No. 667,760. Patented Feb. 12, 1901.

C. H. BENTON.

MULTIPLE PISTON ENGINE.

(Application filed Feb. 13, 1900.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

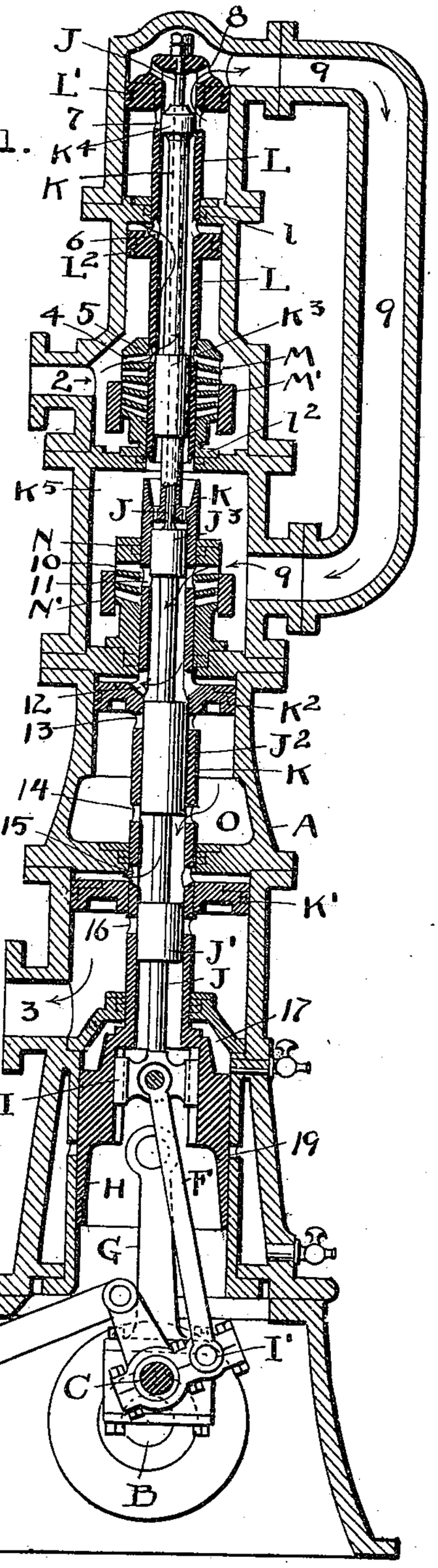
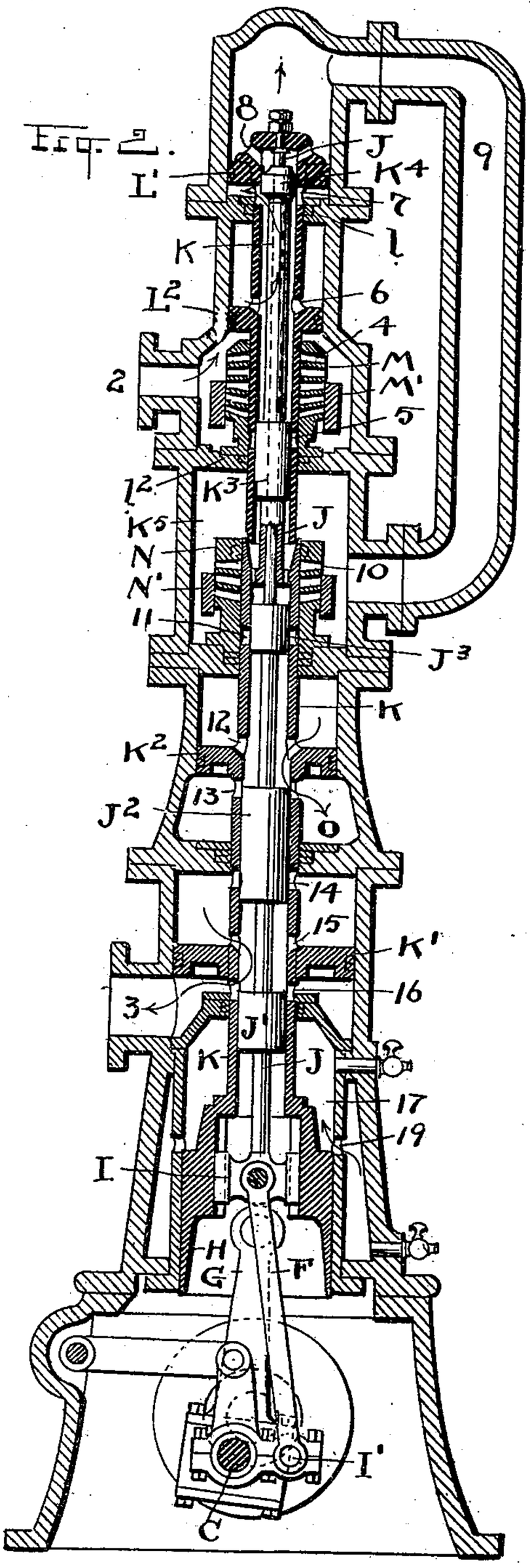


Fig. 2.



ATTEST.

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INVENTOR.

Charles H. Benton

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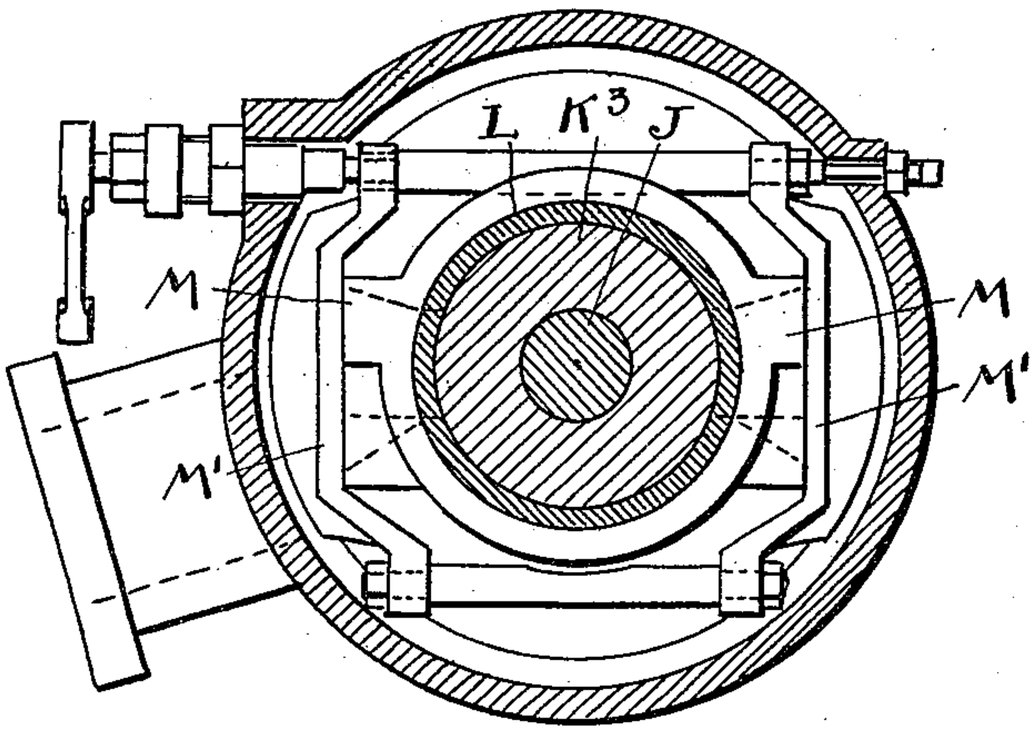
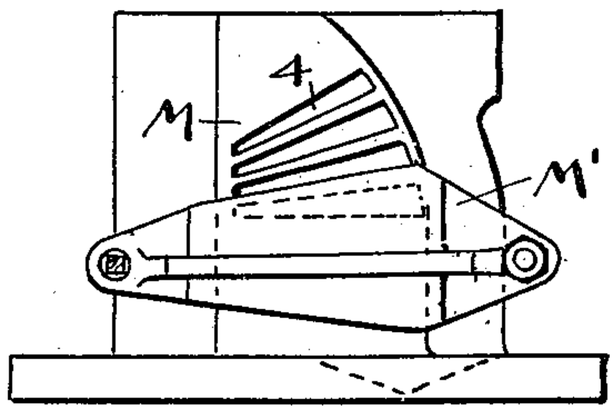


Fig. 3.

Fig. 4.



ATTEST

W. B. Moore

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ATTY.

UNITED STATES PATENT OFFICE.

CHARLES H. BENTON, OF CLEVELAND, OHIO.

MULTIPLE-PISTON ENGINE.

SPECIFICATION forming part of Letters Patent No. 667,760, dated February 12, 1901.

Application filed February 13, 1900. Serial No. 5,073. (No model.)

To all whom it may concern:

Be it known that I, CHARLES H. BENTON, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Multiple-Piston Engines; and I do declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to multiple-piston engines; and the object of this invention is to obtain an engine in which the pistons are single-acting, but having two sets of pistons attached to a single crank, the net effect of which is to have an impulse of steam in each direction per revolution instead of in only one direction, as in ordinary single-acting engines, and one set of said pistons having an indirect connection with the crank to which the other set is directly connected, all substantially as shown and described, and particularly pointed out in the claims. To accomplish these purposes, I have two sets of reciprocating parts generally moving together, but having a slight differential motion in their crank connections. One of these sets is always in tension, the other set always in thrust, the set in tension having piston-valves attached which serve to distribute steam to the pistons in thrust and the pistons in thrust having valves attached to them to effect the distribution of steam to the pistons in tension.

In the accompanying drawings, Figure 1 is a longitudinal sectional elevation of the engine with the pistons and valves at their upstroke, and Fig. 2 is a like elevation with said parts at their downstroke. For convenience in description Fig. 2 may be regarded as the starting-place, though the engine will start from either position. Fig. 3 is a part-sectional view in plan of one of the steam-inlet governors, and Fig. 4 is a side elevation of the same.

L^2 and L' are high-pressure and second-expansion pistons supported on the hollow piston rod or tube L, working in packed bearings l and l^2, and connected by tension-rod J, fixed in the top of said tube at its upper end and to the slide-head I at its bottom, and thence by link F with the secondary crank I'.

K' and K^2 are third and fourth expansion pistons, connected, by means of the hollow piston rod or tube K and two connecting-rods G, one of which only is shown, to the main crank-pin C through slide-head H. The hollow piston-rod K has attached to it valves K^3 and K^4, which effect the distribution of steam to the pistons L^2 and L'. The tension-rod J has attached to it valves J' J^2 J^3, which effect the distribution of steam to the third and fourth expansion pistons K' and K^2.

The steam-chest 2 is openly connected with the boiler-pressure, and L^2 is a high-pressure piston, against the under side of which the boiler-steam is in constant pressure. The hollow connecting-rod L for these pistons reciprocates through the stationary gridiron governing-gear or steam-inlet M, which is controlled by the slidable governor M'. This hollow rod has ports 5, which correspond with the stationary ports 4 of the cut-off inlet M.

In Fig. 1 the valve K^3 is in descending position relatively to the piston L^2. This opens the ports 5 and admits steam through the ports 6 above the piston L^2 into the space over said piston. On the downward stroke, therefore, the piston L^2 is balanced by the live-steam pressure above the piston L^2 and the constant pressure below it. At the bottom of the stroke valve K^3 rises and closes the ports 5, and at the same time the valve K^4 opens the ports 7. The steam, therefore, passes from above the piston L^2 into the chamber below the piston L', and the piston L' is of a larger area than the piston L^2, but attached to the same tubular piston-rod L. At the beginning of the next downward stroke the valve K^4 falls and opens the port 7 and allows the steam to pass through the port 8 into the return-passage 9 and thence to the steam receiver or chest K^5. In this chest is a second governing-gear or grid N, similar to grid M in the primary steam-chest 2. In Fig. 1 the steam is entering through the stationary ports 10 of the governing-gear N above the valves or governors N' through the ports 11 of the hollow piston-rod K and the ports 12 to the space above the piston K^2. At the bottom of the stroke the valve J^3 falls and closes the ports 11, and the valve J^2 drops below the port 13 and allows the steam to pass below the piston K^2 through the ports 12 and 13 into the receiver O. At the beginning of the next downward stroke the steam in the

receiver O passes through the ports 14 and 15 above piston K′. The steam on this piston acts in the same way as on the piston K^2, except that when it passes beneath the piston it passes direct to the exhaust 3 instead of into a receiver. On the downstroke the piston L′ is in equilibrium, as its two sides are connected, and the piston L^2 until the steam is cut off is in equilibrium between the boiler-steam on the bottom and the admitted steam on the top; but after the steam is cut off the steam above the piston L^2 expands and the preponderating pressure is upward. This upward pressure caused by the boiler-steam at the bottom of the stroke takes up the downward momentum of the tension system and prevents its knocking at the bottom of the stroke. On the upward stroke the pistons K^2 and K′ are in equilibrium, as their opposite sides are connected, and in order to prevent the upward momentum from causing a knock at the top of the stroke I introduce a cylindrical air-chamber 17, surrounding the top of the cylindrical cross-head H. At the bottom of the stroke the cross-head H sinks beneath the ports 19 and allows the air at atmospheric pressure to get above the cross-head. On the upward stroke these ports are closed and the air is compressed above the cross-head, this air serving to arrest the upward momentum of the pistons K′ and K^2. The tension-rod J has a cross-head I working in guides placed within the cylindrical cross-head H and between the two connecting-rods G. In the foregoing operation it occurs after the direct action of the steam on each piston successively that on the reverse movement each in its turn is balanced by the presence of steam on both sides, and this balance continues practically until the said piston has completed its return or idle stroke. However, the balancing of any given piston occurs only when there is direct pressure on others. Thus in starting the engine the initial piston L^2 will complete its first up and down strokes with a balance on its downstroke to starting position. Then on the second upstroke the steam behind it rushes in beneath piston L′ and remains behind it until the two pistons again descend. Then the steam behind L′ passes through to its upper side, and this piston is balanced, as is also L^2, as before. The same steam, however, has now traveled through return-passage 9 onto the piston K^2, the upper of the down-pressure pistons, and is acting downward on this piston. When K^2 has reached its downward limit and is ready to return, the valve J^2 has opened the passage into the chamber beneath said piston and the balance of this piston continues to the end of its upstroke. On its start to go down again the steam beneath it is let out by valve J^2 below to pass it over lower piston K′. Here it acts downward on said piston K′ to the limit of its downstroke, when the lower valve J′ opens the way to the exhaust beneath. In these movements valve J^3 keeps the steam in passage 9 back while piston K^2 is returning balanced to the top; but when the piston K^2 has reached the top of its stroke the valve J^3 has not, so that it continues to move upward sufficiently to uncover the inlet from passage 9, and then there is a downward travel of piston K^2, valve J^3, and the tube inclosing said valve and attached to piston K^2. Therefore on each upstroke of piston K^2 the valve J^3 closes the inlet from passage 9 and on each downstroke opens it to about two-thirds of the stroke downward. There may, in fact, be a slight steam-cushion allowed behind each piston in turn, but only such as would best facilitate even operations without the sacrifice of material energy. By the foregoing arrangement both piston-rods F and G reach their lowest points at the same time and begin together to make the return; but after rod G reaches its top limit or end of stroke the rod F has still a slight distance to travel upward and does not begin its descent until the crank C has crossed well over its center to begin its downward movement. This makes the accommodation of the several valves to the several pistons which may be required at this point in the operation, and particularly of valve J^3. It also contributes to the differential motion of the parts hereinbefore referred to and proceeding from the different centers with which the sets of pistons and valves are connected. The same principle of operation substantially would be obtained by discarding pistons K′ and L′ and rearranging the mechanism to use only pistons L^2 and K^2. In this case the return to top of piston K^2 would be by passage 9 directly from top of L^2. Thus the steam above piston L^2 would be caused to expand and act downward on piston K^2.

The differential movement of the tubes K and L, respectively, and their connected parts is somewhat plainly brought out in Figs. 1 and 2, where in Fig. 1 the said tubes are shown as having their extreme separation, while in Fig. 2 they are telescoped, as shown. All the valves are packed in their tubes.

As a peculiarity of construction it will be noticed that the valves for the upper high-pressure pistons L′ and L^2 are connected positively to act with the tube K, which carries low-pressure pistons K′ and K^2, while the valves for the low-pressure pistons are connected to act positively with the high-pressure pistons L′ and L^2. It will also be observed that I cushion the engine by the direct action of the steam on the bottom of piston K^2 in the downward movements of the pistons and by the air-cushion in chamber 17 in the upward movement. This prevents possible knocking or pounding of the pistons at the ends of their strokes and evenly balances the movements.

What I claim is—

1. In a multiple-piston engine, a series of cylinders arranged in axial relation to each other and a series of separate motive pistons

of different areas therein arranged in oppositely-driving pairs, a series of distribution-valves connected in pairs and operating centrally as to said pistons and having a rigid connection with one pair of said pistons and an independent sliding contact within the other pair of pistons, substantially as described.

2. In a steam-engine a series of axially-alined cylinders having a set of high-pressure motive pistons and a set of low-pressure motive pistons therein, and a steam-passage from the high-pressure-piston cylinders to the low-pressure-piston cylinders, separate tubes rigidly connecting said pistons in oppositely-driving pairs and having steam inlets and outlets, and valves in pairs arranged to reciprocate within said tubes and control said inlets and outlets and having each pair of said valves connected rigidly with one set of said pistons to move in time therewith and independently of the other set of pistons and valves, substantially as described.

3. In a steam-engine, a series of cylinders and a series of motive pistons of different areas arranged in axial alinement and in pairs and a separate tube connecting each pair of pistons independently of the other pair, said tubes having steam-ducts on each side of each piston, valves in pairs for each pair of pistons connected with and operated by the opposite driving-pistons, and means for operating the pairs of valves having differently-timed throws to open and close said steam-ducts, substantially as described.

4. In steam-engines of the multiple-piston type, a set of low-pressure motive pistons of different areas and a set of high-pressure pistons of different areas and separate cylinders therefor connected by a steam-passage, separate crank connections with differently-timed throws for said sets, valves centrally as to said pistons and the valves of one set having the same throw as the other set, said valves for the low-pressure pistons having a rigid operative connection with the high-pressure pistons and the valves for the high-pressure pistons having a rigid operative connection with the low-pressure pistons, substantially as described.

5. A steam-engine having a series of cylinders and pistons of different areas arranged in axial alinement and having said pistons connected in pairs to drive in opposite directions, one pair consisting of high-pressure pistons rigidly connected and the other of low-pressure pistons rigidly connected and valves carried by each pair of pistons to operate centrally in the connection of the opposite pair of pistons, and steam-inlets and governing mechanism for each pair of pistons independently of said valves, substantially as described.

6. In a steam-engine, a series of cylinders and pistons of different areas divided into pairs, each pair of pistons having valves connected therewith to operate centrally within the opposite pair of pistons, separate crank connections having differentially-arranged throws for each pair of pistons and valves, ducts to convey the steam from one piston to the other, and separate steam-inlet-governing mechanism for each pair of cylinders and its pistons, substantially as described.

7. A series of steam-cylinders axially arranged and having a set of connected high-pressure pistons and a set of connected low-pressure pistons therein, valves carried by each set of pistons to control the flow of steam between the pistons of the opposite driving set, a duct to lead the steam from one set of pistons to the other set whereby a direct action of the steam is obtained in opposite directions successively, and separate steam-governing mechanism at the inlets of each set of pistons, substantially as described.

8. In an engine as described, a set of cylinders and motive pistons of different areas, the smaller piston located to be subject to constant pressure from the boiler on its under side and the larger piston subject to pressure on its top from steam which has passed the smaller piston, crank connections having differently-timed throws for each piston, and a valve for each piston rigidly connected with and operated by the throw of the opposite moving piston, and separate steam-governing mechanism for said pistons, substantially as described.

9. In steam-engines, two sets of reciprocating motive pistons and cylinders therefor, one of which sets of pistons has a constant steam-cushion in one direction, and the other set a fluctuating air-cushion in the other direction, substantially as described.

10. In an engine, the axially-alined high-pressure and second-expansion cylinders having pistons therein connected by a tube, low-pressure cylinders and the pistons therein, and a supporting-tube for said pistons having crank connections, steam-ducts in said tubes on each side of said pistons, valves on the upper part of the low-pressure-piston tube to control the flow of steam through said ducts about the high-pressure pistons, a tension-rod fixed to said high-pressure pistons having valves to control the flow of steam through the ducts about the low-pressure pistons, separate crank mechanism for said rod timed to work with the low-pressure-piston crank connections, a steam-passage from said second-expansion cylinder and piston to said low-pressure cylinder and pistons, and separate governing mechanism at the steam-inlets of the high and low pressure cylinders and pistons, substantially as described.

Witness my hand to the foregoing specification this 5th day of February, 1900.

CHARLES H. BENTON.

Witnesses:
H. T. FISHER,
R. B. MOSER.