2 Sheets—Sheet 1.

H. KILBOURN.

HOT AIR ENGINE.

No. 50,875. Patented Nov. 7, 1865.

Fig. 1.

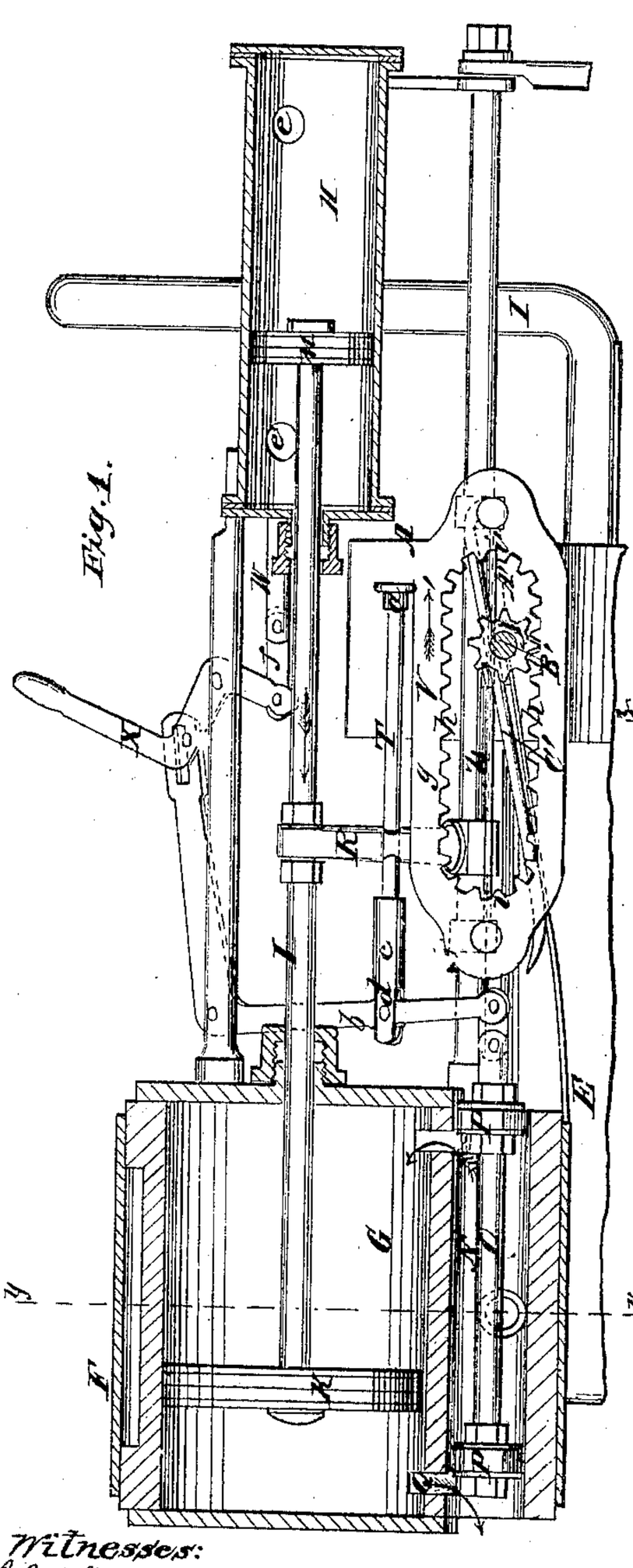
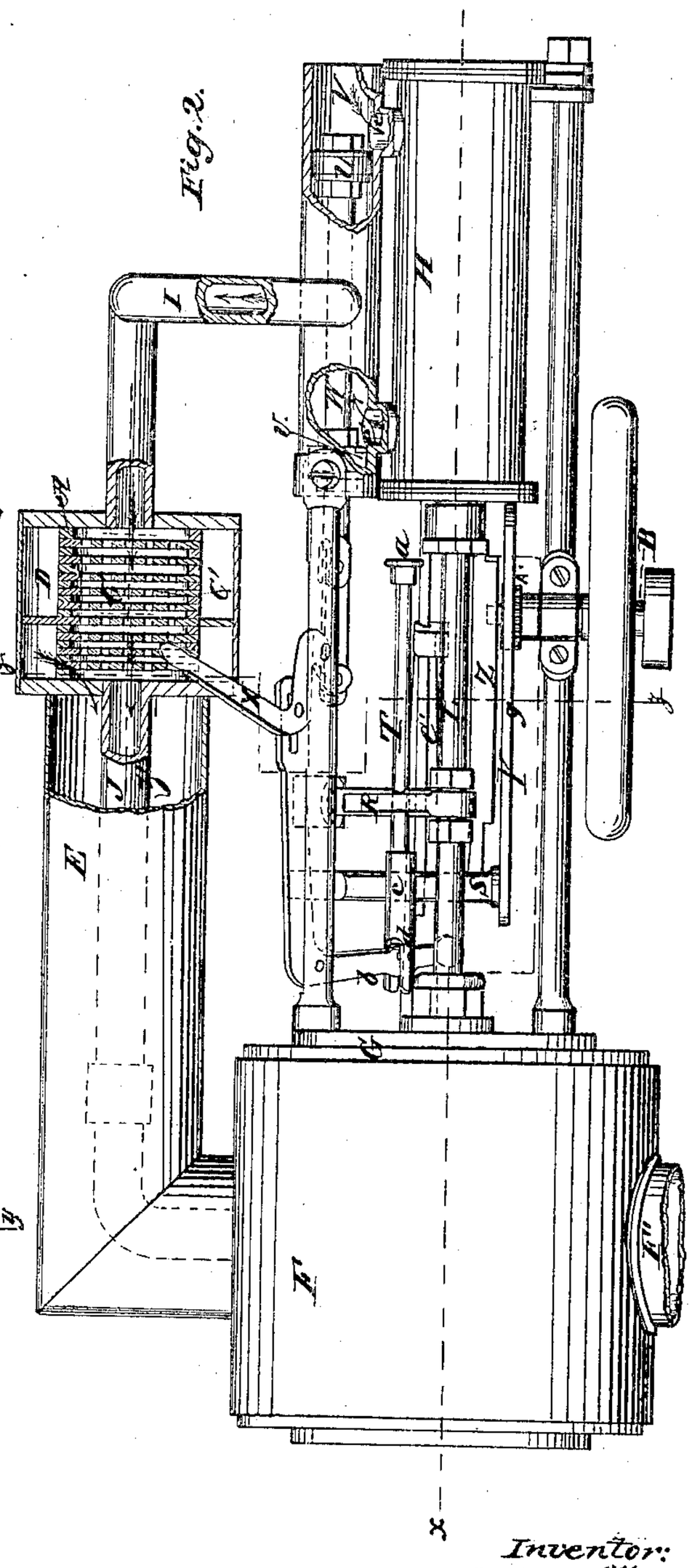


Fig. 2.



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Hew Ewan

Inventor:
Hiram Kilbourn

2 Sheets—Sheet 2.

H. KILBOURN.

HOT AIR ENGINE.

No. 50,875. Patented Nov. 7, 1865.

Fig. 4.

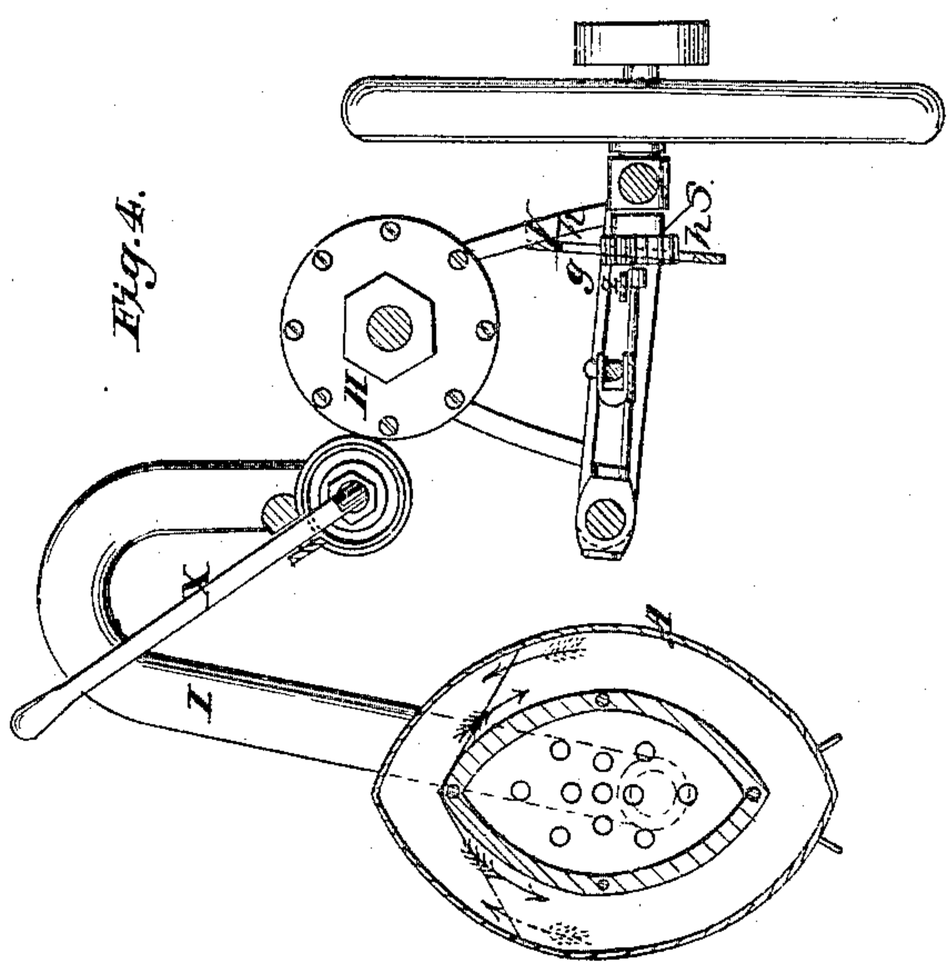


Fig. 3.

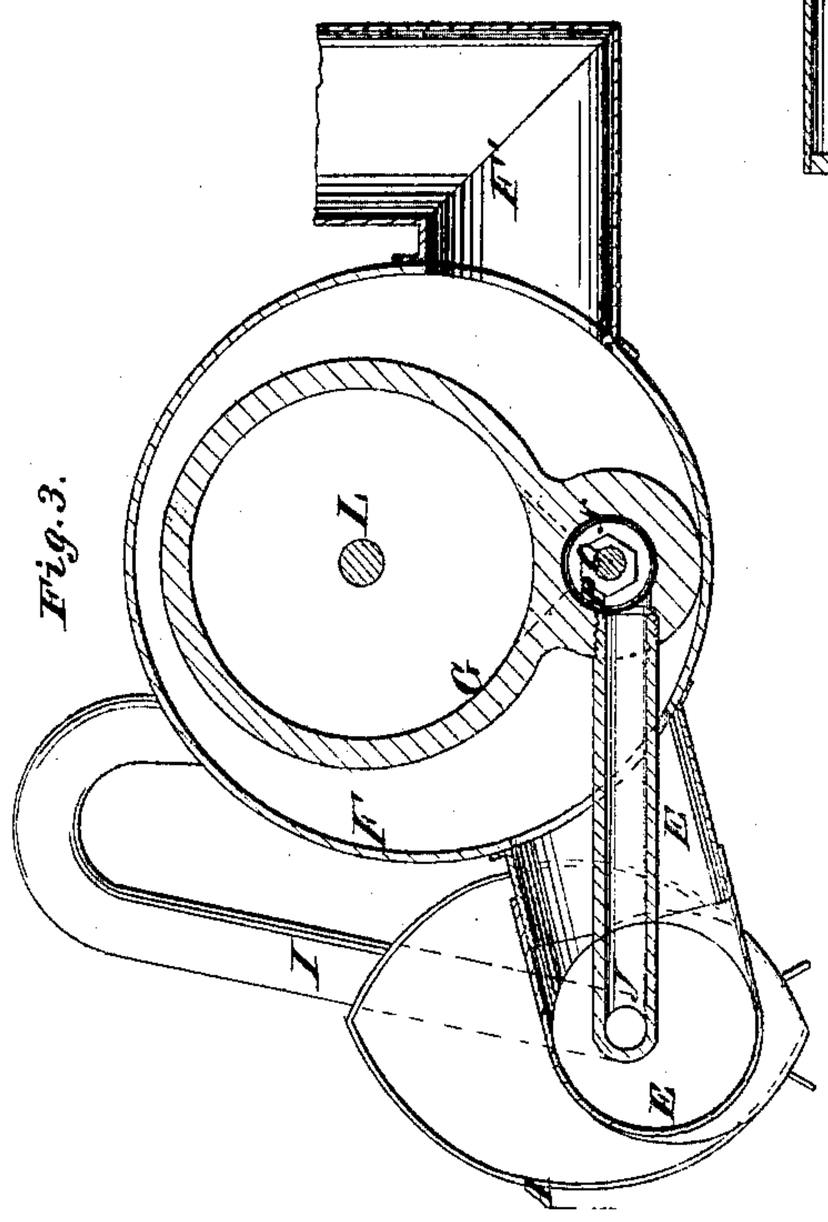
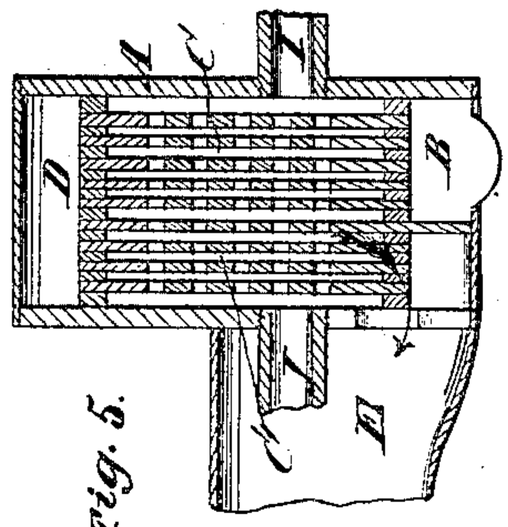


Fig. 5.



Witnesses:
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UNITED STATES PATENT OFFICE.

HIRAM KILBOURN, OF WATERLOO, IOWA, ASSIGNOR TO HIMSELF AND SYLVESTER P. BABCOCK, OF SAME PLACE.

IMPROVEMENT IN HOT-AIR ENGINES.

Specification forming part of Letters Patent No. **50,875**, dated November 7, 1865.

To all whom it may concern:

Be it known that I, HIRAM KILBOURN, of Waterloo, in the county of Black Hawk and State of Iowa, have invented a new and Improved Caloric Engine; and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable others skilled in the art to make and use the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1, Sheet No. 1, is a side sectional view of my invention, taken in the line *x x*, Fig. 2; Fig. 2, a plan or top view of the same, partly in section; Fig. 3, Sheet No. 2, a transverse vertical section of the same, taken in the line *y y*, Fig. 1; Fig. 4, a transverse vertical section of the same, taken in the line *z z*, Fig. 2; Fig. 5, a vertical section of the furnace or heater pertaining to the same, taken in the line *z' z'*, Fig. 2.

Similar letters of reference indicate like parts.

This invention relates to certain improvements in caloric or hot-air engines; and it consists in a novel arrangement of slide-valves for the pump and driving-cylinder, whereby a perfectly-balanced valve is obtained; and the invention further consists in a novel means for communicating a rotary motion to the shaft from which the power is taken from the reciprocating motion of the piston-rod of the driving-cylinder.

A represents the air-heating chamber, in the lower part of which the fire-chamber B is placed.

Within the chamber A there is placed a series of plates, C, arranged parallel with each other, with spaces between them, said plates being perforated and inclosed at their edges, so that the spaces between them cannot communicate with the spaces D between their exterior and the inner side of A, which forms the flue of the fire-chamber B. This flue D communicates with a pipe, E, which leads to a jacket, F, the latter encompassing the driving-cylinder G, as shown clearly in Fig. 3. The flue D extends entirely around the plates C, which constitute the air-heating device, the air being forced through the perforations of said plates by means of a pump, H, a pipe, I, conducting the air to the chamber A, and a pipe, J, conveying the heated air from said chamber to the driving-cylinder G through the pipe E, which conducts the products of combustion from the fire-chamber B to the jacket F, with which the smoke-pipe F' communicates. By this arrangement it will be seen that the heated air will be conveyed to the driving-cylinder G without being reduced in temperature, as the pipe J is inclosed within the pipe E, and consequently surrounded by the heated products of combustion from the fire-chamber B, and the cylinder G is also prevented from radiating heat in consequence of being surrounded by the jacket F. The plates C will also be heated with but a moderate consumption of fuel, as the flue D entirely surrounds them, and it will be seen that said plates, although inclosed within a space of limited dimensions, present a large area of heated surface to the air forced through and between them, and the air will be thoroughly heated.

K represents the piston within the cylinder G, and L the piston-rod, which also has the piston M of the air-pump H attached to it, as shown clearly in Fig. 1. The heated air is conveyed by the pipe J into the center of a cylinder, N, underneath the driving-cylinder G and within the jacket F. This cylinder N has a rod, O, fitted within it, with two valves, P P, upon it, which work past ports Q Q, leading into cylinder G. These valves and ports admit the heated air into cylinder G to drive the piston K and admit of the air escaping from the cylinder at the side of the piston opposite to that being acted upon, as will be fully understood by referring to Fig. 1.

The valve-rod O is driven from the piston-rod L by means of an arm, R, attached to L and to a sliding frame, S, the arm R working loosely on a rod, T, provided with a knob, *a*, at one end, and connected to a bent lever, *b*, at the opposite end, said lever being attached to the valve-rod O, (see Fig. 1.) The arm R acts alternately against the knob *a* and a shoulder, *c*, through which the fulcrum-pin *d* of the lever *b* passes, and thereby actuates the valve-rod O at the proper times to open and close the ports Q of the valves P. Similar valves, U U, are also used in connection with the air-

pump H, as shown in Fig. 2, air being drawn into the open end of a cylinder, V, and through a port, *e*, into the pump-cylinder, and forced out through a port, *e'*, when a valve U closes port *e* and the port *e'* is open. The valves U U are on a rod, W, which is connected by a link, *f*, with a lever, X, the latter being connected to the lever *b*. The valves U U therefore, it will be seen, are, with the valves P P of the driving-cylinder, operated from the piston-rod L, and the engine may be reversed at any time by actuating the lever X so as to change the position of the valves. These valves, it will be seen, are balanced, and they are therefore operated with but little power. This arrangement of the driving-cylinder and air-pump with the pistons of each attached to one and the same rod, and the valves of the pump and cylinder operated from said rod, renders the device very compact.

The sliding frame S has a rack, Y, attached to it, said rack being formed by having teeth all around the edge of an opening in a plate, *g*, attached to said frame. This opening has two parallel sides, *h h*, and semicircular ends *i i*, and a bar, Z, is attached to the plate *g*, which extends longitudinally along one side of it and midway between the upper and lower sides, *h h*, of the rack. Into this rack a pinion, A', on a shaft, B', gears, the power being taken from shaft B', and the rack Y has a reciprocating motion given it from the piston-rod L in consequence of the arm R being connected to the sliding frame S, and the rack Y communicates a rotary motion to the shaft B' through the medium of the pinion A', the latter engaging both with the upper and lower sides, *h h*, of the rack, working in the upper side when the piston K is moving in the direction of arrow 1, and working in the lower side when said piston is moving in the opposite direction, a spring, C', throwing the frame S up and down to cause the two sides of the rack to thus engage with the pinion, so that from the reciprocating movement of the former a rotary motion in one direction will be communicated to the latter.

The bar Z serves as a guide for the frame S, the inner end of shaft B' being against it.

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

1. The balanced valves P P U U, arranged, respectively, with the driving-cylinder and air-pump, and operated from the piston-rod L, substantially as and for the purpose specified.

2. The rack Y, attached to the sliding frame S, in connection with the pinion A and the spring C', substantially as and for the purpose set forth.

The above specification of my invention signed by me this 2d day of June, 1865.

HIRAM KILBOURN.

Witnesses:
M. M. LIVINGSTON,
C. L. TOPLIFF.