(No Model.) 2 Sheets—Sheet 1.

D. L. CROSS.

STEAM ENGINE.

No. 342,335. Patented May 25, 1886.

Fig. 1.

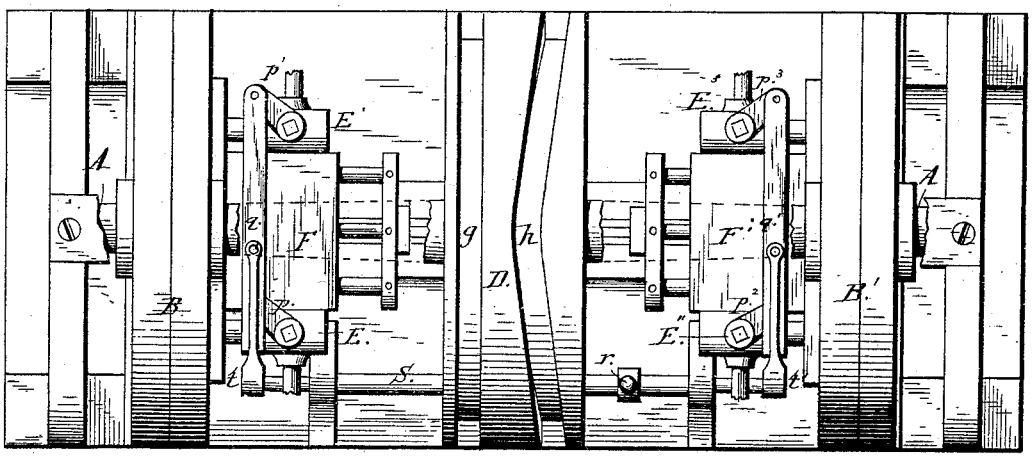


Fig. 2.

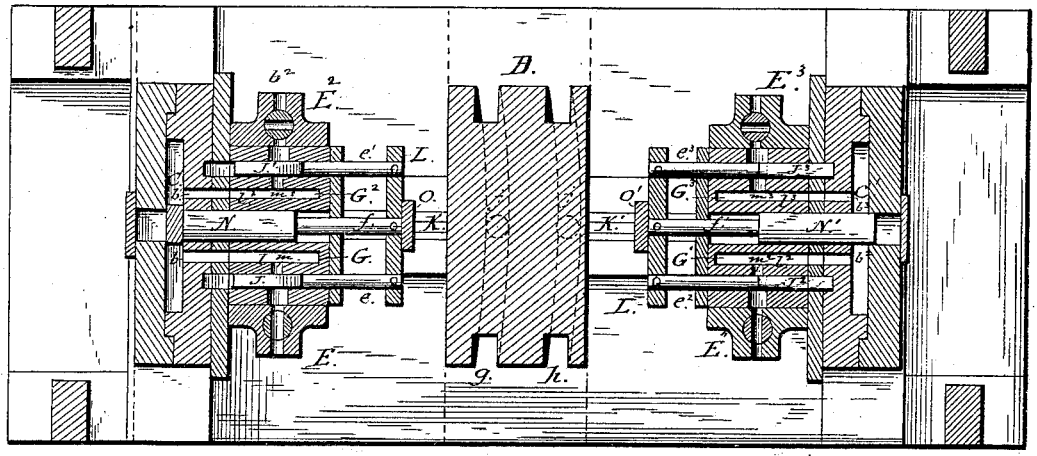


Fig. 4.

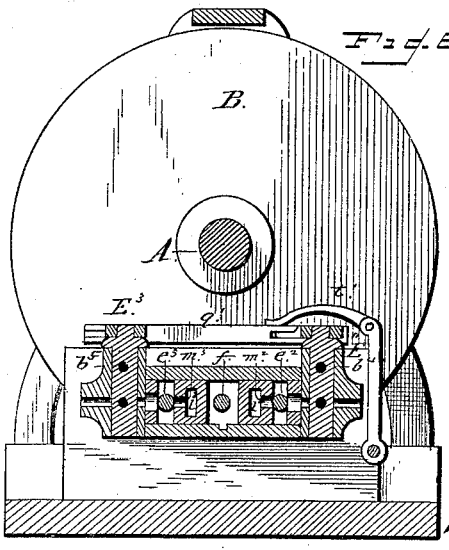
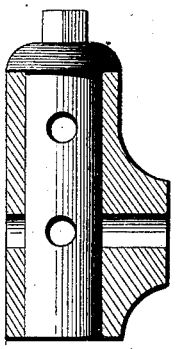


Fig. 3.



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(No Model.) 2 Sheets—Sheet 2.

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STEAM ENGINE.

No. 342,335. Patented May 25, 1886.

Fig. 3.

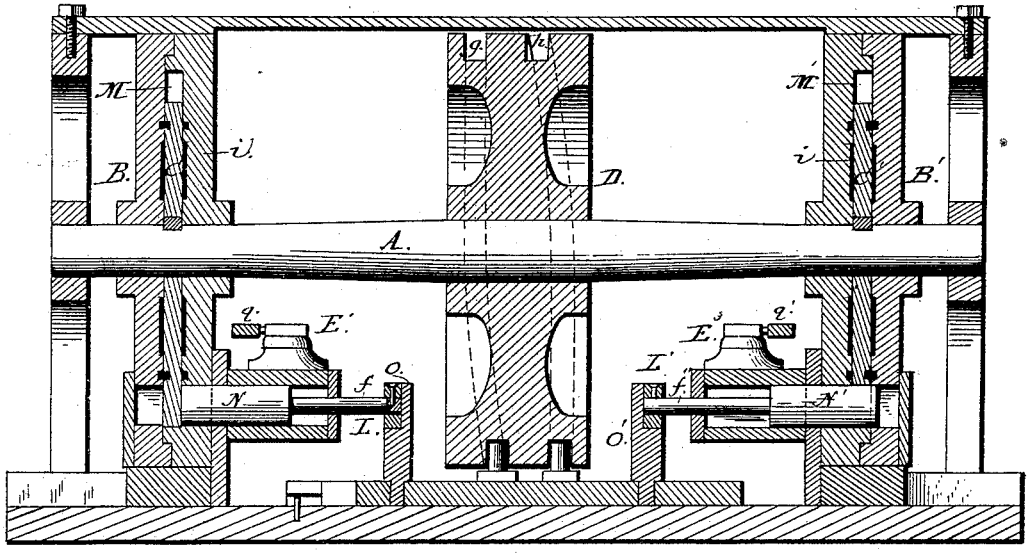


Fig. 5.

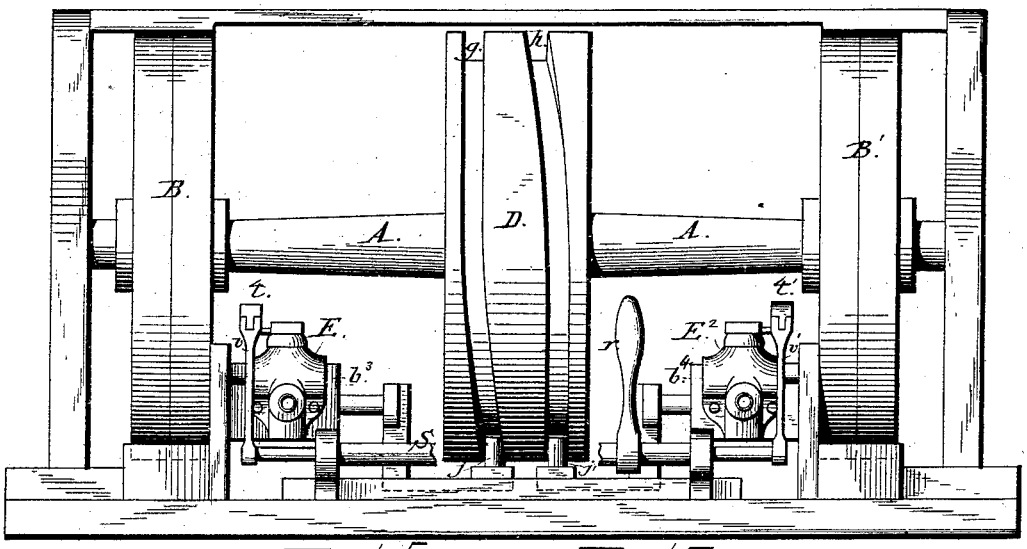


Fig. 6.

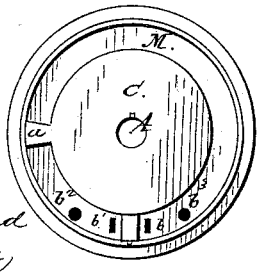
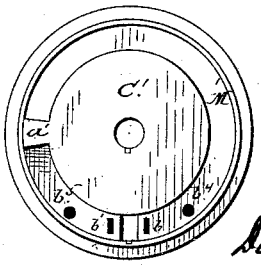


Fig. 7.



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UNITED STATES PATENT OFFICE.

DAVID L. CROSS, OF AUSTIN, TEXAS.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 342,335, dated May 25, 1886.

Application filed November 12, 1885. Serial No. 182,580. (No model.)

To all whom it may concern:

Be it known that I, DAVID L. CROSS, a citizen of the United States, residing at Austin, in the county of Travis and State of Texas, have invented certain new and useful Improvements in Steam-Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention is an improvement in steam-engines applicable particularly where frequent reversing of movement is required, but equally applicable, with immaterial modifications, in driving any class of machinery. The engine is provided with two fixed shallow cylinders, one upon either side of a central point in the main or driving shaft, the axis of said cylinders being in line with the axis of said driving-shaft. Each of these cylinders has within it a piston provided with a piston-head, which revolves upon and with the driving-shaft, both being keyed to it permanently. At a central point upon the main driving-shaft, between the two cylinders, is fixed a cam-wheel which has two annular grooves not parallel to each other, each of which engages a rod sliding in a race, which is connected with and operates a pair of slide-valves to open and close induction and exhaust ports which lead to the cylinder-chambers, and simultaneously with these movements opens and closes the cylinder-chambers by moving the abutments in a line parallel with the axis of the main shaft. The abutments referred to form at times diaphragms to direct steam and confine it between the piston-heads and said abutments.

My engine, as shown in the drawings, has four combined induction and eduction cocks, four slide-valves, four induction-ports, and four exhaust-ports. Two of the induction-ports connect with the cylinder on one side of the cam-wheel, and the other two connect with the cylinder on the opposite side of said wheel. Each cylinder has passing from it two exhaust-ports, which discharge through their respective cocks. Steam enters the cylinders, starting first on one side and then on the other, from steam-pipes which enter the combined cocks at points longitudinally opposite, the two others transversely opposite to these being at the time closed against the entrance of steam, but which serve meanwhile as exhaust-cocks. The two combined induction and eduction cocks on either side of the cam-wheel are connected with cranks, which surmount their valve-stems by an arm connected to a shaft properly journaled to the engine-frame by a lever and a hinged arm, so that when said shaft is moved by the engineer frontward or backward longitudinally, opposite cocks and ports are opened and the two others closed to reverse the motion of the driving-shaft and machinery connected with it. The grooves in the cam-wheel are formed exactly parallel to the central plane of said wheel one-half its circumference, while their other halves run inward toward said plane, nearly touching said plane in the periphery of said wheel at exactly opposite points. By this arrangement of cam-grooves opposite slide-valves and abutments are reciprocated alternately, one set with reference to the other, at each revolution of the shaft, and impulse is given to one piston or the other the entire time that the portions of the grooves parallel to the plane of the cam-wheel are traversing the friction-rollers of the sliding bar to move the abutments and slide-valves. The piston-heads of the two cylinders are fixed in radial lines from the axis of the driving-shaft exactly one hundred and eighty degrees, the one with reference to the other, and this arrangement facilitates a uniform movement to the said driving-shaft while steam is supplied to the cylinders, precluding the possibility of dead-points to check the movement of the machinery.

In my drawings, Figure 1 is a plan or top view of the engine. Fig. 2 is a horizontal section through the steam-chests, exhibiting the exact relation between the slide-valves and other parts on either side of the cam-wheel. Fig. 3 is a longitudinal section in a vertical plane, showing the cylinders, the cam-wheel, the sliding bars connecting slide-valves, and abutments, &c. Fig. 4 is a transverse section through valves and steam-chest on one side of the cam-wheel. Fig. 5 is a front elevation of the engine. Figs. 6 and 7 are elevations of the interiors of the steam-cylinders, exhibiting the relative positions of the abutments of the pistons when steam is entering in one and

exhausting in the other. Fig. 8 shows the arrangement of one of the combined cocks.

Similar reference-letters indicate like parts in all of the figures of the drawings.

Referring to the drawings, A is the main or driving-shaft connected with my engine, which passes through cylinders B B′, and to which is fixed pistons C C′ and cam-wheel D, provided with grooves *g h*. The cylinders B B′ are formed in two parts and secured together by bolts, &c., in the usual manner of steam-cylinders. They are provided with the ordinary packing-rings to make them steam-tight. When the parts of the cylinders are placed together, spaces M M′ are inclosed, forming channels for the passage of steam received by the induction-ports and exhausted from the exhaust-ports. Between the pistons and the outer heads of the cylinders are formed annular spaces *i i*, which serve to receive any steam escaping through joints, by the expansion of which packing purposes are served.

The cylinders B B′ and their immediate surroundings are precisely similar in construction, so that a description of the parts on one side of the cam-wheel will answer as a description of the parts on the other side of said wheel. Within the steam-cylinder B on the left, which is immovably secured to the frame of the engine, is the rotary piston, keyed to the shaft A and provided with piston-head *a*. Immediately under the driving-shaft A is an abutment, N, which plays through the inner head, across the chamber, and through the other head of the cylinder. This abutment is connected to the yoke L by a rod, *f*, and through upright O to the rod K, which moves in a groove and connects with the cam-groove *g*. The rod K is provided with an upright pin, to which is loosely secured an anti-friction roller, *j*, to modify friction to the bearing-surfaces of the said groove *g*. Slide-valves J J² are secured to the yoke L, and these valves and the abutment N move simultaneously and rest simultaneously, influenced by the groove *g* during the motion of the cam-wheel through the sliding rod K.

F is a double steam-chest located next to the steam-cylinder B, and between it and the cam-wheel D. This chest has chambers *l l′*, provided with openings *m m′* for entrance of steam, and ports *b b′*, which open into the steam-cylinder B.

J J′ are the slide-valves, provided with stems *e e′*, moved from the cam-wheel to open and close the induction-ports *b b′*. Cocks E E² are located at points, as shown, convenient to the steam-cylinder B and slide-valves J J′. The construction of one of these cocks is exhibited in Fig. 8 of the drawings. This cock has a valve provided with two openings, one above the other and parallel, the upper communicating with the exhaust-port from the steam-cylinder, and the lower connecting with the steam-pipe which brings the supply of steam from the boiler.

As seen in Figs. 1 and 2 of the drawings, cock E is so fixed that live steam may enter the chest when the slide-valve on that side is open and the abutment of the cylinder B is in place in said cylinder. Steam passes through the opening *m*, thence through chamber *l* and port *b* into said cylinder behind the piston-head. At this time the cock E² is closed, so that no steam may enter the cylinder on its side; but its exhaust-orifice *b²* being open dead steam finds its way from in front of the piston-head C out through the exhaust-port on that side. The cocks E E² are, by cranks *p p′*, link-bar *q*, arm *t*, and shaft *s*, shifted at the option of the operator to change their relations with reference to the piston-head, and make one side or the other the induction and its opposite the exhaust side.

It is obvious from the construction of the cocks and their connecting arrangements that one must always be open for live steam, while the opposite serves as an exhaust-cock.

The shaft S serves to connect the two sets of valves on opposite sides of the cam-wheel, so that by one movement of the arm *r* in the hands of the operator, all four of these combined cocks are operated at one movement. Two opposite ones, as E E′, are opened for the entrance of live steam and closed for the exhaust, while the other two are closed to live steam and opened for exhaust. This simultaneous movement of cocks throws the power of the engine in a manner to drive the main shaft first in one direction and then in the other, carrying the machinery influenced either way at the will of the operator at any moment without injury to the operating parts of the engine.

It may be observed that the abutments of the engine move across the steam-cylinders and into openings in the outer cylinder-heads before the slide-valves open their respective ports. Therefore no live steam is lost, and when these valves are open steam acts positively upon the piston-head with both primary and expansive force, thus giving maximum results and rapid movement. The slide-valves close also before the abutments are withdrawn through the cylinder-chambers, so that exhaust-steam is gotten rid of before a new supply of live steam is taken in. It may also be observed that in the arrangement of the pistons on either side of the cam-wheel the head of one bears such a relation to the head of the other that full steam is at all times acting positively upon one or the other, so that the movement to the driving-shaft is positively uniform and constant while the engine is in operation, giving advantages over any system now in use that I am aware of.

In my drawings I have shown two double steam-chests with double slide-valves and steam-cocks, and this arrangement is necessary when the reversing mechanism is required; but where it is not necessary to use the reversing machinery single steam-chests, single slide-valves, and one cock only is necessary on each side of the cam-wheel. In the

latter application steam is received from but one side of the driving-shaft, and the exhaust takes place from exhaust-ports arranged on the opposite side.

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

1. A cam-wheel applicable to a steam-engine and adapted to move in a plane at right angles to the axis of the driving-shaft, provided with two cam-grooves, each of which is parallel with a right central plane of said wheel one-half of said wheel's circumference, the other half of said grooves having direction inward toward said central plane, with the greatest inward variance of the one at an angle of one hundred and eighty degrees to the greatest inward variance of the other, substantially as and for the purpose set forth.

2. In a steam-engine, the cam-wheel having two annular cam-grooves formed in a manner substantially as described, fixed to the main or driving shaft, by which motion is imparted from said shaft in opposite directions in a line parallel with the axis of said shaft to operate certain mechanism connected with the steam-cylinders, as and for the purpose set forth.

3. A cam-wheel formed substantially as described, and fixed upon the driving-shaft of a steam-engine, one of the grooves of which gives motion to a steam-abutment and one or more slide-valves on one side of said cam-wheel simultaneously, and the other of said grooves alternately with the first giving corresponding motion to an abutment and slide-valves on the opposite side of said wheel, as and for the purpose set forth.

4. A steam-engine having two steam-cylinders, one fixed to the base upon one side and parallel with a central plane, and one upon the opposite side of the said plane, said cylinders being set with their common axis coincident with the axis of the driving-shaft, in combination with concentric pistons provided with suitable piston-heads, substantially as described, fixed upon and moving said driving-shaft when influenced by steam received into and discharged from said cylinders, substantially as and for the purpose set forth.

5. The combination, with a steam-cylinder fixed about the axis of the driving-shaft of an engine, and a rotary piston fixed to and moving with said driving-shaft, provided with a suitable head, of an abutment having an alternate movement into and out of said cylinder with an interval of rest, a rotary cam-wheel provided with annular grooves about its periphery, and suitable rod-connections for said cam-wheel and abutment, all arranged as and for the purpose set forth.

6. The combination, with the cylinder, rotary-piston, and steam-abutment, substantially as described, of a slide-valve operated from the motion of the main driving-shaft through the influence of the cam-wheel grooved on its periphery and fixed to the driving-shaft, and suitable connecting mechanism, as and for the purpose substantially as specified.

7. The combination, with the steam-cylinders fixed at opposite points about the axis of the driving-shaft and provided with induction and exhaust ports, the rotary pistons, movable abutments, steam-chests, and slide-valves, of the rotary cam-wheel located between the steam-cylinders upon the driving-shaft provided with cam-grooves on its periphery, and connecting mechanism for the abutments, slide-valves, and cam-wheel, substantially as specified.

8. The reversing mechanism composed of cocks E E′ E^2 E^3, shaft *s*, arm *r*, levers *t t′*, arms *w w′*, and link-bars *q q′*, and cranks connected to said cocks, whereby steam is changed and directed from one side of the abutments of the steam-cylinders to the other to give forward or backward movement to the pistons and driving-shaft, substantially as and for the purpose set forth.

9. The combination, with a steam-chest and a slide-valve moving horizontally therein, and the combined induction and eduction cocks, of the fixed concentric cylinder and rotary piston fixed to the driving-shaft and moving in said cylinder, and the steam-abutment moved horizontally from a concentric cam-wheel, grooved as described, and fixed to said driving-shaft, as and for the purpose specified.

10. A steam-engine having duplicate cylinders and rotary pistons arranged about the axis of the driving-shaft, duplicate slide-valves and abutments arranged and moved in connection with a cam-wheel having two cam-grooves, substantially as described, whereby said pistons are rotated by force of steam, which enters and continues to enter through an induction-port into one cylinder to drive its piston half a revolution and cuts off simultaneously with the entrance and continued entrance of steam in the opposite cylinder during a half-revolution, thus keeping up an unabated steam-pressure and movement consequently to the driving-shaft, substantially as and for the purpose specified.

11. The combination, with the steam-cylinder provided with suitable ports located at opposite points about the axis of the driving-shaft, the pistons fixed to the driving-shaft and moving with it within the said cylinders, of the double-grooved cam-wheel, the slide-valves, the induction and exhaust ports connected with the cylinders and slide-valves, the steam-abutments, and the induction and eduction cocks, all arranged as and for the purpose set forth.

In testimony whereof I affix my signature in presence of two witnesses.

DAVID L. CROSS.

Witnesses:
H. A. HALL,
EDW. W. DONN.