W. C. TURNBULL.

AIR ENGINE.

No. 27,938. Patented Apr. 17, 1860.

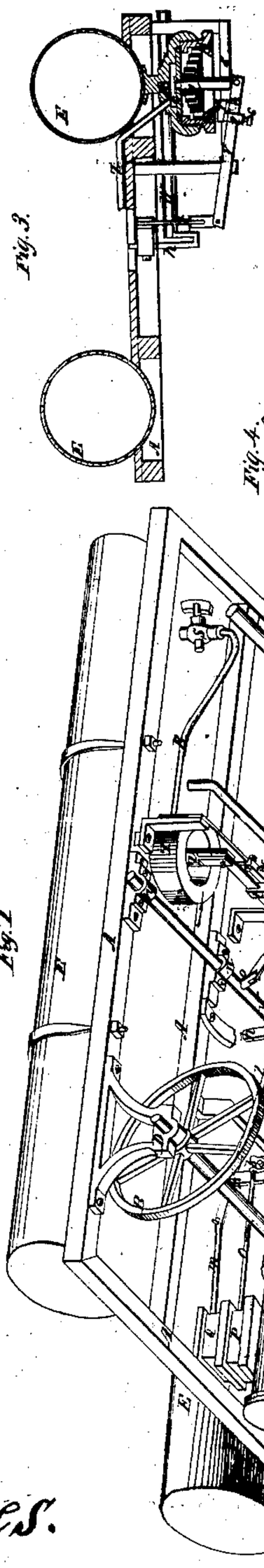

Fig. 3.

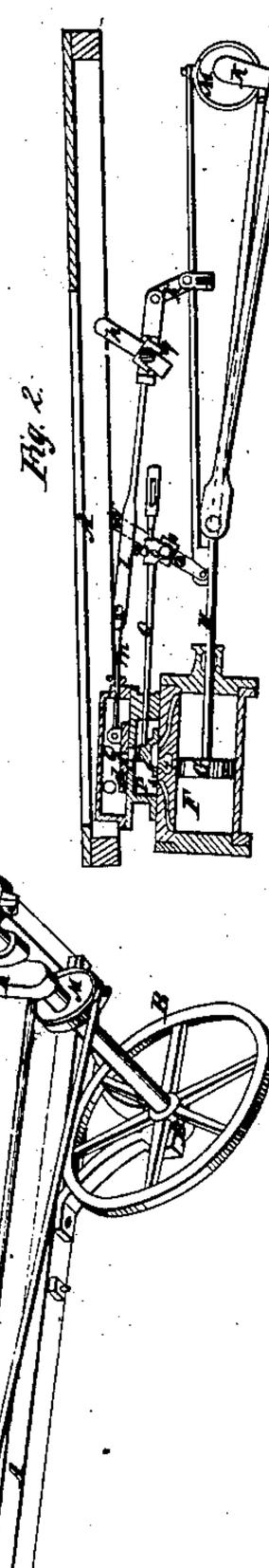

Fig. 2.

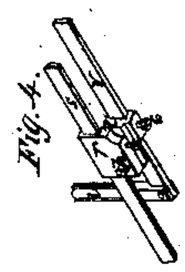

Fig. 4.

Fig. 1

Witnesses.
L. Cohen
Thos. H. Upperman

Inventor.
W. C. Turnbull
per atty
A. B. Stoughton

UNITED STATES PATENT OFFICE.

W. C. TURNBULL, OF BALTIMORE, MARYLAND.

IMPROVEMENT IN COMPRESSED-AIR ENGINES.

Specification forming part of Letters Patent No. **27,938**, dated April 17, 1860.

To all whom it may concern:

Be it known that I, W. C. TURNBULL, of the city and county of Baltimore, and State of Maryland, have invented certain new and useful Improvements in the Construction of Compressed-Air Engines; and I do hereby declare that the following is a full, clear, and exact description of the construction and operation of the same, reference being had to the accompanying drawings, in which—

Figure 1 represents a perspective view from below of a truck and a compressed-air engine attached to it. Fig. 2 represents a longitudinal vertical section through said air-engine. Figs. 3 and 4 represent detached views, hereinafter to be referred to.

I am aware that an air-engine has been described which was to be propelled by compressed air that was carried by the engine in suitable air-reservoirs connected therewith; but such engines from some fatal defect have never become practical or even used, and I do not know that anything further than mere theorizing has been done in this line.

I have proven by actual experiment to my own satisfaction that an air-engine for street-railroads more particularly can be propelled economically for several miles with the compressed air, which the car or engine can carry with it in suitable compartments, from which it is supplied to the cylinders; but it is necessary to the economical use of this compressed air so carried that it should be admitted to the cylinders in regular or uniform volumes, while the body of the compressed air is constantly diminishing in power by every stroke of the engine. To effect this object, I use a cut-off, which is operated by the pressure of the air in the reservoir or compartments, so that as the air expands or becomes less powerful a greater quantity shall be admitted to the cylinders, and thus make up in quantity what the air has lost in density or power. Working compressed air from a reservoir which is not being constantly replenished, but constantly exhausting, is an entirely different thing from applying steam by a cut-off where steam is constantly being added to the steam-chamber, for in one case the supply of power diminishes by every stroke of the engine, while with steam it may be increasing notwithstanding the supply that is constantly taken away to work the engine, or at least kept at a uniform pressure.

My object is to make an engine or car that is to be driven by the compressed air, which it carries with it, for street-railroad purposes, the engine or car to be supplied from reservoirs of compressed air at stations where it is prepared previously, and to have this air automatically supplied to its cylinders in uniform quantities by a cut-off that is governed by the pressure of the air in the compartments which carry it, though that pressure be constantly diminishing, and I propose to carry this compressed air in cylinders or in and about the engine or car, as may be most convenient, the space overhead, or under the car, or under the seats, or between the walls of the car being, if found essential, used for this purpose.

To enable others skilled in the art to make and use my invention, I will proceed to describe its construction and operation.

A represents the frame of a car, carriage, or engine, which is supported by the wheels B, they being secured to the axles C, which turn in suitable boxes D.

E represents two air-holders, which are secured to the truck A, and into which the air is admitted, which is used for driving the engine.

F represents the cylinder, (one only being shown, but I purpose using two and arranged like locomotive-cylinders,) which in its construction is similar to a steam-engine cylinder, the compressed air acting on the piston G in a similar manner as the steam does on the piston of a steam-engine.

H represents the piston-rod, I the connecting-rod, and K the crank by means of which one of the axles C is driven.

L represents a slide-valve or cut-off. It works within the chest P, and is similar in its construction to a steam-engine valve. It is operated from the eccentric M by means of the lever N, which turns on the fulcrum or shaft *a*, the rod *o* of the slide-valve L being secured to the pivoted sleeve *b*, by means of which the length of its stroke can be adjusted.

Q represents an air-chest, into which the compressed air passes when it escapes from the air holder or compartment, and which supplies the air-chest P with a regular volume of

air for each stroke of the piston, the slide-valve *d* cutting off the air quicker when the same is under high pressure and slower when it is under low pressure, and the compressed air in the air-holder acting so as to regulate the motion of this cut-off. This operation is performed by the application of the hereinafter-described devices, which constitute a principal part of my invention. The compressed air escapes from the air-holder through the pipe R, which may be opened or closed by means of an air-cock S. This pipe communicates with the interior of a dome T, which is secured to one of the air-holders or compartments E. The compressed air entering this dome presses on an elastic diaphragm *f*, which is secured within said dome or chamber.

U represents a stem which is secured to the diaphragm *f*, and to which the volute or helical spring *g* is secured. The outer coil of said spring rests on the rim *i* of the chest T. The end of the stem U is pivoted to the lever V, which turns on the fulcrum *h*, while the longer end of the lever V is connected by means of a link K with the pitman *l*, to which the rod *m* of the cut-off *d* is pivoted.

W represents a rock-shaft which has its bearings in the journal-boxes *n*. It is operated by means of the eccentric X, whose rod Y is pivoted to the arm O of said shaft W. The end of this shaft is bent in the shape represented in the drawings, and the bent end *p* can freely play within a swivel-nut *q*, which is pivoted to the flat portion of the connecting-rod *l*.

The operation of this apparatus is as follows: The air-holders E being filled with compressed air, the air-cock S is opened, and the compressed air passes into the chamber T and thence through the pipe Z into the air-chest Q, whence it passes through the ports 1 2 into a second air-chest P, and thence through the port 3 into the cylinder F. The pressure of the air being very high when the machine is started it causes the diaphragm *f* to distend and presses the stem U downward. This motion causes the lever V to turn on its fulcrum *h*, Figs. 3 and 4, and to slip the swivel-nut *q* on the shank *p* of the rock-shaft W, whereby a proportional long stroke is imparted to the side *d*, which thus cuts off the air quickly and admits only such a volume of air into the chest P as is necessary to drive the engine at a certain speed. As the pressure of the air in the air-holder decreases, the stem U is raised by the action of the spring *g* and the swivel-nut *q* slides nearer to the line of the axis of the rock-shaft W; and the stroke of the rod *l* is shortened, which causes the ports 1 and 2 to remain opposite each other for a longer period of time, and thus to pass an equivalent volume of air into the chest P at a low pressure as was admitted before at a high pressure and for a shorter period. This operation continues until the pressure of air in the air-holder is so low that the fulcrum of the swivel-nut *q* is in the elongation of the axis of the rock-shaft W, when the motion of the slide *d* will be altogether arrested, and there will be an uninterrupted communication between the air-holder and the air-chest P, and the slide-valve L alone admits and cuts off the air, the one *d* being inactive. During the operation of the engine the motion of the cut-off L is not varied, and it acts in the same manner as the cut-off of a steam-engine, passing the compressed air alternately through the ports 3 to the front and to the rear of the piston G, and causing the same after each stroke to escape through the exit or exhaust port 4.

The fulcrum *h* of the lever V can be adjusted so as to adjust the length of the arms of said lever. This is effected by the following devices: The pin *h* turns in the body of a slide *r*, which can be moved over the brace *s* and can be secured in any desired position by the set-screw 5, and said pin is secured to the sleeve *t*, which can be moved over the lever V, and can be secured thereto by a set-screw 6, thus affording two adjustments—one on the brace *s* and the other on the lever V—by which the action of this regulating apparatus can be adjusted with the greatest accuracy. The two air-holders E are connected to each other by a pipe *u*, by which the density of the air in both holders remains the same. Thus it will be seen that the velocity of the engine is the same throughout the different degrees of pressure of the air by which it is driven, as the air is cut off quicker while under high pressure than when under low pressure, and that this cut-off is operated by the pressure of the air itself in the air-holder.

A lever can be applied to the air-valves or their rods, so that the engineer or conductor from his stand on starting his car or engine may let on a greater volume of air than the cut-off would supply.

The air holders or compartments may be instantly filled by connecting them with the main supply-reservoirs at the station or end of the route, which reservoirs are kept supplied by steam or other power through an air-pump. A pair of cylinders which I have used in my experiments have held a volume of air compressed to three hundred pounds to the square inch, and I see no difficulty in holding and carrying air at twice that pressure.

It is well known that heat applied to air increases its expansive properties, and I propose to apply to my car or engine, should it be found advantageous to do so, a charcoal fire or gas-furnace, by which the air may be heated to increase its expansive properties by passing the air-pipes through, over, or around said fire or flame. Other fires or heat may be used; but the sparks and smoke in a city would be dangerous and annoying.

I have described the valves as operated by eccentrics on the axles of the driving-wheels; but of course the air may be let on by the conductor or engineer with an ordinary start-

ing-bar and worked by hand, when so preferred.

Having thus fully described the nature of my invention, what I claim therein as new and desire to secure by Letters Patent is—

The application to compressed-air engines of an expansion cut-off which is operated by a positive motion, but the stroke of which is regulated automatically by the pressure of the air in the air-holder or reservoir, so as to admit a volume of air of a certain density directly to and allow it to expand in the cylinder for each stroke of the piston as is necessary to drive the engine at a certain speed, substantially in the manner herein described.

W. C. TURNBULL.

Witnesses:
WM. H. HAYWARD,
J. F. WAGNRR.