N. H. Barbour,

Gas Engine,

No. 46,769. Patented Mar. 14, 1865.

Fig. 1.

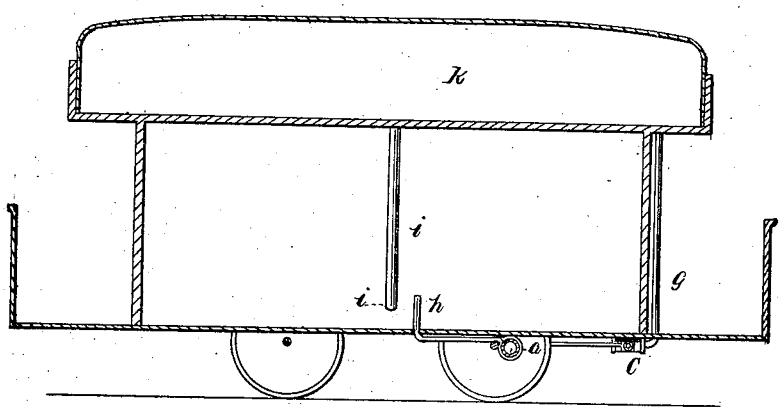
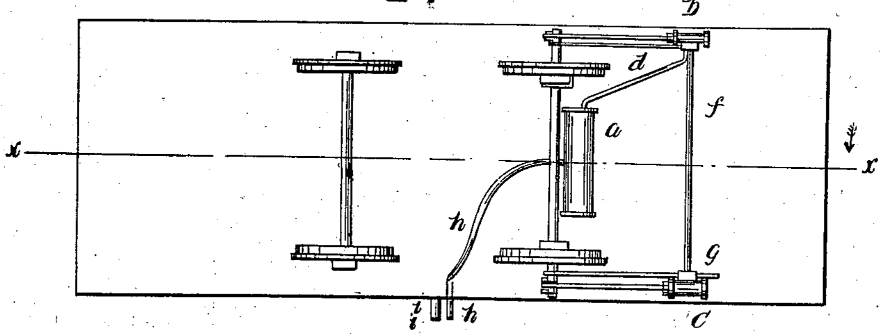


Fig. 2.



Witnesses:

[illegible]

Joseph B. Ball

Inventor:

N. H. Barbour.

UNITED STATES PATENT OFFICE.

NELSON H. BARBOUR, OF AUBURN, NEW YORK.

IMPROVEMENT IN CARBONIC-ACID ENGINES.

Specification forming part of Letters Patent No. 46,769, dated March 14, 1865.

To all whom it may concern:

Be it known that I, NELSON H. BARBOUR, of Auburn, in the county of Cayuga, in the State of New York, have invented a new and Improved Method for Applying Force to Locomotive Purposes; and I do hereby declare that the following is a full and exact description thereof, reference being had to the accompanying drawing, and to the letters of reference marked thereon.

My invention consists in using the expansive force of the vapor or gas resulting from the evaporation of liquefied carbonic acid and other gases to be used as a portable motive power, and in collecting the whole or a considerable part of the expanded gas to be again liquefied for subsequent use by a force independent of or in addition to that resulting from its own expansion.

I proceed to describe the general features of the arrangement and machinery that may be used in applying my invention to propelling street-railroad cars, now ordinarily drawn by horses.

Machinery for liquefying the gas would be established at convenient points on the line of road, ordinarily at one or both ends of such road, depending, of course, upon its length.

In liquefying carbonic acid, which is the gas I deem best adapted to the application of my invention, I prefer to divide the process into three stages. Taking the gas at atmospheric pressure, it is condensed by one pump or set of pumps to about ten atmospheres. The gas so compressed is then, by another pump or set of pumps, taken from the receiver and forced into a second receiver at a pressure of about twenty-five atmospheres. A third pump or set of pumps then carries it to a third receiver, where it is liquefied under a pressure of thirty-six or more atmospheres, depending upon its temperature. The temperature of the gas should be kept as low as is practicable during its compression by surrounding these receivers with ice. The receivers for holding the liquid should be made of the best wrought-iron, with welded joints, and of sufficient strength to safely bear at least one hundred and fifty atmospheres to the square inch. The force-pumps used in liquefying the gas are worked by steam or other convenient power. Each locomotive-car has a receiver or "boiler," as shown at *a*, in the accompanying drawing, for holding the liquefied gas, and also suitable machinery for applying the expansive force of the gas to propelling the car. This machinery consists of one or more pairs of cylinders, with pistons, valves, connections, &c., similar to those used with steam.

Cylinder *b* (see drawing) is connected with the boiler through its steam or vapor chest and pipe *d*. The amount of vapor to be used at each stroke is regulated by "throttle" or cut-off valves. The second cylinder, C, is "fed" by or through the exhaust of *b*, through pipe *f*, and is twice the diameter of cylinder *b*. Two and four inches diameter and twelve inches stroke are the sizes here represented for the pairs of cylinders. The exhaust of cylinder C is through pipe *g*, and into *k*, which which is a gasometer attached to the top of the car, and of a capacity of four hundred and fifty times that of the volume of liquefied gas in boiler *a*. This gasometer may be made of any suitable material. I prefer to make the sides, for about one-half its height, of thin boards, properly supported, and lined, together with the roof of the car, with glazed or enameled muslin, cemented to the wood by paint or other means, so as to render it impervious to the gas. The top of the gasometer is made of similar material, and of a size and shape to cover and fit onto the top of the car. The sides of the upper half of the gasometer are made of india-rubber cloth. When the gasometer is empty, its top will rest on the top of the car. When half full, its top will rise to the level of the upper edge of the wood-work around its sides, and when full it will project above the wooden sides.

The relative size of boiler *a* and of the gasometer *k* is always the same; but their real capacity should vary with the length of road, size of car, &c. Boiler *a* may hold one, two, or more cubic feet, according to the amount of work to be accomplished at each trip. The one here presented, *a*, holds two cubic feet.

The pressure of vapor as it enters the cylinder *b* will vary from about five hundred pounds to eight hundred per square inch, depending upon its temperature. At 60° Fahrenheit it is about fifty atmospheres. In being drawn off or permitted to escape through

the cylinders its temperature and pressure fall to about the minimum point, caused by its own evaporation; hence, under some circumstances, I apply artificial heat to the vapor just before it enters the cylinders, by means of a lamp or other contrivance.

To explain my method of transferring the liquid to the boiler on the car and the gas from the top of the car to the stationary gasometer at the depot, we will suppose the car to have just entered the depot, at the end of a trip. There is but little liquid gas in *a*, while gasometer *k* is nearly filled with gas.

Communication between boiler *a* and the reservoir of liquid gas, which is kept constantly on hand at the depot, is made by coupling a pipe leading from such reservoir with pipe *h*, which connects with *a*, while a second pipe connecting the top of *a* with the top of the reservoir is opened. The reservoir stands on a higher level than *a*, so that the liquid flows into *a* by its gravity, while the second pipe allows the pressure of vapor to equalize itself in the two vessels. *a* should never be filled entirely full of liquid, for similar reasons that make it improper to fill a steam-boiler full of water. It may, however, be filled to within three or four inches of the top. I use a glass liquid-gage, (of very thick glass, like a barometer-stem,) so as to see how high the liquid stands in *a*. At the same time that *a* is being filled, I empty the gasometer *k* by coupling a pipe which leads from the stationary gasometer onto *i*, at *i*, when the gas in *k* is drawn off by means of a "blower" or a suction-pump, or other convenient means. The drawing off of this gas, and filling of *a*, will ordinarily require two or three minutes, when the car is ready for a second trip. The handles of the valves for feeding the cylinders *b* and C are so arranged to be governed at either end of the car.

I do not claim as my invention, nor do I limit my invention to, any particular arrangement or form of apparatus or machinery for liquefying the gas, or for applying its expansive force for locomotive purposes.

What I claim as my invention, and desire to secure by Letters Patent, is—

The application of the expansive force of the vapor or gas derived from the evaporation of liquefied carbonic acid and other gases, and retaining the whole or a considerable part of the expanded gas to be again liquefied for subsequent use, when the same is done through devices and by a power and machinery independent of or in addition to that connected with its own expansive force, substantially in the manner shown and described.

N. H. BARBOUR.

Witnesses:
PETER COOPER,
JOSEPH B. HALL.