(No Model.) 3 Sheets—Sheet 1.

P. Z. DAVIS & A. M. BARTON.

ENGINE.

No. 534,600. Patented Feb. 19, 1895.

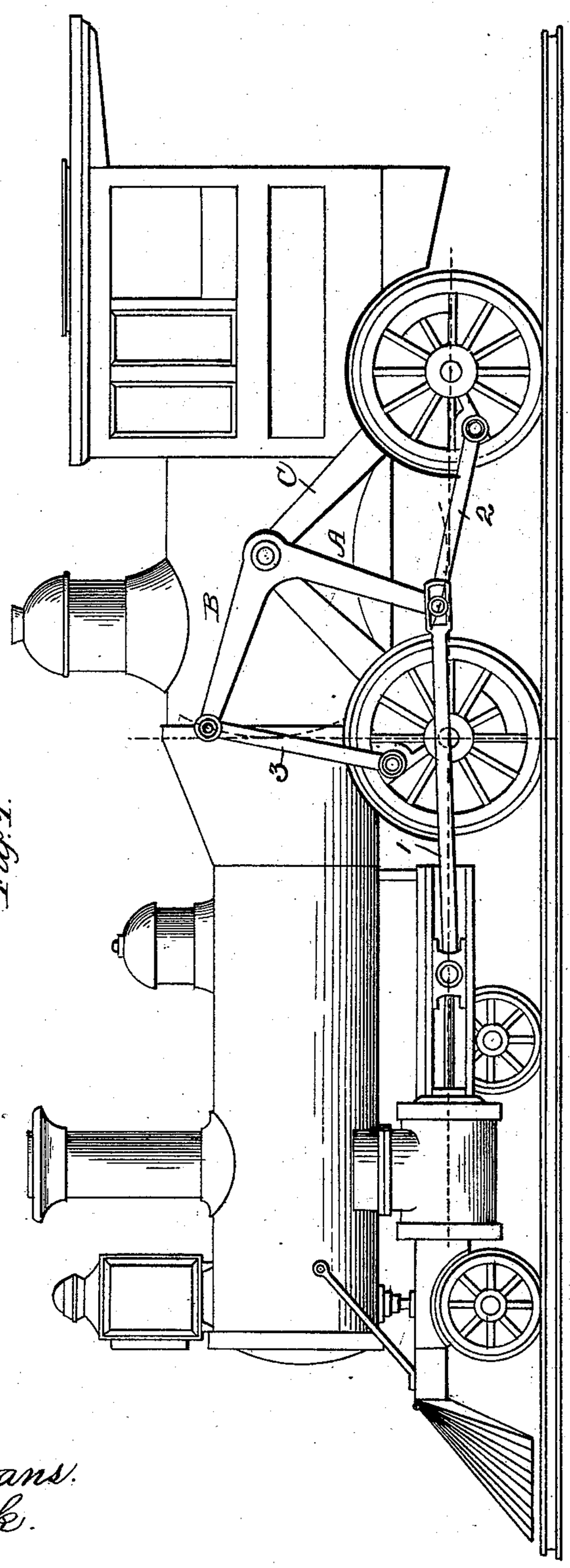

Fig. 1.

Witnesses.
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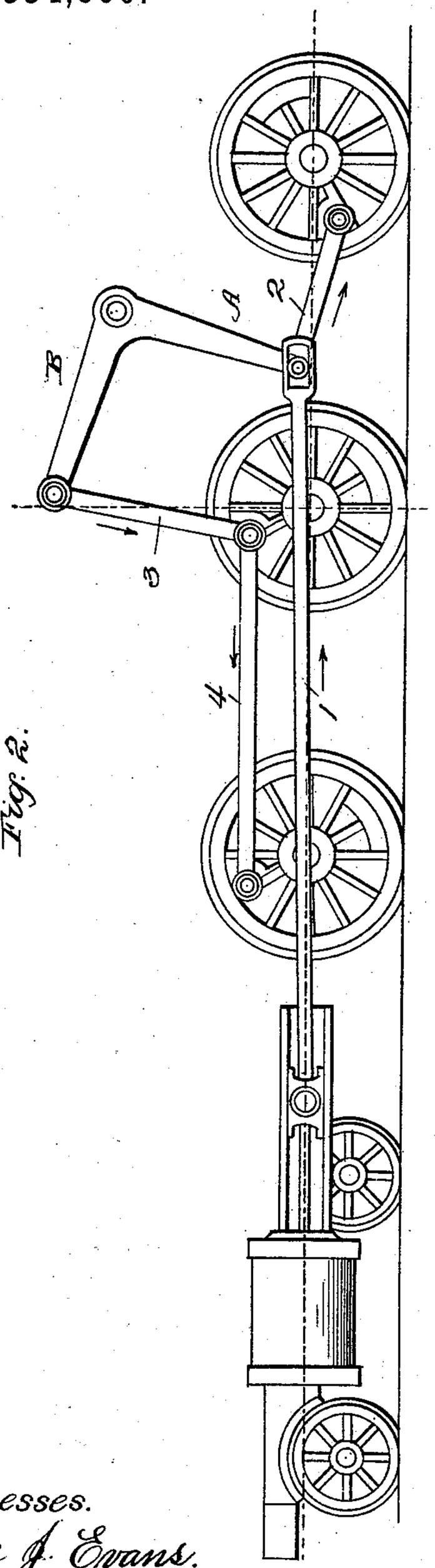

Fig. 2.

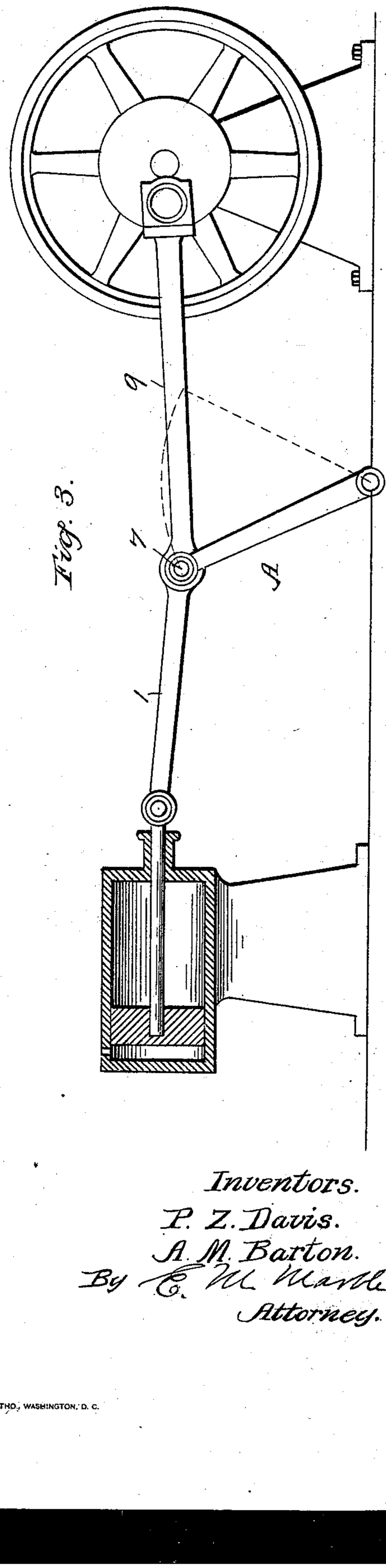

Fig. 3.

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(No Model.) 3 Sheets—Sheet 3.

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ENGINE.

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Fig. 4.

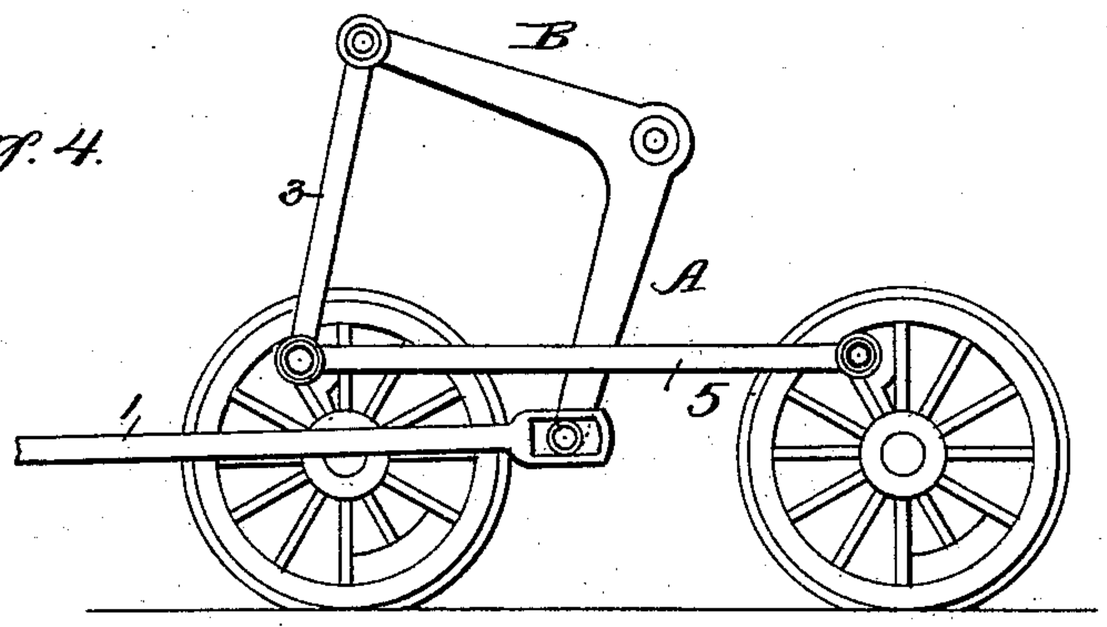
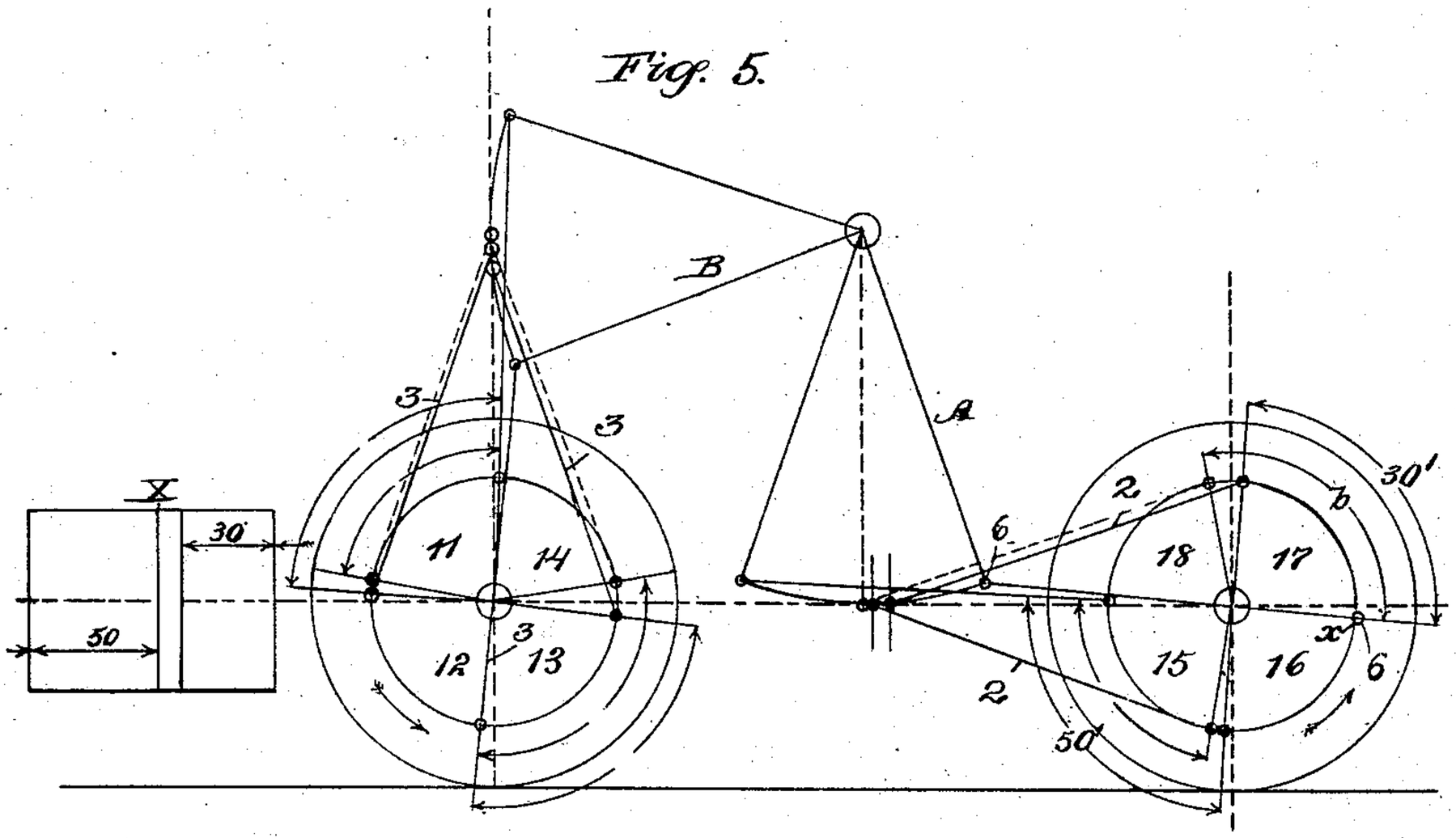


Fig. 5.



Witnesses.
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UNITED STATES PATENT OFFICE.

PHILIP Z. DAVIS, OF LOMETA, AND ALEXANDER M. BARTON, OF BERTRAM, TEXAS.

ENGINE.

SPECIFICATION forming part of Letters Patent No. 534,600, dated February 19, 1895.

Application filed October 9, 1893. Serial No. 487,653. (No model.)

To all whom it may concern:

Be it known that we, PHILIP Z. DAVIS, residing at Lometa, Lampasas county, and ALEXANDER M. BARTON, residing at Bertram, Burnet county, State of Texas, citizens of the United States, have invented certain new and useful Improvements in Engines; and we 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.

Our invention relates generally to improvements in engines, and while one feature of our invention is adapted for use on all styles of engines, the invention in the complete form in which it is herein set forth is especially suited for use on locomotive engines designed to exert high tractive power and to attain high speeds.

The objects of our invention are, first, to provide means on an engine of any type for increasing the ratio of crank travel to piston travel at the portions of the stroke at which steam is admitted, thus permitting the utilization of a far greater proportion of the power of the piston when moving through the initial portions of its stroke (those preceding the cut off of the steam) than can now be beneficially used, and also to overcome and practically obviate the hurtful effects of dead centers which are met with in all present constructions; second, to provide means operating in conjunction with that just stated for increasing the tractive and driving force of two or more wheels connected together and operated by a single connecting rod, such as are found in locomotive engines, whether of the four, six, or eight coupled type; third, to obtain a better distribution of the force among the driving wheels of locomotive engines, so that, instead of such wheels being subjected to a tendency to be raised from the track when running at high speed from the fact that the balance weights of the wheels are all above the wheel centers at the time when the connecting rod is moving in the direction opposite to that in which the train is moving, as is the case in the construction now commonly used, the power applied to the different wheels will be so distributed that two or more of the wheels will at all times have their balance weights below the centers of the wheels. Thus the tendency of the wheels to raise from the track will be avoided, and the present difficulty due to the balance weights will be diminished. This feature of our invention, operating in connection with the one just preceding, will permit us, by gaining in tractive power and in the distribution of the driving power, to keep an engine on the track without difficulty, and thus to run at a much higher rate of speed than can at present be attained, and also to pull a heavier load.

We accomplish the objects of our invention by pivoting to each side of a locomotive engine, (illustrating the attainment of the first object of invention stated by means of this type of engine, although it may be attained on any other type of engine,) a bell crank lever, the arms of which are of equal length, in such a manner that one arm of the lever hangs substantially vertically, and the other substantially horizontally. The vertical arm is of such a length when vertical as to hang with its lower end in the plane passing through the wheel centers of the engine, and its lower end is connected to the end of the connecting rod. The horizontal arm is connected by a suitable connecting bar to one of the driving wheels in such a manner as to place any spoke on that wheel ninety degrees behind a corresponding spoke on the rear wheel. Connecting bars are run from the two points of attachment thus given to the other drivers of the engine. By the connection thus set forth, we impart to the joint of the connecting rod an arc movement, which, as will presently be set forth, enables us to utilize a far greater proportion of the power of the piston when moving through the initial portion of its stroke than can be utilized by the present construction. This feature of our invention can be used on all types of engines; also, by applying the power to the forward driving wheel in a vertical direction, we obtain a great gain in tractive force, and, by virtue of the relative directions of the forces acting on the wheels of the engine, a distribution of force over the whole engine which in four coupled engines tends to greatly equalize the force, and in six coupled engines makes the power practically constant.

Our invention is fully represented in the

drawings accompanying and forming a part of this application, in which the same reference letters and numerals refer to the same or corresponding parts, and in which—

Figure 1 is a view of a locomotive constructed in accordance with our invention, showing the bell crank lever in position. It will be observed that the only alteration necessary to be made in the present engines in order to apply our invention to them is to put in place the bell crank lever, and to make the necessary connections with the connecting rod and the driving wheels. Fig. 2 is a view of one set of wheels of a six coupled locomotive engine, with the bell crank lever and connecting rods shown in position. Fig. 3 is a view of a horizontal stationary engine constructed in accordance with our invention. In this engine, as no power is to be transmitted to a second wheel, only one arm of the bell crank is shown, and it appears simply as a pivoted arm. Fig. 4 is a view showing another style of connection of the wheels of a four coupled locomotive engine. Fig. 5 is a diagrammatic view, showing the travel of the piston with different degrees of crank travel, when our improved construction is used.

Referring first to Fig. 1, the engine therein represented is of the ordinary four coupled type. To each side of the locomotive, supported as shown in suitable bearings C, is pivoted a bell crank lever, whose arms are of equal length. One of the arms of each of the levers hangs substantially vertically, and the other substantially horizontally. The vertical arm, designated by the letter A, is of such a length as when vertical to hang with the center of its lower end lying in the plane of the wheel centers, which may be also termed the crank centers, and this arm is connected to the end of the connecting rod 1, which is the power exerting element, a suitable connecting bar 2 being run to the rear wheel of the engine. The horizontal arm B is connected by the connecting bar 3 to the front driving wheel quarteringly or in such a manner as to place any spoke on this wheel just ninety degrees in the rear of a corresponding spoke on the rear wheel.

Referring now to Fig. 5, as the positions of the connecting rods can be more easily seen there than in the other figures of the drawings, it will be noted that the end of the connecting rod is above the plane of the wheel centers at the beginning of the stroke, at the point 6, on account of the arc movement of the arm A of the bell crank lever. The other arm of the lever is shown at B, and the positions occupied by the same, and also by the bar 3 which connects it to the driving wheel are shown at the different points which are treated of in considering the action of the rear wheel. Due to the arc movement of the end of the connecting rod, the dead center of the crank of the rear driver is not determined with reference to the plane of the wheel centers, but by the position of the end of the connecting rod at its extreme arc movement. The point of dead center is therefore, at the beginning of the stroke in the construction shown, below the plane of the wheel centers at the point x. The crank travel in this figure, being reckoned from the point of dead center, commences, therefore, below the plane of the wheel centers.

The arrow 30 indicates the piston travel due to the crank travel through the arc 30′, which is ninety degrees, and the arrow 50 the return piston travel due to the crank travel through the arc 50′. The arc b shows the crank travel due to the piston travel up to the point of cut off, X, which has been chosen at fifty per cent.

The overcoming and practical obviation in our new movement of the hurtful effects resulting from dead centers is due to the following reasons:—Referring first to the rear driver, it has been stated that the dead center of the crank of the rear driver with reference to the end of the connecting rod is not determined with reference to the plane of the wheel centers, but by the position of the end of the connecting rod at its extreme arc movement. The arc movement of the end of the connecting rod results in such end being out of the plane of the wheel centers at both ends of its stroke, and in said plane at the center of its stroke, whether the swinging arm A, which causes the arc movement, be supported above the plane of the wheel centers, as shown in Fig. 5, or below the plane of the wheel centers, as shown in Fig. 3. The dead centers of the crank with reference to the end of the connecting rod will, therefore, be either above or below the plane of the wheel centers, but in any case out of said plane.

In the case of both drivers, the dead centers of the cranks with reference to their power exerting elements are passed in the dead arcs of the crank travel, and can therefore cause no loss of applied power. Since the dead arcs end out of the plane of the wheel centers, and since both the end of the connecting rod, and the end of the arm B of the bell crank lever are also out of the plane of the wheel centers at the ends of the stroke of the piston, when the piston commences its stroke after passing through its dwell at the end of the cylinder, it has a good leverage from the start, the effective crank arm being longer, and but little of the applied power is taken up against the axles. The gain in the advantageous power of the piston stroke is very great, as the strongest part of the stroke, that preceding the cut off of the steam, is the part benefited.

The length of the arms of the bell crank lever is determined by the distance between the driving wheels of the engine, but it is also in some respects a function of the diameter of the crank circle. The shorter their length, the larger the arc through which they swing, and consequently the greater the angle the connecting bar bears to the plane of the wheel centers when the crank is at dead center with

reference to the end of the connecting rod. It is to be observed that if the arms of the lever be made too short, the dead arcs of the wheels cannot be utilized, and thus the useful results attained by means of the arc movement of the end of the connecting rod will be neutralized.

The gain in traction and distribution of power over the engine will be spoken of together. The gain in traction is due to the vertical movement of the force impelling the front wheel. The tractive force of the front wheel is greatest when the bar 3 connecting it to the arm B of the bell crank lever is moving through the quadrants 11 and 12. It has a negative value when moving through the quadrant 13, but attains a positive value when passing through the quadrant 14. The traction of the rear wheel, on the other hand, is greatest when passing through the quadrants 15 and 17, and has a negative value when passing through the quadrants 16 and 18. When the rear wheel is passing through the quadrant 16, where it has a negative value, the front wheel is passing through the quadrant 12, where it has a positive value; and when the front wheel is passing through the quadrant 13, where it has a negative value, the rear wheel is passing through the quadrant 17, where it has a strong positive value. Due to the application of the power quarteringly, there is, therefore, at all times during the revolution of the wheel, a strong tractive force exerted; and if it be borne in mind that in a locomotive engine the wheels on one side are set ninety degrees ahead of those on the other side, it will be seen that in this way the power over the entire engine will be fairly constant in a four coupled engine, and with a six or eight coupled engine will be practically so. The balances of the wheels are so distributed that they do not all pass above or below the wheel axle at the same moment. The present trouble arising from the tendency of the wheels to lift from the track when running at a high speed will thus be avoided, and a much higher speed can be obtained.

Referring now to Fig. 1, attention is called to the fact that the pressure of the bell crank lever against its bearings is always upward. There will, therefore, be no pounding here, and but little wear on the bearings. Due to the position of the bearings, the whole weight of the engine is utilized to work against the pressure of the levers.

In Fig. 2, we have shown the connection that is used with six coupled engines. A connecting bar 4 is run from the middle wheel to the front wheel, the other connections being the same as already described. If the directions of the different forces bearing upon the different wheels at any one moment be considered, it will be seen that in this construction they are all exerted in opposite directions. Thus during the rear movement of the connecting rod, the arm actuating the rear wheel moves backward, that actuating the middle wheel downward, and that actuating the front wheel, forward. The distribution of power over the whole engine thus obtained is very uniform.

In Fig. 3, we have shown the arc movement, which forms one feature of our invention, applied to a horizontal stationary engine. It will be seen that by using a connecting rod 1 which is not of sufficient length to reach to the drive wheel, connecting the said rod to the drive wheel by an additional bar 9, and attaching the swinging arm A at the joint 7 of the said connecting-rod 1 and bar 9, which arm is of such a length as to lie with its upper end in the plane of the piston and wheel centers when vertical, but to be out of such plane at the ends of the stroke of the piston, the gain in crank travel relative to piston stroke, avoidance of the hurtful effects resulting from dead centers, and increased utilization of the initial power of the stroke is obtained. The arc movement as thus described can be used on any type of engine, whether locomotive, or stationary, or marine, or otherwise, and we do not limit ourselves to its use on locomotive engines.

In Fig. 4 we have shown a mode of connection of the bell crank lever to the wheels of a four coupled locomotive engine which is different from that shown in Fig. 1. In this case, the connecting rod is directly attached to the bell crank lever, and no direct connection is made between such connecting rod and the rear driver. All of the power is thus applied with a vertical application to the front wheel. A connecting bar 5 runs from the point of attachment of the bar 3 to the driver to the rear wheel. When the power is applied vertically to the front driver, it is applied horizontally to the rear driver. The connection is such that when the effective crank arm on the front wheel is increasing, that on the rear wheel is decreasing. Combined together, therefore, there is a full crank arm during each portion of the rotation.

Many other connections may be made, all embodying the principles of the use of the arc movement of a power exerting element, which in the present case is the connecting rod of an engine, and by use of this movement transmitting a positive rotative impulse to one or more wheels operated by said power exerting element. It is also apparent that instead of using a bell crank lever for the purpose desired, a quadrant may be used, the ends of the arc of the quadrant being connected to the mechanism of the engine in the same manner as the two arms of the bell crank lever, or other mechanism may be used for effecting this purpose.

Having thus fully described and illustrated our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. In an engine, the combination, with a connecting rod, a cylinder, a piston, and rotary cranks, of a suitably supported pivoted arm for causing the end of the connecting rod to

describe an arc movement during its reciprocation, the length of the arm being such as to cause the end of the connecting rod to be out of the plane of the crank centers at both ends of its stroke, and to be in said plane at the center of its stroke, and means for transmitting the force of the stroke to the cranks to be driven, substantially as described.

2. In an engine, the combination with a connecting rod, a cylinder, a piston and a rotary crank the center of the piston and the crank center being in the same plane, of a suitably supported pivoted arm for causing the end of the connecting rod to describe an arc movement during its reciprocation, the length of the arm being such as to cause the end of the connecting rod to be out of the plane of the piston and crank center at both ends of its stroke, and to be in said plane at the center of its stroke, and a bar connecting the end of the connecting rod to the crank, substantially as described.

3. In a locomotive engine having a plurality of drive wheels on each side, the combination on each side with a connecting rod, of a bell crank lever pivoted in a suitable manner to the engine, one arm of which is arranged substantially vertically and the other arm substantially horizontally, the vertical arm of which is attached to the connecting rod, and a bar for directly connecting the horizontal arm of said lever to one of the drive wheels, substantially as described.

4. In a locomotive engine having a plurality of drive wheels on each side, the combination on each side with a connecting rod, of a bell crank lever pivoted to the engine, and suitable connections between the ends of said lever, the connecting rod, and the drive wheels, the connection between the ends of the lever and the drive wheels being such as to exert the power quarteringly, substantially as described.

5. In an engine having a plurality of drive wheels on each side, two bell crank levers pivotally attached thereto, one on each side, each lever having one of its arms arranged substantially vertically and the other arm substantially horizontally, a connecting rod attached at one end to the end of the vertical arm of said lever, connection between said vertical arm and one of the drive wheels, and a bar connecting the end of the horizontal arm with another of said drive wheels, the connections between the arms of the lever and the drive wheels being so arranged as to exert the power quarteringly, substantially as described.

6. In a vehicle driven by power and having a plurality of drive wheels on each side, the combination with power exerting elements, of suitable levers, one on each side, each of which is pivotally attached to one of said elements, and is also directly connected through suitable means to drive wheels, the connections of the levers to the wheels being so arranged as to exert the power quarteringly on each side upon the wheels to which connection is made, substantially as described.

7. In a vehicle driven by power and having a plurality of drive wheels on each side, the combination with power exerting elements, of pivoted bell crank levers, one on each side, each of which is attached to one of said elements and is also directly connected through suitable means to drive wheels, the connections of the levers to the wheels being so arranged as to exert the power quarteringly on each side upon the wheels to which connection is made, substantially as described.

In testimony whereof we affix our signatures in presence of two witnesses.

PHILIP Z. DAVIS.
ALEXANDER M. BARTON.

Witnesses:
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M. ARBUCKLE.