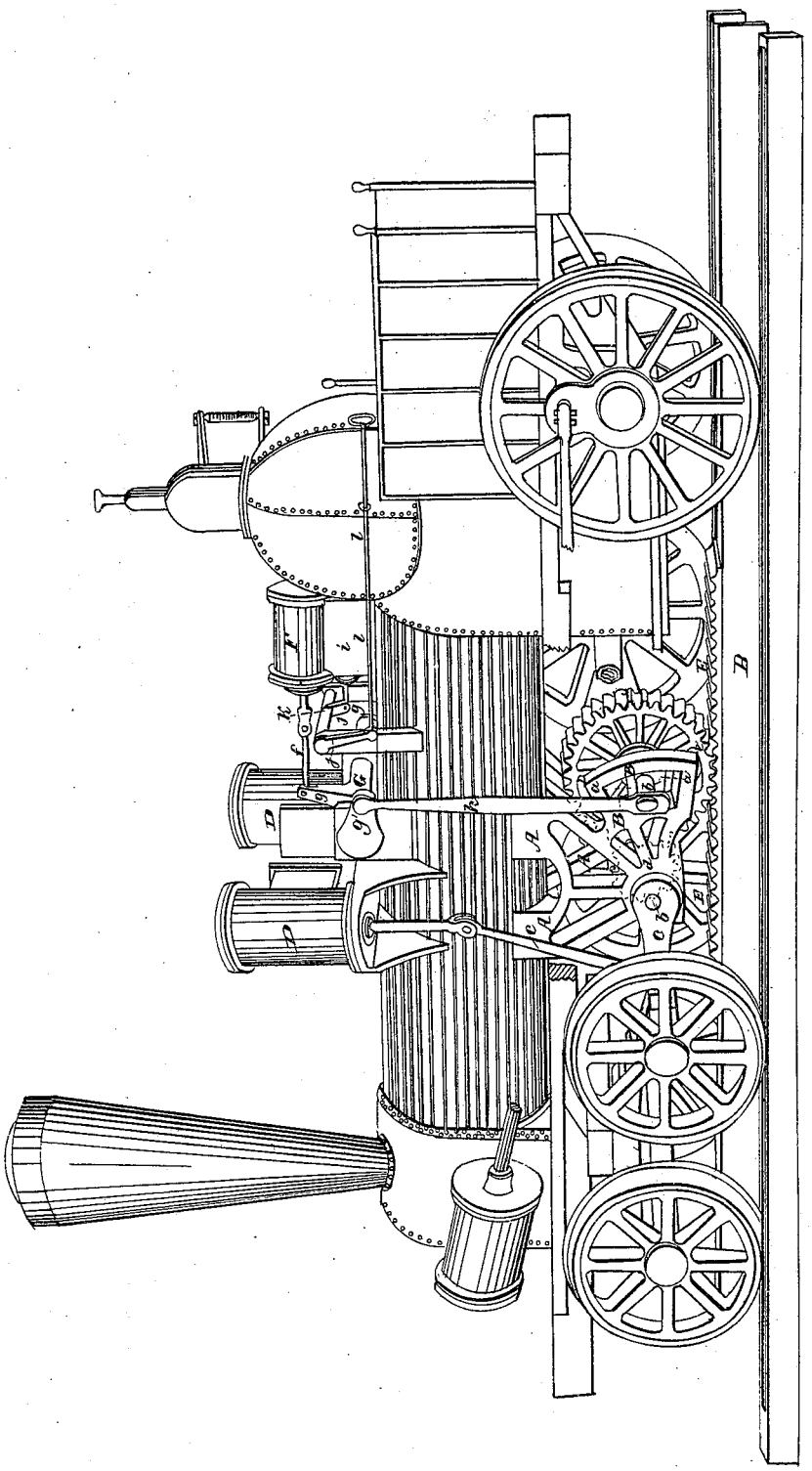
2 Sheets—Sheet 1.

A. CATHCART.

Traction-Wheel.

No. 6,818. Patented Oct. 23, 1849.



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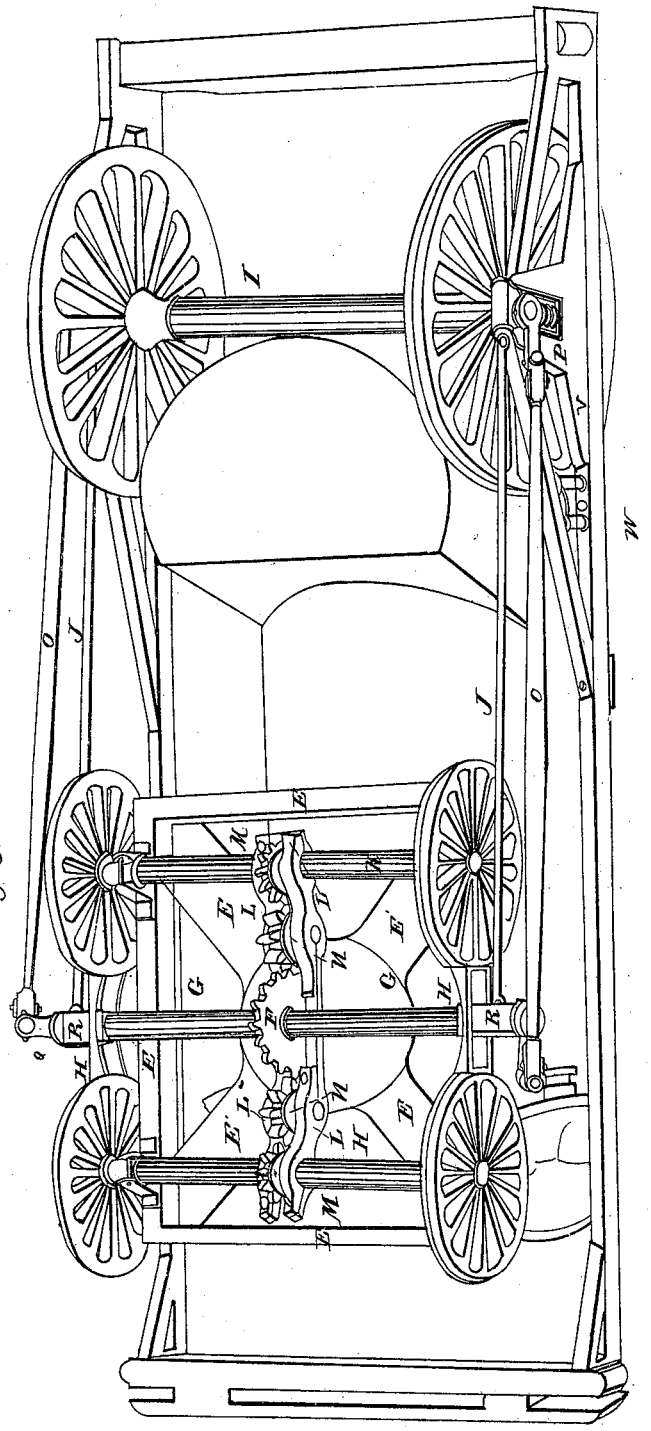

Fig. 3.

UNITED STATES PATENT OFFICE.

ANDREW CATHCART, OF MADISON, INDIANA.

IMPROVEMENT IN LOCOMOTIVES FOR ASCENDING INCLINED PLANES.

Specification forming part of Letters Patent No. **6,818**, dated October 23, 1849.

To all whom it may concern:

Be it known that I, ANDREW CATHCART, of Madison, in the county of Jefferson and State of Indiana, have invented a new and useful Improvement in Locomotive-Engines to Enable them to Draw Freight up Inclined Planes without the Use of Stationary Power; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawing, which is a perspective view showing the principal parts of my improved locomotive.

Whereas on railroads it is desirable that the speed on all ordinary grades should be considerable while the load drawn at that speed is limited by the power of the locomotive, and as it is also desirable that the same locomotive should be able to draw the same load up an inclined plane without the assistance of stationary power or of an additional locomotive while the speed in ascending the comparatively short length of the inclined plane may be very much diminished without inconvenience.

Now the nature of my invention consists in so constructing a locomotive that while its speed on ordinary grades is not affected, yet it can, when required, draw a heavy load up a steep inclined plane. It is based upon the assumption that the power of a locomotive available in drawing a load (other things being equal) is proportioned to the amount of steam expended in moving over a given length of track, and therefore, in order that the tractive force of the locomotive may be increased to enable it to exert sufficient power to draw the load up an inclined plane, the engine should consume the steam as fast when moving slowly up the ascent as it does when moving on a level at its ordinary speed. To accomplish this result, auxiliary cylinders are attached to the locomotive, which act upon a wheel considerably smaller than the ordinary driving-wheels, and in order to prevent the slipping of the engine on the rails the small wheel is toothed and a stationary rack is attached to the track. The small wheel does not mesh directly into the rack, but is connected with it by an intermediate toothed driving-wheel, which can be raised or lowered in a circular arc of which the axis of the small wheel is the center, so as to be thrown out or into gear with the rack.

The general form of my locomotive does not differ from those usually employed, having a boiler, driving and truck wheels, driving steam-cylinders with their appropriate connecting-rods, valves, eccentrics, pumps, &c., the last of which are omitted in the model and drawing, as they would merely increase their complexity without elucidating the action of my invention. My invention can also be attached to any locomotive without materially altering its arrangements, and can be adapted to any inclined plane already constructed by attaching a rack to the track.

To the bottom of the boiler are secured two strong frames A A′, parallel to and corresponding with each other. These frames have each a fixed pillow-block *a* for a shaft *b*, extending transversely beneath the boiler, and a circular slot B, in which move the pillow-blocks *a′* of a second shaft *b′*, parallel to the first. The center from which the circular slot B is described is the axis of the first shaft *b*. Hence it follows that the axis of the second shaft *b′* will always be equidistant from the axis of the first shaft *b*, no matter how much its pillow-blocks may rise or fall in the circular slots. The extremities of the first shaft extend beyond its pillow-blocks, and to each of these extremities a crank C is secured. These cranks are connected by the rods *c* with the pistons of the auxiliary steam-cylinders D, mounted on the top of the boiler. Each cylinder is furnished with its appropriate steam-passages, valves, and eccentrics.

To the crank-shaft *b* a cog-wheel *e* is secured, and to the second shaft *b′* a toothed driving-wheel *e′* is attached, meshing into the teeth of the first-named wheel *e*. Immediately below this driving-wheel a stationary rack E is attached to the railroad-track and extended the whole distance, throughout which it would be necessary to use additional power to enable a common locomotive to draw its freight. The teeth of the driving-wheel mesh into this rack, and can be held in mesh by a spring or arrangement of weighted levers. An arrangement of levers might also be used to raise the wheel out of gear with the rack; but to accomplish these objects—viz., the throwing and holding the wheel out or into gear with the rack—I use the pressure of the steam, acting in a horizontal steam-cylinder F, mounted upon the top of the boiler. The piston-rod of this steam-cylinder is con-

nected by the rod *f* with the upright arm *g* of a rock-shaft G, extending across the boiler above the shaft of the toothed driving-wheel *e'*. The extremities of this rock-shaft are each furnished with an arm *g'*, connected by rods *h* with the extremities of the shaft of the toothed driving-wheel. The cylinder F is double-acting and has a steam-valve of the usual form in the steam-chest *i* below the cylinder. This valve is moved exclusively by hand and not by any eccentric or other arrangement attached to the engine. The valve-rod passes through the stuffing-box of the steam-chest, and is attached to an arm *j* on a rock-shaft *k*, extending across the boiler. To one extremity of this rock-shaft is secured an arm *j'*, which is moved by the hand-rod *l*. By thrusting this forward the steam is admitted behind the piston of the cylinder F, and, acting through the rock-shaft G and connecting-rods *h*, depresses the driving-wheel into gear with the rack. At the same time the elasticity of the steam, acting as a spring, allows the wheel to adapt itself to the inequalities of the track. By drawing the rod *l* backward the steam is admitted in front of the piston, and, acting through the same rock-shaft and connecting-rods, elevates the driving-wheel above the rack and holds it in that position.

A rack is attached to the track wherever the power of the ordinary driving-wheels II is insufficient to draw the load up steep grades. As the locomotive arrives at these points, the toothed driving-wheel is depressed into gear with the rack by admitting steam in front of the piston of the spring-cylinder F, and steam is admitted into the two auxiliary cylinders D. The pressure upon the pistons of these, acting through the crank-shaft *b* and the wheel *e*, attached to it, upon the toothed driving-wheel *e'*, already in gear with the rack, enables the engine to draw heavy loads up inclined planes, where without such an arrangement it could not raise its own weight. The proportion between the radius of the cranks of the auxiliary cylinders and the diameter of the cog-wheel *e* may be varied according to the steepness of the inclined plane and the load to be drawn up it.

Great advantages result from having the toothed driving-wheel entirely independent of the ordinary driving and running gear. First, the speed in ascending an inclined plane with a load is very much less than that of the same engine drawing the same load on a level, and the driving-cylinders expend a proportionably less amount of steam, while the power of the boiler to furnish steam is not affected. Consequently, unless much larger steam-cylinders were employed than could be advantageously used on the more level portions of the road, it would be impossible to use the whole power of the boiler, and the tractive force of the engine would be diminished, while at the same time the work (through the inclination of the plane) is increased. By my arrangement of an auxiliary set of cylinders acting upon a wheel *e*, smaller than the ordinary driving-wheels, the pistons of these cylinders can move much faster in proportion to the space traversed by the locomotive than the pistons of the ordinary cylinders connected with the usual driving-wheels. For example, let us suppose that the ordinary driving-wheels have a diameter of five feet. Then for each revolution of these wheels, or in about each fifteen feet traversed by the locomotive, the pistons of the driving-cylinders will make a double stroke. On the other hand, let the toothed wheel *e*, on which the auxiliary steam-cylinders act, have a diameter one-quarter of that of the ordinary driving-wheels. Then in traversing the same length of track these last cylinders will make four times the number of strokes of the ordinary driving-cylinders, and the power of the boiler to generate steam remaining the same and the two sets of cylinders being of equal size in both cases, it is evident that four times the amount of tractive force can be exerted by the same boiler to drag the load up an inclined plane. No arrangement of cog-wheels can increase the actual power of the engine; but the cog-wheel *e* by revolving much faster in the same length of track than the ordinary driving-wheels enables the auxiliary cylinders, when the locomotive is slowly ascending an inclined plane, to expend all the steam which the boiler can produce, and thus renders the whole power of the engine available in drawing the load. In this example I have (for the sake of clearness) supposed that the auxiliary cylinders acted alone in ascending inclined planes; but in practice steam is admitted into both sets of cylinders and the ordinary driving-cylinders co-operate in drawing the load.

It might be urged that the ordinary driving-wheels might be connected with toothed wheels of a less diameter meshing into a stationary rack; but if this were done the circumference of the driver, describing a larger space than that of the toothed wheel, would slip and grind on the rail, and the friction thus caused, in addition to the liability to breakage, would actually detract from the power of the engine to draw its load, while, on, the other hand, if the cog-wheel *e* were of the same size as the ordinary driving-wheels the auxiliary cylinders could not move faster than the ordinary driving-cylinders, and the whole of the steam which the boiler is capable of furnishing might not be used. Again, it is hardly probable that the teeth of the driver should always exactly coincide with the spaces between the teeth of the rack when the locomotive arrives at the foot of the plane, and if the toothed wheel was connected with the ordinary running-gear without an arrangement to allow of its being elevated above the rack the momentum of the train would inevitably break either the rack or the wheel.

I have hitherto described auxiliary steam-

cylinders acting in combination with a toothed driver and stationary rack; but it is obvious that where the inclination to be ascended is not very steep auxiliary cylinders acting, in combination with plane driving-wheels and smooth rails, can be used with great advantage. I have also described the spring-cylinder as being placed horizontally above the boiler; but it is evident that steam spring-cylinders may be placed vertically above the shaft of the toothed driving-wheel and act directly upon it without the intervention of a rock-shaft.

Having thus described the construction and operation of my improved locomotive, what I claim therein as new, and desire to secure by Letters Patent, is—

1. A spring or other equivalent device for holding a self-adjusting toothed driving-wheel in gear with a toothed rack, substantially as herein set forth.

2. The employment of steam acting on the piston of a supplementary cylinder to throw an adjustable toothed driving-wheel in or out of gear with a stationary rack and at the same time to operate as a spring to hold it in either position, substantially as herein set forth.

In testimony whereof I have hereunto subscribed my name this 4th day of May, 1849.

ANDREW CATHCART.

Witnesses:

W. N. JACKSON,

P. H. WATSON.