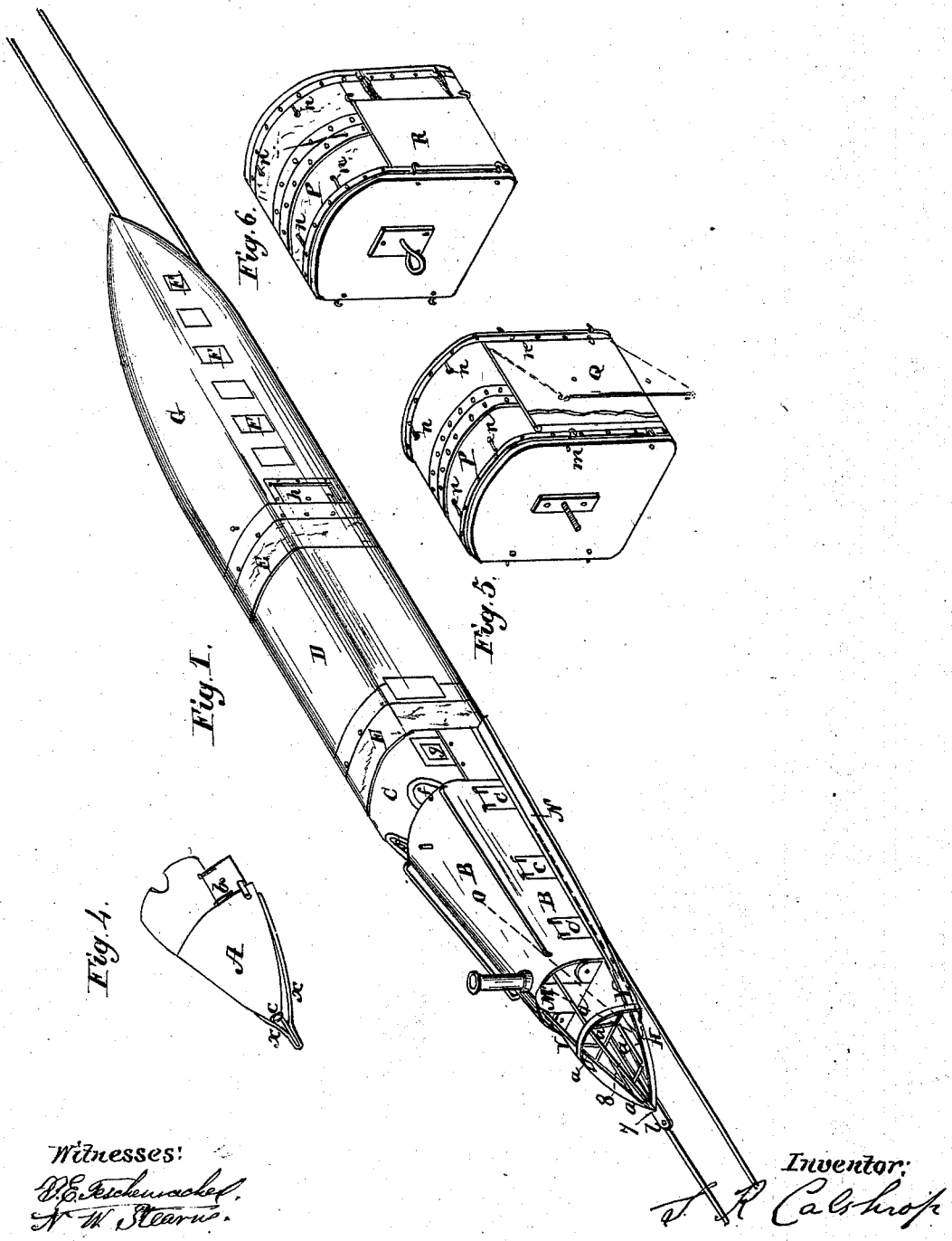
2 Sheets—Sheet 1.

S. R. CALTHROP.

Railway Car.

No. 49,227. Patented Aug. 8, 1865.



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2 Sheets—Sheet 2.

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Fig. 2.

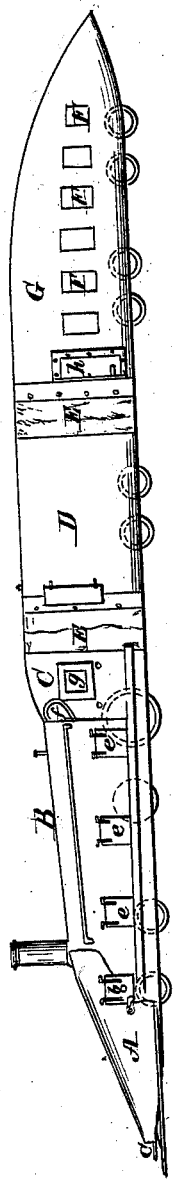
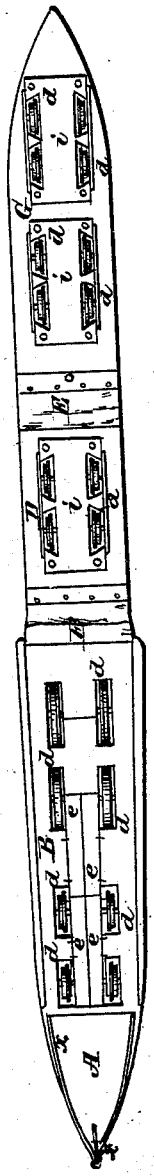


Fig. 3.



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UNITED STATES PATENT OFFICE.

SAMUEL R. CALTHORP, OF ROXBURY, MASSACHUSETTS.

IMPROVEMENT IN CONSTRUCTION OF RAILWAY TRAINS AND CARS.

Specification forming part of Letters Patent No. **49,227**, dated August 8, 1865.

To all whom it may concern:

Be it known that I, SAMUEL R. CALTHORP, of Roxbury, in the county of Norfolk and State of Massachusetts, have invented certain new and useful Improvements in the Construction of Railway-Trains, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, making part of this specification, in which—

Figure 1 is a perspective view of a railway-train modeled according to my improvements, a portion of the casing of the engine being removed to show the construction of the framework on which it rests. Fig. 2 is a side elevation of the train with the casing secured in place upon the engine. Fig. 3 is a plan of the under side of the same, showing the manner of inclosing the wheel-trucks, driving machinery, &c., by a false bottom placed under both engine, tender, and cars, made flush to a line below the axles of the wheels. Fig. 4 is a view of the front portion of the casing detached. Figs. 5 and 6 are views of different methods of closing in the intervals between any two cars.

The chief resistances opposed to the progress of a railway-train are those arising from the following causes: First, the friction of the machinery, which includes the friction of the wheels in their boxes, that of their surfaces bearing upon the rails, and the friction of the working parts of the engine itself; second, the back-pressure on the piston of the steam which is forced through the blast-pipe; third, the resistance occasioned by the passage of the train through the atmosphere.

It is now known beyond doubt that at high speeds the atmospheric constitutes the chief portion of these resistances, and that in very high rates of speed it becomes so enormous that the power required to overcome it cannot be generated except at very great cost.

To diminish this atmospheric resistance is the object of my invention, which consists in regarding the whole train as an ærial ship and modeling its whole surface in accordance with the principles so successfully applied to ship-building, modified, however, by the considerations, first, that the railway-train is wholly immersed in the fluid through which it is passing; second, that while running on a fixed track it has to meet winds blowing from all quarters; and, third, that the bottom of the train is always near the ground, and therefore a too great proportion of air should not be forced into the confined space below the train. I therefore proceed to model it as follows: First, by tapering its front and rear in a manner hereinafter carefully to be described, it being sufficient in this summary to say that the engine furnished with its pointed and peculiarly-shaped projection, which protects its front, its covering, which envelopes it both above and below, inclosing its machinery, truck, &c., and sheltering from the wind the cab above and the fire-box below, leaving only slits for the lower parts of the wheels, forms what may be called the "prow," while the rear car, slowly tapered off both above and below and on the sides, forms what may be called the "stern;" second, by putting a false bottom analogous to the casing under the engine, under the tender, and under every car throughout their whole length, including underneath the platforms, inclosing and sheltering from the wind the wheel-trucks, steps, &c., as said false bottom is made flush with a line below the axles of the wheels, leaving only slits provided for their lower parts; third, by raising the tender to the same height as the rear of the engine and the front of the first car, providing it with a covered roof and conforming its whole outline (top, bottom, and sides) to the general contour of the train, thus sheltering the first car from the direct resistance occasioned by the sudden depression of the tender; fourth, by inclosing the sides of the platforms by means of doors flush with the sides of the carriage, and extending to the bottom of the steps, by which, in conjunction with the projecting roof of the platform already in use and the false bottom previously mentioned, the whole platform will be inclosed; fifth, by inclosing the remaining intervals between the engine, tender, and cars by means of flexible hoods, as hereinafter to be described, placed flush with the sides, top, and bottom of the engine, tender, and cars, the object of these last two devices being to shelter the apertures between the cars from the resistance of the wind; sixth, by rounding, as far as is practicable, the sides of the train above and below, in order to offer less resistance to a side wind; and, seventh, by avoid-

ing, as far as possible, all projecting surfaces, such as window-ledges, and, in a word, presenting a smooth and curving outline to the pressure of the atmospheric fluid, whereby the train may obtain a greater rate of speed with the same consumption of fuel than has heretofore been practicable.

To enable others skilled in the art to understand and use my invention, I will proceed to describe the manner in which I have carried it out.

The front of the engine (see Fig. 1) has projecting from it a number of rods or braces, *a*, constituting a frame-work for supporting a casting, A, of sheet metal or other suitable material, either made in one piece or in sections, and is provided with a door, *b*, on each side immediately below the front of the engine to allow of cleaning out the smoke-box, &c.

If it be necessary on account of the small size of the engine-house or other local causes, either a part or the whole projection and the frame-work included may be made removable, or the main supports may turn upward on hinges resting on the front of the boiler, while the lesser rods are removed with the casing.

The shape of the projection is of considerable importance, not only because it is the first to meet the unbroken force of the wind, but also because it must present the best average angle of resistance to winds blowing in all directions. In a dead calm a wedge-shaped projection would lessen the resistance considerably; but if an adverse side wind of any considerable force was blowing, (which is the worst wind a train has to contend against,) it would be of little or no use, as its shape would cause its sides to be not far from perpendicular to the direction of the wind the train has actually to meet, it being remembered that the current of air actually met by a train when a side wind is blowing is in the direction of the resultant of two forces: first, of the current which may be considered as generated by the train itself—that is, in a direction exactly opposite to the motion of the train—and, second, of the current of the side wind, said resultant therefore being much more nearly opposite to the direction of the train than the side wind alone. A perfect cone (though far better) would, from its under surface, throw too much air into the confined space below the train, and even if its lower portion were to be considerably flattened the upper half would still to some extent be amenable to the same objection as the wedge—*i. e.*, it would present too much surface in a direction not far from perpendicular to an adverse side wind.

If the train moved through a dead calm or against a directly adverse wind, the above shape (a conical convex projection flattened below) would perhaps be the best of all. If, on the other hand, an adverse side wind were the only wind to be guarded against, the best shape for the projection would probably be to continue throughout its whole length a breadth at least equal to the breadth of the engine, and terminate, not in a point, but in a horizontal line, being in front perfectly flat and slowly curving toward the rear, the curve being more rapid in the center and very slight at the sides until the projection becomes tangential to the covering of the engine, which would be, as at present, rounded over the top of the smoke-box and then sloping obliquely over the cylinder with a very slight curvature. I propose, therefore, to solve the problem by a compromise between these two methods, so as to obtain the best average angle for all winds, premising, however, that it is impossible to give the exact mean in all cases between the two, as even the nature of the country through which a railroad has to pass may modify somewhat the form desired. A sheltered railroad might have one nearer the first, an exposed railroad nearer the second. It is likewise to be borne in mind that the second method is more cumbersome than the first.

I now proceed to describe the projection. It will be seen to resemble somewhat the shape of a "shark's head," which is constructed both for speed when going straight ahead and for rapidity of turning, and therefore has an acute angle at the side as well as in front.

In the following description I refer rather to the frame-work *a* than to the casing A, as the mechanical difficulties incident to a representation on a small scale render it impossible to give anything like a perfect comprehension of the shape of the projection. The shape of the projection, then, is substantially as follows: The two outermost arms, V V, of the frame-work, uniting at the point 7, (which together form, so to speak, the base of the upper and lower portion of the projection, and which to a great extent determine its shape,) have outwardly a convex curvature, which curvature should be very gradual in the rear toward V and more abrupt in the forward portion—say at 8—if, as may be presumed, it be desired to present an angle of considerable acuteness to a side wind. The upper portion of the casing in its transverse section (which may be represented by the red line 8 H over the frame-work) will somewhat resemble toward the apex a very obtuse hyperbola, becoming gradually less obtuse as it approaches the casing of the engine proper, which casing itself will keep changing its curvature as it approaches the rear of the engine, where its transverse section will be not far from semicircular in outline. A longitudinal section of the projection (which may be represented by the longitudinal rods of the frame-work *d*, will also reveal a slight convex curvature from the apex to the smoke-box, where the casing of the projection becomes tangential to the casing of the body of the engine onto which it is fastened.

A more simple description would be to say that the upper part of the projection proceeds from the apex slowly to curve upward and side-

wise until it becomes tangential to the front of the casing B of the engine, which is rounded over the top of the smoke-box, and thence slopes obliquely with a very slight curvature over the cylinder till it meets the outer frame of the engine. The lower portion of the casing of the projection is considerably flatter than the upper, as too much air should not be deflected into the confined space below the train, and similarly with the upper slowly changes its outline until it becomes tangential to the rounded lower part of the main casing B of the engine.

At *l*—the apex of the projection—is provided a hole for temporarily attaching the engine to a car, the rods *x x* forming a cow-catcher. The covering B of the body of the engine rests upon a frame-work, composed of rods and ribs similar to those forming the frame-work *a*, which are themselves supported by rods radiating from the boiler and riveted to it, as well as by the outer frame on which the engine rests. The longitudinal rods are also fastened to the front of the smoke-box on one end and to the front of the cab on the other. Said rods may or may not extend in one piece to the end of the projection itself. This covering B incloses the boiler, cylinders, machinery, &c., of the engine, both above and below, including the upper part of the driving-wheel and the wheel-truck of the front wheels to below the axles of said wheels, leaving slits or apertures *d* for the lower part of the wheels, apertures being also made for escape-pipes, stop-cocks, &c., while doors *e* are placed in the sides and bottom of the covering to render the machinery accessible for the purpose of oiling, cleaning, &c. The shape of this covering B is as follows:

First. Its upper surface, at the front of the engine, is rounded over the top of the smoke-box, its sides becoming much flatter as they slope obliquely downward over the cylinders. Toward the rear it becomes more and more rounded, till at the cab it is not far from semi-circular, its height at the same time continuously rising from the top of the smoke-box in front till in the rear it equals in height the forward part of the cab, thus protecting the front of the cab from the direct pressure of the wind. It will be readily understood that this shape carries out the same principle as the shape of the projection—namely, it decreases the pressure of a side wind as well as a directly adverse one.

Second. Its under surface begins to round off on its sides below the outer frame of the engine, and then extends horizontally, or nearly so, under the body of the engine. The bottom of this covering should be on a level with the top of the aperture for the draft, (both before and behind the ash-pit, which is left as it is.) Thus the whole front of the fire-box and all the confined space under the engine, as well as the machinery, is protected from the adverse pressure of the wind.

The small doors (not shown in the drawings) which close the apertures for draft, both in front and behind, but especially in front, should be fastened by hinges to the lower, not the upper, part of the fire-box, and should be made to close upward, not downward; and if the door is made larger than the aperture, it will meet the covering obliquely, and when closed will offer but little resistance to the wind.

The spaces between the spokes of the driving-wheels should be filled up with wood, or double plates of metal flush with the outer edge of the spokes, in order to get rid of the resistance of the atmosphere between the spokes.

It is believed that this complete covering in of the engine will also save fuel by keeping in the heat and preserve the engine by keeping out sand, dirt, &c., from the machinery. Small escape-holes may be left to allow for the expansion of the air within.

The house or cab C (for the engineer and stoker) has a window, *f*, in each of its forward corners, and a window, *g*, on each side, from which may be seen objects in front and on the sides of the engine. The glass of the windows *f* is inclined as much as is compatible with the clear view of the engineer, and can be made either to slide or open inward on hinges.

In foul weather the aperture made when the window is open may be protected above by sliding shutters, placed either without or within the cab C. The front of this house C is tapered off to meet the upper portion of the covering B, and the small space left between the engine and tender is inclosed by a flexible hood, E. (See intervals under cars.) As the engine and tender do not alter their relative positions, the simple form of hood herein described (which is fixed on the rear of the engine, and whose metal rim is attached to the body of the tender by screws, clamps, or any other suitable contrivance) will probably be preferred.

In order to illustrate the way in which the covering of the engine, including not only the projection, but also the main casing, acts upon a side wind, let H be the point at which the resultant of the side wind and the current generated by the train acts. The angle from H to the smoke-box is represented as M H N, while the angle presented by the engine as a whole will be nearly as acute as N H O. The tender in its whole contour is made to conform to the general outline of the train. To effect this it is raised to the same height as the roof of the engine-cab and cars, and is provided with a covered roof, in which are placed doors, either sliding or opening outward on hinges, to admit coal, wood, &c., and can have windows in its sides, roof, or both, to admit light and air. Its sides are to be made flush with the sides of the engine-cab and cars, and below its wheel-trucks are inclosed by a false bottom similar to that under the cars, to which description I refer.

The front of the tender should correspond exactly with the rear of the engine, and its rear with the front of the first car. If the trans-

verse section of the rear of the engine be smaller than that of the front of the first car, then the transverse section of the tender must slowly increase from front to rear. The interval between the tender and the first car is inclosed by a flexible hood, E, which is described more fully under the head of "Intervals."

The cars.—First. Under each car a false bottom is placed, extending along its whole length, including underneath the platforms. This incloses the whole of the wheel-trucks and the upper part of the wheels, leaving merely slits *d* of sufficient size to leave room for play for the under part of the wheels, and throughout its whole length is flush, or nearly so, with a line falling below the axles of the wheels. To be made complete, it should also inclose the cross-bars of the brakes, which therefore should not be placed lower that is absolutely necessary, as the false bottom should not come too near the ground. When it is remembered that each separate truck exposes from twelve to fourteen square feet of surface directly perpendicular to the motion of the train, the importance of this contrivance will be understood, (apart from the consideration of the protection of the wheels, axles, and trucks generally from the weather, the deadening of the noise of the wheels, the lessening of the dust, &c., which are incidental advantages.) The sides of the false bottom are rounded off, while the underneath surface is nearly flat. That part of the false bottom which incloses the trucks is to be made easily removable in sections, in order that the trucks may be removed when needing repair. Small doors (not represented in the drawings) are to be made in the side opposite the grease-boxes and wheels, for greasing, testing wheels, &c.

Second. The platform-doors *h* on each side, by which to enter or leave the car G, may slide or swing on hinges opening inward, inclosing the steps and side of the platform when shut. These doors *h* and the glass of the windows F should come as nearly as possible flush with the outer surface of the sides of the car. The doors *h* may be provided with windows.

The sides.—All needless inequalities in the sides—such as jutting window-ledges—are to be avoided. Instead of the projecting eaves or ledges, which increase the ill effects of a side wind, small gutters, running along the sides of the roof, may be provided for carrying off the rain, connecting with pipes running between the windows, which need not project on the outside at all. This will enable the roof in all cases to be rounded off, commencing immediately above the tops of the windows; but a perfect construction would require that the whole side should be rounded, the rounding off at the upper part commencing more than half-way down the side of the car. In railways of considerable length, especially those which run over exposed portions of the country and where violent side winds are common, it will be worth while to incur the additional expense of rounding the sides still more than shown in the drawings, including the very glass of the windows and the spaces between the windows, since the more the sides of the train are rounded off the less direct effect will a side wind have in retarding its progress, while the amount of the friction of the flanges of the wheels against the side of the rails will at the same time be materially diminished.

The intervals.—The interval between any two contiguous carriages is inclosed by a flexible covering or hood, E, attached to the extreme edge of the top, bottom, and sides of the cars, so that the hood, when stretched, will be flush with the general outline of the train. The best hood (apart from consideration of expense, &c.) will be one made of elastic material, so that it may keep sufficiently stretched, though the distance between the two carriages or sides of the carriages may vary. If unelastic material be used, the greater part of it may be kept stretched by elastic bands, or by cords governed by springs, or in any other suitable manner, leaving only a small fold at one or both ends of the cloth. Figs. 5 and 6 represent three different methods of effecting this end.

P is a double hood, half belonging to each car. Each half has a metal rim at the edges, which are fastened together by key-clamps or other suitable contrivances. A portion only of each is shown, it being remembered that each hood goes completely round. Q is a single hood, which is broad enough to cover the whole interval, the corresponding hood attached to the other car being fastened up when not in use. The hood in use is to be fastened to the opposite car by hooks *m*, screws, clamps, or in any other suitable manner. If the hoods P and Q be not made of elastic material, they can be stretched by elastic bands *n*.

R is a double hood with elastic bands attached to each edge, which bands are fastened to the opposite car. The parts of this hood R are made to overlap, the part attached to the rear of the forward car being always placed outside. For this purpose hooks or catches should be placed on each car just outside and just inside the hood.

The bands may be either fastened singly, or the bands of each side, top, and bottom, respectively, may be connected by a rod, which can be hooked directly into its place.

If the hoods Q or R are used, their outer edges must either not be so stiff as to prevent one hood from going over the other, or if the edges are made of metal small joints, moving inward, must be made at the corners.

A perfectly feasible contrivance for closing the intervals is already in use, consisting of a kind of bellows made of leather and kept expanded by steel ribs. As used it has had little or no effect as far as reducing the atmospheric resistance is concerned, since it has been placed a considerable distance from the sides, being used simply for the purpose of ventilation and protection from rain.

The manner of ventilation is as follows: Air is admitted in the front of the train, and the central platform-doors of the cars are left open, the side windows being closed, and the air thus circulates from the front to the rear, where an outlet for it is provided. The above method is equally applicable to the construction I propose, with the addition that the air may enter as far forward as the projection of the engine and be conveyed underneath the covering of the engine and roof of the tender by tubes, and thence into the cars. It is hardly necessary to state that this additional advantage of my invention is purely incidental and cannot form the subject of a claim, my sole claim in this regard being the closing in of the platforms and the remaining interval between the cars flush with the sides, top, and bottom of said cars, such identity of outline being necessary to the complete carrying out of my idea, and, as I believe, has never before been used. Any other of the ordinary systems of ventilation may be used, provided only that as small a surface as possible be exposed to the resistance of the atmosphere. One of the simplest methods, and one most free from objection on this account, is that of square holes in the top part of the side of the car, with a square plate turning on a pivot.

The last car, which forms what may be termed "the stern" of the aerial ship, should, from its very front, commence to taper slowly toward the rear, decreasing gradually in both breadth and height, (the bottom itself immediately in the rear of the last truck commencing to slope upward, so that at the rear the car terminates in a point, or as nearly so as convenient.) By this means I am enabled to overcome the chief part of the resistance arising from the drag of the air behind the rear car in trains as ordinarily constructed.

I do not confine myself to the precise details of construction here shown, as it is evident that they may be varied without departing from the spirit of my invention—for instance, the cars in common use may be much improved simply by closing the intervals, as set forth, and placing a false bottom under the train, leaving the sides unchanged.

When a lamp is required the exterior surface of the glass should conform as much as possible to the shape of the projection, the minimum of surface being used, and the lamp should be made removable.

The smoke-stack should be made as small as possible, and even might be inclined toward the rear.

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

1. Giving to the exterior surface of a railway-train a form tapering from the center of the train toward either end, or tapering the engine or car at the front or rear of the train, substantially as described, for the purpose of diminishing the atmospheric resistance.

2. Constructing the engine and its truck with a projection in front, in its several parts of the shape substantially as set forth, and incasing its body, both above and below, substantially as set forth, and rounding its cab, so that its projection and main casing (while protecting its own surface from the direct resistance of the wind) may, together with its rounded cab, form a single prow to the whole of the train, in the manner and for the purpose herein described.

3. Placing a false bottom, substantially as described, under each carriage of the train, for the purpose of protecting the trucks and other projecting surfaces under the carriages from the adverse action of the wind.

4. Inclosing the whole space between any two contiguous carriages of the train flush with the sides, top, and bottom of said carriages by means of the false bottom aforesaid, (which is extended under the platform,) in combination with the projecting roof already in use and a flexible hood or hoods, substantially as set forth.

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