C. STEVENS.

HOT AIR ENGINE.

No. 50,506. Patented Oct. 17, 1865.

Fig. 2.

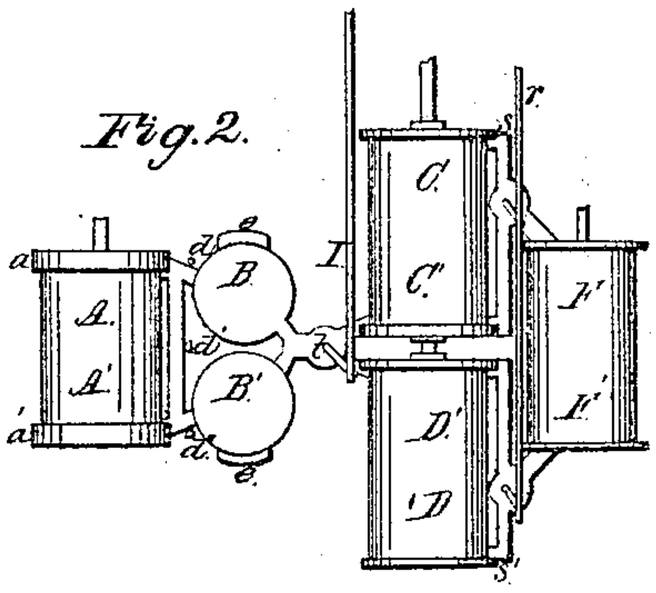
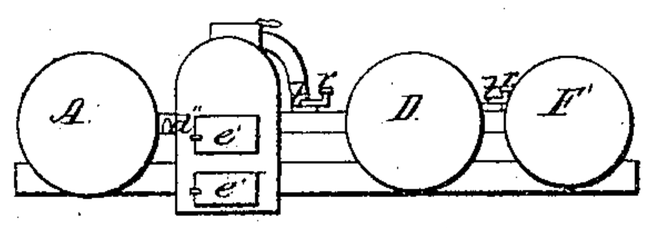



Fig. 3.



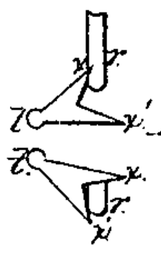
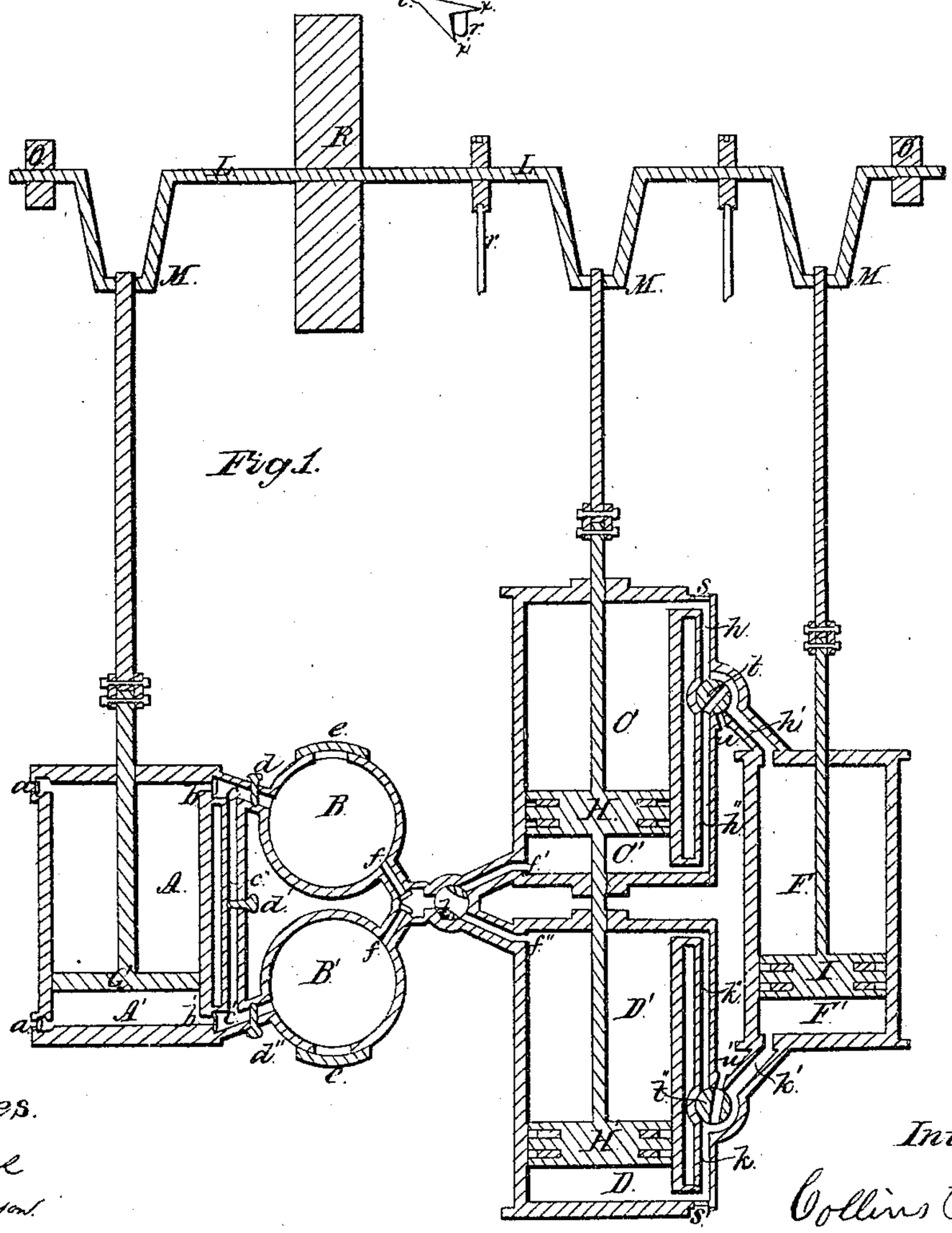




Fig. 1.




Witnesses.

Geo. U. Stearns

F. E. Emerson

Inventor.

Collins Stevens

# UNITED STATES PATENT OFFICE.

COLLINS STEVENS, OF BOSTON, MASSACHUSETTS.

## IMPROVEMENT IN HOT-AIR ENGINES.

Specification forming part of Letters Patent No. **50,506,** dated October 17, 1865.

*To all whom it may concern:*

Be it known that I, COLLINS STEVENS, of Boston, in the county of Suffolk and State of Massachusetts, have invented a new and Improved Hot-Air Engine; and I do declare that the following is a full and exact description thereof, reference being had to the annexed drawings and letters of reference thereon.

The nature of my invention is, first, the means and devices for the introduction of cold air between two or more movable and connected surfaces, constructed and arranged in such a manner that the bulk of air introduced shall be confined and shall not be materially increased or diminished between such surfaces, and so that the air may be heated between such surfaces before it is permitted to expand, and so that the pressure of the air being heated shall operate equally and counterbalance in opposite directions upon said surfaces, so as to produce no effect while the heated air is confined, and then using the expansive force of said heated air for producing power and motion, substantially as hereinafter described.

To enable others skilled in the art to make and use my invention, I will proceed to describe an air-engine made in accordance therewith.

Figure 1 of the drawings is a longitudinal section of the engine. Fig. 2 is a top view, (except the fly-wheel and shaft.) Fig. 3 is an end view. Figs. 2 and 3 are on one-half the scale of Fig. 1.

The machine may have four cylinders of equal length, and all (except, perhaps, the cylinder F F′) are of equal diameter. These cylinders hereinafter will be designated as marked in the drawings by the letters, respectively, A A′, C C′, D D′, F F′.

The cylinder A A′ has working air-tight therein a piston, G. This piston will divide the space within the cylinders into two variable portions, designated, as shown in the drawings, by the letters A and A′, respectively. The piston H works air-tight in C C′, dividing it into two variable portions, C and C′, respectively. The piston H′ works air-tight in the cylinder D D′, dividing it into two variable portions, D and D′, respectively. The piston I works air-tight in F F′, dividing the cylinder into two variable portions, F and F′. These letters will be respectively used to denote such spaces and pistons, as A will denote the space within A A′ on one side of the piston G; A′, the space on the other side. The said cylinders are closed air tight at the ends, having proper stuffing-boxes, so that the piston-rods may work air-tight. Said pistons are all connected with the shaft L L by connecting piston-rods, so that all the pistons move together as one solid, and just the same as if all the cylinders had a common axis and all the pistons a common piston-rod.

Opening from the open air into A and into A′ are orifices *a* and *a′*, having valves therein, allowing air to flow freely into A and A′, but preventing the exit of air therefrom. Opening from A and A′ into the tubes *c* and *c′* are the orifices *b b′*, having valves therein, allowing air to flow from A or A′ into *c* or *c′*, respectively, but preventing any flow from *c* or *c′* into A or A′. The pipes *c* and *c′* are connected by the pipe *c″*, and open into the furnaces B B′, within which the air from A and A′ is heated. The pipes *c c′ c″* have each therein a stop-cock, *d d′ d″*, so that the air from A and A′ may be conducted into either or both of said furnaces B B′, or shut off from either or both, so that one of the furnaces may be opened and fuel supplied without stopping the engine or relieving the pressure in the other. The furnaces are strong air-tight chambers, with a door in each for supplying fuel, air-tight when closed.

A system of pipes, *f f′ f″*, connect the furnaces B B′ with C′ and D′. These pipes have close to the furnaces valves or stop-cocks therein, so operated as to prevent the return of air from the pipes *f f′ f″* into either of the furnaces. The pipe *f′* opens into C′, and *f″* into D′. At the junction of these pipes with *f* is the valve *t*, so arranged that when it is in one position the pipe *f* and *f′* is open and *f″* is closed. In its other position *f* and *f″* are open and *f′* closed, so that air may flow from the furnaces first into C′ and then into D′ alternately. This valve is automatically worked by the engine.

Connecting C and F are the pipes *h* and *h′*, which pipes are always open and connected. Connecting D and F′ are similar pipes, *k k′*, always open and connected. Opening into the pipes *h h′* and *k k′* from the open air are two orifices, *s* and *s′*, having each a valve therein,

allowing air to flow into the pipes, but preventing its flowing out.

Branching from the pipe *h h'*, connecting with the space C', is the pipe *h''*, and also opening into the air is the escape-pipe *u*. A valve, *t'*, is placed at the junction of these pipes *h*, *h'*, *h''*, and *u*, which is so arranged and automatically worked that in one position of the valve the pipe *h''* is closed and cut off from the pipes *h h'* and the escape-pipe *u* is open and connected with the pipes *h h'*, and in its other position the escape-pipe *u* will be closed and cut off from *h h'* and the pipes *h h' h''* will all be open and connected, so that the spaces C, C', and F' will be connected. The pipes *k k'* have similar pipes connected, the pipe *k''* connecting with D', and the other (the escape-pipe *u'*) opening into the air. A similar valve, *t''*, operates at the junction of pipes *k*, *k'*, *k''*, and *u'*, operating similarly to the valve *t'*, and these valves *t t'* are so automatically operated that when the pipes *u* and *k''* are open and connected, as before mentioned, *u'* and *h''* are closed, and when *u* and *k''* are closed *u'* and *h''* are open. The valves *t t' t''* are all worked automatically by a rod connected with the shaft L L by a crank or eccentric working at right angles to the cranks M M M, so that the motion of this rod is greatest when the piston-rods move the least. This rod is connected with the valves by a crank. The valves shown in the drawings are cylindrical ones.

In order to obtain a quicker motion of the valves *t*, *t'*, or *t''*, the crank, as shown in Fig. 4, *x x'*, may be forked and so arranged with respect to the rod that a pin or projection upon the rod, when it is moving in one direction, shall push one of the forks, *x*, one side, bringing the other over the rod. On the return vibration the fork *x'* shall be pushed aside and *x* brought over the rod again. The motion may thus be given to the valves when the pistons are near one end of the cylinder.

In addition to the usual metal packing used in the cylinders of steam-engines, the inventor uses packing-rings of soft and unctuous mineral substances—such as soapstone or plumbago—for lubricating the hot-air pistons.

The operation of the machine is as follows: In Fig. 1 the pistons are represented as moving from the shaft L L, and the valves *t t' t''* are all arranged for that purpose. Cold air is flowing into A through the orifice *a*. The air in A', first being brought to a tension equal to that in the furnaces B B', then flows through the pipes *c c' c''* into the furnaces B B', and is there being heated. Heated air is flowing into D' from the furnaces through the pipes *f f''*. At the beginning of the stroke, owing to the difference of the tension of the air in A' and in the furnaces B B', considerable power will be exerted usefully on the piston H', C being exhausted. After the tensions become equal the pressures on G and H' in opposite directions balance and neutralize each other. Air from F' and D is escaping through the pipes *k*, *k'*, and *u'* into the air. Hot air introduced by the previous vibration into C' is flowing through the pipes *h h' h''* into C and F, and forcing the piston I' along. The pressure on both sides of H being nearly equal, no effect is produced. The pressure of the expanding air upon I forces that piston, and with it all the others, along. The pistons having completed this stroke the valves *t t' t''* automatically change. Cold air flows into A' through *a'*. Air is first condensed, and then flows through *c c' c''* into the furnaces, is there heated, and flows from the furnaces through the pipes *f f''* into C'. Air escapes from C and F through the pipes *h*, *h'*, and *u*. Air is expanding and flowing into F' and D from D' through the pipes *k k' k''*, and forces the piston I, and with it all the other pistons, toward L L. The pistons having reached the other ends of their cylinders, the valves *t t' t''* again change and the pistons return as at first. The vibratory motion is changed to circular by the cranks M M M of the piston-rods and of the shaft L L, and the motion is equalized by the fly-wheel upon said shaft. The shaft L L is supported upon pillars O O. The fire within is supplied as follows: The stop-cock *d* of the pipe *c* is closed and the door *e* is opened and fuel supplied to the furnace B. The stop-cock *d* is then reopened, the door having first been closed, and the stop-cock *d''* is closed and the door is opened and fuel supplied to the other furnace, B'. The door is then closed and the stop-cock reopened. Closing the stop-cock *d'* causes air from A to flow into one of the furnaces, air from A' into the other. Should not the air be sufficiently heated so as to fill the spaces C and F or D and F' without becoming rarer than the air outside, air will flow through the orifices *s* or *s'* and prevent a prejudicial pressure upon the piston I.

The arrangement of the details in the above-described engine is made with special reference to a clear description of the principles used in the invention. For this purpose the axes of all the cylinders, as well as the connecting-pipes, are thrown into one plane. The cylinders may be differently arranged. They may all except F F' have the same axis and piston-rod; or the hot-air cylinders C C', D D', and F F' may be grouped about the furnaces, so as to economize heat and room. An upright position of the cylinders would make the pistons wear more evenly.

Instead of cylindrical valves, slide or puppet valves may be used, and nearly all may be automatically worked. The pipes *c c'* should enter the furnaces B B' below the fire-grate and near the bottom, and the pipe *f* should open near the top, as shown by the dotted lines in Fig. 3. Instead of the use of soft and unctuous rings of mineral substances, as described, the substances may be supplied in the state of powder or otherwise; and by varying the length of the strokes of the different pistons the cylinder may be made of different lengths

and diameters, so long as the pressure on G and H or G and H′ in opposite directions prejudicial to the working of the engine is counterbalanced substantially as described.

What the inventor claims, and desires to secure by Letters Patent, is—

1. Introducing cold air between two or more connected pistons or surfaces, so arranged that while between such surfaces it shall not materially increase in bulk, and heating it after it has been introduced and while confined between such pistons or surfaces, and after the air so confined has been heated using the expansive force thereof for producing power by means and devices substantially as described.

2. Arranging the said pistons or surfaces so that the pressure of the heated confined air in opposite directions shall be balanced and neutralized, substantially as described.

3. The combination of the three cylinders and pistons, A A′, C C′, D D′, and H H′, or their equivalents, substantially as described, for the purposes set forth.

4. The arrangement of the furnaces between the cylinders A A′ and C C′ or D D′, substantially as described, for heating the air.

5. Using soft unctuous substances, substantially as described, for lubricating the pistons.

6. The arrangement of the valves or stop-cocks, as *d d′ d″*, for the purpose of cutting off one of the furnaces, so that fuel may be supplied without stopping the engine, substantially as described.

7. The arrangement of valves, operating substantially as the valves *t t′ t″* in *u* and *u′*, respectively, for the purpose of opening and closing the pipes between said cylinders and allowing the exit and escape of the hot air, substantially as described.

8. The arrangement of valves, as *s s′*, for preventing a partial vacuum when the air is not sufficiently heated to fill the working-cylinder or its equivalent.

COLLINS STEVENS.

Witnesses:
GEO. M. STEVENS,
F. E. EMERSON.