(No Model.) 4 Sheets—Sheet 1.

G. S. STRONG.

VALVE MOTION FOR STEAM ENGINES.

No. 304,970. Patented Sept. 9, 1884.

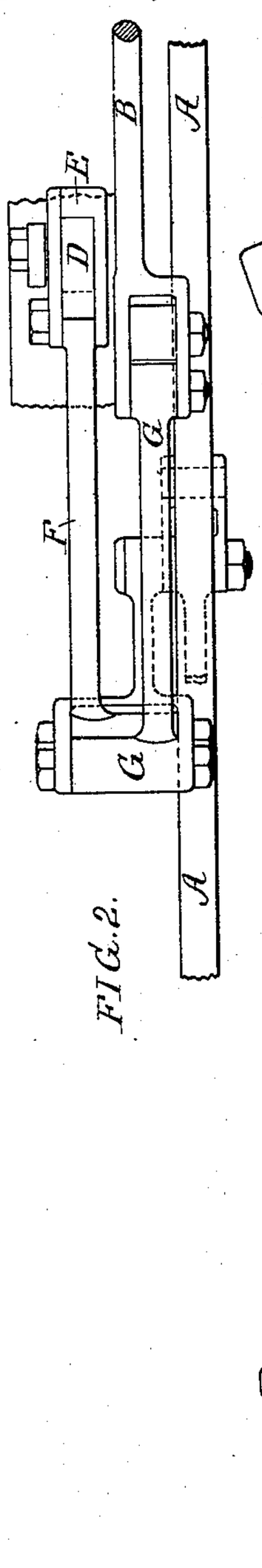
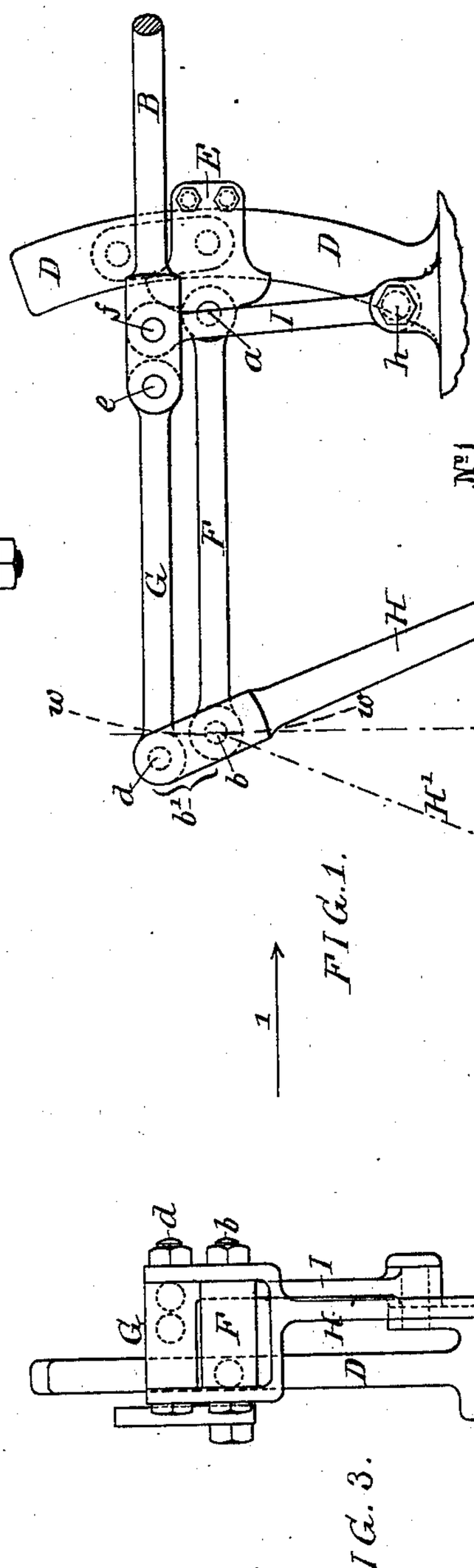


FIG. 2.



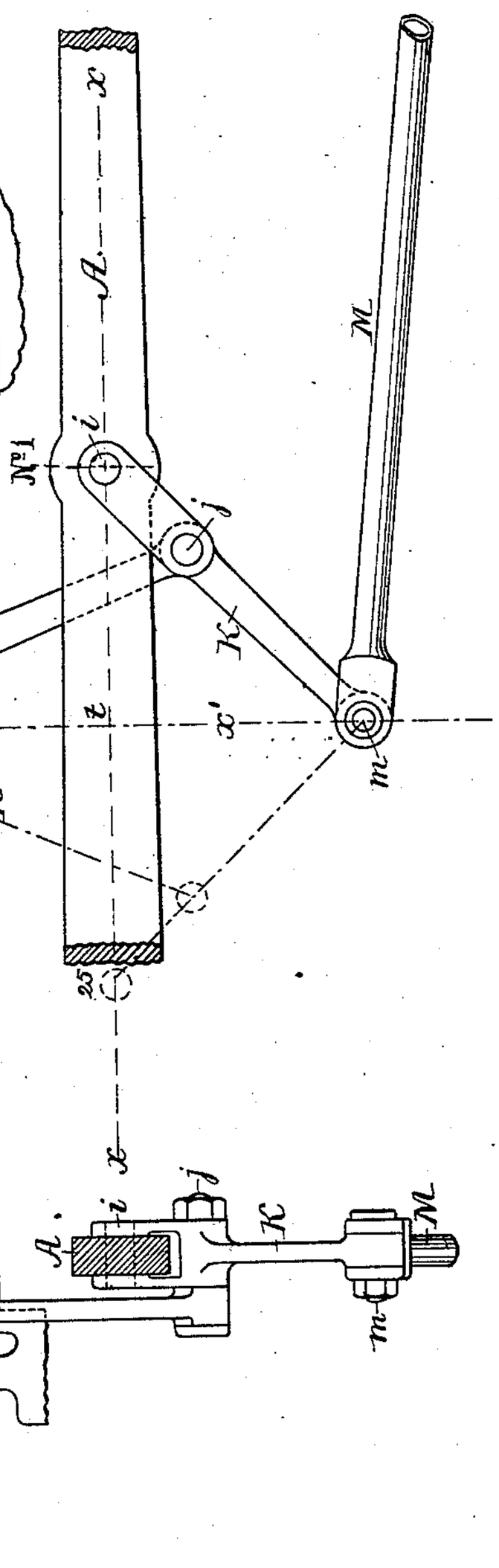


FIG. 1.

FIG. 3.

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FIG. 6.

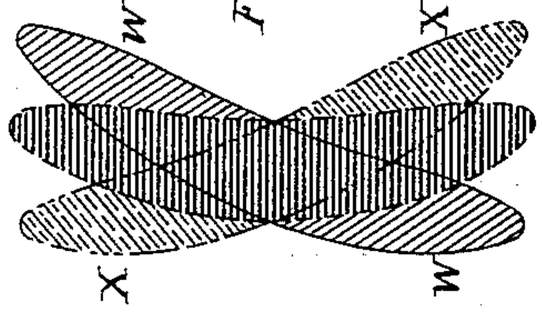

FIG. 5.

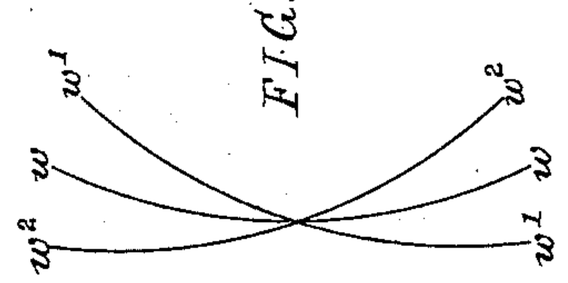

FIG. 4.

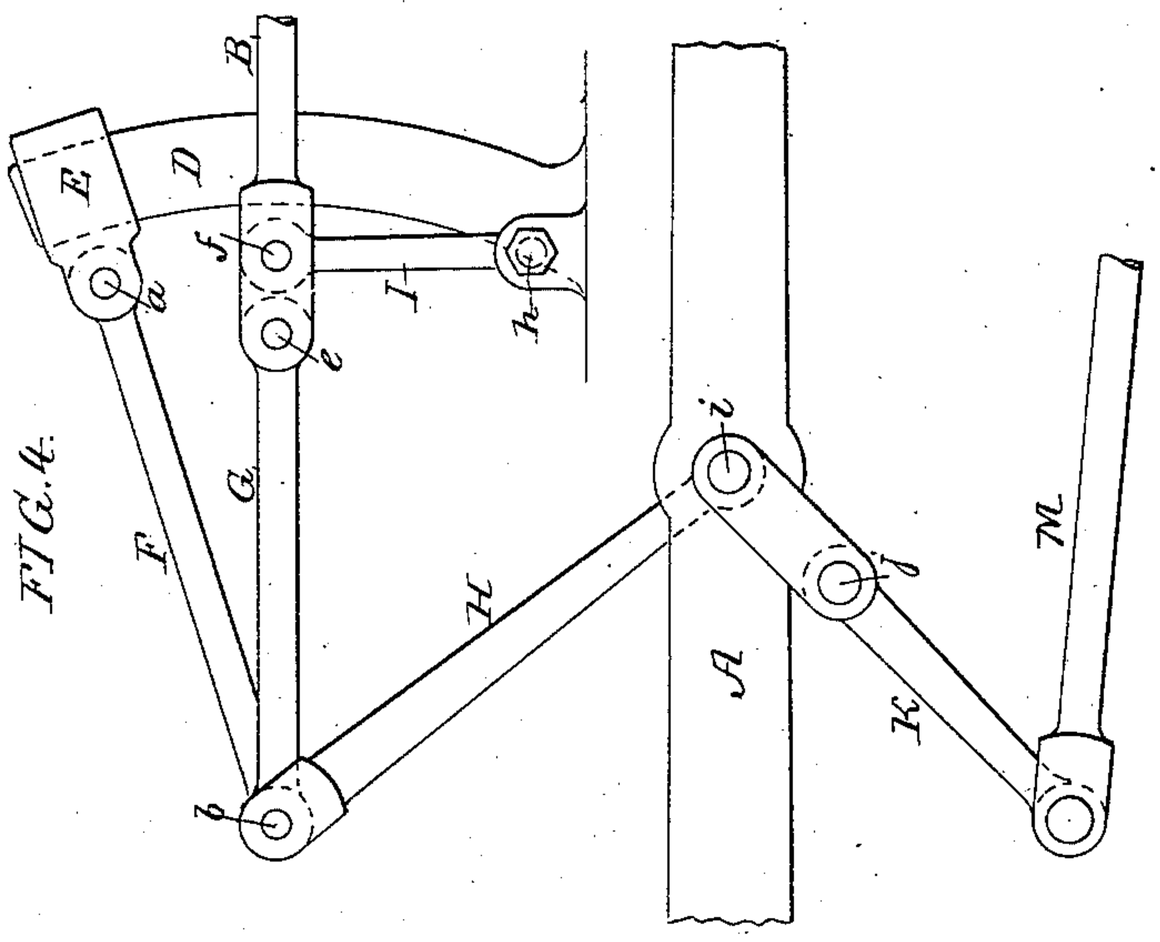

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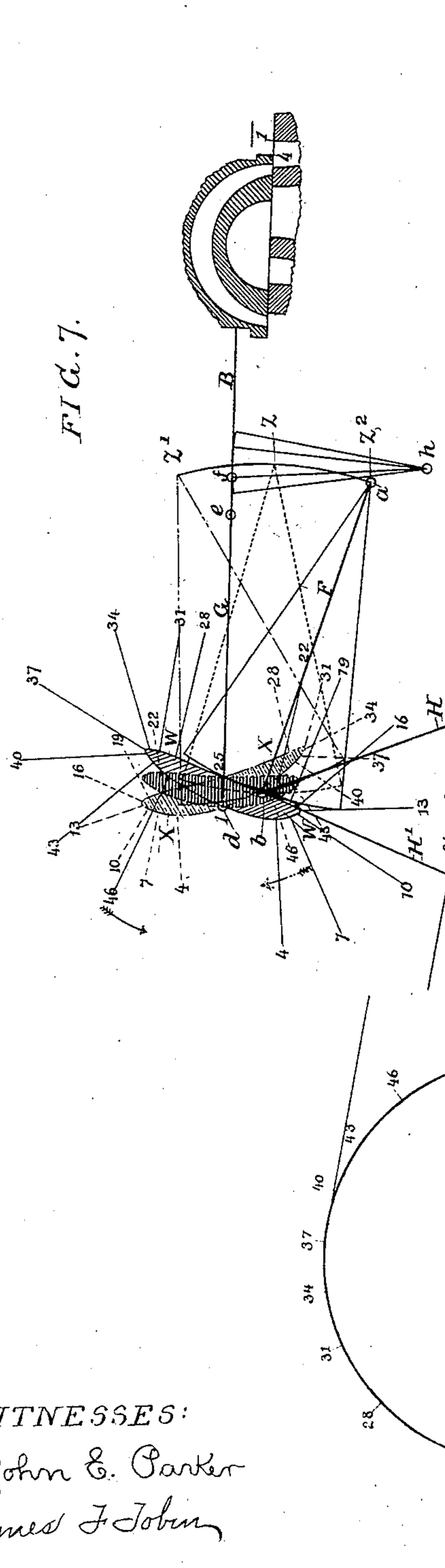
FIG. 7.



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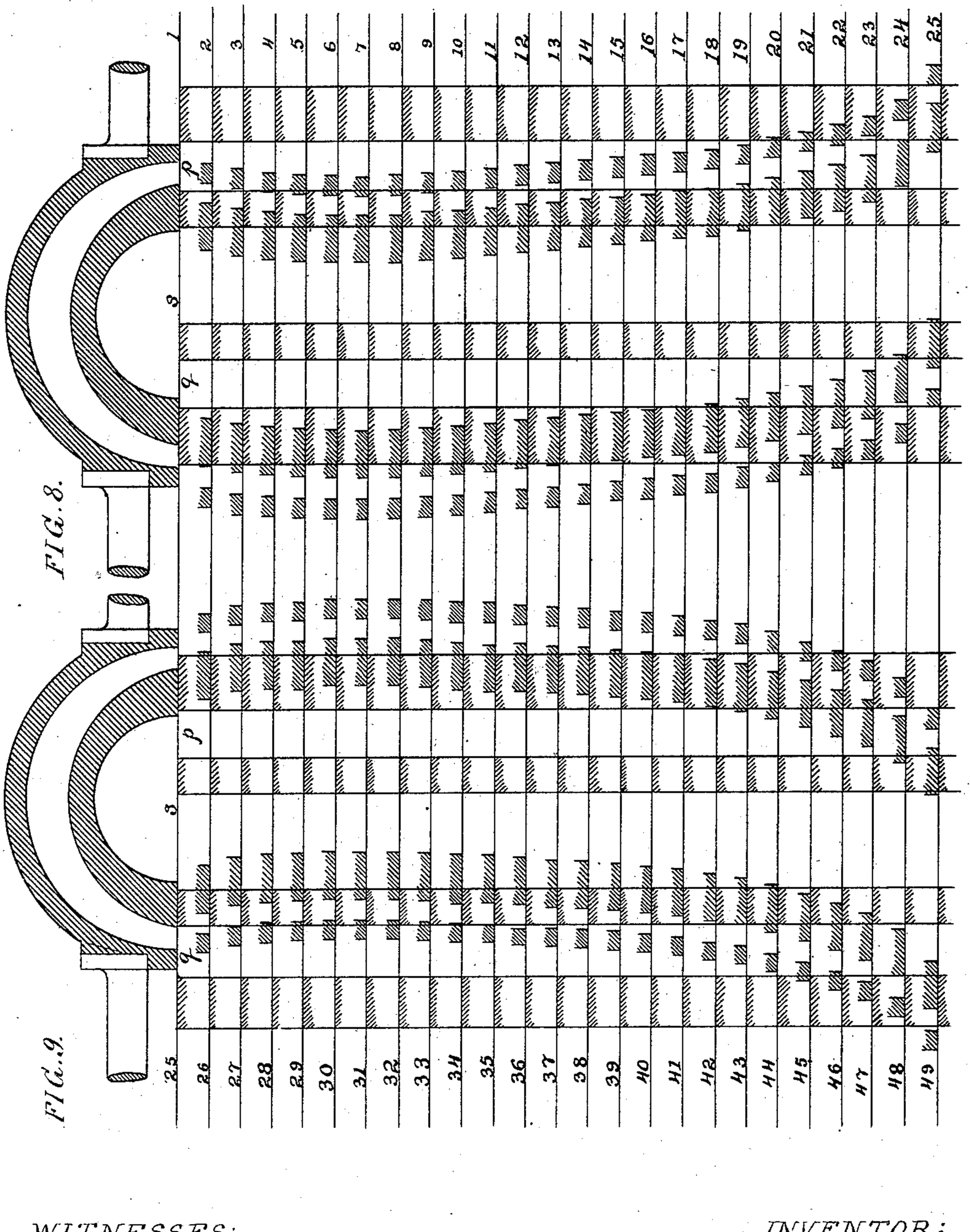

FIG. 8.

FIG. 9.

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UNITED STATES PATENT OFFICE.

GEORGE S. STRONG, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO JOHN T. MORRIS, TRUSTEE, OF SAME PLACE.

VALVE-MOTION FOR STEAM-ENGINES.

SPECIFICATION forming part of Letters Patent No. 304,970, dated September 9, 1884.

Application filed January 19, 1884. (No model.)

To all whom it may concern:

Be it known that I, GEORGE S. STRONG, a citizen of the United States, and a resident of Philadelphia, Pennsylvania, have invented certain Improvements in Valve-Motions for Steam-Engines, of which the following is a specification.

My invention consists of valve-gear, too fully explained hereinafter to need preliminary explanation, to be used in connection with either locomotives, stationary or marine steam-engines, the main objects of my invention being as follows: First, to enable the engineer to stop, start, and reverse an engine with slight exertion; second, to permit the use of a governor, in the case of a stationary or marine engine, to regulate the movement of the valve; third, to obtain the desired lap, lead, and cut-off of the valve to insure the quick admission of steam, and at the same time a long-continued opening of the exhaust; and, fourth, to avoid extended frictional surfaces in mechanism for operating the valves of a steam-engine.

In the accompanying drawings, Figure 1, Sheet 1, is a side view of my improved valve-gear as I prefer to make it; Fig. 2, a top view of Fig. 1; Fig. 3, an end view of Fig. 1, looking in the direction of the arrow; Fig. 4, Sheet 2, a view of my improved valve-gear in its simplest form; Fig. 5, a diagram illustrating the action of the gear, Fig. 4; Fig. 6, a diagram illustrating the action of the gear, Fig. 1; Fig. 7, Sheet 3, a general diagram illustrating the action of my improved valve-gear; Figs. 8 and 9, Sheet 4, diagrams illustrating the result of my improved valve-gear on a valve and parts of the valve-seat.

Referring in the first instance to Figs. 1, 2, and 3, Sheet 1, A represents part of the connecting-rod of a steam-engine, B the valve-rod, and D a fixed segment, made in the arc of a circle and secured to any available fixed part of the engine, the dotted line *x* representing the central line of the engine—that is, a line passing through the center of the crank-shaft and that of the cylinder. It is also the central line of the connecting-rod when the crank-pin is either at its rear or front dead-center, the crank-pin being supposed to be at its rear dead-center in Fig. 1. A block, E, is fitted to and arranged to be adjusted on the segment, and one end of a link, F, is connected to this block by a pin, *a*, the opposite end of the said link being connected by a pin, *b*, to a lever, H, which has a short arm, *b'*, connected by a pin, *d*, to one end of a rod, G, the opposite end of the latter being connected by a pin, *e*, to the valve-rod B, which is also connected by a pin, *f*, to the upper end of the rocking link I, the lower end of the latter being hinged by a pin, *h*, to any available fixed part of the engine. The purpose of this rocking link is to support the end of the valve-rod and that of the rod G when the two are connected together. A lever, K, is hinged by a pin, *i*, to the connecting-rod A of the engine, and one end of the lever H is connected by a pin, *j*, to the said lever K, the latter being also connected by a pin, *m*, to one end of a radius-rod, M, the opposite end of which is hinged to any fixed part of the engine at the point indicated in the diagram Fig. 7.

In explaining the operation of the above-described valve-motion and the relation of the several parts to each other, it will be necessary to refer from time to time to the diagram Fig. 7, Sheet 2. The line *x* in this diagram is the central line of the engine, and corresponds with the dotted line *x* in Fig. 1, the circle Y indicating the path of the center of the crank-pin, and the two diagonal lines A' A'' showing the two extreme positions of the center of the connecting-rod A.

In Fig. 1 the crank-pin of the engine is, as before remarked, supposed to be at its rear dead-center, by which I mean that the said pin is at its nearest point to the cylinder of the engine, the piston being at the rear end of the same, this position of the crank-pin being marked No. 1 on the circle Y of the diagram. When the crank-pin is in this position, the pin *i* will be in a dotted line, (also marked No. 1 in Fig. 1,) its position in the diagram being indicated by the same number on the central line, *x*, of the engine. The block E is midway between the two extreme points of its adjustment—that is to say, the block is at the point known to engineers as "mid-gear." When

the crank-pin has been moved in the direction of the arrow in the diagram until it is at its outward dead-center—that is, at No. 25 of the diagram—the pin *i* will be at the point marked with the corresponding number, 25, in Fig. 1, and the central line of the lever H will be in the position indicated by the dotted line H′. The point where the two diagonal dotted lines indicating the two extreme positions of the lever H meet in a line, *x*′, drawn through the center of the pin *m* and through a point, *t*, midway between the two positions 1 and 25 in the said line *x*, is the center of the segment D and the center of the fulcrum-pin *b*, which will be in the same position when the crank-pin is at its rear dead-center as it is when the crank-pin is at its front dead-center.

Referring again to the diagram Fig. 7, it will be seen that the pin *i* of the connecting-rod traverses in the path indicated by the oval figure M, the pin traversing the lower portion of this path, while the crank-pin is moving in the circle Y from its rear dead-center, No. 1, to its front dead-center, 25, in the direction of the arrow, and the pin *i* traversing the upper half of the path when the crank-pin is returning from 25 to No. 1. The pin *j*, however, which connects the lever K to the lever H, traverses the path indicated by the irregular oval figure N. Hence the pin *b* will, when the block E is at mid-gear, move up and down in the arc *w w* of a circle, this arc being indicated by a dotted line in Fig. 1 and by a plain line in Fig. 5.

Turning now to Fig. 4, which represents the valve-motion in its simplest form, and in which the block E has been raised on the segment D, it will be seen that the pin *b* is connected to the valve-rod, the lever H having no short arm *b*′ and no pin *d*, and consequently becoming a simple link. In this case, when the block is at mid-gear, there will be no movement whatever of the valve-rod, the pin *b* traversing in the arc *w w*, Fig. 5; but when the block has been adjusted to its lowest point the pin will traverse in the arc *w*′ *w*′, Fig. 5, and the valve will have its full throw. Should the block be adjusted to the position shown in Fig. 4, the pin *b* will traverse in the arc w^2 w^2, Fig. 5, the motion of the valve will be reversed, and will still have its full throw, but cannot have any lead, no matter what position the block E occupies. This modification of my invention may, however, be used on engines in which the lead of the valve is obtained by mechanism outside of the valve-operating mechanism. In most cases, however, it will be desirable to make the valve-motion as shown in Fig. 1, and as illustrated in the diagram Fig. 7, so that two movements of the valve may be obtained, one being the usual reciprocating movement or throw of the valve, the other being a movement relating to the lap-lead and cut-off of the valve, which I will proceed to describe.

In Fig. 1 the pin *b* is moving in the arc *w w* of a circle the center of which is in the center of the pin *a* in the block E; but the lever H, of which the said pin *b* is the fulcrum, has an arm, *b*′, carrying a pin, *d*, which is connected to the valve-spindle, and this pin must have a vibration from 1 to 25, Fig. 7, the pin being at the point 1 when the crank-pin is at 1 in the diagram Fig. 7, and at 25 when the crank-pin is at its corresponding number, and hence the pin *d*, instead of traversing in the arc *w w* of a circle in the diagram Fig. 5, will pursue a course indicated by the margin of the black figure in the diagram Fig. 6, and therefore there will be a movement of the valve even when the block E is at mid-gear; but this movement relates entirely to the lap and lead of the valve. When it is desired to give the average full throw to the valve, the crank still turning in the direction of the arrow, Fig. 7, the block E must be depressed on the segment so that the pin *a* will be moved from the point *z* in the diagram Fig. 7 to the point z^2, when, although the pin *d* will continue to traverse a path of the form indicated by the margin of the black figure, the position of the path will be changed to that indicated by the irregular figure W in the diagrams Figs. 6 and 7, and the result will be an extended movement of the valve, due to the vibration of the short arm *b*′ of the lever H, and this movement may be reduced to any extent desired by adjusting the block E on the segment toward its original mid-gear position. When the engine has to be reversed, the block E should be adjusted in a contrary direction on the segment so adjusted—for instance, that the pin *a* will be moved from the point *z* in the diagram Fig. 7 to the point *z*′, when the path traversed by the pin *d* will be again changed, this time to the position indicated by X in the diagrams Figs. 6 and 7, and there will consequently be a reversal of the engine. It will now be seen that a compound movement is imparted to the lever H—namely, first, a vibrating movement on its fulcrum-pin *b*, and, second, a movement of the lever by which, under the control of the rod F, the fulcrum-pin is caused to traverse in the arc of a circle. To this second movement is due the throw of the valve, the extent and direction of the throw being determined by the adjustment of the block on the segment. To the first movement—that is, to the vibration of the lever on its fulcrum-pin—is due the lap-lead and cut-off of the valve.

While different kinds of valves may be used in connection with the above-described movements, I will explain the result attained by the said movements in connection with the valve shown in Figs. 8 and 9, Sheet 4, the valve in both cases being supposed to be at its full throw.

On the line 1, Fig. 8, is shown the position of the valve in relation to the steam-ports *p* *q* and exhaust-port *s* of the cylinder when the crank-pin is at its rear dead-center—that is, at No. 1 in the diagram Fig. 7. The valve,

owing to the lead which it derived from the above-described movement of the short arm b' of the lever H, has slightly opened the rear steam-port, q. When the crank-pin has reached its outward dead-point 25 in the diagram Fig. 7, it will be in the position shown on the line 25, Fig. 8, and on the intermediate lines, 2 to 24, are indicated the different positions of the valve at the different parts of the movement of the crank-pin indicated by corresponding numbers on the circle Y in the diagram Fig. 7.

It will be seen that the steam-port p is at its fullest opening on the line 7, and this will be the case when the crank-pin has reached the point 7 in the circle Y on the diagram Fig. 7, thus indicating a quick opening of the valve and a quick admission of steam during the early part of the movement of the piston, which is one of the objects of my invention. At the same time the exhaust is not closed until the crank-pin has nearly reached its front dead-center. This will be seen by referring to the position of the valve on the line 24 in Fig. 8. The long-continued opening of the exhaust is another important object of my invention. When the crank-pin has reached the front dead-center, the valve will be in the position shown on line 25, Fig. 9, and will bear precisely the same relation to the steam-port q as it did to the steam-port p when the crank-pin was at its rear dead-center. The course pursued by the valve in its relation to the steam-port q during the return of the crank-pin from 25 to 1 is indicated in the diagram Fig. 9, and will be readily understood by reference to the said diagram, which shows that there will be the same quick admission of steam and long-continued opening of the exhaust during the return movement of the piston as there was during its forward movement.

Referring back to Fig. 1, it will be seen that the pin e, which connects the rod G to the valve-spindle B, is at a distance from the pin f, which connects the upper end of the rocking link I to the said valve-rod—an arrangement which I have found in practice to be the best for insuring an accurate movement of the valve.

Whatever may be the position of the block E on the segment, it may be said to be locked by the latter as against any shocks or jars, technically termed "backlash," due to the movement of the parts connected with the block, and hence the block can be easily adjusted on the segment, the backlash or strains on the block presenting no impediment to its free adjustment. For this reason, if the block is connected to the starting, stopping, and reversing gear of a locomotive, but little exertion is demanded from the engineer in performing these duties. The easy adjustment of the block, moreover, is a matter of importance if it is connected to the governor of an ordinary engine; and it may be remarked here that if the valve-gear is applied to an engine the crank-shaft of which has never to be reversed the segment D may be of more limited extent, as the block will not require to be adjusted to more than half the distance required in an engine which has to be reversed.

Another prominent advantage of the improved valve-gear, when applied to a locomotive, is that it may be arranged in any position desired in respect to the driving-wheels, for, no matter what this position or that of the stopping, starting, and reversing lever may be, mechanism for connecting the said lever to the sliding block can always be arranged to clear the driving-wheels, the valve-gear being entirely outside the said wheels.

I have not shown any connection to the block for adjusting the same other than links V, to be connected to any operating mechanism which the character of the engine may suggest.

I claim as my invention—

1. The combination, in valve-gear for steam-engines, of the following elements, namely: first, a fixed segment, D, and a block, E, adjustable thereon; second, a lever or link, H, and connecting-rod A, lever K, and rod M, for imparting the within-described compound movement to the said lever H; and, third, a rod, F, connecting the adjustable block to the pin b of the lever or link, to which lever is also connected the valve-rod, substantially as set forth.

2. The combination, in valve-gear for steam-engines, of the following elements—namely: first, a fixed segment, D, and a block, E, adjustable thereon; second, a lever, H, having its fulcrum-pin connected to the said block, and having an arm, b', connected to the valve-spindle; and, third, the connecting-rod A, lever K, and rod M, for imparting the within-described compound movement to the said lever H, all substantially as set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

GEO. S. STRONG.

Witnesses:
JOHN M. CLAYTON,
HARRY SMITH.