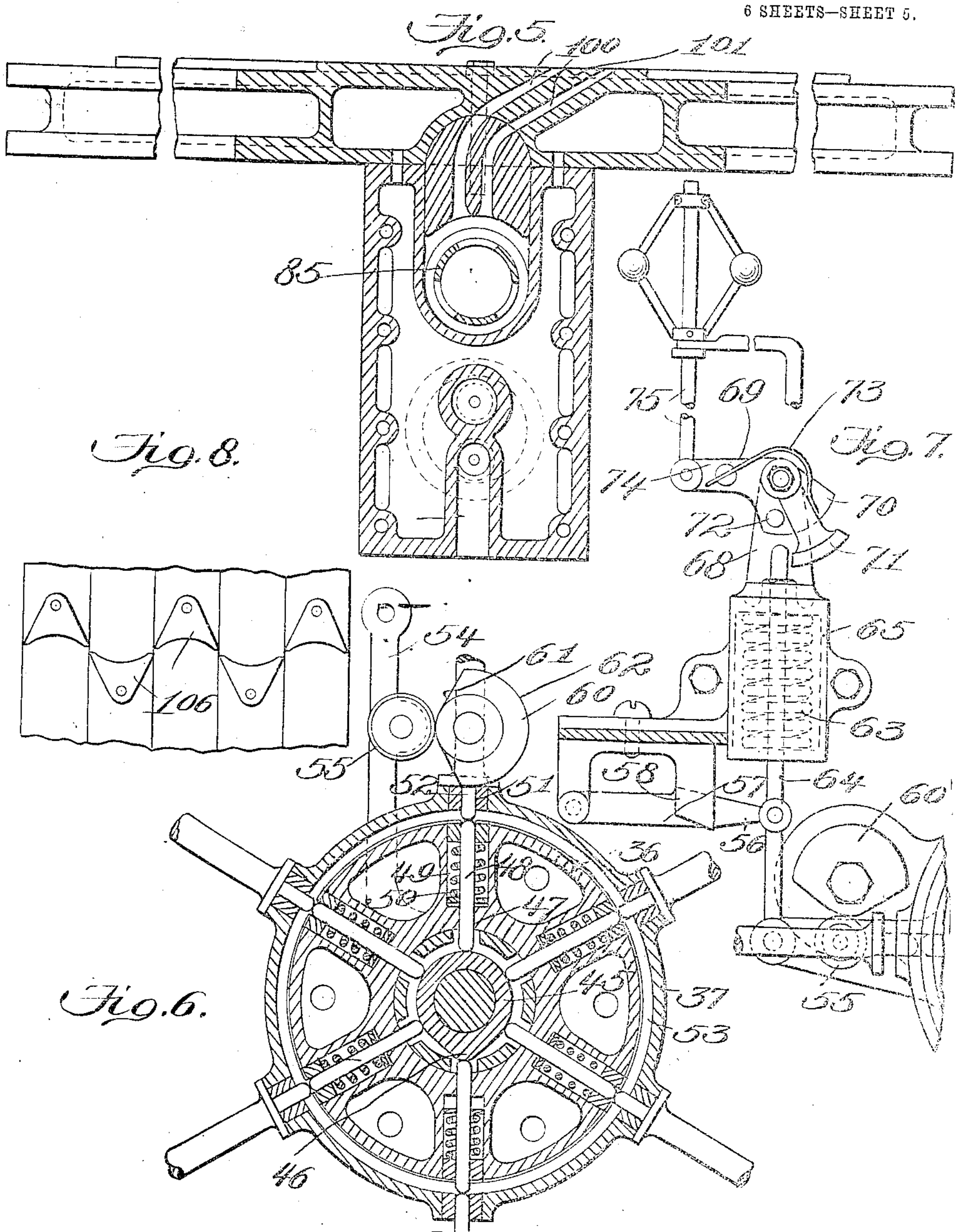
6 SHEETS—SHEET 5.



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6 SHEETS—SHEET 6.

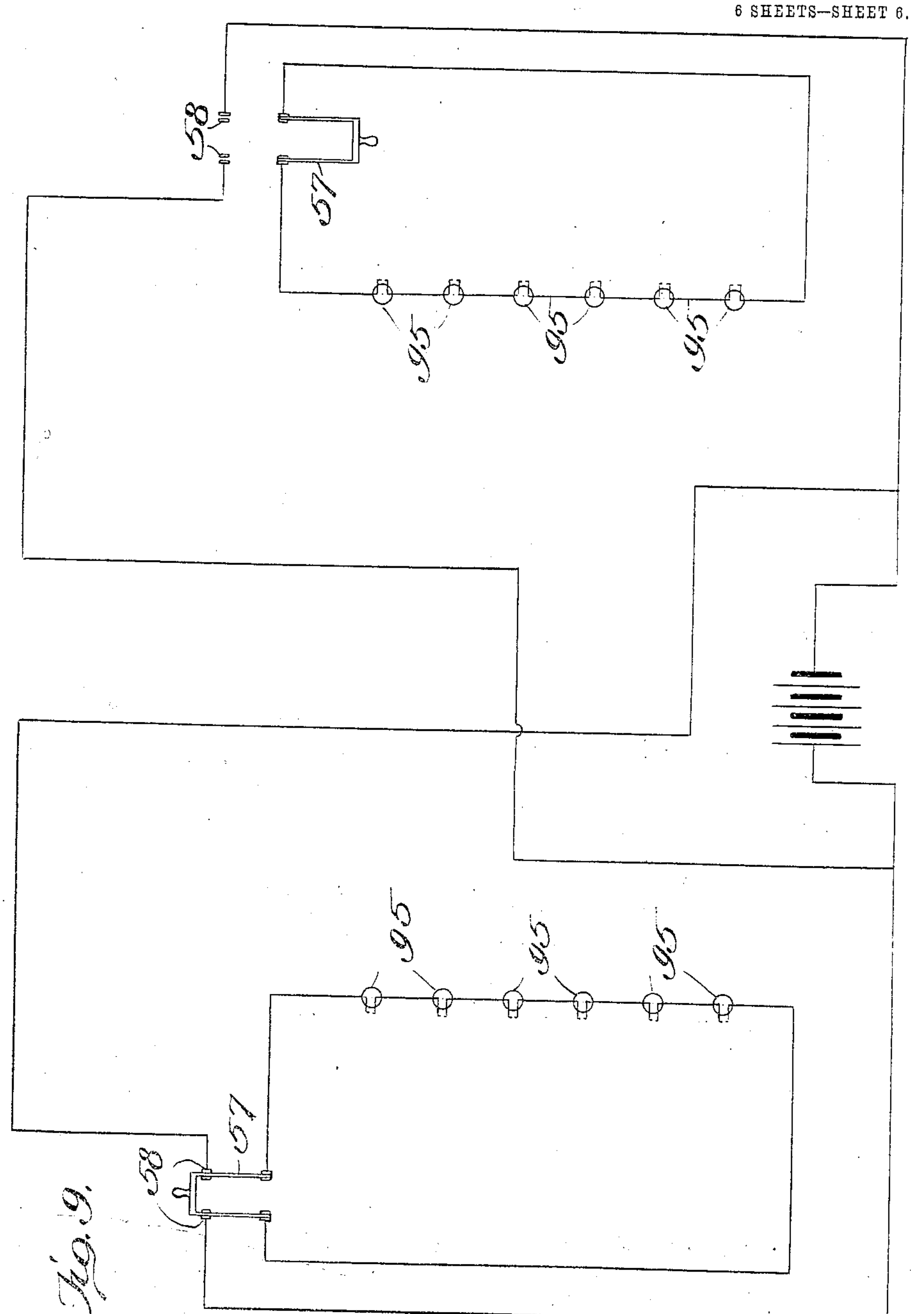

Fig. 9.

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UNITED STATES PATENT OFFICE.

LEWIS A. HAINES, OF MOUNT VERNON, OHIO, ASSIGNOR TO HAINES THERMO DYNAMIC MOTOR COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF WEST VIRGINIA.

THERMODYNAMIC MOTOR.

1,037,757. Specification of Letters Patent. Patented Sept. 3, 1912.

Application filed August 3, 1908. Serial No. 446,640.

To all whom it may concern:

Be it known that I, Lewis A. Haines, a citizen of the United States, residing at Mount Vernon, in the county of Knox 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 thermo-dynamic motor and is preferably embodied in that class of engines known as turbines of the internal combustion type, though the essential principle of operation may be equally well utilized or carried out in other classes of engines wherein it may be found necessary at intervals to permit a part of the working organization to cool down without deteriorating the rotative effectiveness and generated driving power of such engines.

It is essential in engines of the turbine class using an explosive motive agent and wherein a highly heated condition of the driving elements results by a continual contact of the motive agent therewith, that the temperature of the said elements be controlled to such an extent as to obviate and prevent molecular disintegration and structural deterioration of the buckets, vanes or analogous driving means constituting the turbine driving elements to maintain a practical operation of the said elements and render them commercially valuable from a standpoint of structural economy. This temperature control, however, must be practised without causing a fluctuation or an intermittence in the constancy of actuation of the driving elements, and it is also necessary under these conditions to so regulate the supply of motive agent and its explosion that the generation of potential energy and the instant resolving of the latter into kinetic energy will be uniformly maintained without the least waste or irregular supply of the motive agent.

The reduction of temperature of the driving elements of a motor in alternation in relation to different parts of said elements and without modifying the constancy of operation of the driving elements is a primal feature of the present invention, and secondarily the control and regulation of supply to various parts of the motor of the motive agent and the explosion of the latter at predetermined intervals conjointly with the reduction of temperature and as practised in the present motor are characteristics which render it possible to continuously operate the driving elements at a high rate of speed with obvious advantages in the driving power of the motor for various uses and particularly in applications to electrical generators and analogous electrical apparatus.

The invention in its broadest sense consists of a motor having power generating means or elements, mechanism controlling the delivery of a heated motive agent to the power generating means, and means for automatically shutting off the motive agent at intervals from portions of the power generating means without cessation of movement of the latter to permit said portions to cool down.

The invention further consists of a motor having power generating means, mechanism controlling the delivery of the motive agent to different portions of the power generating means, and means for automatically shutting off and applying the motive agent from and to the power generating means to permit different portions of the latter to become alternately inactive and active as a driving means and respectively cool down at intervals.

The invention further consists of a motor having power generating means, and automatically operating mechanism for alternately applying and shutting off a motive agent to and from different portions of the said generating means to render the latter respectively inactive and active in part as a drive means at intervals and permit the inactive part to cool down while the active part coöperating therewith is driving the inactive part and generating power.

The invention further consists of a thermo-dynamic motor of the internal combustion type provided with related driving and motive agent supply means, and having mechanism for rendering portions thereof alternately active and inactive to reduce the heated condition of the inactive parts.

The invention still further consists of a thermo-dynamic motor having driving elements, means for supplying a motive agent to said elements in alternation and including combustion mechanism under electric control, and means for automatically shutting off the supply of motive agent at intervals and simultaneously electrically de-energizing a portion of said combustion mechanism.

The invention specifically consists also in certain combinations and subcombinations of elements which will be particularly referred to in preferred form in the subjoined description and subject to modification as to equivalent structures fairly falling within the scope of the invention, 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 controlling principle and essential features of the invention, but it will be understood that the invention is not limited to this precise machine or to the specific structural features which will be hereinafter enumerated.

In the drawings: Figure 1 is an elevation of a motor embodying the features of the invention. Fig. 2 is an end elevation of the same. Fig. 3 is a longitudinal vertical section of one half of the motor. Fig. 3A is a similar view of the remaining half of the motor. Fig. 4 is a transverse vertical section taken in the plane of the line 4—4, Fig. 3. Fig. 5 is a horizontal section taken in the plane of the line 5—5 of Fig. 3. Fig. 6 is a transverse section taken in the plane of the line 6—6 of Fig. 3. Fig. 7 is a detail sectional elevation of a part of the timing mechanism and the governing mechanism. Fig. 8 is a plan view of portions of the turbine elements showing the arrangement of the buckets. Fig. 9 is a diagrammatic view of the electrical connections for the two sets of sparking plugs.

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 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 interrelated mechanisms for mechanically controlling explosion and delivery of the motive agent to the turbine driving element 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 terminal 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 two sets of pumps and explosion devices and insure constancy in the accumulation of potential energy and delivery of kinetic energy to the turbine driving elements and thereby avoid also extra 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 the 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, and exactly corresponding in dimensions and number of teeth to the pinion 7. The pinions 11 are held in continual mesh with a gear 12 keyed to the shaft 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 proportions or ratio of speed is 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 hollow piston 14 and a corresponding number of piston rods 15 and 16, the one 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 strap 17 and at its outer extremity likewise connected within the piston 14, as shown by Fig. 4, the said eccentric strap 17 being applied to an eccentric 18 carried by the shaft 5. The outer extremity of the piston rod 16 is movably connected to the piston 14, but the inner extremity of said piston rod is fast to the eccentric strap to maintain the latter in proper position and against wabbling or to insure a positive operation of said strap by the eccentric 18. It will therefore be understood that the piston rod 16 acts as a holding leg for the eccentric strap 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. An eccentric 19 is also secured on the shaft 5 adjacent to the eccentric 18 and connected to the latter for conjoint operation by bolts 20, the eccentric 19 being engaged by an eccentric strap 21 to which are movably attached a series of radially arranged plungers 22 reciprocatingly mounted in compression or explosion chambers 23 corresponding in number to the pumps. The eccentric 18 is set in advance of the eccentric 19 so that the compression or explosion chambers will be sufficiently charged with the motive agent prior to the time that the several plungers 22 reach a full compressing position or exert a degree of compression on the motive agent desired to effect a practical potential energy. In other words, the pumps operate, as will be presently explained, to charge the chambers 23 with the motive agent regularly and sufficiently prior to the time that the several plungers 22 reach the limit of their full compressing movements.

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 supplied at the outer extremity with an annular mixing chamber 24 to which suitable carbureting mechanism may be exteriorly connected, and communicating with this mixing chamber at intervals are inlet passages 25 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 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 coöperating 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 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 24 into the passages 25. 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 not desired to be active in charging the 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 and passages 25 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 in 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 24. 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 projecting extremity of the shaft 5 and coöperating with a timing mechanism. This mechanism comprises an inner circular frame 36, see Fig. 6, which is shiftably disposed or oscillatable within an outer fixed inclosure or shell 37 having a sleeve 38 fitted in the center of the end inclosing head 39 of the motor and having the shaft 5 rotatably extending therethrough, the center of the inclosure or shell being bored out at its outer side and centrally to receive a cam 41 secured on the outer reduced extremity 42 of the shaft 5 and held in place by a nut or analogous device 43, the inclosure or shell 37 being also secured at intervals to the head 39 by bolts 44.

The cam 41 is fixed on the shaft 5 and consists of a sleeve having a single cam projection 46 which rotates closely to the inner surface of the wall 45 of the bored out portion 40 of the inclosure or shell 37, the said wall 46 being circumferentially slotted at intervals, or having in the present instance a series of six slots 47 through which are projected a plurality of radially arranged slide pins 48, which are also movable outwardly through the periphery of the shiftable frame 36. The pins 48 are movable in a corresponding number of radial pockets

49 in which springs 50 are disposed and bear on portions of the pins to normally project the latter inwardly through the slots 47. These slots 47 have such linear extent as to compensate for shifting movement of the frame 36 and the pins 48. The outer ends of the pins 48 are normally within or coincident with the plane of the periphery of the frame 36 and also in radial alinement with openings 51 in the inclosure or shell 37 and through which project terminal pins or extensions 52 on the inner ends of the connecting rods 35. The inner side of the inclosure or shell 37 is formed with a circumferential groove 53 which is intersected by the openings 51, the pins 48 being projectable into this groove when the controller or frame 36 is shifted in a manner which will be presently explained.

From the foregoing it will be understood that there are the same number of slide pins 48 and connecting rods 35 as there are pump cylinders 13, and through the operation of the cam 41 the several pump cylinders in each of the sections A, B, are regularly opened to the mixing chamber 24 in succession so long as the pins 48 are in radial alinement with the projections 52 of the said connecting rods, and by this means the pump cylinders will be charged or supplied with the motive agent by mechanically operating timed means. The controller or frame 36 is shifted or oscillated at intervals within the inclosure or shell 37 through the medium of an arm 54 rigidly connected thereto and carrying a roller 55, see Figs. 2, 6 and 7. The outer end of the arm 54 is movably connected to the inner terminal of the arm 56 of a switch yoke 57 coacting with contacts 58 in electrical connection with a source of electricity and also with the sparking plugs in the explosion chambers and which will be more fully hereinafter explained. Adjacent to the roller 55 and fixed on the outer extremity of a shaft 59 is a cam 60 having peripheral low and high portions 61 and 62, as clearly shown by Fig. 6. The roller 55 is always in contact with some portion of the perimeter of the cam 60, and when the low portion 61 of said cam is in engagement with the roller 55 the shifting frame or controller 36 will be in the position shown by Fig. 6, but when the high portion 62 of said cam is in engagement with the roller 55 the arm 54 will have been pushed laterally and the frame or controller 36 shifted or oscillated within the inclosure 37 to throw the slide pins 48 out of alinement with the projections 52 of the connecting rods 35, and under the latter condition the connecting rods 35 will remain inactive or immovable and the valves 26 will all stand in closed condition and shut off the adjacent pump cylinders from communication with the passages 25 and mixing chamber 24 because the pins 48, though rendered active by the cam 41, simply project into the groove 53 without engaging the projections 52 of the said connecting rods 35. The circumferential groove 53 is deep enough to compensate for the maximum outward movement of the slide pins 48 without the least restriction and the shaft 5 is thus permitted to have unretarded rotation. When the arm 54 is pushed laterally by the high portion 62 of the cam 60 to shift the frame or controller 36, the switch yoke 57 is simultaneously disengaged from the contacts 58, and hence the disengagement of the timing mechanism coöperating with one section, either A or B, simultaneously effects a breaking of the electric circuit in which the sparking plugs of the section affected are included, and thereby the said plugs are electrically deënergized and all liability of sparking of the said plugs and irregular explosions in the compression or explosion chamber is avoided, and, furthermore, the full strength of the electric current from the electrical source is thrown over to the section which is active.

The lateral movement of the arm 54 takes place against the resistance of a spring 63 engaging a rod 64 which is directly connected to the arm 54 and interposed between the latter and the yoke arm 56, as clearly shown by Fig. 2. The spring 63 is located in a box or inclosure 65 secured on the head 39 adjacent to the cam 60 and the rod 64 is movable through the said inclosure or box and when the arm 54 is pushed laterally by the said cam the rod 64 is pulled through the box against and compresses the spring 63 so that when the roller 55 is released or disengaged from the high portion 62 of the cam 60 and is engaged by the low portion 61 of said cam, said arm 54 is gradually forced into normal position by said spring 63 tending to resume its normal condition and thus the shiftable frame or controller 36 will be moved within the inclosure or shell 37 around the outer extremity of the shaft 5 until the pins 48 are in alinement with the projections 52 of the connecting rods 35, the movement of the frame or controller 36 being dependent upon traverse of the low portion of the cam 60 with relation to the roller 55. This restoration of the frame or controller 36 to normal position through the movement of the arm 54 will at the same time again establish engagement of the switch yoke 57 with the contacts 58 and energize the sparking plugs of the section directly affected by the redisposition of the timing mechanism to regularly and successively open the valves 26 of the adjacent pump cylinders. This inactive movement of the frame or controller 36 and the consequent inoperativeness of the connecting rods 35 will be effective in alternation in the two sections A and B, the cams 60 being so arranged that just as the last pump of each series and the explosion chamber and devices coöperating therewith have completed their functions the pumps and explosion chambers of the opposite section will immediately act and thus avoid any intermittence in the operation of the turbine elements or a fluctuation in the generated driving power.

The shaft 59 has a gear 66 on its inner end which is held in continual mesh with a pinion 67 fast on the shaft 5, the proportions of the pinion 67 and gear 66 being about in the ratio of two to one so that one revolution of the pinion 67 will give one-half of a revolution to the gear 66, or, in other words, it will require two revolutions of the shaft 5 to rotate the gear 66 and shaft 59 and to completely revolve the cam 60, and the revolution of the cam is therefore comparatively slow. This slow movement of the cam 60 is adopted and regulated in accordance with the movement of the pistons 14 of the pumps and in proportion to the operation of the eccentric 18 to effect a supply of the motive agent to the pump cylinders and an expulsion from the cylinders of said agent at such intervals as to be most effective in the explosion of predetermined charges of the motive agent or the creation of potential energy and immediate resolving thereof into kinetic energy to actuate the turbine elements without the least fluctuation. The governor mechanism also coöperates with the rod 64 included in the timing organization hereinbefore explained. The upper end of the rod 64 is movable through and normally projects above the top of the inclosure or box 65, and rising from the top of the latter is an upright 68 having a lever 69 fulcrumed thereon and of the bell-crank type, the arm 70 of this lever adjacent to the top inclosure or box 65 carrying a movable locking segment 71 normally held in engagement with a stop 72 secured to the arm of the lever by a spring 73. To the free extremity of the arm 74 of the lever 69 the lower end of a governor staff or rod 75 is movably attached, the said staff or rod forming a part of an ordinary centrifugal governor as shown, and having a rising and falling movement imparted thereto in accordance with the outward or inward swing of the governor arms.

Should the motor attain a speed above normal or in excess of a predetermined rate, it is obvious that through well known interconnected devices the governor arms will be thrown outwardly and by this movement of the latter arms the governor staff or rod 75 will be drawn upwardly and throw the arm 70 of the lever 69 inwardly and the locking segment 71 is shifted inwardly toward the upper end of the rod 64. If the upper end of the rod 64 at the time the locking segment is moved inwardly be projected above the top of the inclosure or box 65 and the segment 71 contact therewith, the said segment will yield owing to the spring 73 engaging the same, and movement of the rod 64 will not be checked. This excess of speed and the consequent inward swing of the segment 71 may take place before the cam 60 has laterally moved the arm 54, and if such position of the parts does exist it is obvious that the swing of the segment 71 will be limited, but the frictional engagement of this segment with the upper projecting end of the rod 64 should be of such minimized degree that the said rod will be free to be moved or pulled downwardly when the cam 60 moves the arm 54. As soon as the rod 64 is moved downwardly the segment 71 is then free to continue its movement inwardly and over the upper end of the inclosure or box 65 and prevent the rod 64 from resuming its normal position or maintain the section so affected without supply of the motive agent, and immediately after the motor resumes normal speed the governor arms will move inwardly and depress the staff or rod 75 and consequently throw the segment 71 away from the top of the inclosure or box 65, the stop 72 then coming into play to positively move the segment in the manner just specified. The moment that the segment 71 clears the top of the inclosure or box 65 the spring 63 throws the rod 64 upwardly, which is permitted in view of the fact that the roller 55 at that time will be in traversing relation to the low part 61 of the cam 60.

The operation of the governor mechanism as just explained is practically instantaneous or a small interval of time only elapses between the excess of speed of the motor and the rectification or reduction of the speed to the normal or predetermined rate, and hence no irregular operation of the timing mechanism coöperating with either section A or B ensues, particularly in view of the slow movement of the cams 60 and also that the segments 71 will not assume locking positions over the inclosures or boxes 65 until the rods 64 have been drawn downwardly by the lateral movement of the arms 54 to shut off the supply of motive medium to the pump cylinders of the sections, and the timing and governor mechanism are both duplicated at opposite ends of the motor, or, in other words, each section is provided with similar mechanisms. Each pump cylinder 13 also has an outlet valve 76 coöperating therewith and provided with a stem 77 movable in a cylinder or casing 78 having a sliding thimble 79 therein to receive the said stem, the thimble working against the resistance of a spring 80 also inclosed within the casing 78. The casing 78 is suitably fitted within the frame of the motor and this particular valve organization is duplicated in connection with each pump cylinder, each valve 76 opening outwardly with relation to its cylinder and in contradistinction to the valve 26 opening inwardly into the cylinder. The valves 26 and 76 together with their stems and coöperating spring devices are arranged in a section 81 suitably constructed for this purpose, said section also having the passages 25 formed therein and extending fully around the series of pumps or applied adjacent to the pump cylinders as shown by Fig. 1. Between the casing 78 and the passage 25 the section 81 is projected as at 82 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 76. Between each casing 78 and the seat for the valve 76 a chamber 83 is provided and has communication through or around the valve casing with a channel or conduit 84 opening fully at one extremity into the casing 78 and at the opposite extremity where a valve seat 85 is formed, communicating with the compression or explosion chamber 23. An inwardly opening valve 86 coöperates with the seat 85 and has an outwardly extending stem 87 movable in a tubular head 88 closed by a plug 89, the said head 88 forming a part of a section 90, the latter also having the channel or conduit 84 formed therein. A spring 91 coöperates with the stem 87 of the valve 86 to normally hold the said valve to its seat and said spring has a tension which is sufficient to resist a certain predetermined pressure of the motive agent within the channel or conduit 84 and which may be regulated at will by removing the plug 89 and tightening up or loosening a nut 92 on the outer end of the stem 87 and bearing against a follower 93 with which one extremity of the spring 91 engages. The motive agent is accumulated within the channel or conduit 84 by successive operations of the plunger 14 in the cylinder 13, the valve 26 controlling the inlet to the chamber 13 being closed by the compressing stroke of the piston 14 and the valve 76 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 84, 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 particularly after a repeated operation of the piston prior to compression movement of the plunger 22.

When the motive agent accumulated in the channel or conduit 84 has a pressure greater than the resistance set up by the spring 91 the valve 86 will be forced open and the motive agent under pressure will enter the compression or explosion chamber 23 just at the instant that the head 94 of the plunger 22 begins its outstroke. At the instant the plunger 94 begins its outstroke, the valve 86 is closed and the motive agent is compressed to a degree in accordance with the limit of the outstroke of the plunger and which compression will be determined when the several elements or components of the motor are organized. Within the outer extremity of the compression chamber 23 is a sparking plug 95 connected up in electrical circuit to a source of electric supply or generation, as shown by Fig. 9, this circuit also including the contacts 58 with which the switch yoke 57 coacts. There will be the same number of compression or explosion chambers 23 as there are pumps in each section A and B, and the several plungers 22 will be timed to move outwardly at an interval in each instance after the pump pistons 14 have completed their charging operations or have accumulated a sufficient charge of the motive agent under pressure within the several channels or conduits 84. Each plunger head 94 is tubular and provided with suitable packing rings, the wall of the head adjacent to its inner extremity being cut through as at 96 to form egress passages which register with outlet openings 97 and 98 respectively located at intermediate and inner portions of the wall of the chamber 23. The openings 97 communicate with a discharge duct 99 which surrounds the chamber and terminates at its inner extremity close to the turbine elements. This duct 99, as shown by Fig. 5, is divided by preference into two outlet spouts 100 separated by a central partition 101 and converging toward their outlet extremities and also deflected at oblique angles in the direction of rotation of the turbine elements.

The outlet spouts 100 have their inner terminals spaced a distance equal to that between the driving buckets or analogous devices carried by the turbine elements and which will be more fully hereinafter described. The opening 98 communicates with a residuum exhaust passage or duct 102 which surrounds the inner extremity of the wall of the chamber 23 and outlets into the inner part of the turbine to permit the exhausted residuum to become dissipated. When the plunger head 94 reaches the limit of its outstroke or completes its compressing action with relation to the motive agent the egress passages or openings 96 will be in registration with the discharge duct 99 and instantly or at a short interval after the full compression the charge will be exploded and the potential energy generated by the explosion of the motive agent will be instantly resolved or converted into kinetic energy which will forcefully escape through the said discharge duct and be delivered to the rotating elements or driving means of the turbine through the spouts 100. While these spouts 100 have been found of practical advantage and preferred in delivering the motive agent resolved into kinetic energy to the rotating elements or buckets of the turbine elements, it will be understood that the motor organization is not limited to this precise means of discharge. It is also proposed to introduce linings and protective inclosures of highly refractory material at all points found necessary to prevent burning out or rapid deterioration of the highly heated walls of the compression or explosion chambers and outlet ducts and which is due to the continual contact with the chambers and ducts of the exploded motive agent. When the plunger head 94 in each chamber 23 reaches the limit of its inner stroke the egress openings 96 will register with the openings 98 and the residuum remaining in each chamber 23 will escape through the exhaust passage 102 into the inner or interior portion of the turbine, as hereinbefore specified. By thus liberating the residuum from the several compression or explosion chambers 23, the charges of motive agent or medium successively admitted to the said chambers will be more effectively exploded and the resolution thereof into kinetic energy will be more uniform and without the least fluctuation or deterioration.

On the flanges or flanged extremities 4 of the supports 3 of the turbine, a plurality of turbine elements are disposed and are preferably in the form of rings or annular sections, a portion of which is movable and intersected by stationary similar devices which serve as guiding means for the spouted or exploded motive agent discharging through the several ducts 99. The movable turbine elements or rings 103 are three in number and separated by fixed elements or rings 104 which rotate with the flanged extremities 4, but are held against movement on the said extremities and between the movable and fixed elements or rings, suitable packing rings 105 are introduced to form tight joints. The buckets 106 forming part of the elements or rings 103 and 104 are preferably of the form shown by Fig. 8 and are disposed at such angles with relation to each other on the 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 ducts 99. 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 ducts 99 a movable element or ring 103 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 107 common to both sets of turbine elements and completely extending around the turbine between the supports 3 and having an enlarged outlet 112 at its lower portion, as indicated by dotted lines in Fig. 2. Though the form of buckets 106 shown is preferred, it will be understood that any other analogous devices might be used. It will be seen that by locating the exhaust chamber 107 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 107 is free to take place entirely around the opposite similar operating portions of the turbine without the least restriction or any tendency to backing up or obstructively accumulating in the exhaust chamber 107.

The entire motor organization and particularly the working parts including the pump cylinders, valves, compression or explosion chambers and the several conduits, ducts and passages, are double-walled or enveloped with chambers which are all intercommunicating for the free circulation of water therethrough to maintain the several mechanisms in cool condition and as particularly shown by Figs. 3 and 4, the water being fed into one end of the motor, as at 115, and discharged at the opposite extremity, as at 109. 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 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.

One of the most effective features of the present construction is a cooling medium introduced in the exhaust chamber 107 and consisting of an annular hollow partition 110 having water supply connections 111 at opposite portions in relation to the remaining water chambers or jacket means, and in the cooling partition 110 a circulation of water is continually maintained. The exhaust is thrown against the cooling partition 110 with advantages in rapidly reducing the temperature thereof and also lowering the temperature of the exhaust chamber to a comparatively low degree and materially assisting in maintaining the entire motor organization in cool condition, but especially the turbine elements heretofore explained and which are continually subjected in alternation to a high degree of heat which would be increased by the rapid rotation of the turbine as a whole but for the cooling partition and other means which will now be explained. Between the supports 3 and the adjacent partition 110 the exhaust chamber 107 is formed as hereinbefore specified, and this exhaust chamber also becomes an air receiving chamber by the ingress of air thereto from the exterior of the motor through openings 113 formed in the heads of an outer inclosing casing 114. These openings permit air to pass between the turbine elements or buckets while the latter are rotating, the air being separated from the motive agent passing through the said elements or buckets, and flowing into the exhaust chamber and escaping with the exhaust. The casing 114 may be removed 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 107 has a tendency to draw the air inwardly sufficiently to create a circulation of the air and which will result in a continuous displacement of the heated air in the exhaust chamber by 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 degree that would be injurious to the turbine buckets, 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.

From the foregoing the operation of the motor will be readily understood, but to summarize the same in its broadest aspect it will be understood that the pumps and explosion chambers of the two sections A and B alternately coact in delivering the motive agent 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 and the desired speed maintained so as to rotate the two shafts 5 from which power may be taken by any suitable 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 and thus materially reduce the cost of maintaining high speed turbines in practical condition.

Having thus described the invention, what is claimed as new, is:

1. A motor of the class described having rotary power generating turbines, mechanism controlling the delivery of a heated motive agent to different portions of the power generating turbines in alternation, the power generating turbines becoming heated by the motive agent, and means for automatically shutting off and applying the motive agent from and to different portions of the power generating turbines to render portions of the latter alternately inactive and active and permit the same to cool down at intervals, the inactive portions of the turbines having the motive agent wholly excluded therefrom while the active portion thereof is supplied with said agent.

2. A motor having rotary power generating turbines embodying separate groups of active elements, mechanism controlling the delivery of a heated motive agent to the groups, the groups of elements becoming heated by the motive agent, and means for completely shutting off the motive agent at intervals from the groups in alternation without fluctuating the operation of the motor as a whole to permit the group relieved of the motive agent to cool down while the remaining group is active.

3. In a motor, power generating turbines having separated groups of revolubly active elements, and means having an automatic operation for alternately applying and shutting off a heated motive agent to and from the groups of active elements in alternation to render one group inactive as a drive means at intervals but revoluble with the active group to permit the inactive group to cool down while the active group is driving.

4. A thermodynamic motor having separate groups of coacting rotary driving elements, each group embodying a plurality of similar elements, means controlling the supply of motive agent successively to the elements of the separate groups in alternation, the elements becoming heated from the motive agent, and means for automatically and successively shutting off the supply of motive agent from the separate groups of elements at intervals to permit said elements to cool.

5. A thermodynamic motor having driving elements arranged in separate groups, means for supplying a motive agent to the groups of elements in alternation including combustion means having electrically con-

trolled ignition devices, and means having electrically controlled ignition devices for automatically shutting off the supply of motive agent from the separate groups of elements at intervals and simultaneously cutting off the combustion means and electrically controlled ignition devices coöperating with the said elements relieved of the motive agent.

6. A thermodynamic motor provided with separate groups of coöperating driving and motive agent supply means and including explosion chambers, the driving means becoming heated from the motive agent, and mechanism for each group of driving and motive agent supply means operating alternately to render the groups active and inactive and permit the inactive group to run free to reduce the heated condition thereof.

7. A motor of the class described having separate groups of rotatable turbine elements, and means for supplying an exploding motive agent and directing the exploded agent alternately against the separate groups of elements to permit a part of the groups of elements to run free at intervals, the groups of turbine elements moving in a zone of low temperature.

8. A motor of the class described having means for regulating the supply of motive agent therethrough, turbine elements with which said motive agent coacts, and means for directing the motive agent at intervals in alternation to different portions of the turbine elements so that immediately it ceases to act on a part of the turbine elements it instantly becomes active on another part of the said elements.

9. A motor of the class described having separate groups of rotating turbine elements against which a heated driving medium is alternately directed, an inclosure for the groups of turbine elements having ventilating means, and a cooling partition interposed between the groups of elements.

10. A motor of the class described having separate groups of rotating turbine means, inclosed chambers in which the said groups of turbine means are disposed and provided with exteriorly open air inlet means, and a cooling partition between the said chambers and groups of turbine means.

11. A motor of the class described having separate groups of rotating turbine devices, groups of devices for delivering a motive agent to the respective groups of turbine devices, an inclosed air chamber in which the groups of turbine devices are disposed and having exteriorly opening air inlet means, and a cooling partition dividing the air chamber and arranged between the turbine devices.

12. A motor of the class described having separate groups of rotating turbine devices, means for supplying a motive agent in alternation to said groups of devices, the one group of turbine devices being active while the other is inactive as a driving means, an inclosed cooling chamber in which said groups of turbine devices are mounted, and a cooling partition dividing said chamber and located between the groups of turbine devices.

13. In a motor of the class described, separate groups of rotary turbine devices, means for alternately supplying the groups of turbine devices with a motive agent, the groups of elements being inactive at intervals, a cooling chamber in which said devices are disposed, and a hollow partition within the chamber between the groups of turbine devices and provided with means for supplying a cooling medium thereto.

14. In a motor of the class described, rotary turbine devices adapted to have a motive agent alternately directed thereagainst, an aerated chamber in which said devices are disposed, and a hollow partition dividing said chamber and provided with means for causing a circulation of water therein.

15. In a motor of the class described, duplicate motive agent compressing and exploding mechanism, an exhaust chamber between and common to the said duplicate mechanisms, rotary turbine devices individually operated by and located between the mechanisms, and a cooling partition interposed between the outlets of the mechanisms within the said chamber.

16. In a motor of the class described, duplicate motive agent controlling supply means and combustion devices, a main driving or turbine shaft interposed between and operatively associated with the duplicate motive agent controlling supply means and combustion devices and having independent turbines thereon, the turbines both being rotatable with the shaft, power transmitting shafts individually associated with the duplicate motive agent controlling supply means and combustion devices and separate from the main driving shaft and in longitudinal alinement with the latter, and gearing interposed between the main driving shaft and the power transmitting shafts to rotate the latter at a speed for practical service relatively to the higher speed of the main driving shaft.

17. In a motor of the class described, power generating turbines, means for applying and shutting off the motive agent thereto, the power generating turbines being duplicated and each including a power shaft, a main driving shaft between the duplicate power generating turbines and in longitudinal alinement with the power shafts, turbine devices on the main driving shaft for individual coöperation with the respec-

tive power generating turbines and alternatively active and inactive, and means for cooling the inactive turbine devices.

18. In a motor of the class described, a shaft having turbines mounted thereon, groups of devices for supplying and shutting off motive agent relatively to and independently coöperating with the turbines, and a shaft coöperating with each group of devices, the shafts of the groups of devices being operatively associated with the turbine shaft and the latter having a greater speed of rotation than the shafts of said groups of devices.

19. In a motor of the class described, duplicate motive agent power generating devices each including a power shaft, a turbine shaft between the duplicate power generating devices in longitudinal alinement with the power shafts and carrying turbine devices individually operable by the power generating devices, and gearing interposed between the two extremities of the latter shaft and power shafts for independently operating the said turbine shafts.

20. In a motor of the class described, the combination with duplicate motive agent power generating devices and turbine devices, centrifugal governor devices coöperating with the power generating means, and timing mechanism to control the admission of motive agent to the power generating devices in alternation and operatively associated with the centrifugal governor means.

21. In a motor of the class described, duplicate motive agent power generating devices including sparking plugs and an electric circuit for said plugs, turbine devices individually operable by the power generating devices, timing mechanisms coöperating with the power generating devices, and means interposed between the timing mechanisms and the electrical circuit for the sparking plugs for rendering the said plugs active and inactive in the individual generating devices.

22. In a motor of the class described, duplicate motive agent power generating devices including sparking plugs and electric circuits for said plugs, turbine devices individually operable by the power generating devices, timing mechanisms coöperating with the power generating devices to control the feed of the motive agent alternately to the power generating devices, and means operated by the timing mechanisms for opening and closing the electric circuits simultaneously with the admission and cut-off of the motive agent with respect to the generating devices.

23. In a motor of the class described, duplicate motive agent power generating devices including power shafts, sparking plugs and electric circuits for the plugs, turbine devices individually operable by the power generating devices, timing mechanisms coöperating with the power generating devices for regulating the supply of motive agent thereto, centrifugal governor means, and connections between the centrifugal governor means and timing mechanisms for regulating the operation of the latter and between the said timing mechanisms and the electric circuits for rendering the plugs of the duplicate power generating devices alternately active and inactive.

24. In a motor of the class described, motive agent power generating devices including a power shaft and motive agent compressing and explosive means and admission valves, actuating levers coöperating with the admission valves, a timing mechanism having reciprocating devices for actuating the said levers, and means for rendering the timing mechanism inactive.

25. In a motor of the class described, motive agent power generating devices having admission valves, levers for operating said valves, connecting rods for said levers, a timing mechanism provided with reciprocating devices to engage the connecting rods, and means for shifting the reciprocating devices of the timing mechanism and throwing them out of engaging position with relation to the connecting rods.

26. In a motor of the class described, motive agent power generating devices including admission valves, a power shaft having a cam device thereon, a timing mechanism concentrically arranged over the power shaft and cam device and provided with a plurality of radially arranged reciprocating devices operatively associated with the cam device, levers for actuating the admission valves and provided with connecting rods, the connecting rods being operatively engaged by the reciprocating devices of the timing mechanism, and means for shifting a portion of the timing mechanism to throw the reciprocating devices out of operative relation with respect to the connecting rods.

27. In a motor of the class described, motive agent power generating devices including admission valves, a timing mechanism operative by the power generating devices and having reciprocating devices to individually open the valves, devices, interposed between the reciprocating devices and admission valves, a shiftable frame carrying the reciprocating devices and provided with a projecting means, and a cam device engaging said projecting means.

28. In a motor of the class described, motive agent power generating devices having admission valves, a timing mechanism including a shiftable frame carrying reciprocating devices, operating devices interposed between the reciprocating devices

and valves, the shiftable frame having a projection carrying a roller, a rod connected to the projection and engaged by a spring to restore the shiftable frame to normal position, a cam to engage the roller and shift the frame carrying the reciprocating devices, an oscillating member, and a governor connected to an oscillating member, the said member being actuated to engage the rod and prevent the timing mechanism from being thrown into operative position.

29. A motor of the class described having separated groups of coacting driving elements, means controlling the supply of motive agent to the groups in alternation, separate turbine organizations individually coöperating with the groups of driving elements, a shaft common to the turbine organizations, and a power shaft coöperating with each group of driving elements, the power shafts being operatively connected to the shaft of the turbine organizations.

30. A thermodynamic motor having separated rotary driving organizations, groups of devices controlling the supply of motive agent to said organizations in alternation, and means for automatically shutting off the supply of motive agent at intervals with relation to the said groups of devices to alternately lower the temperature of the driving organizations.

31. A thermodynamic motor having separate driving organizations connected for unitary rotation, means individually coöperating with each of the driving organizations for controlling the supply of motive agent to the latter, and mechanism for automatically shutting off the motive agent from and supplying said agent to the individual means at intervals.

32. A motor of the class described having turbine devices, motive agent compression and combustion means having a cycling operation, igniting means in the combustion means, and mechanism for controlling the supply of motive agent to the compression and combustion means in timed relation to the cycling movement of the latter, the supply controlling mechanism operating to apply and shut off the motive agent in relation to different portions of the compression and combustion means and turbine devices in alternation.

33. A motor of the class described having turbine means, compression and combustion devices coöperating with the turbine devices and having a cycling operation, means for igniting the motive agent in the compression and combustion means, and mechanism for controlling the supply of motive agent in alternation to different portions of the said means to render the turbine means inactive in part at intervals as a prime power generating means without causing cessation of movement of the said inactive part.

34. A motor of the class described having motive agent generating means, rotary turbine devices, compression and combustion means having a cycling operation, igniting means for the compression and combustion means movable with the latter, and mechanism for controlling the initial supply of motive agent in alternation to different portions of the compression and combustion means and of the exploded agent to the turbine devices to render a portion of the latter and of the compression and combustion means inactive at intervals in relation to the exploded and normal motive agent without causing a cessation of movement of the said inactive means.

35. A motor of the class described having motive agent generating means provided with portions arranged for alternate activity and inactivity, all of the generating means having a continuous rotary movement, rotary turbine devices, and mechanism for supplying and shutting off a motive agent at intervals in relation to different portions of said turbine devices.

36. In a motor of the class described, cycling motive agent generating means having portions arranged for alternate activity and inactivity, rotary turbine devices, and mechanism for controlling the supply of an exploded motive agent to different portions of the turbine devices in alternation to permit the inactive portion of said devices to run free without generating power and cool down while the active portion is generating power and receives the motive agent.

37. In a motor of the class described, cycling turbine power generating devices arranged in independent groups, turbines with which said power generating devices coöperate in alternation, and mechanism for supplying and shutting off an explosive motive agent relatively to different portions of said generating devices and turbines to render a part of the latter inactive as a drive means and completely free of any active portion of the motive agent but freely operable in timed relation to the remaining part of said generating devices and turbines.

38. In a motor of the class described power generating devices arranged in independent groups and having a cycling operation, turbines with which said power generating groups of devices independently coöperate, and mechanism for supplying and shutting off an explosive motive agent alternately relatively to the groups of said generating devices and turbines to render a part of the turbines inactive as a drive means and completely free of any active portion of the motive agent but freely rotatable with the remaining part of the turbines.

39. In a motor, turbine means composed

of separated groups of revolubly active elements, and means having an automatic operation for alternately applying and shutting off an explosive motive agent to and from said groups.

40. A thermodynamic motor provided with coöperating driving and motive agent supply means including explosive chambers, and means for automatically and alternately supplying an explosive motive agent to and shutting it off from the coöperating driving and supply means.

41. In a motor of the class described, cycling turbine power generating devices, and mechanism for supplying and shutting off an explosive motive agent relatively to different portions of the said generating devices in alternation to render a part of the generating devices inactive as a drive means and completely free of the motive agent but freely operable in timed relation to the remaining part of said devices.

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

LEWIS A. HAINES.

Witnesses:

JOHN K. SCHNEBLY,

JOHN E. LOBER.