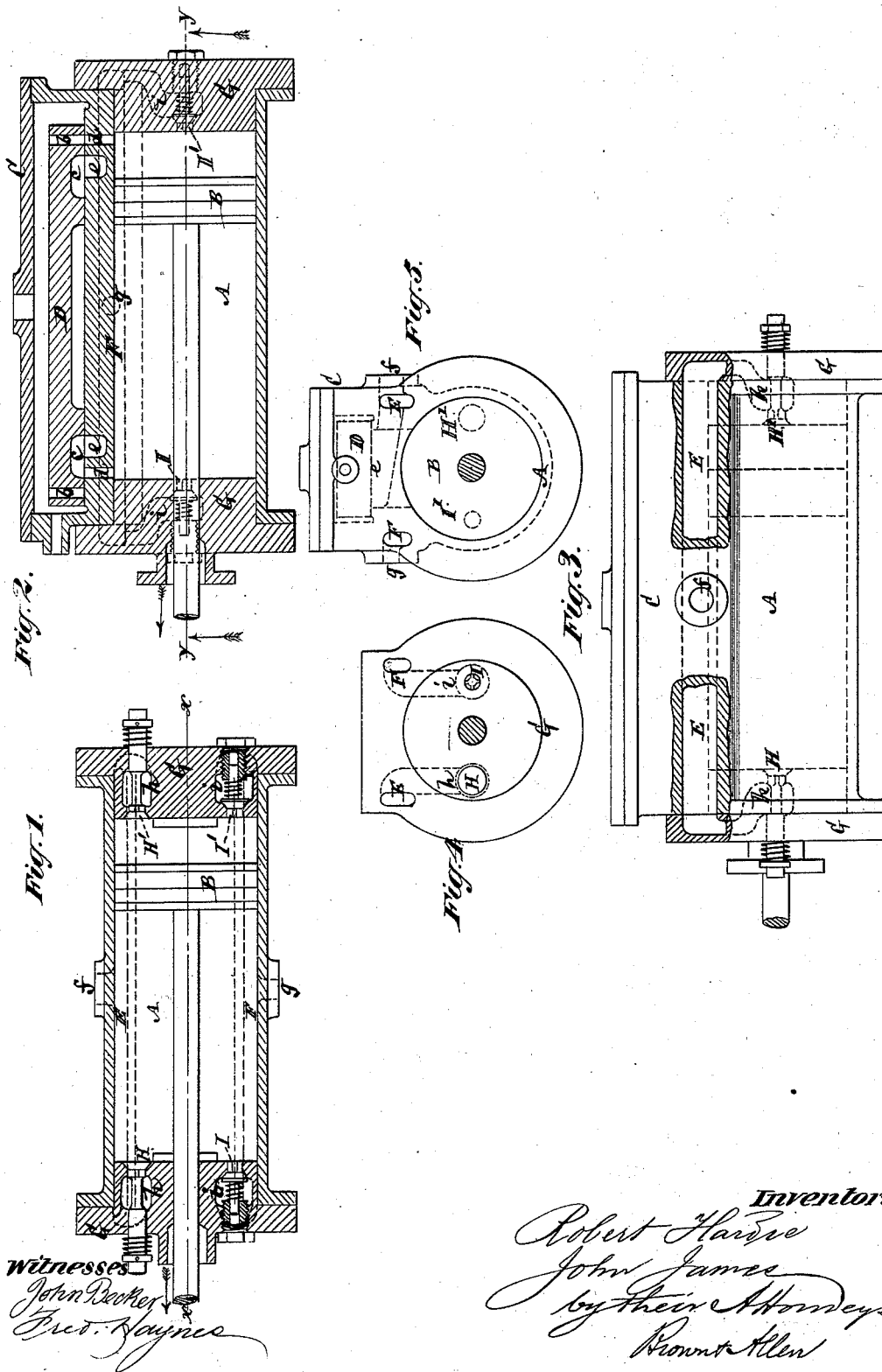


R. HARDIE & J. JAMES.  
Compressed-Air Engine.

No. 216,611.

Patented June 17, 1879.



# UNITED STATES PATENT OFFICE.

ROBERT HARDIE AND JOHN JAMES, OF NEW YORK, N. Y., ASSIGNORS TO THE  
PNEUMATIC TRAMWAY ENGINE COMPANY, OF SAME PLACE.

## IMPROVEMENT IN COMPRESSED-AIR ENGINES.

Specification forming part of Letters Patent No. **216,611**, dated June 17, 1879; application filed  
October 3, 1878.

*To all whom it may concern:*

Be it known that we, ROBERT HARDIE and JOHN JAMES, both of the city and State of New York, have invented certain new and useful Improvements in Compressed-Air Engines for Locomotives or Locomotive-Cars, of which the following is a description, reference being had to the accompanying drawings, forming part of this specification.

This invention more particularly relates to compressed-air engines for propelling cars on street-railroads.

This invention consists in the combination, with the cylinder, the piston, and the main induction-valve of a compressed-air engine, of a novel system of self-acting inlet and outlet valves, at opposite ends of the cylinder, and passages communicating respectively with the air-supply reservoir and the exhaust-outlet of the engine, whereby the engine-cylinder may, when desired, be converted into a compressor, and so made to serve the purpose of a brake for stopping or retarding the motion of the engine or car.

In the accompanying drawings, Figures 1 and 2 represent central longitudinal sections, in planes at right angles with each other, of the cylinder of a compressed-air engine, with piston thereof, main valve, and other valves and passages, in accordance with our invention, and as applicable to the propulsion of a street-railroad car. Fig. 3 is a side view of the same. Fig. 4 is an interior face view of one of the cylinder-heads removed, and Fig. 5 an end view of the cylinder after the head which closes said end has been removed.

A is the working cylinder of the engine of a street-railroad car, and B its piston. C is the main valve-chest, and D the main valve, which is or may be in the form of an ordinary slide-valve, having opposite end inlets *b b* and duplicate or opposite end outlet-cavities *c c*, for operation in connection with opposite end passages *d d* and opposite end exhaust-cavities *e e* in the cylinder A. These exhaust-cavities *e e* connect with a longitudinal exhaust-passage, E, in one side of the cylinder, which passage has an exhaust-outlet, *f*, to the atmosphere.

On the opposite side of the cylinder A is another longitudinal passage, F, connected by an aperture, *g*, with the compressed-air reservoir from which the engine draws its supply.

The passage E connects at its opposite ends with valve chambers or spaces *h h* in the heads G G of the cylinder, which spaces are closed by valves H H', opening within the cylinder against the tension of light closing springs. The other passage, F, connects at its opposite ends with other valve chambers or spaces *i i* in the heads of the cylinder. These last-named valve chambers or spaces are closed by valves I I', opening outward from the cylinder against the tension of suitable closing springs.

The objects of these several valves H H' and I I' will be hereinafter described, and, although they might be otherwise arranged in connection with the cylinder, it is very desirable to place them in the heads of the latter, as by so doing they allow of the piston working close up to the heads, and, on removing the heads, are readily accessible for adjustment or repair.

In the operation of the engine as applied to a street-railroad car, supposing the supply of compressed air to the working cylinder A, through the main valve D, to be cut off early in the stroke of the piston B, so that the pressure on the receiving or working side of the piston gets below that of the atmosphere, then the inlet-valve H or H' on such side of the piston opens, and, by the connection of its chamber *h* with the exhaust-passage E and opposite side of the piston, air passes into the cylinder on the working side of the piston from the opposite or exhaust side thereof, thus reducing the amount of air to be exhausted into the atmosphere from the forward or exhaust side of the piston, and consequently reducing the noise to that extent of exhausting into the atmosphere, which is of no small importance in the running of a car through crowded thoroughfares.

The inlet-valves H H' also serve to admit air into the cylinder when the engine is converted into a compressor by linking up the main valve or placing it at mid-gear, as in the running of the car downhill, or for stopping, thus com-

pressing fresh volumes of air received from the atmosphere. The air, as it is compressed by the engine, passes out through either outlet-valve I or I'.

When it is desired to stop the car the main valve D is brought to mid-gear and both the inlet and exhaust passages or cavities in the cylinders controlled by said valve are closed. Thus no compressed air can pass from the reservoir, but the air received from the atmosphere through either inlet-valve H or H' is compressed and forced by the engine through either outlet-valve I or I'.

For varying the braking effect, as for different grades, the stop-valve which controls the admission of air from the reservoir must be closed and the valve-gear be linked up to give the resistance required. In such case air enters the engine-cylinder at the back of the piston by the self-acting inlet-valves H H' alternately, as it does when the main valve is at mid-gear, and compression is produced on the forward or opposite side of the piston the whole of the period in which the exhaust is closed by the main valve. Thus, by setting the link-motion of the main valve at mid-gear, or by setting said link-motion to cut off short and closing the stop-valve, the braking action

produced by the engine acting as an air-compressor may be regulated to suit different grades. To stop the car, all that is necessary is to bring the link-motion of the main-valve to mid-gear.

I claim—

The combination, with the cylinder of the engine and its piston, of independent self-acting outlet-valves at opposite ends of said cylinder, a passage or passages in communication with the supply-reservoir opened and closed by said valves, independent self-acting inlet-valves at opposite ends of the cylinder, and a passage or passages opened and closed by said inlet-valves and in communication with the exhaust-outlet, for operation in connection with the main valve of the engine, essentially as and for the purpose or purposes herein described.

ROBT. HARDIE.  
JOHN JAMES.

Witnesses to the signature of Robert Hardie:

T. J. KEANE,  
HENRY T. BROWN.

Witnesses to the signature of John James:

HENRY T. BROWN,  
T. J. KEANE.