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F. CAREY.

STEAM ENGINE.

No. 441,932. Patented Dec. 2, 1890.

Fig. 1.

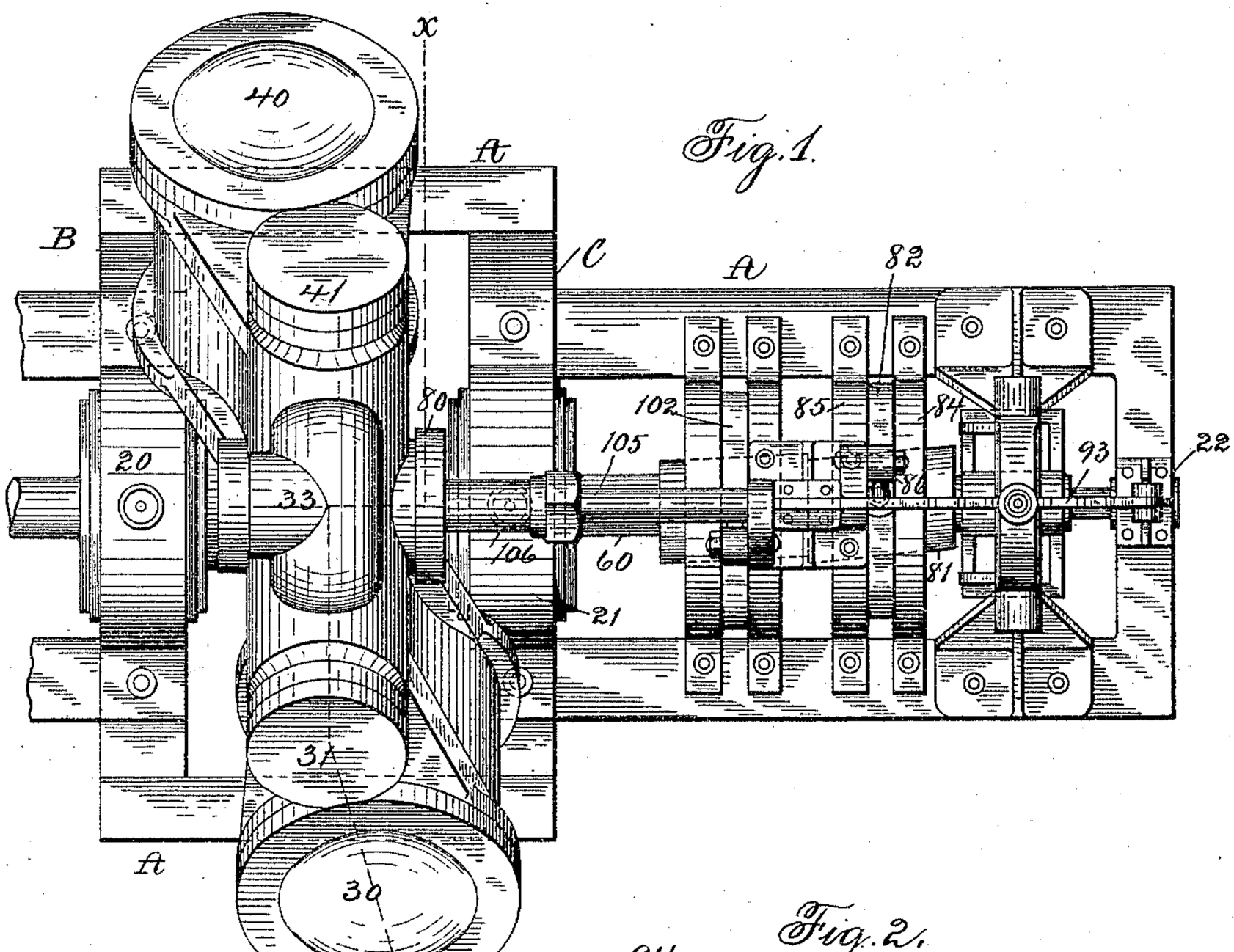

Fig. 2.

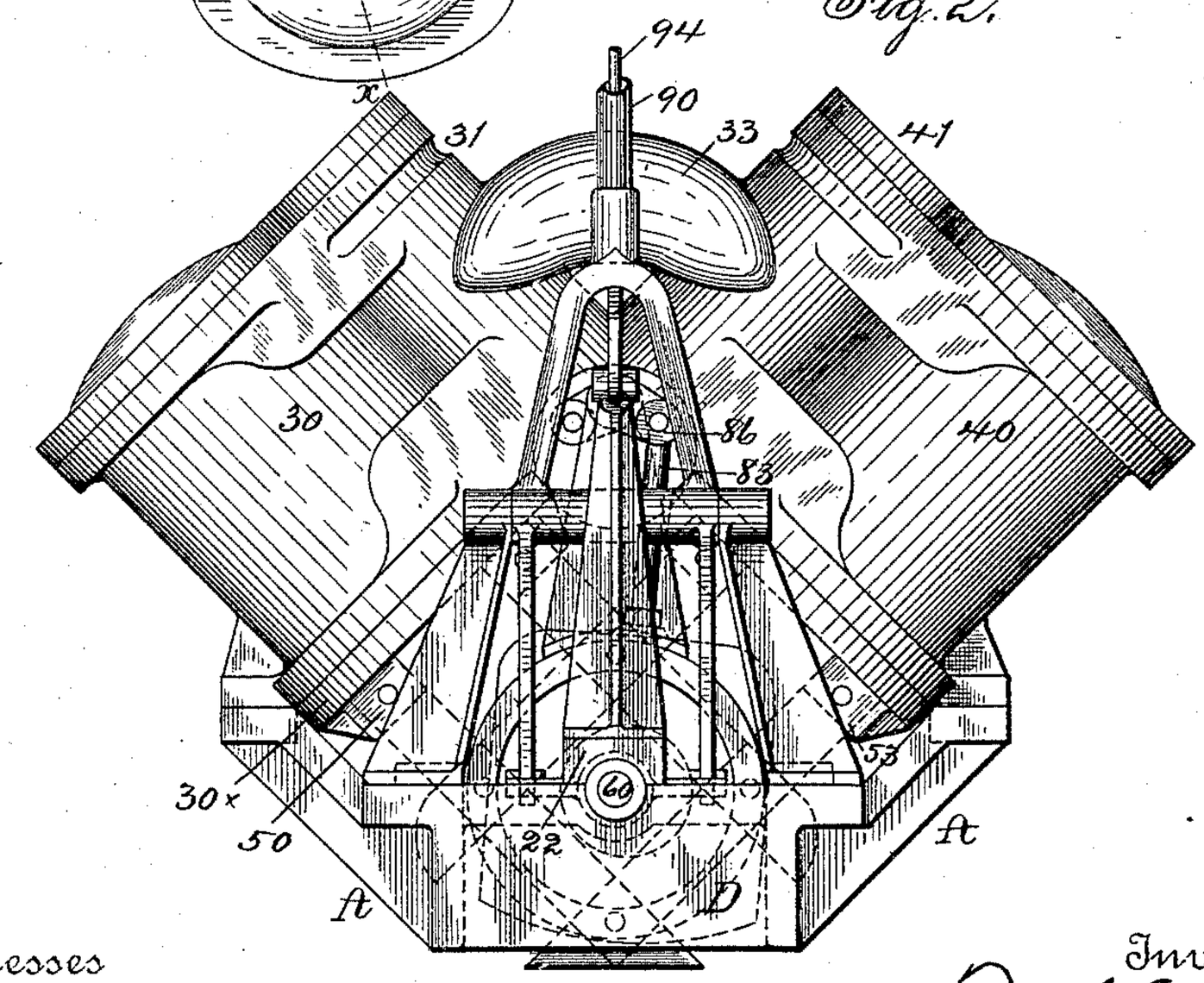

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Fig. 3.

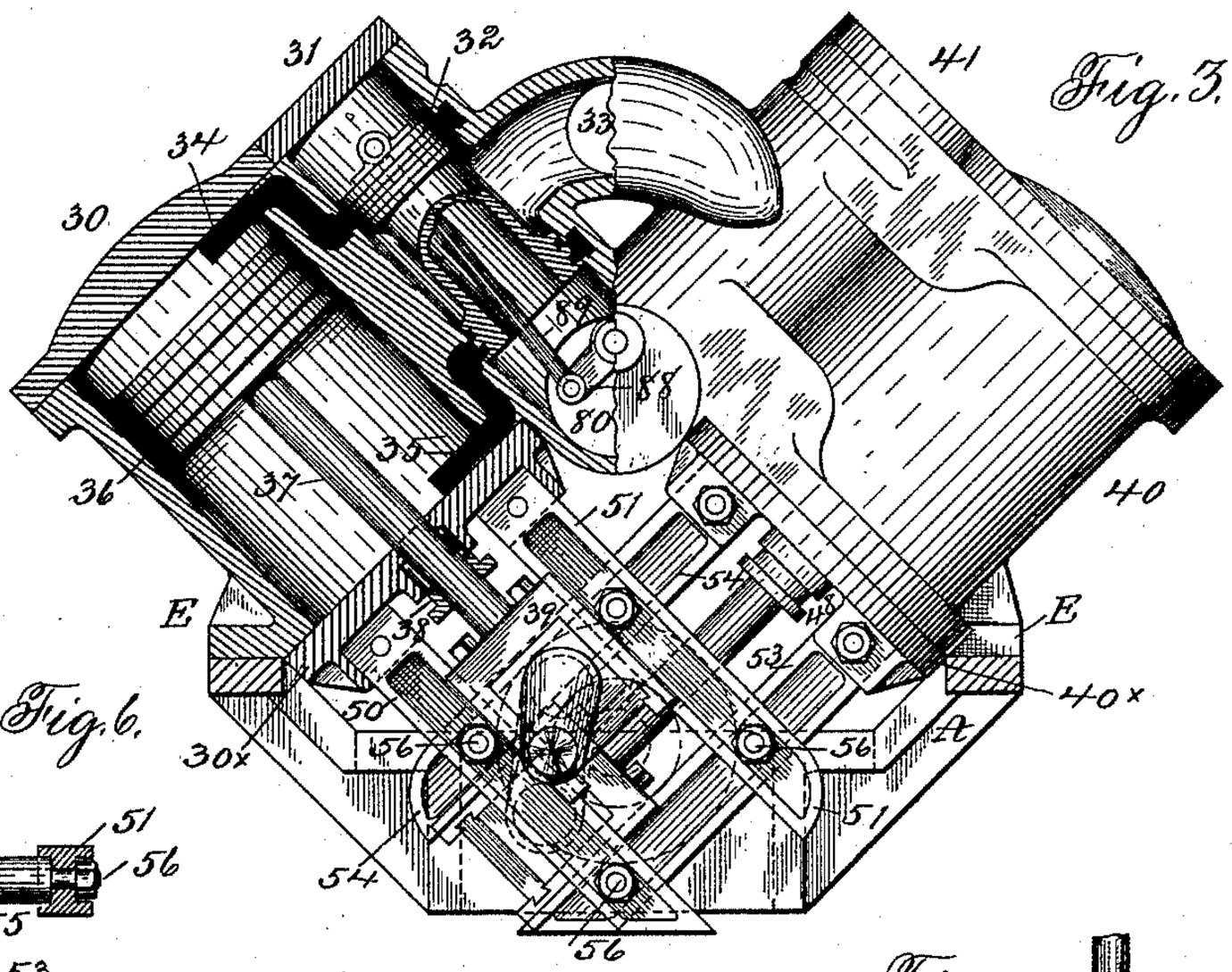


Fig. 6.

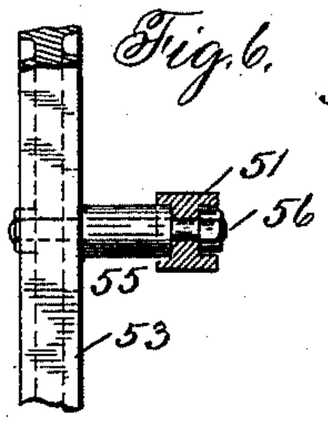
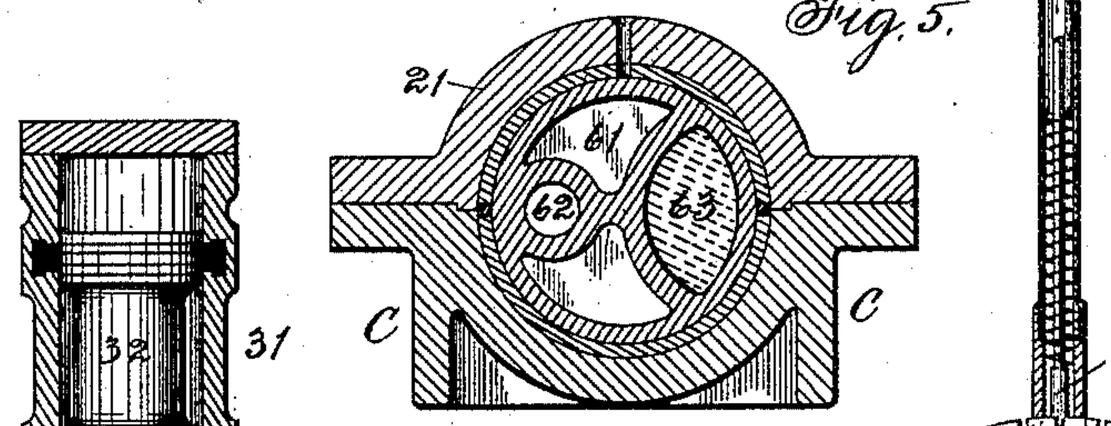


Fig. 5.



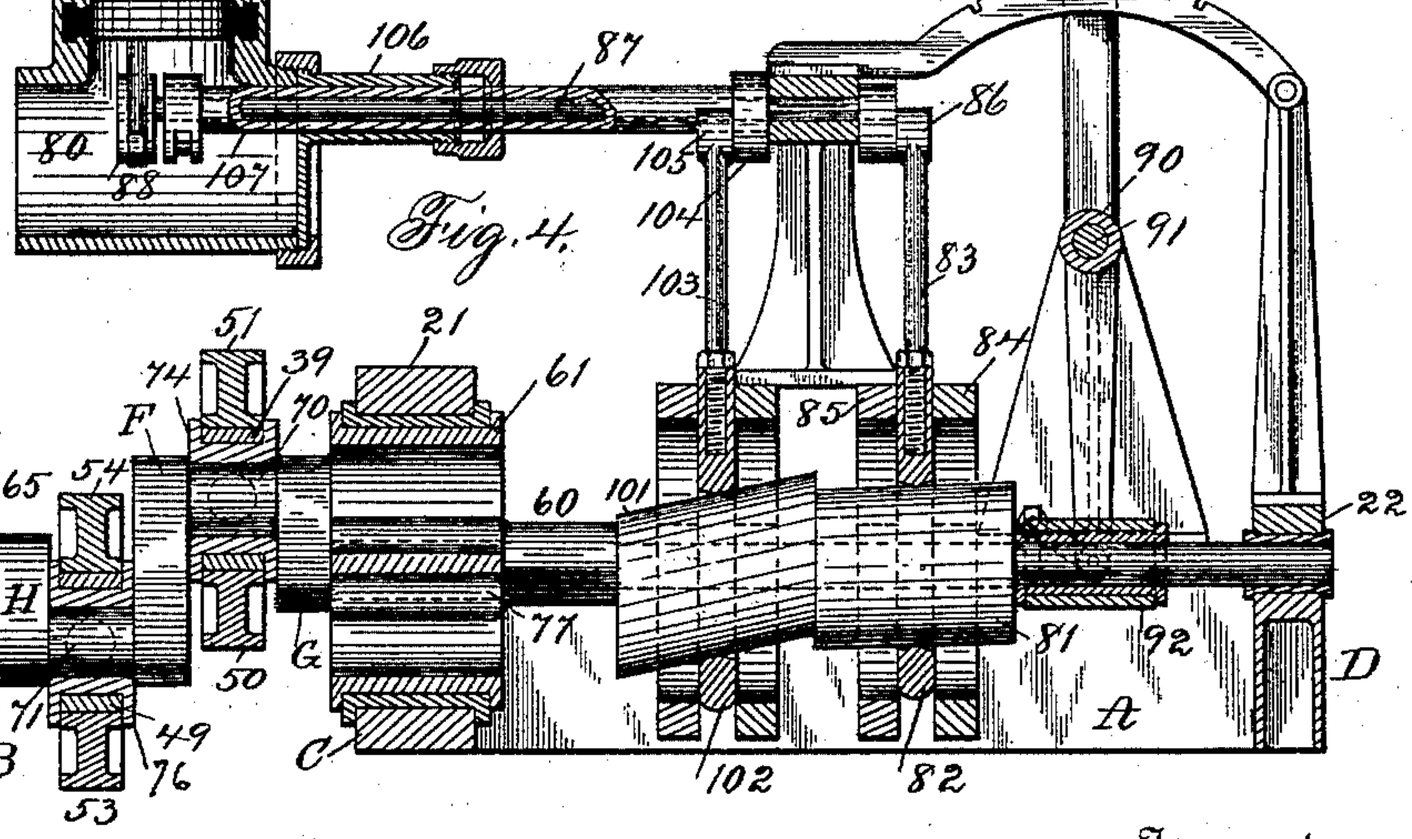


Fig. 4.

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Fig. 7.

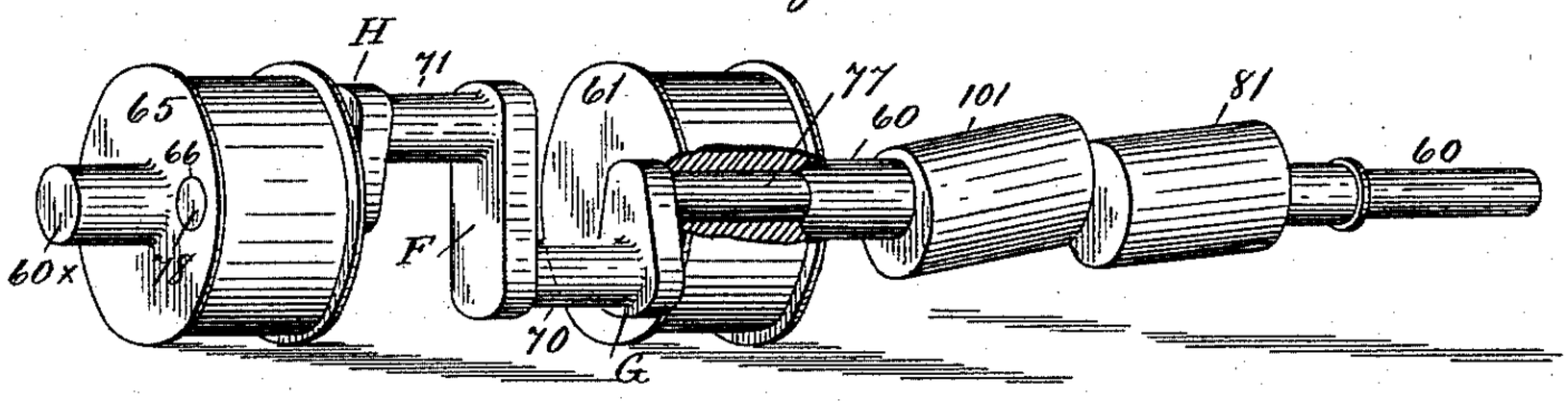
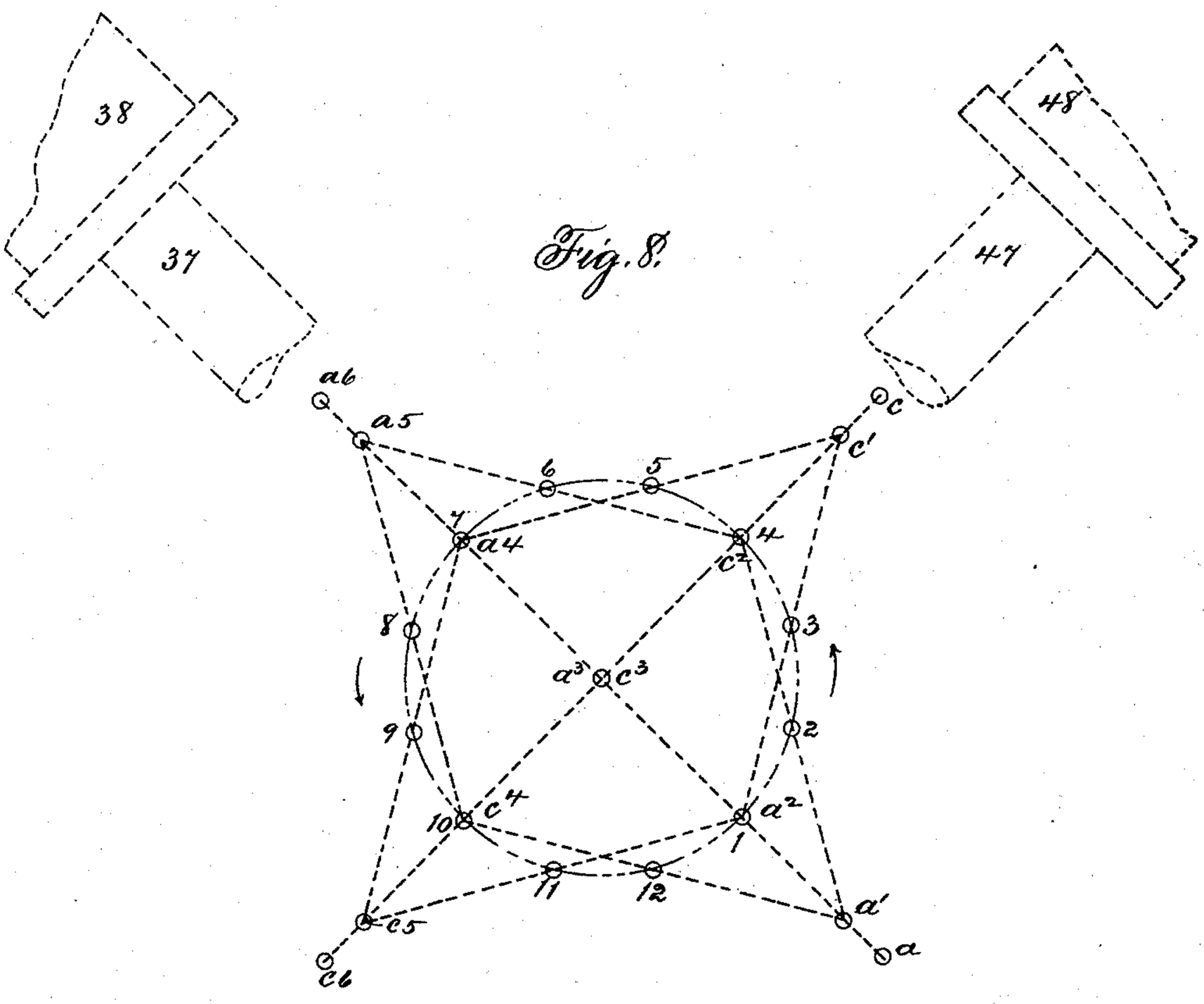


Fig. 8.



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By his Attorney. Wm A Barrett

UNITED STATES PATENT OFFICE.

FRANK CAREY, OF PENN YAN, NEW YORK, ASSIGNOR OF ONE-HALF TO JOHN W. YOUNG, OF TUNKHANNOCK, PENNSYLVANIA.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 441,932, dated December 2, 1890.

Application filed March 11, 1890. Serial No. 343,534. (No model.)

To all whom it may concern:

Be it known that I, FRANK CAREY, residing at Penn Yan, in the county of Yates and State of New York, have invented certain new and useful Improvements in Steam-Engines, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to steam-engines of the cylinder and piston variety.

The object of the invention is to produce an engine in which the piston shall be directly connected to the driving-shaft without an intervening pitman; also, to connect the piston-rods of a multiple-cylinder engine to the driving-shaft in such manner that all but one of the pistons shall be off the dead-center, and one of the cross-head bearing-pins shall serve as a fulcrum about which all the others shall have leverage; also, to improve the valve-gear and other operative parts of a steam-engine.

I have shown and described an engine with two cylinders set in different planes and arranged at a right angle to each other; but it will be understood that the general principle of construction is applicable to more than two cylinders and that the engine may be made compound by exhausting one cylinder into the other, as is common in this art.

Figure 1 is a top plan of the engine and valve-gear. Fig. 2 is an end elevation of the same. Fig. 3 is a section on line *x x*, Fig. 1, one valve-chest being broken away. Fig. 4 is a central longitudinal section and partial elevation of Fig. 1, the valve-bore shown vertical to better illustrate its working. Fig. 5 is a section through one of the enlarged shaft-bearings or face-plates. Fig. 6 is a broken detail section showing guide or slide ways and their connection. Fig. 7 is a diagrammatic perspective of the shaft and cranks. Fig. 8 is a diagram intended to illustrate the operation of the device.

A indicates the frame of the machine. This frame is of rectangular or other suitable form in plan and has cross-bars B C, which have large boxes 20 and 21 to support the face-plate bearings of the shaft. The frame has also a cross-bar D at one end, which has a brass or bearing 22 for the shaft 60. The face-plates need not necessarily have bearings, but the shaft may be kept in line by any usual arrangement of bearing-boxes.

The cylinders 30 and 40 are supported on the frame A by flanges E, or in other suitable manner. The cylinder 30 has a steam-chest 31, provided with a piston-valve 32, Figs. 3 and 4, which valve is hollow to permit the exhaust-steam to pass through it. The steam enters port 33, and as the valve 32 slides the steam is admitted to the cylinder 30 by ports 34 and 35 alternately, thus acting alternately on opposite sides of the piston 36. The piston-rod 37 passes through stuffing-box 38. The steam-chest, valve, and connections thus described are not essentially different from like parts employed in many double-acting engines.

The piston-rod 37 bears a cross-head 39, which moves in guide or slide ways 50 and 51, which guides are preferably bolted or otherwise attached to the head $30^{\times}$ of the cylinder 30. The cylinder 40 is shown to be a duplicate of cylinder 30, and has a steam-chest 41 and valve-connection corresponding to those described for cylinder 30. The piston-rod 47 has a cross-head 49, which moves in guideways 53 and 54, attached to the cylinder-head $40^{\times}$. The slideways are connected and held by the bolts 56 and spreaders 55. (See Fig. 6.) The slideways or guides are thus at the same angle relatively to each other as the cylinders and extend across the line of the shaft 60. The shaft 60 has an enlarged bearing-piece or face-plate 61, which has a socket 62 for a crank-pin. The face-plate 61 may be a web with a counterbalance-piece 63 at the side opposite the socket 62 to counterbalance the crank. The shaft $60^{\times}$ is practically a continuation of shaft 60, and has a face-plate 65, corresponding in all respects with the face-plate 60, and having a socket 66 in line with the socket or bearing 62. A compound or quadruple crank is placed between the two face-plates 61 and 65. This compound crank consists of the bar F and two cross-head bearing-pins 70 and 71, extending at opposite sides and at opposite ends thereof. The cross-head 39 surrounds a suitable bear-

ing or collar 74 or crank 70. The cross-head 49 in similar manner surrounds collar or wear-piece 76 on crank 71. Cross-head pin 70 has a rigid arm or web G, parallel with arm F and bearing a crank-pin 77, which enters the socket 62 in face-plate 61. A similar arm or web H, rigid with cross-head-bearing pin 71, has a pin 78, which enters socket 66 in face-plate 65.

The pins 70 and 71, on which the piston-rods have direct bearing, must be rigid both with the bar F and with the arms G and H; but the pins 77 and 78 may be rigid with the face-plates and turn in sockets or bearings in the arms G H.

The centers of pins 77 and 78 are opposite the center of arm or web F, and the arm G (from center to center of its two crank-pins) is equal to the distance from center of the shaft 60 to center of pin 77. Consequently the pin 70 might by itself have a movement around the pin 77, being at one time in line with shaft 60 and again twice the distance from the center of said shaft 60 that the pin 77 is from the center of said shaft. The pins 77 and 78 may be carried by cranks instead of plates on the shaft 60 $60^{\times}$. We have thus for the piston-rod or cross-head 39 a limit of travel of four times the length of arm G, (measuring from center of crank-pins,) which revolve around center of shaft 60 at a distance from its center of exactly the length of the arm G. We have a precisely similar limit of movement of piston-rod 47 and its cross-head; but as piston-rod 37 moves at a right angle to the line of movement of rod 47 the rod 37 will be in its most effective position when rod 47 is on its dead-centers, and vice versa. Thus one cross-head pin serves as a fulcrum while the other crank is working at its best leverage, and the pins 77 78 are all the time acting on face-plates 61 and 65 to revolve said plates and the shaft 60 and $60^{\times}$, of which the face-plates form a part.

The diagram Fig. 8 outlines the movement of parts, as understood. The dotted circle 1 2 3, &c., denotes the movement of driving-pins 77 78. The dotted line $a\ a^6$ outlines the path of cross-head pin 70, and the line $c\ c^6$ the path of the cross-head pin 71. With one cross-head pin a on the dead-center the other at c^3 will be in position to present the greatest leverage on the driving-crank at 1. The movement of a to a' and c^3 to c^2 carries driving-crank center from 1 to 2. a' to a^2 and c^2 to c' carries driving-crank center from 2 to 3. a^2 to a^3 and c' to c carries driving-crank center from 3 to 4. c to c' and a^3 to a^4 carries driving-crank to 5. c' to c^2 and a^4 to a^5 carries crank-pin from 5 to 6. c^2 to c^3 and a^5 to a^6 brings crank-pin to 7. Piston 37 has now made one complete stroke and piston 47 two half-strokes, and the driving-crank pin has made a half-revolution, the parts being in the same relative position as to the application of power as at first, but the pistons moving in opposite directions. Intermediate positions are indicated on the diagram, which, it is believed, gives a correct theoretical explanation of the movement of the cranks.

It will be seen while the cross-head bearing of 37 goes from a' to a and back to a' that the cross-head bearing of 47 sweeps clear across the center of motion from c^4 to c^2, carrying the crank-pin on the dotted circle from 12 to 2. The paths of both crank-pins are to be taken as one circle. The distance from 12 to 2 is just half the distance traveled from c^4 to c^2. Cross-head bearing goes through the same performance from a^2 to a^4, carrying crank-pins from 3 to 5, while 47 works from c' up to c and back to c'.

From the foregoing it will be understood that the direct coupling of the piston-rods to the driving-crank at the cross-head bearing permits a very compact arrangement of parts, and that there is no dead-center as far as the driving-crank pin is concerned.

As both cylinders are supplied with steam from port 33, so both will exhaust through the hollow slide-valves, (one being shown at 32,) to exhaust the port 80.

There is a direct relation between the movement of the slide-valves and that of the pistons caused by the peculiar valve-gear employed.

On the shaft 60 there are two eccentric cylindrical bodies 81 and 101, which are secured together and may be moved lengthwise of the shaft 60, being held from turning on the shaft by a straight spline or key. The movement of the eccentrics is directly lengthwise of the shaft. The eccentrics are formed from cylindrical bodies bored through eccentrically from end to end, the bore of each being at the side of the center, so that the bands will never be exactly concentric with the shaft. (See 101, Fig. 4.) These eccentrics are not true cylinders in any section taken from their own surfaces at right angles to their bore. Any such section would be an ellipse. Cut through at exactly right angles with the periphery any section would be a true circle bored eccentrically. Every different section would show a different amount of eccentricity, and the lines of such greatest eccentricity would radiate at varying degrees from the axis of the shaft.

As shown in Fig. 4, the eccentrics are in central position longitudinally of the actuating-sleeves 82 and 102; but the rods 83 and 103 will still give a valve movement sufficient to move the valve exactly up to the steam-admission and to exhaust the cylinders. Following now the course of the gear from eccentric 81, it will be understood that the sleeve band or collar 82 is held between guides 84 and 85. The rod 83 connects with crank 86, which is secured to rock-shaft 87, which rock-shaft passes through suitable packing-boxes into the exhaust port or chamber 80, and is there provided with a crank 88, which by a pitman 89 connects with the slide valve 32. The rod 103 similarly engages a crank 104,

which is connected to a hollow rock-shaft 105, which surrounds rock-shaft 87. Hollow shaft 105 passes through stuffing-box 106 and has a crank 107 in position to operate the slide-valve in steam-chest 41. Thus the two eccentric sleeves 81 and 101 control the movement of the two slide-valves. The eccentrics 81 and 101 are shifted lengthwise of the shaft 60 by means of hand-lever 90, hung at 91, and having a collar 92 coupled to the eccentrics so as to permit the eccentrics to rotate independently of the collar. The lever 90 has spring-catch 94, which engages one of the notches in the quadrant bar 93 to hold the eccentrics in any adjusted position.

When the eccentric cylinders are adjusted in the middle position with lever 90, as in Fig. 4, the valves have their minimum travel, and such travel of either valve is exactly with the piston of its accompanying cylinder. This reduced valve travel opens the exhaust, but does not admit steam, owing to the slight lead of the exhaust ends of valve. The shifting of the lever 90 either forward or back produces a corresponding change in the position of the eccentric cylinders moving then lengthwise of the shaft, producing a valve movement if the engine is at a standstill and giving the valves an increased travel when in motion and admitting steam to the pistons for either forward or reverse motion. The lever may be thrown far enough to bring any part of the bearing-surfaces of the eccentric-cylinders in position to actuate the valves, the graduated notches of the quadrant holding the lever and the eccentrics in any desired position, so that steam may be cut off from the piston at any point of the stroke from 0 to nearly full-stroke. The point of cut-off varies with the position of the eccentrics, the ends of the eccentrics giving valve travel sufficient to admit steam nearly full-stroke; but the point of steam admission and exhaust never varies, steam, if admitted at all, being admitted just as the piston has passed its lead point, the exhaust having a slight lead on the steam. This valve motion is believed to have advantages over any heretofore used, and is due to the peculiar shape of the eccentric cylinders. This valve-gear may be made automatic in its action by the use of the usual weights and springs to shift the eccentrics by means of centrifugal force, and may be used on any reciprocating engine.

It will be understood that the face-plates 61 65 may be simply arms on the shaft and that the crank-connection may be made with a single face-plate or arm on a single shaft instead of with two cranks or face-plates on separate shaft-sections.

While the valve-gear described is specially adapted to the engine, other valve-gear may be employed.

I do not herein broadly claim the valve-gear shown, but only the special combinations of such gear with the engine, snbstantially as described.

What I claim is—

1. A steam-engine having a plurality of cylinders fixed to the frame, a piston in each cylinder, and a piston-rod rigid with the piston and directly connected to the shaft by a compound crank, in combination, substantially as described.

2. The combination, with the frame of an engine, of a plurality of steam-cylinders set at an angle to each other, a piston in each cylinder, a piston-rod rigid with the piston cross-head on the piston-rod, and slideways for said cross-heads connected to the cylinder and crossing the line of the shaft, substantially as described.

3. The combination, with the frame, of a plurality of steam-cylinders attached thereto, a piston in each cylinder, a piston-rod and cross-head attached thereto, slideways for cross-heads connected to the cylinders, and bolts and distance-pieces by which said ways are held together, substantially as described.

4. The combination, with the shaft, of a face-plate or enlargement thereon, a compound crank having a connection to said shaft, so as to rotate independently of the shaft rotation, and steam-cylinders having piston-rods connected directly to the compound crank.

5. The combination of the plurality of steam-cylinders, the compound crank having direct crank engagement with cranks of the driving-shaft, and the pistons, each having a rigid piston-rod directly connected to the pins of the compound cranks.

6. In a steam-engine, a shaft having an enlargement or face-plate confined by a bearing, a crank directly engaging said face-plate, and a steam-cylinder with a piston rigidly attached thereto and directly engaging said crank, all in combination, substantially as described.

7. The combination, in a steam-engine, of a divided shaft, a compound crank between the shaft-sections engaging cranks connected to both shaft-sections, and steam-cylinders and pistons with their piston-rods directly connected to the compound crank, substantially as described.

8. In a steam-engine, a plurality of cylinders having pistons moving at right angles to each other, cross-heads at the other ends of said pistons and guideways for said cross-heads, a compound crank having pins in each of the cross-heads, and a driving-shaft having crank connection with said compound crank, all in combination, substantially as described.

9. The combination, with the main shaft of a plurality of steam-cylinders, a piston in each cylinder, and a rod from each piston connected to the shaft by a compound crank, of a plurality of cylindrical bodies moving with the main shaft, but placed eccentrically thereto and to each other, means for shifting said cylindrical bodies lengthwise of the shaft, and sleeves or collars on said eccen-

trics connected to the valve-operating shafts of the steam-cylinders.

10. In a steam-engine, the combination of the main shaft and a plurality of fixed steam-cylinders having pistons and piston-rods connected to said shaft by a compound crank, with a plurality of cylindrical bodies bored eccentrically and movable lengthwise on said shaft, sleeves on said eccentrics and connection therefrom connected to the valve-operating mechanism of the steam-cylinders, and a lever-connection for shifting said eccentrics lengthwise of the shaft, all substantially as described.

11. In an engine of the character described, the counter balanced face-plates 61 65, rigid with the divided shaft and having sockets for crank-pins, the compound crank interposed between the face-plates and having crank-pin connection with both plates on the same line, and the pistons directly coupled to the compound crank, all in combination.

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

FRANK CAREY.

Witnesses:
SILAS KINNE,
U. S. BALDWIN.