(No Model.) 4 Sheets—Sheet 1.

H. C. BEHR.

BALANCED SLIDE VALVE.

No. 305,134. Patented Sept. 16, 1884.

Fig: 1.

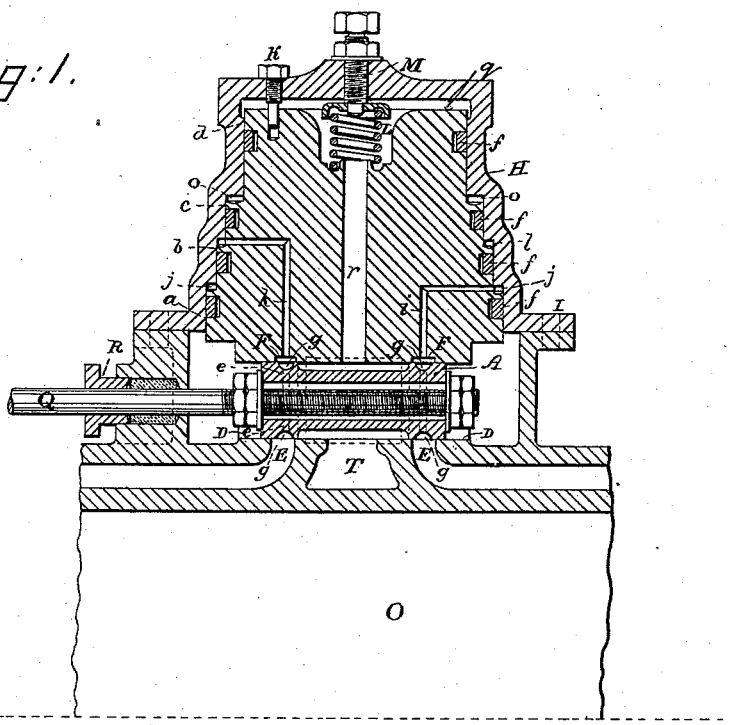
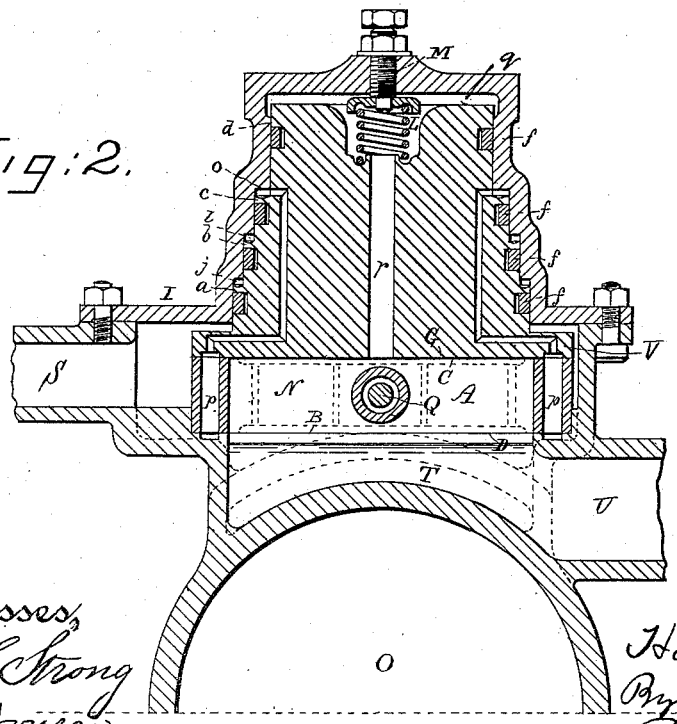


Fig: 2.



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BALANCED SLIDE VALVE.

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Fig: 3.

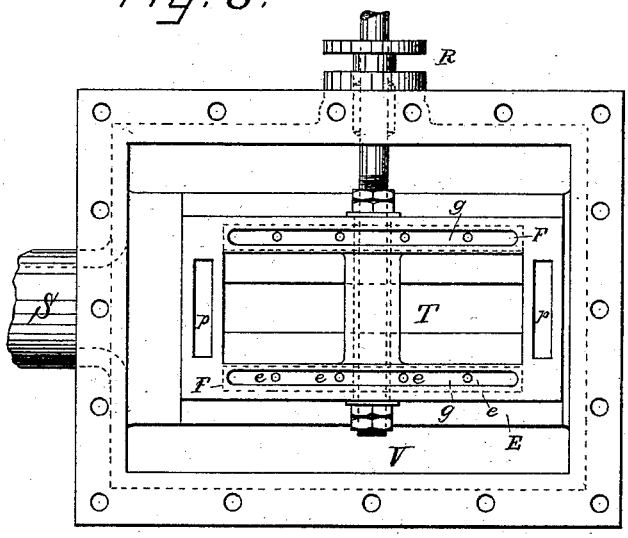
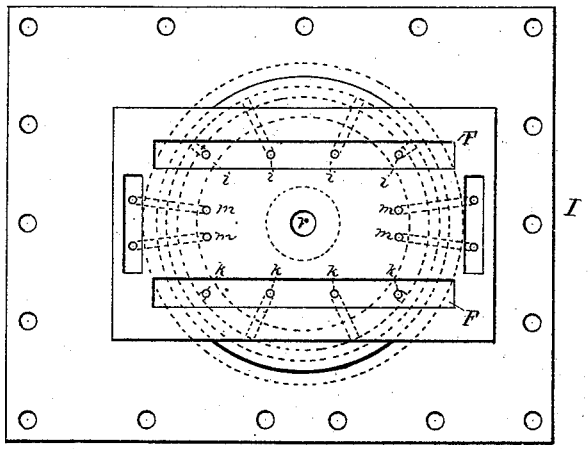


Fig: 4.



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BALANCED SLIDE VALVE.

No. 305,134. Patented Sept. 16, 1884.

Fig. 5.

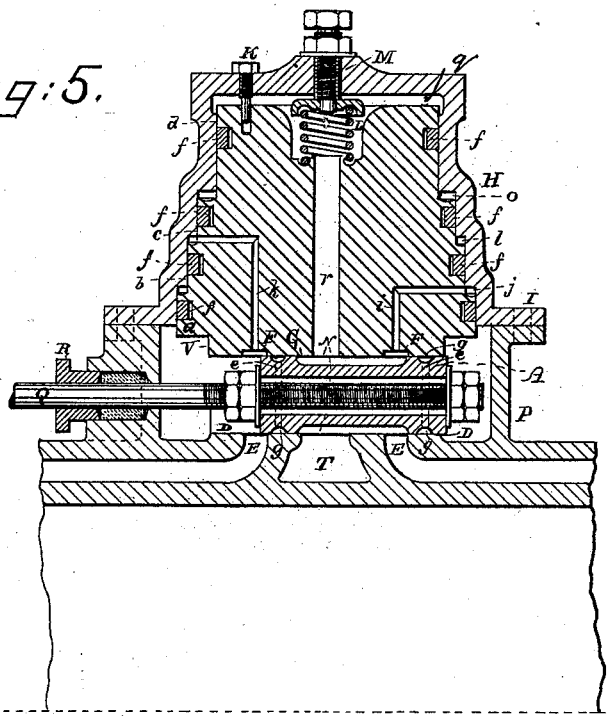
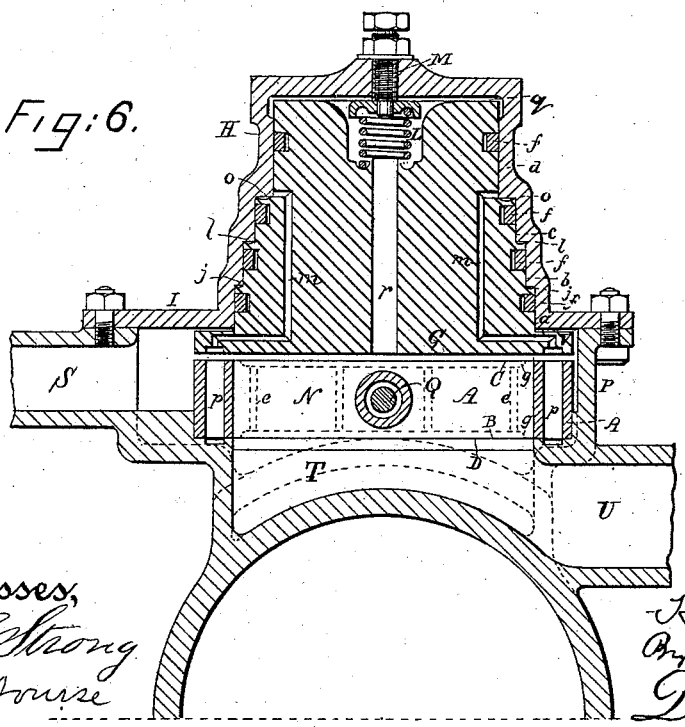


Fig. 6.



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BALANCED SLIDE VALVE.

No. 305,134. Patented Sept. 16, 1884.

Fig: 7.

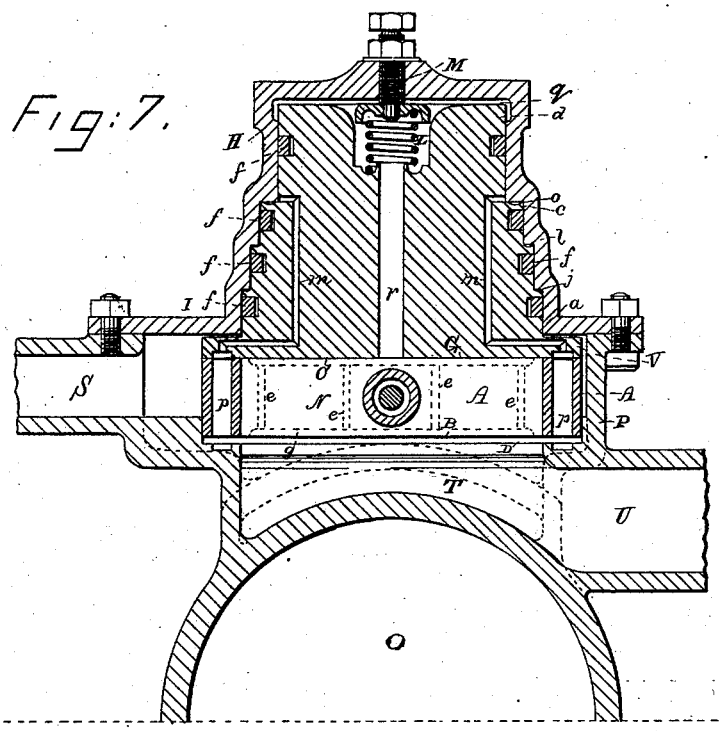


Fig: 8.

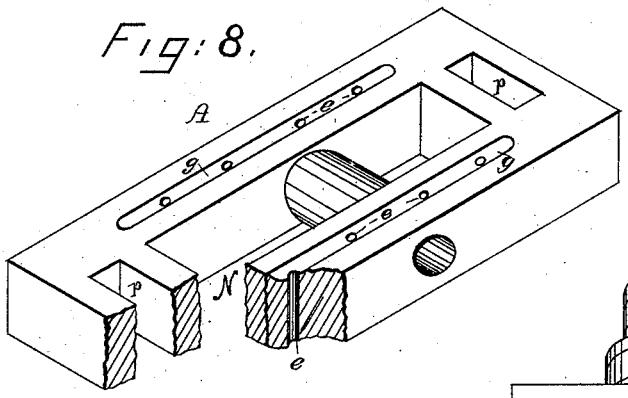
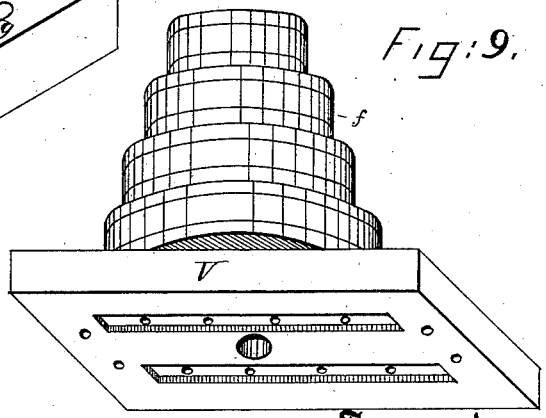


Fig: 9.



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UNITED STATES PATENT OFFICE.

HANS C. BEHR, OF SAN FRANCISCO, CALIFORNIA, ASSIGNOR OF ONE-HALF TO W. I. SALKELD, OF SAME PLACE.

BALANCED SLIDE-VALVE.

SPECIFICATION forming part of Letters Patent No. 305,134, dated September 16, 1884.

Application filed January 17, 1884. (No model.)

To all whom it may concern:

Be it known that I, HANS C. BEHR, of the city and county of San Francisco, and State of California, have invented an Improvement in Balanced Slide-Valves; and I hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to certain improvements in engine slide-valves; and it consists in a means for maintaining the valve in a balanced condition, and relieving it from the friction incidental to the varying pressure of steam upon it, as will be more fully explained by reference to the accompanying drawings, in which—

Figure 1 is a vertical section of the valve and pistons, taken in a plane through the axis of the valve-stem, showing the steam and exhaust ports, the valve being closed. Fig. 2 is a vertical section taken transversely to the valve-stem. Fig. 3 is a plan view of the valve with valve-casing, showing the cover removed. Fig. 4 is a bottom view of the balancing-plate and valve-chest cover. Fig. 5 is a vertical section of the valve and pistons, similar to Fig. 1, but showing the valve open. Fig. 6 is a vertical section of the valve, similar to Fig. 2, but showing the balancing-plate and pistons raised from the valve. Fig. 7. is a vertical section showing the balancing plate and valve raised from the seat. Fig. 8 is a perspective view of the valve, with a portion broken away to show the ports. Fig. 9 is a perspective view from below of the balancing plate and pistons.

Slide-valves are called "balanced" when they can be moved upon their seats with little or no resistance. Most balanced slide-valves require the greatest nicety of adjustment in order to keep them in a balanced condition, and any unequal expansion or contraction of component or adjacent parts is liable also to destroy the balanced condition of the valve, particularly in engines subject to great variations of pressure and temperature. Most of these valves are balanced only when the valve is closed, so as to present the least resistance to opening.

The accompanying drawings represent a slide-valve, A, which is balanced—that is, free from pressure producing frictional resistance to motion—under all the conditions of pressure and closed or open ports to which it is subject during its movement. The valve A has two equal faces, B and C, symmetrical with regard to ports, areas, &c. One face, B, which in the course of this description I shall call the "steam-face" of the valve, is in contact with and slides upon the seat D, containing the ports E E to the cylinder. The other face, C, which I will call the "balancing-face" of the valve, is in contact with, and slides beneath the balancing-seat G on the balancing-plate V, formed on the larger piston of a nest of decreasing balancing-pistons, as shown. Holes *e e e e* are drilled through the valve where it covers the steam-ports, and the edges of each set of these holes are connected together by grooves *g g*, running in the direction of the ports. These grooves are intended to prevent the holes *e e* being stopped up by grease or dirt. The balancing-seat G has shallow ports F F cut into it corresponding in area and outline with the steam-ports, so that when the valve uncovers the steam-port E, it will simultaneously uncover the corresponding balancing-port, F, in the balancing-seat G.

The balancing-pistons attached to the balancing-plate V consists of a series of single pistons, *a b c d*, decreasing from the plate V and preferably formed in one piece with the balancing-plate V, and they are fitted into a casing, H, formed on the valve-chest cover I, in which casing they are free to move in an axial direction to compensate for wear of the valve faces and seats. A pin, K, is screwed into the top of the piston-casing and projects into the piston-block, thereby preventing rotation of the latter and keeping steam-ports and balancing-ports in line. The pistons are each made steam-tight by suitable packing, *f f f f*. A light spring, L, sufficiently strong, however, to insure contact of the valve faces and seats, holds the pistons and plate V down upon the valve A. The spring is adjusted by the screw M.

The area of piston *a* is equal to the area inclosed by the extreme dimensions of the valve A without deducting for spaces cut out of the

valve—in other words, its area is equal to the extreme length of the valve-face multiplied by the extreme breadth. The piston *b* is of such a diameter that the difference in area between it and the piston *a* is equal to the area of one steam-port E. The difference in area between piston *b* and piston *c* is equal to the area of the other steam-port E. The area of piston *d* is equal to the area cut out of the valve-face for exhaust purposes. The difference in area between piston *c* and piston *d* will then be equal to the area of the valve-face diminished by the area cut out of the valve-face for exhaust purposes and the area of the two steam-ports.

One of the shallow ports F in the balancing-seat G communicates by a passage, *i*, with the space *j*, between piston *a* and piston *b*. The other shallow port F communicates by a passage, *k*, with the space *l*, between piston *b* and piston *c*. The space *o*, between piston *c* and piston *d*, communicates by passages *m m* with ports *p p*, cut through each side of the valve where it projects beyond the ends of the ports. The space *q*, above piston *d*, communicates by a passage, *r*, with the space N, cut out of the valve for exhaust purposes.

The other incidental parts shown on the drawings may be briefly described, as follows:

O is the cylinder, with the ports E E leading to each end.

P is the valve-casing.

Q is the rod for moving the valve and passing through the stuffing-box R.

S is the steam-inlet.

T is the exhaust-port, leading to the exhaust-outlet U.

Operation: Since the valve A has two opposite equal and symmetrical faces, B and C, each in contact with one of two equal seats, it is evident that the valve A will be balanced for every position within the limits of its movement, for at the same instant that one of the steam-ports E is uncovered by the face B the opposite equal balancing-port F in the balancing-seat G is uncovered by the opposite face, C, of the valve, thus admitting equal pressures above and below the valve. As soon as the ports E and F are simultaneously closed again by the valve the steam in the cylinder O and steam-port E would, until exhausted, exert a pressure diminishing gradually from the point of cut-off to that of exhaust, while the pressure due to the steam remaining in the balance-port F and the connected spaces would remain constant.

The valve would therefore have an excess of pressure upon its balancing-face C, and would be pressed down upon the seat B, were it not for the holes *e e e e*, drilled through the valve where it covers the ports, which establish communication between the ports E and F, and thus eqalize the pressure above and below the valve. The valve A is therefore balanced for every point of its movement, as long as the balancing-face G remains in contact with the valve. The balancing-plate V is prevented from being pressed down upon the valve by being attached to a piston, *a*, of equal area with that included by the length and breadth of the valve-faces B and C, so that the pressures above and below it will be equal, because an equal area is thus subtracted both from the upper and from the lower surface of the balancing-plate. When the valve uncovers the shallow port F in the balancing-seat G, the balancing-plate V would be forced away from the valve A by the steam-pressure; but since the pressure in the shallow port F is communicated by the passages *i* or *k* to the spaces above pistons *a* and *b*, alternately, and acts in an opposite direction upon an equal area to that of the port F, it follows that the balancing plate and seat will in this case also remain in balanced contact with the valve. Any back-pressure caused by the opening of the exhaust-port would be balanced by the steam passing up through the valve and the passage *r* into the space *q*, above the piston *d*.

I will now describe a means to provide against an emergency which might disturb the balanced condition of the valve A.

If, through some cause or other the balancing plate and pistons should be lifted away from the valve, the latter would no longer be balanced for the time during which it is not in contact with the balancing-seat G, and, moreover, the steam would escape through the central opening, N, in the valve directly into the exhaust-passage T, without having done its work in the cylinder O. Should the balancing-plate be accidentally raised from the valve-face C, in the manner described, the steam would also find access to all the spaces above all the pistons through the passages *m m* and T, leading from those spaces to the balancing-seat G, the pressure tending to raise the balancing-face would then be counteracted by an equal pressure above the pistons *a*, *b*, *c*, and *d*, and the spring L would bring the pistons and plate back into contact with the valve-face C. Should the valve A be raised with the balancing-face away from the surface D, containing the ports leading to the cylinder O, then the steam would find its way through the passages *p p*, in the valve A into the spaces above the pistons, and the lifting-pressure would be also counteracted, and the balancing-plate and pistons be pressed back to their seats by the spring L, in the same way as when the balancing-plate and pistons alone were lifted without the valve.

The two extreme pistons *a* and *d* must fit snugly into the casing H, allowing only sufficient freedom for axial movement, and they should be far enough apart to counteract any tipping tendency produced by the valve, exposing, alternately, the opposite edges of the balancing-seat to the steam-pressure. Another advantage is that the valve requires no adjustment whatever after once manufactured.

It will be readily seen that this method of

balancing may be applied also to valves for admitting steam to and exhausting it from one end of the cylinder only; or to valves for admitting steam only to either one or both ends of the cylinder, or for exhausting steam from either one or both ends of the cylinder. The difference will in these cases only consist in employing a less number of balancing-pistons.

It will also be evident that the valve shown in the figures may be used to admit steam by the central passage, T, between the steam-ports generally used as exhaust-ports. In this case the exhausted steam would pass into the valve-casing P, and the steam-pipe would become the exhaust-pipe. By using the valve to admit steam, either from the casing or from the central passage, to either of which it could be led by a three-way cock, the valve could serve as a simple reversing-gear.

The advantages of a valve balanced in the manner described in these specifications are, apart from its very slight friction and resistance to motion, chiefly two: first, it will wear much longer than the ordinary slide-valve; and, secondly, it will not wear rounding, which is the case with the ordinary slide-valve where the pressure at the ports is continually changed from one end to the other, as the ports are covered and uncovered by the valve, which gives a rocking tendency to the rectilinear motion of the valve, producing by degrees stronger abrasion of the valve-face at the ends, and finally developing a convex surface.

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

1. A reciprocating slide-valve moving over ports by which the supply and discharge of steam to and from the engine-cylinder is effected, in combination with a balancing-plate, above and in contact with the valve, and a series of pistons which may move axially at right angles with the valve, and passages through which steam may be admitted above one or more of the pistons to balance the valve at all times in its various positions, substantially as herein described.

2. A reciprocating slide-valve moving over ports through which steam may be alternately supplied to and exhausted from an engine-cylinder, a balancing-plate between which and the valve-seat the valve moves, and said plate provided with a differential piston, having shallow ports corresponding in outline and area with the cylinder steam-ports, in combination with holes or passages *e* through the valve, substantially as and for the purpose set forth.

3. In a balanced slide-valve, a differential piston provided with a series of packing-rings of gradually-decreasing diameter, and a series of ports leading above said rings and a central port to the upper face of the piston, all arranged as and for the purposes set forth.

4. In a balanced slide-valve, a differential piston having ports leading to the upper faces of the gradually-reduced piston, and a central port extending to the smallest area of said piston, and communicating with the port F in the balancing-plate, as and for the purpose specified.

5. In a balanced slide-valve having holes *e e e e* communicating with the ports E and F, in combination with a differential piston having ports leading to the upper faces of the gradually-reduced piston, and a central port leading to the area of least diameter, with a spring and adjusting-screw, all substantially as and for the purpose specified.

6. A reciprocating slide-valve moving over ports through which steam is supplied to and exhausted from an engine-cylinder, and a balancing-plate between which and the opposite valve-seat the valve moves, in combination with a series of pistons decreasing in diameter as they extend away from the top of the balancing-plate, with which they are connected, a cylinder or casing within which they fit and may have an axial movement, and a spring, L, and adjusting-screw M, substantially as herein described.

7. A reciprocating slide-valve moving over ports through which steam is supplied to and exhausted from an engine-cylinder, a balancing-plate resting upon the top of the valve, and having a series of pistons connected with it and decreasing in diameter as they extend away from it, and a casing within which they may work, in combination with ports *i*, *k*, and *m*, extending from the valve-chamber to points above the pistons, whereby steam is admitted to balance the valve in its various positions, substantially as herein described.

In witness whereof I have hereunto set my hand.

HANS C. BEHR.

Witnesses:
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