M. G. CRANE.

HOT AIR ENGINE.

No. 46,084. Patented Jan. 31, 1865.

Fig: 1.

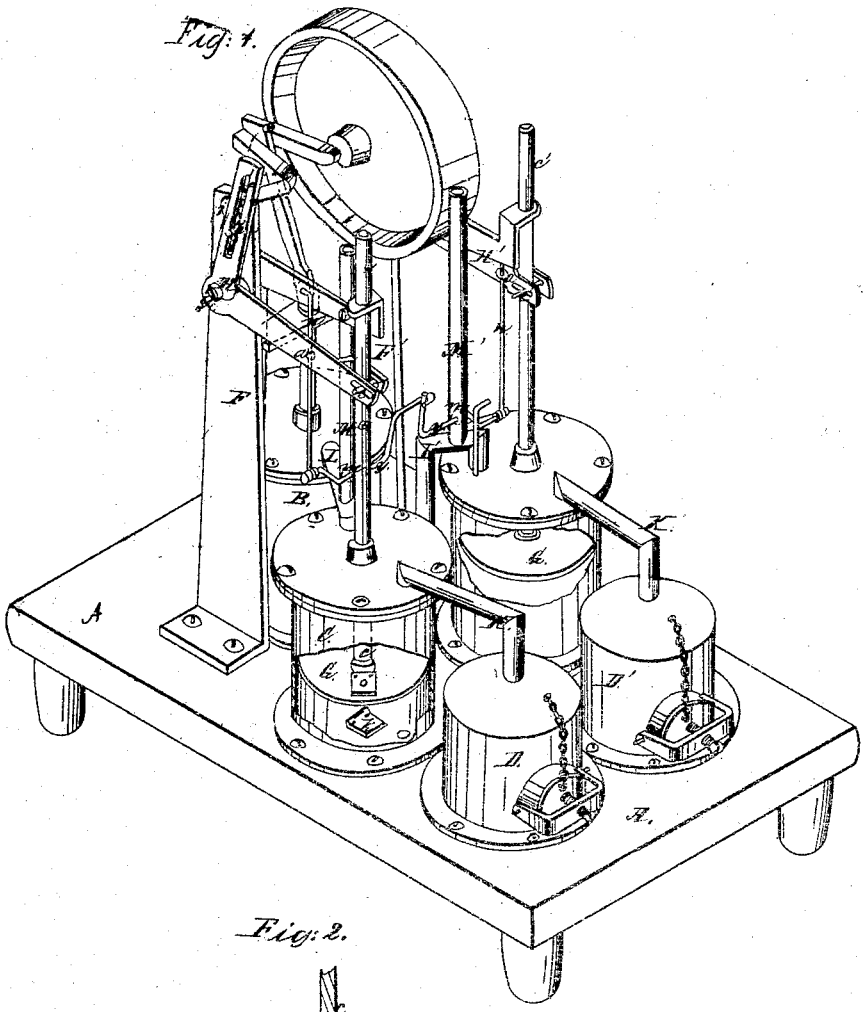
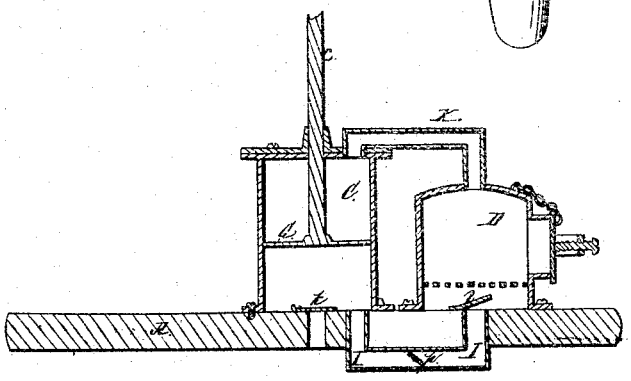


Fig: 2.



Witnessed:

S. B. Kidder

Francis Gould

Inventor:

Moses G. Crane

By his Atty.

W. B. Bailey

UNITED STATES PATENT OFFICE.

MOSES G. CRANE, OF CHELSEA, MASSACHUSETTS.

IMPROVEMENT IN HOT-AIR ENGINES.

Specification forming part of Letters Patent No. **46,084**, dated January 31, 1865.

To all whom it may concern:

Be it known that I, MOSES G. CRANE, of Chelsea, in the county of Suffolk and State of Massachusetts, have invented an Improvement in Hot-Air Engines; and I do hereby declare that the following, taken in connection with the drawings, which accompany and form part of this specification, is a description of my invention sufficient to enable those skilled in the art to practice it.

Of said drawings, Figure 1 shows my improved hot-air engine in perspective with some of the parts broken away to exhibit internal structure. Fig. 2 is a vertical section taken through one of the air-pumps and the furnace therewith connected.

A represents the bed of the engine, and B the main or working cylinder thereof, which is provided with heads and a suitably-packed piston, similar to an ordinary steam-engine cylinder.

The piston-rod, cross-head, slides, crank, connecting-rod, balance-wheel, shaft, and upright supports usual for ordinary vertical engines are all plainly shown in the drawings and need not be referred to by letters.

Two air-pumps, C C′, are shown, each connected, respectively, with its own air-heating furnace D and D′. From one of these pumps, C, air is supplied to the main cylinder B above its piston to drive it downward, while from the other pump, C′, air is supplied to the main cylinder below the piston to drive it upward. The air-pumps C and C′ and also the furnaces D and D′ are similar in construction and operation. The pump C is provided with a piston, G, which is operated through its piston-rod *e* by the following or other mechanical devices, which operate to drive down the air-pump piston faster than the piston moves in the main cylinder, so that the charge of air in the pump may all be expelled and passed into the furnace to supply the main cylinder before its piston completes its stroke in one or the other direction, according as it receives its supply of heated air by the agency of the pump C or C′. A cam may be used on each end of the engine-shaft for operating the air-pumps through suitable connections, and these cams may be made of such shape as to move the pump-pistons down very quickly or while the engine-piston is moving through but a small portion of the first of its stroke, said cams being also so fashioned as to cause the pump pistons to rest at the completion of their downward stroke till the engine-piston completes the stroke which is made by the expansion of the air supplied by one or the other of the pumps, and said cams being also further fashioned so that the upward stroke of the pump-pistons shall be coincident, or nearly so, with the strokes of the engine-piston.

The particular mechanism shown in the drawings for effecting the different velocities of motion between the piston in the engine-cylinder and the pistons in the air-pumps consists of a crank, *i*, on the engine-shaft, having its crank-pin *h* working in the slot *f* of one arm of the bent lever H, which is pivoted at *g* to the upright F. The other arm of the bent lever H is slotted and embraces a pin, *e*, which is fixed in the air-pump piston-rod *c*, said rod being guided in a projection from the upright F.

In each pump the air is taken in from below, past a valve, *k*, when its piston rises, and on the descent of the piston the air is displaced from beneath it through a pipe, I, past a valve, *l*, into the furnace beneath the grate-bars, as shown in Fig. 2, or the air-passage may be so made as to deliver the air partly above the grates, if desired. The air in passing from the furnaces into the main cylinder enters the pump-barrels through pipes K K′, above the pump-pistons, before passing into one or the other end of the engine-cylinder, so that during the downward stroke of the pump-pistons the pressure is alike on both sides.

From the pipes L and L′, which form the air-passages between the main cylinder and the pump-barrels, the exhaust-pipes M and M′ rise from the main cylinder B, each being provided with an exhaust-valve so operated by mechanism as to be opened and closed at the times needed for the perfect working of the engine. This mechanism is as follows: Passing through each exhaust-pipe is a cranked shaft, *y*, and in the pipes M and M′, respectively, and on said shaft *y*′, are valves *m* and *m*, by which the exhaust-passages can be left open to the atmosphere or by which they may be wholly closed. In each lever H H′ are tappet-eyes *a a*′, through which rods *n n*′ can freely work, each having a stop on its upper end, so that when by the movement of H H′

the tappets strike the stops on $n\,n'$, one exhaust-valve is closed and the other is opened, this being effected by the partial rotation or rocking of the cranked shaft y, caused by the connection of the rods $n\,n'$ with the cranks of the cranked shaft. It will be obvious from inspection of the drawings that this exhaust-valve mechanism operates so as to open the exhaust-valve connected with each pump, as well as with one end of the main cylinder B, when the pump pistons are rising, and it will therefore appear that in the upward movement of the pump-pistons, as well as in their downward movement, the pressure on each side thereof is alike. From this it follows that by the construction or arrangement shown by which the air-pump pistons work in equilibrium, substantially as shown, and in which arrangement my invention principally consists, no power is required to work the pumps other than that which is absorbed in friction of the machinery and of the air in the passages, the operation of the pumps being to displace cold air from a cool place and to cause it to flow through the furnace, where it is heated and expanded, the pressure on both sides of each pump-piston in this operation being alike.

In the pipes which connect the pumps at their bases with the furnaces, I place regulator-valves p, to be operated upon by any well-known form of "governor" worked by the engine. In the piston of the air-pump I arrange a valve, like that marked o, to be kept shut by its weight or by a spring, and intended to operate so as to let the piston pass the air beneath it when the regulator works the valve p to prevent or check the air from passing through the furnace to be heated.

I claim—

1. In hot-air engines, the arrangement of the main cylinder, the air-pump, the furnace, the air-passages, and exhaust-valve, so that the air-pump piston shall work with equal pressure on each side thereof, substantially as set forth.

2. The employment of the valve o in the pump piston in connection with the regulator-valve in the passage between the pump and furnace, when arranged to operate substantially as specified.

3. So operating the pump-piston in the stroke which supplies the main cylinder that said piston completes its said stroke before the main cylinder-piston completes the stroke which is consequent upon said supply.

In witness whereof I have hereunto set my hand this 3d day of December, A. D. 1864.

MOSES G. CRANE.

In presence of—
J. B. CROSBY,
FRANCIS GOULD.