(No Model.) 3 Sheets—Sheet 1.

E. HILL.

VALVE GEAR.

No. 359,865. Patented Mar. 22, 1887.

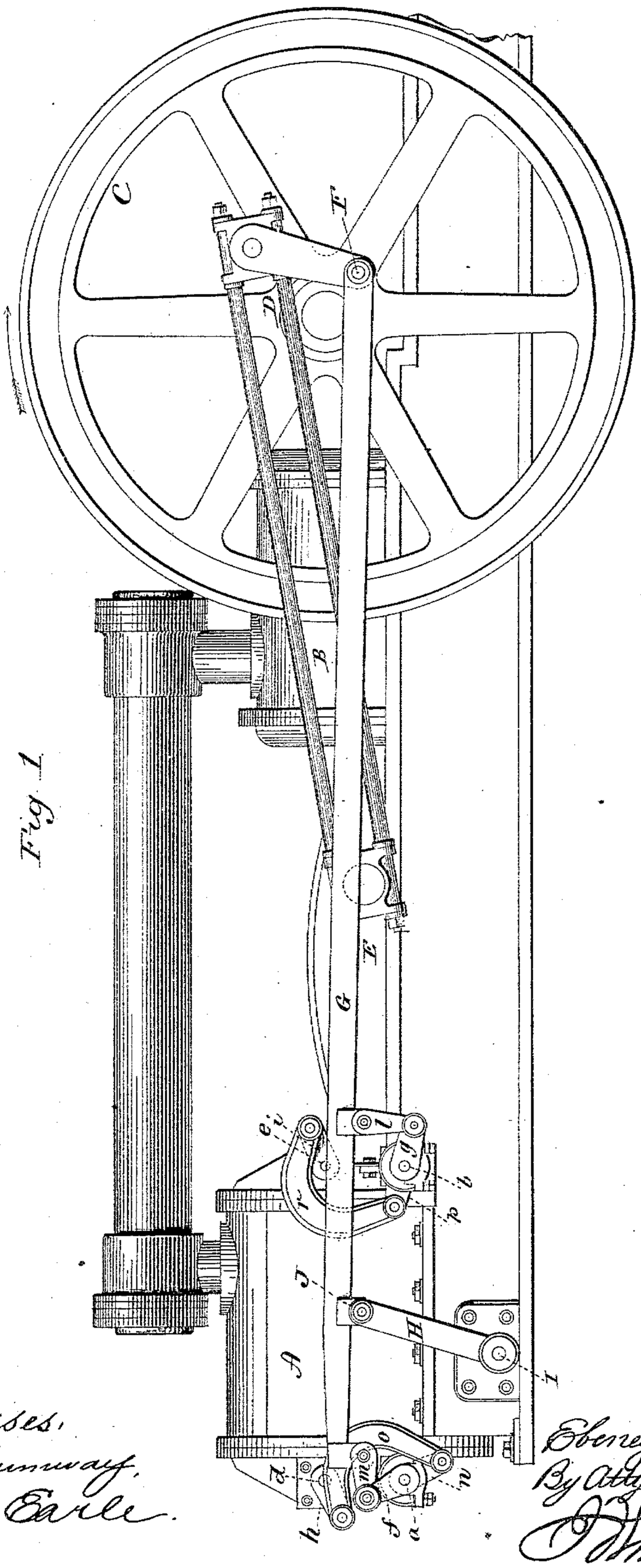

Fig. 1.

Witnesses.
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Wm C Earle

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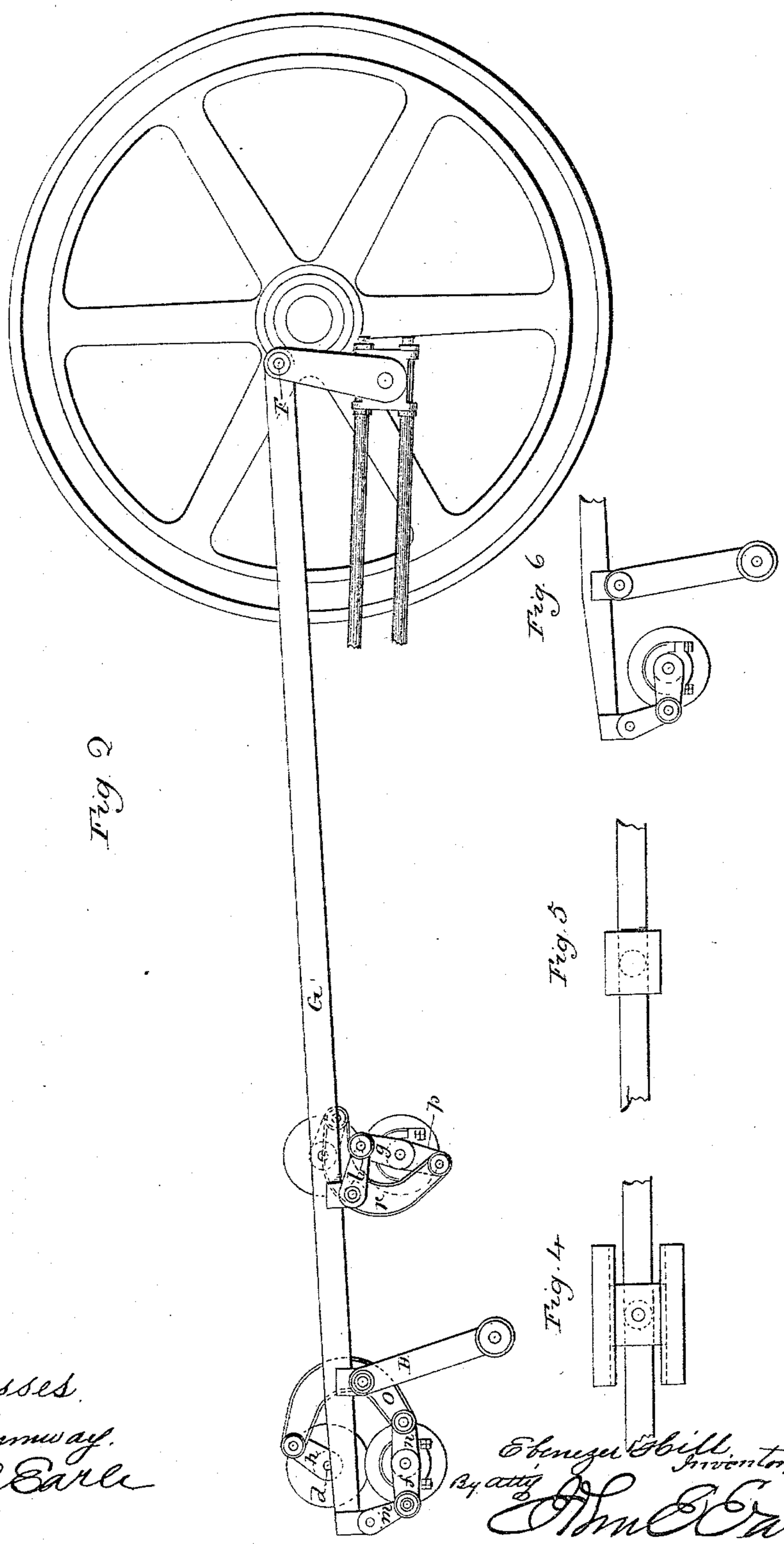

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(No Model.) 3 Sheets—Sheet 3.

E. HILL.

VALVE GEAR.

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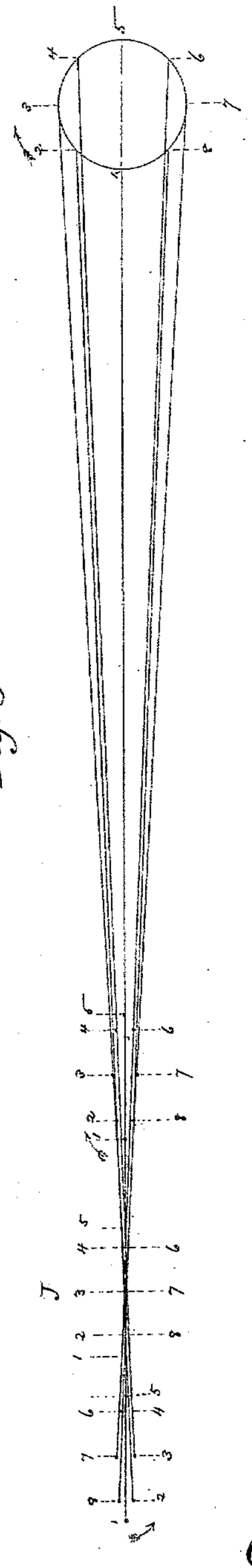

Fig. 3

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UNITED STATES PATENT OFFICE.

EBENEZER HILL, OF SOUTH NORWALK, CONNECTICUT.

VALVE-GEAR.

SPECIFICATION forming part of Letters Patent No. 359,865, dated March 22, 1887.

Application filed September 27, 1886. Serial No. 214,611. (No model.)

To all whom it may concern:

Be it known that I, EBENEZER HILL, of South Norwalk, in the county of Fairfield and State of Connecticut, have invented a new Improvement in Valve-Gears; and I do hereby declare the following, when taken in connection with accompanying drawings and the letters of reference marked thereon, to be a full, clear, and exact description of the same, and which said drawings constitute part of this specification, and represent, in—

Figure 1, a side view of an air-compressor, showing the valve-gear in a position just after the driving-crank has passed its dead-center in one direction; Fig. 2, the same view representing the position of the parts as having just passed the opposite center—that is, in a position diametrically opposite the position indicated in Fig. 1; Fig. 3, a diagram illustrating the path of the eccentric-rod at the points where the links are connected thereto; Figs. 4 and 5, modifications in the arrangement of the reciprocating pivot upon which the eccentric-rod is hung; Fig. 6, a modification showing the method as applied to a single valve.

This invention relates to an improvement in the method of and mechanism for operating the induction and eduction valves of cylinders within which a piston is driven from end to end, and in which an induction and an eduction valve are arranged at one end of the cylinder and like induction and eduction valves for the opposite end of the cylinder, and in which the valves receive a positive movement, the valve-gear being particularly applicable to air-compressors, but may be employed as a valve-gear for steam-engines.

The object of the invention is to operate both the induction and the eduction valves by a single eccentric, and to increase the throw of the valves at those portions of their travel where the ports are opened, and at the same time accelerate the closing movement of the eduction-valves; and it consists in changing the time of a valve's movement at different parts of its stroke by changing the direction of its connection with the eccentric-rod.

In illustrating my invention I show it as applied to a compound air-compressor, A being the initial cylinder, and B the compressing-cylinder; C, the fly-wheel, which is mounted in the usual bearings, and which is driven from the prime motor. Upon the shaft of the fly-wheel a crank, D, is fixed, by which the rotary movement of the fly-wheel shaft is communicated to the piston-rod E through the usual connecting-rods; but the arrangement of the cylinders, fly-wheel, and connections constitute no part of my invention. The direction of revolution of the fly-wheel is indicated by an arrow.

The valves of the cylinder A are common rotary or oscillating valves, whose ports open to the respective ends of the cylinder—an arrangement of valves too well known to require particular illustration or description, further than to say that *a* represents the spindle of the induction-valve at one end of the cylinder and *b* the spindle of the induction-valve at the opposite end of the cylinder.

d represents the spindle of the eduction-valve at the same end of the cylinder as the induction-valve of *a*, and *e* the spindle of the eduction-valve at the opposite end of the cylinder, these spindles extending from the valves through the usual stuffing-box, and so that by the rotative movement of the spindle the valves oscillate upon their respective seats to open and close their respective ports, the axis of the several valves being parallel with the axis of the driving-shaft.

On the outer end of the induction-valve spindle *a* a crank, *f*, is fixed, and on the other induction-valve spindle, *b*, a similar crank, *g*, is fixed. On the eduction-valve spindle *d* a like crank, *h*, is fixed, and on the other eduction-valve spindle, *e*, is a corresponding crank, *i*, through which cranks the oscillatory movement is imparted to the respective valves.

To obtain the best results in a machine of this character the induction-valves must open soon after the dead-center is passed—that is, at the beginning of the stroke of the piston—and should remain open until the stroke is completed. This movement, it is well known, is obtained from an eccentric set at right angles to the crank. The eduction-valve, however, should not be opened until after the piston has moved sufficiently far toward the eduction-port to compress the air to an extent equal to the reservoir-pressure. At that time the eduction-valve should open and remain open until the stroke is complete, and then should instantly close.

F represents the eccentric, which, as here shown, is in the form of a crank fixed to the pin of the crank D, this being a well-known substitute for the disk-eccentric, and is employed in this case as a convenience for illustration. From the eccentric F the eccentric-rod G extends longitudinally, and is hung upon a rocking arm, H, at a point midway between the valve-spindles at the respective ends of the cylinders. This arm is hung at I below the cylinder, and extends vertically upward, and is hinged to the eccentric-rod G at J, and so that as the reciprocating movement is imparted to the rod by the eccentric in the usual manner the arm H will swing, say as from the position in Fig. 1 to that seen in Fig. 2, and return. The driven end of the eccentric-rod G travels in and makes a complete circle at each revolution of the driving-shaft.

At the point J, or connection between the rocking arm H and the eccentric-rod G, the rod travels in a slightly-curved line, but to all practical purposes substantially a straight line, and may be a straight line, if desired. At other points in the rod both sides of the point J the path traveled by such points is elliptical; but the direction of travel in such elliptical paths is that on the side of the point J nearest the eccentric, in the same direction as the eccentric; but on the opposite side of the point J the path is in the opposite direction and as indicated in Fig. 3, and in which the circle at the right indicates the path of the eccentric at the opposite end. The intermediate series of points 1, 2, 3, 4, 5, 6, 7, and 8 indicate the position of the pivots at corresponding points in the path of the eccentric. On the side of the said intermediate point next the eccentric the figures 1, 2, 3, 4, 5, 6, 7, and 8 indicate corresponding points in the path of the eccentric-rod at the connection of the valve on that side, and at the extreme left 1, 2, 3, 4, 5, 6, 7, and 8 indicate corresponding points in the movement of the eccentric-rod at the point of connection with the other valve, these three series of points representing equal divisions in the movement of the eccentric.

From the rod G a link, *l*, extends downward, and is connected to the crank *g*, so that when in the position seen in Fig. 1 the crank stands nearly parallel to the connecting-rod, while the link *l* is at substantially right angles to the rod. Upon the opposite side of the arm a link, *m*, connects that end of the eccentric-rod G with the crank *f* on the valve-spindle *a*, and so that in the position seen in Fig. 1 the crank *f* extends up nearly at right angles to the rod G, and the link *m* nearly parallel with the rod; hence when in the position seen in Fig. 1 the crank *f* receives the direct longitudinal movement of the rod G, but is not affected to any material extent by the up-and-down movement of the rod, whereas at the same time the crank *g* partakes of the up-and-down movement of the rod G and not materially of its longitudinal movement.

The time of the up-and-down movement will be ninety degrees behind the horizontal movement, and will correspond with the movements of an eccentric set in unison with the movement of the main crank.

From the valve-spindle *a*, and diametrically opposite the crank *f*, is a crank, *n*, from which a connection, *o*, is made to the crank *h* of the eduction-spindle *d* and valve-spindle *b*, and diametrically opposite the crank *g* is a crank, *p*, from which a connection, *r*, is made to the eduction-crank *i*. These connections *o r* are here shown of crescent shape as a matter of convenience; but their effect is practically the same as if they were straight.

In the position seen in Fig. 1, and as the parts are there indicated as moving, the induction-valve of the spindle *a* is open to admit air into the cylinder. Upon the opposite end of the cylinder the eduction-valve upon the spindle *e* is open to allow the compressed air to escape. At this time the induction-valve of the spindle *b* is closed, and, because the link *l* is at substantially right angles to the movement of the eccentric-rod G, that valve is not materially affected by the horizontal movement of the eccentric-rod while the eduction-valve of the spindle *a* is moving under the longitudinal or horizontal movement of the connecting-rod; but as the rod moves forward under the action of the eccentric—say to the position seen in Fig. 2—the link-connections gradually change their relative positions until, as seen in Fig. 2, the link *m* has attained and passed its position at right angles to the path of the eccentric-rod, while the link *l* has reached and is working in a path parallel with the eccentric-rod. The piston having now passed the opposite center, the spindle *b* has been quickly turned during this last part of the advance movement of the eccentric-rod, and while the link *l* is moving in a path substantially parallel with the path of the rod, and the valve therefore correspondingly quickly opened, whereas at the same time the opposite induction-valve of spindle *a* has been closed, and its link *m*, coming into the vertical position, or position at right angles to the path of the eccentric-rod, attains but slight movement from the eccentric-rod, and the same which the valve-spindle *b* on the other induction-valve attained when the valve of the spindle *a* was opening.

The cranks *n* and *p* on the induction-valve spindles being diametrically opposite the cranks *f g* of the said spindles, and through which they are operated, it follows that when the said eduction-valve cranks are receiving the movement under the longitudinal or horizontal movement of the eccentric-rod the cranks *n p* are respectively passing their dead-center with relation to the exhaust-valves, and hence in such position very little movement is imparted to the exhaust-valves—that is to say, in Fig. 1, while the induction-valve is being rapidly moved, the crank *n* is imparting very little movement to the exhaust-valve spindle *d* at that end of the cylinder, whereas at the

opposite end of the cylinder the up-and-down movement of the eccentric-rod is imparting very little movement to the valve-spindle *b;* but that movement is communicated to the exhaust-crank *i*, and the exhaust-valve is therefore at this time receiving its quickest movement; but arriving at the opposite points, as in Fig. 2, this condition, it will be observed, is reversed. Thus practically the induction-valves are operated under the longitudinal movement of the eccentric-rod, while the eduction-valves are operated by the up-and-down movement of the eccentric-rods.

It will be observed that in the illustration the throw of the eccentric is twice as great as the length of the cranks *f g;* but because of the swinging movement of the respective links *l m*, whereby they change their direction after the induction-ports are closed and while the same ports are being opened, the short cranks are permissible, and consequently a correspondingly quick movement under the greater throw of the eccentric, and because of the connection with the exhaust-valves, as described, a correspondingly quick closing and opening of the exhaust-valves is produced, and so quick as to be practically instantaneous, and the movement of all the valves is produced by a single eccentric.

I have stated that this valve-gear is applicable to a steam-engine as well as to an air-compressor, for mechanically an air-compressor is simply a steam-engine driven in a direction opposite to that for which the valves are properly set for the admission and escape of steam.

While I prefer to employ the rod H as a means for supporting the pivot upon which the eccentric-rod is hung, so that that pivot may partake of the reciprocating movement of the rod, the pivot may be arranged upon a slide, which will reciprocate in a perfectly-straight path—say as seen in Fig. 4—or the rod may slide through a pivoted box, as seen in Fig. 5.

The method of changing the time of the induction-valves may be performed without necessarily connecting the same to the eduction-valves—that is to say, the eduction-valves may be operated in any of the well-known methods of operating the eduction-valves independent of the mechanism for operating the induction—and the method of so changing the movement of a valve may be applied to a single valve, as indicated in Fig. 6. I therefore do not wish to be understood as limiting the invention to the combination of connections from the single eccentric-rod to all the valves; but by this method I am thus enabled to operate all the valves by a single rod.

I claim—

1. The method herein described for changing the time of a valve's movement at different parts of its stroke, and which consists in automatically changing the direction of the valve's connection with the eccentric-rod during the movement of the valve, substantially as described.

2. The herein-described valve-gear for operating oscillating induction and eduction valves, consisting in the combination of an eccentric, an eccentric-rod extending therefrom and hung upon a pivot in a position between the valve-spindle at one end of the cylinder and the valve-spindle at the opposite end of the cylinder, and whereby under the longitudinal reciprocating movement imparted to the rod by the eccentric an up-and-down movement is imparted to the said eccentric-rod by said pivot, a crank on each of the valve-spindles, a link connecting one valve-crank with the rod upon one side of its said pivot, and a similar link connecting the other crank with the said rod upon the opposite side of said pivot, substantially as described.

3. The herein-described valve-gear for the operation of induction and eduction valves, consisting of an oscillating induction and an oscillating eduction valve, whose ports open into one end of the cylinder, and a like induction and an eduction valve, whose ports open to the opposite end of the cylinder, the axis of said valves being substantially parallel with each other, an eccentric, an eccentric-rod extending therefrom and hung upon a pivot in a position between the valve-spindles at one end of the cylinder and the valve-spindles at the opposite end of the cylinder, and whereby under the longitudinal reciprocating movement imparted to said eccentric-rod it will also receive an up-and-down movement, a crank on each of the said valve spindles, a link connecting one of the valve-cranks at one end with the rod upon one side of its said pivot, and a similar link connecting a valve-crank at the opposite end of the cylinder with the said rod upon the opposite side of said pivot, and a connection between the two cranks so connected to the eccentric-rod and the cranks of the other valves at the respective ends of the cylinder, substantially as described.

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