(No Model.) 3 Sheets—Sheet 1.

C. C. WEBBER.

STEAM PUMPING ENGINE.

No. 493,668. Patented Mar. 21, 1893.

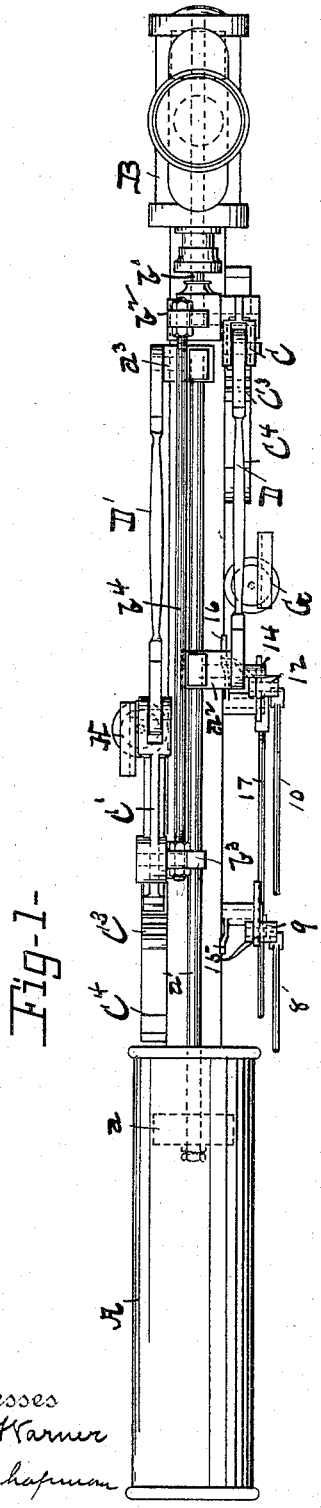

Fig-1-

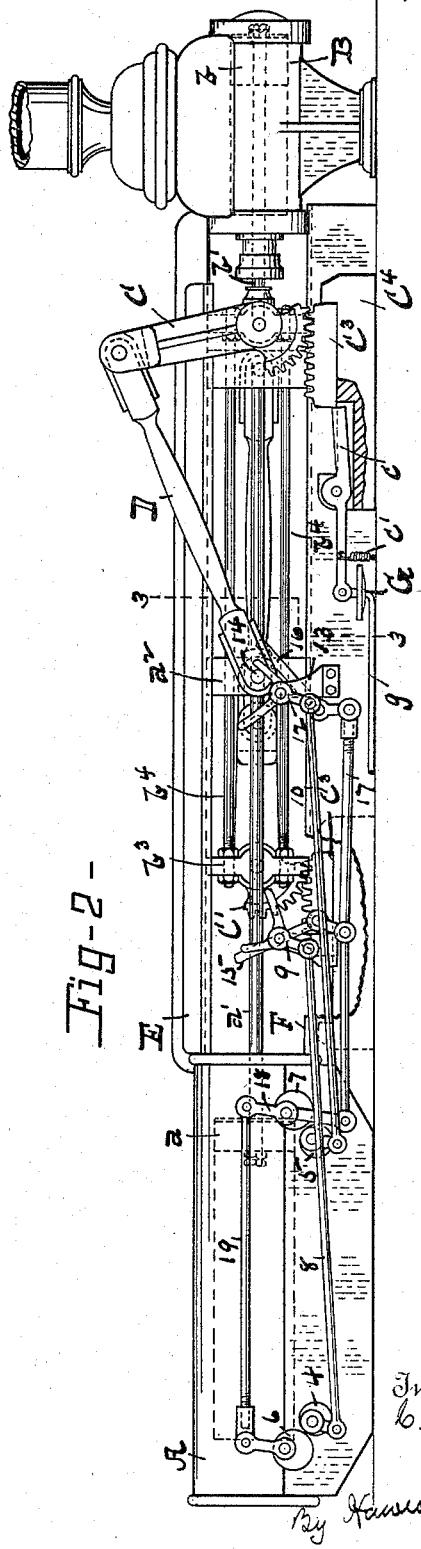

Fig-2-

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(No Model.) 3 Sheets—Sheet 2.

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Fig-3-

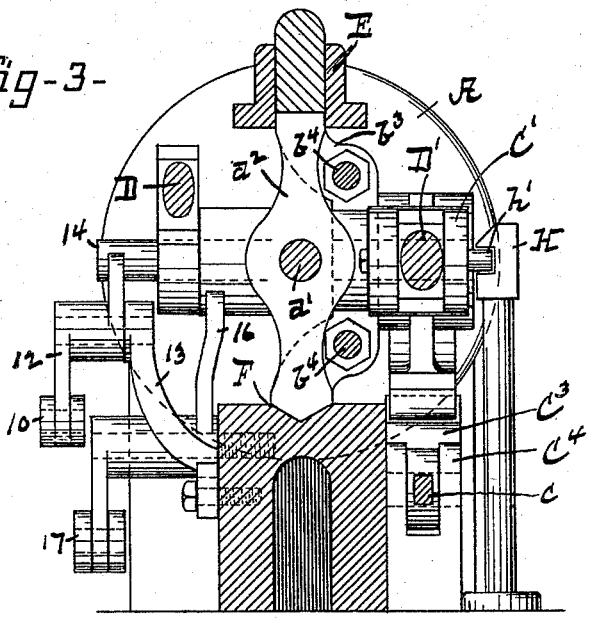
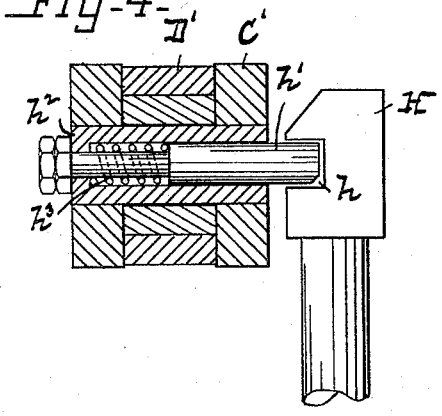


Fig-4-



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(No Model.) 3 Sheets—Sheet 3.

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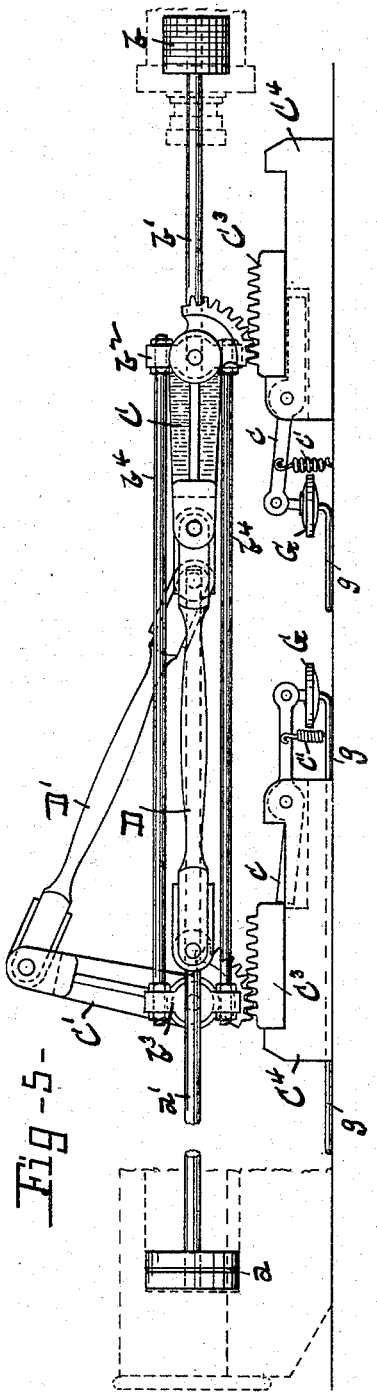

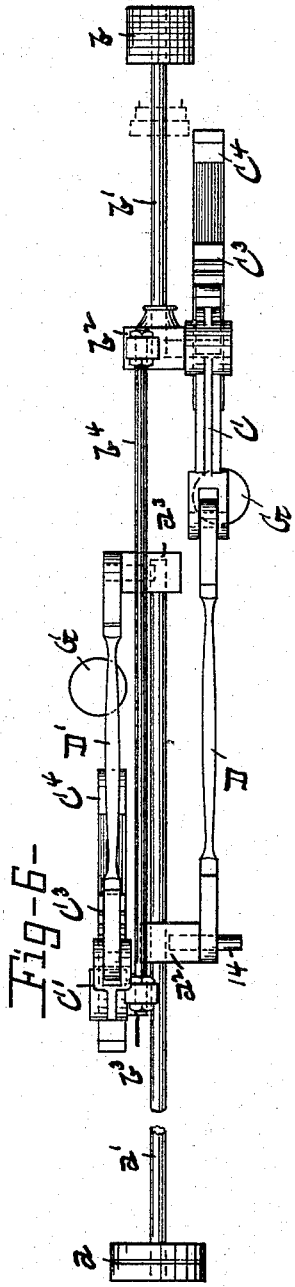

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UNITED STATES PATENT OFFICE.

CHARLES C. WEBBER, OF SPRINGFIELD, MASSACHUSETTS.

STEAM PUMPING-ENGINE.

SPECIFICATION forming part of Letters Patent No. 493,668, dated March 21, 1893.

Application filed April 2, 1892. Serial No. 427,468. (No model.)

To all whom it may concern:

Be it known that I, CHARLES C. WEBBER, of Springfield, in the county of Hampden and State of Massachusetts, have invented a new and useful Improvement in Steam Pumping-Engines, of which the following is a specification, reference being had to the accompanying drawings, forming part thereof.

My invention relates to direct acting pumping-engines, and it has for its object to provide such an engine with means whereby the steam can be cut off from the steam cylinder or cylinders at any part of the stroke and the steam used expansively for the remainder of the stroke of the piston, with practically no diminution in the acting pressure upon the piston of the water cylinder and without the use of fly or balance wheels.

To this end my invention consists in the pumping engine provided with the means for mechanically compensating for the loss of pressure due to cutting off the steam from the steam cylinder hereinafter fully described and particularly pointed out in the claims.

Referring to the drawings, in which like letters and numerals designate like parts in the several figures, Figure 1 is a plan view of a pumping-engine embodying my invention. Fig. 2 is a side elevation thereof, with the parts occupying the same position as in Fig. 1. Fig. 3 is a cross-section taken upon line 3—3 of Fig. 2. Fig. 4 is a detail view presently to be described. Fig. 5 is a side elevation of certain parts of the mechanism, with said parts shown in the reverse position to that shown in Fig. 2. Fig. 6 is a plan view of said parts in the same position.

The letter A designates the steam cylinder and B the water cylinder of a common form of pumping engine, said cylinders containing the usual pistons *a b* and having connected therewith the usual piston-rods *a' b'*, respectively. The steam cylinder is provided with the valves 4 5 governing the admission of steam to the opposite ends thereof and with the exhaust valves 6 7, which are preferably of the well known rotary form and are operated as will be presently described. Instead of connecting the piston of the steam cylinder directly with that of the water cylinder, I pivotally connect with the water piston-rod two toothed sectors, each of which operatively engages a rack, and join the steam piston-rod with each of said sectors by suitable connecting rods, whereby I am enabled to utilize the leverage afforded by said sectors to compensate for the loss of pressure upon the steam piston when the steam is cut off, for the completion of the stroke in both directions.

The letter C designates one of said sectors, which is pivotally mounted upon a cross-head b^2 secured to the end of the water piston-rod b', and D designates the connecting rod which connects said sector with a guide-block a^2 secured to the steam piston-rod at a point substantially midway between the ends of the latter. The opposite sector C' is pivotally mounted upon a head-block b^3 rigidly secured to the ends of two rods b^4, which rods at their opposite ends are rigidly secured to the cross-head b^2, and a connecting rod D' connects said sector with a guide-block a^3 secured to the steam piston-rod at its outer end. Said cross-head b^2, head-block b^3, and guide-blocks a^2 a^3 are guided at their upper and lower ends in suitable guides E F, see Fig. 3, whereby they are caused to move in a true horizontal plane and with but slight friction. Each of said toothed sectors meshes with a rack C^3, which racks are supported in bed-pieces C^4 in such manner as to be capable of a limited movement thereon in a horizontal plane, the amount of such movement corresponding to the distance which the steam piston moves from the time it begins its stroke until the steam is cut off, preferably one-fourth of its entire stroke or less. Each of said bed-pieces C^4 has pivotally secured to its inner end a detent-lever *c*, adapted to have a slight rocking movement in a vertical plane, one arm of which lever occupies a recess or depression in the upper face of the bed-piece and is adapted, in its raised position, to project slightly above said face and to engage the end of the rack, and the other arm of which is suitably connected with one end of the steam cylinder, whereby said lever will be automatically operated by the steam admitted to said cylinder at the beginning of the stroke of the piston to cause it to release the rack, as will be presently described. As one example of such connection I have herein shown the arm of each of said levers as being

connected to the upper member of a steam diaphragm G, of a well known construction, which diaphragms are connected with opposite ends of the steam cylinder by pipes g, and have shown as a means for assisting the action of said diaphragms to return the levers to their normal position, coil springs c' connected at their upper end to said levers and at their lower end to the bed of the engine. The inlet valve 4 at the outer end of the steam cylinder is connected by a rod 8 with the depending arm of a lever 9 having two upwardly extending tappet-arms, and the inlet valve 5 at the inner end of said cylinder is connected by a rod 10 with a similar lever 12, said levers being pivotally supported by bracket-arms 13 projecting upwardly from the bed. A stud or pin 14 projecting outwardly from the guide-block a^2 on the steam piston-rod, by alternately engaging the tappet-arms of said levers and rocking the latter, causes an automatic operation of the valves 4 5 to admit steam alternately to opposite ends of said cylinder and to cut off the same at a point in the stroke which can be accurately predetermined by varying the angle of the tappet-arms of each lever relatively to each other, in a well known manner. The exhaust valve 7 at the inner end of the steam cylinder is operated by two tappet-levers 15 16, which are located adjacent to each end of the stroke of the guide-block a^2 and are adapted to be alternately engaged by a portion of said block, a rod 17 to which each of said levers is connected, and a lever 18; and a rod 19 connecting the opposite end of said lever 18 with the exhaust valve 6 at the outer end of the cylinder, transmits motion from the former to the latter, whereby both of said valves are operated simultaneously, the one opening as the other closes, in a manner which will be well understood by persons skilled in the art without further description. It will be understood that said valve motions are herein shown as one example of the many forms of means in common use for such purpose, merely, and that I do not restrict myself to the use of the particular form of valve shown nor to the means shown for operating the same the broader features of my invention being adapted to be used in connection with any of the forms of valves and valve motions with which direct acting pumping engines have heretofore been supplied, it being essential merely that means be provided for cutting off the steam at an early period of the stroke of the piston.

At the beginning of the stroke of the steam piston in either direction, the long arm of one of the sectors C or C′ and its connecting rod D or D′ are in direct parallelism with the piston-rods a' b', and maintain such position until the steam is cut off, the steam piston during such time exerting a direct pushing action against the water piston in a horizontal plane, and for the purpose of preventing the said long arm of the sector and its connecting-rod from being deflected from a straight line with each other during such period, I provide means whereby the pivotal connection between said parts will be positively guided in a horizontal plane from the beginning of the stroke to the point at which the steam is cut off, and as a simple form of means for such purpose I have herein shown a guide-block H rigidly supported in any suitable manner adjacent to the path of movement of said pivotal connection during the period mentioned, said block having within its inner side a horizontal groove h, see Fig. 4, and having its inner side beveled above said groove as shown, and a pin or stud h' located within a socket in the pivot-pin h^2, which connects the sector to its connecting rod, in such manner as to be capable of a limited longitudinal movement therein, a coil spring h^3 within said socket exerting an outward pressure upon said stud or pin. As the idle sector and its connecting rod descend from an angular position to one in which they are in a straight line with each other, which occurs during the time when the opposite and active sector and its connecting rod are transmitting the pressure of the steam piston to the water piston, said pin or stud h' is moved downwardly against the beveled surface of said guide-block H, and, yielding sufficiently to pass said surface, is projected by its spring into the groove h, in which it travels upon the return stroke to the end of said groove, or in other words to the point in the stroke at which the cut-off occurs, thereby positively preventing the deflection of the arm of the sector and its connecting rod from a straight line with each other during such movement.

The operation of the mechanism thus described is as follows:—Supposing the parts to be in the position shown in Figs. 5 and 6, with the steam piston at the outer end of its stroke, the connecting rod D and long arm of sector C occupying a position parallel with the piston-rods a' b', connecting rod D′ and sector C′ occupying the angular position shown, and the rack with which said sector C′ engages held from movement by its detent-lever c, the steam enters the cylinder A through inlet valve 4 and, simultaneously therewith, passes to the diaphragm G and operates the latter to cause the depression of said detent c and the release of the rack with which said sector C′ engages. During the first part of its stroke the steam piston acts directly against the water piston, the two piston-rods, connecting rod D, and the long arm of sector C forming a direct connection for such purpose, and said connecting rod and arm being held from deflection from a straight line with each other by their guide H. During such portion of the stroke also, the two piston-rods, the sectors, the connecting rods, and the racks move as one, said racks sliding freely upon their bed-pieces. Such movement continues until pin 14 on the guide-block a^2 rocks the tappet-lever 9 and operates valve 4 to cut off the steam, at which time the two racks come into engage-

ment with the end walls of their bed-pieces, whereby they are prevented from further movement in that direction, and the rack with which sector C engages is held by its detent from movement in the opposite direction. The pivotal connection between the connecting rod D and sector C having now passed beyond the end of its guide H, the continued movement of the steam piston, due to the expansion of the steam in cylinder A, causes said connecting rod to swing said sector C about its axis, and the engagement of its teeth with those of its now stationary rack converts said swinging movement thereof into a progressive movement of the water piston, which continues until the end of the stroke, the connecting rod D′ and sector C′ at the same time descending from their angular position to one of parallelism with each other. By reference to the drawings it will be observed that the steam cylinder is of sufficiently greater length than the water cylinder to permit the two pistons to have the requisite difference between the length of their respective strokes, the steam piston having an excess of movement over the water piston corresponding to the arc traversed by the pivotal connection between the connecting rod and the long arm of the sector. The two pistons having now reached the ends of their respective strokes, the guide-block a^2 reverses the position of the valves for the return stroke. On such return stroke the sector C′ and connecting rod D′ become the active parts, transmitting the movement of the steam piston to the water piston through the rods b^4 as before described, and their action is identical with those of the sector C and connecting rod D just described. By reason of the great leverage obtained through the long arms of the two sectors and the connecting rods, I secure substantially the same pressure against the water piston from the expansive energy of the steam, after cutting off the latter, as is exerted thereon by the live steam before the cut off, and, consequently, I am enabled to cut off the steam at a very early part of the stroke without impairing the work of the engine. In other words, I thereby provide means for mechanically and antomatically compensating for the loss of pressure upon the steam piston due to cutting off the live steam. It will be observed, furthermore, that I secure such compensation without previously adding to the work to be performed by the live steam, as is the case with most if not all of the compensating mechanisms heretofore devised, which have generally operated upon the principle of subtracting a portion of the power exerted by the live steam and storing it for use after the cut off. In my mechanism, on the contrary, the live steam, until the cut off, exerts its full power directly upon the water piston, both the active and the idle compensating devices moving freely with the two piston-rods during such period, and it is not until the cut off occurs that the active compensating device begins its work, its powerful leverage being exerted from thence to the end of the stroke. By providing for an excess in the length of the stroke of the steam piston over that of the water piston, I am enabled to secure a percentage of useful effect from the expansive energy of the steam which cannot be secured in an engine whose steam and water pistons move with the same length of stroke. It will be seen, therefore, that without materially increasing the cost of construction of the ordinary direct acting pumping engine, I am enabled to effect a very material saving in the cost of operating the same.

While I have illustrated my invention in connection with a pumping engine having a single steam cylinder, it will be apparent that it is equally applicable to compound, duplex, and compound-duplex engines, the necessary intermediate connections for which will be understood by persons skilled in the art without description or illustration of the same herein.

Believing myself to be the first to devise a pumping engine whose steam and water pistons move in unison through a portion of their stroke and whose steam piston has an excess of movement over that of the water piston during the remainder of the stroke, with intermediate connections for mechanically and automatically increasing the pressure exerted by said steam piston during the latter portion of its stroke, I do not wish to restrict myself to the precise form or arrangement of said intermediate connections as herein shown and described, the same being capable of various modifications within the spirit of my invention.

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

1. In a steam pumping engine, the combination with the steam and water cylinders and their pistons and piston-rods, of a bell-crank lever connected to and carried by the water piston-rod, a connecting rod connecting one arm of said lever with the steam piston-rod, and a stop adapted to be engaged by the opposite arm of said lever, substantially as and for the purpose described.

2. In a steam pumping engine, the combination with the steam and water cylinders thereof and their pistons and piston-rods, of suitable steam inlet, cut-off, and exhaust mechanism for said steam cylinder operatively connected with the steam piston-rod, a toothed sector connected with and carried by said water piston-rod, a jointed connection between said sector and the steam piston-rod, and a rack adapted to be engaged by said sector, substantially as and for the purpose described.

3. In a steam pumping engine, the combination with the steam and water piston-rods thereof, a toothed sector pivotally mounted upon and carried by said water piston-rod, intermediate jointed connections between said sector and the steam piston-rod, and a movable rack operatively engaging the teeth of

said sector, substantially as and for the purpose set forth.

4. In a steam pumping engine, the combination with the steam and water piston-rods thereof, of a toothed sector pivotally connected with said water piston-rod, a rod connecting said sector with the steam piston-rod, a movable rack operatively engaging the teeth of said sector, a fixed stop permanently limiting the movement of said rack in one direction, and a movable detent adapted to temporarily limit its movement in the opposite direction, substantially as and for the purpose described.

5. In a steam pumping engine, the combination with the steam and water piston-rods thereof, of a toothed lever mounted upon and carried by the water piston-rod, intermediate jointed connections between said lever and the steam piston-rod, a movable rack engaging the teeth on said lever, a fixed stop for limiting the movement of said rack in one direction, a movable detent for limiting its movement in the opposite direction, and means substantially as described for automatically retracting said detent from its engagement with the rack upon the admission of steam to one end of the steam cylinder, arranged and operating substantially as set forth.

6. In a steam pumping engine, the combination with the steam and water cylinders thereof and their pistons and piston rods, of a toothed sector pivotally mounted upon and carried by the water piston-rod, a jointed connection between said sector and the steam piston-rod, a movable rack engaging the teeth of said sector, a fixed stop for limiting the movement of said rack in one direction, a detent-lever for limiting its movement in the opposite direction, a liquid or fluid pressure-actuated device operatively connected with said detent-lever and adapted by imparting movement thereto to withdraw the latter from its engagement with said rack, and pipe connections between said device and one end of the steam cylinder, arranged and operating substantially as set forth.

7. The combination with the steam and water cylinders of a pumping engine and their pistons and piston-rods, of two toothed levers pivotally connected to and carried by the water piston-rod, jointed connections substantially as described between each of said levers and the steam piston-rod, two movable racks engaging the teeth on said levers, two fixed stops for limiting the movement of said racks in one direction, and movable stops for limiting their movement in the opposite direction, arranged and operating substantially as set forth.

8. The combination with the steam and water cylinders of a pumping engine, their pistons and piston-rods, and suitable valve gear governing the admission of steam to and its exhaust from said steam cylinder operatively connected with the steam piston-rod, of two toothed sectors operatively connected to and moving with the water piston-rod, connecting rods connecting each of said sectors with the steam piston-rod, movable racks engaging the teeth of said sectors, fixed stops for limiting the movement of said racks in one direction, movable detents for limiting their movement in the opposite direction, pressure-actuated devices operatively connected with said detents for withdrawing them from their engagement with said racks, and pipe connections connecting said devices with opposite ends of the steam cylinder respectively, substantially as and for the purpose described.

9. The combination with the steam and water cylinders of a pumping engine, their pistons and piston-rods, and suitable valve connections as described, of two toothed sectors mounted upon axes which are rigidly connected to the water piston-rod, connecting rods connecting one of said sectors to the steam piston-rod at the outer end of the latter and the other at a point substantially midway between the ends of said piston-rod, movable racks engaging the teeth of said sectors, and stops for limiting the movement of said racks, arranged and operating substantially as set forth.

10. In a steam pumping engine, the combination with the steam and water piston-rods thereof, of a cross-head, as b^2, secured to said water piston-rod, a head-block, as b^3, suitably guided upon the frame of the machine, rigid connections as the rods b^4, connecting said head-block to said cross-head, two toothed sectors mounted respectively upon said head-block and said cross-head, connecting rods connecting each of said sectors with the steam piston-rod, movable racks engaging the teeth of said sectors, and stops for limiting the movement of said racks, substantially as described.

11. In the pumping engine herein described, the combination with the toothed sectors carried by the water piston-rod and operatively connected with the steam piston-rod, of the bed-pieces C^4, the racks C^3 engaging the teeth of said sectors respectively and having a capacity for a limited sliding movement upon said bed-pieces, and the detent-levers c mounted upon said bed-pieces and adapted, in one of their positions, to engage said racks to prevent movement of the latter, substantially as and for the purpose set forth.

12. In a steam pumping engine, the combination with the steam and water piston-rods, of a bell-crank lever carried by said water piston-rod, a rod connecting one of the arms of said lever with the steam piston-rod, and a guide for holding said rod and the arm of the lever to which it is connected in alignment with each other and parallel with said piston-rods during a portion of the stroke of the latter, substantially as set forth.

13. In a steam pumping engine the steam and water pistons of which move in unison during the first part of their stroke, the combination with the steam and water cylinders

thereof and their pistons and piston-rods, of intermediate connections substantially as described between said piston-rods whereby the steam piston has a movement in excess of that of the water piston during the latter part of the stroke of said pistons, substantially as and for the purpose set forth.

14. In a steam pumping engine, the steam piston of which has a greater length of stroke than the water piston, the combination with the steam and water cylinders thereof and their pistons and piston-rods, of intermediate connections substantially as described between said piston-rods for mechanically increasing the pressure exerted by the steam piston against the water piston during the latter portion of the stroke of said pistons, substantially as set forth.

15. In a steam pumping engine the steam and water pistons of which move in the same or parallel planes and the steam piston of which has a greater length of stroke than the water piston, the combination with the steam and water pistons thereof and their piston-rods, of a lever pivotally connected with and carried by one of said piston-rods, intermediate jointed connections between one arm of said lever and the other piston-rod, and a fulcrum adapted to be engaged by the opposite arm of said lever during the latter portion of the stroke of said pistons, substantially as set forth.

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Witnesses:
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