(No Model.) 3 Sheets—Sheet 1.

M. BODEFELD.

PNEUMATIC RAILWAY SYSTEM.

No. 409,769. Patented Aug. 27, 1889.

Fig. 1.

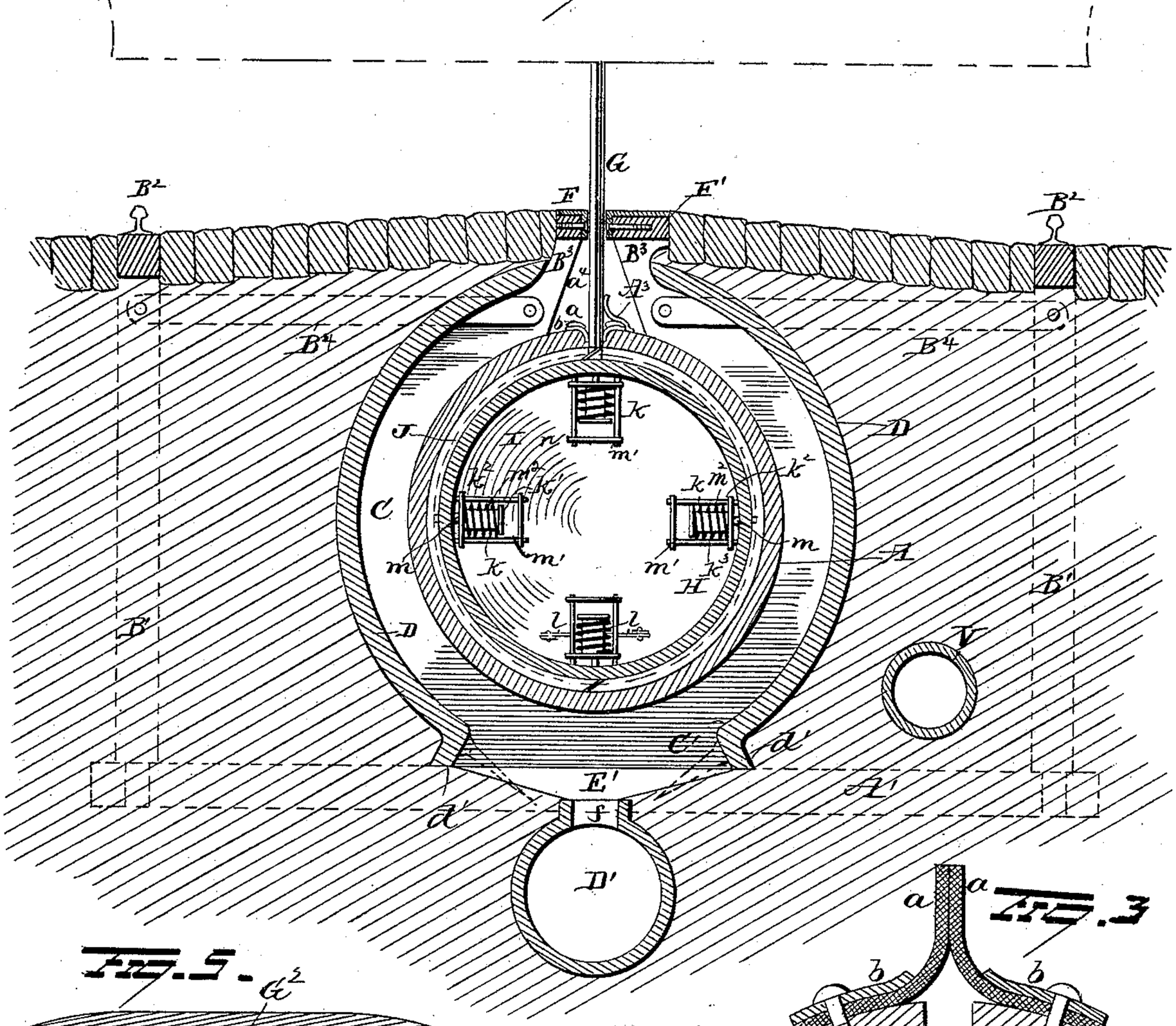

Fig. 5.

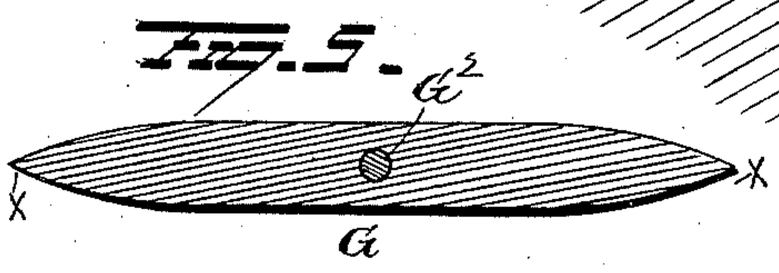

Fig. 3.

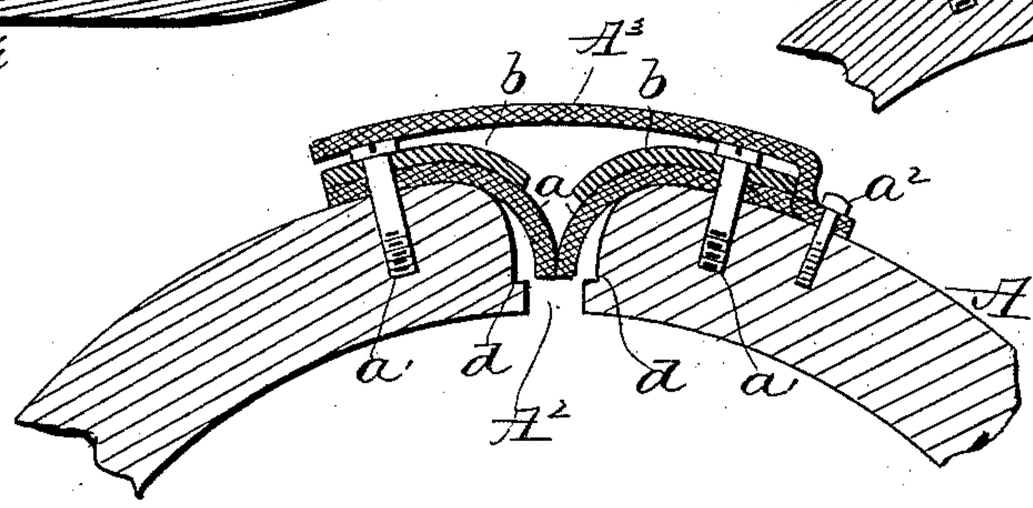

Fig. 4.

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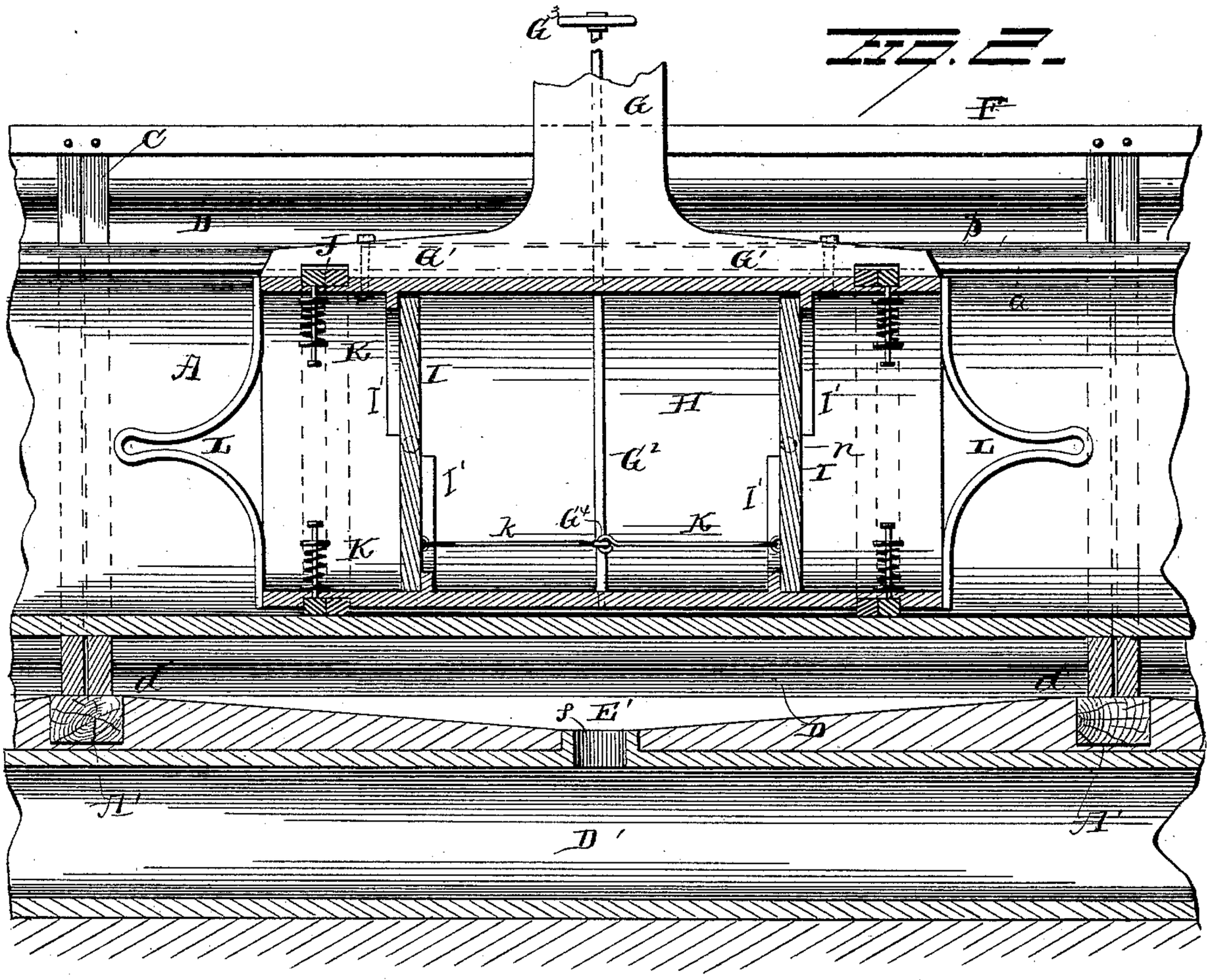

Fig. 2.

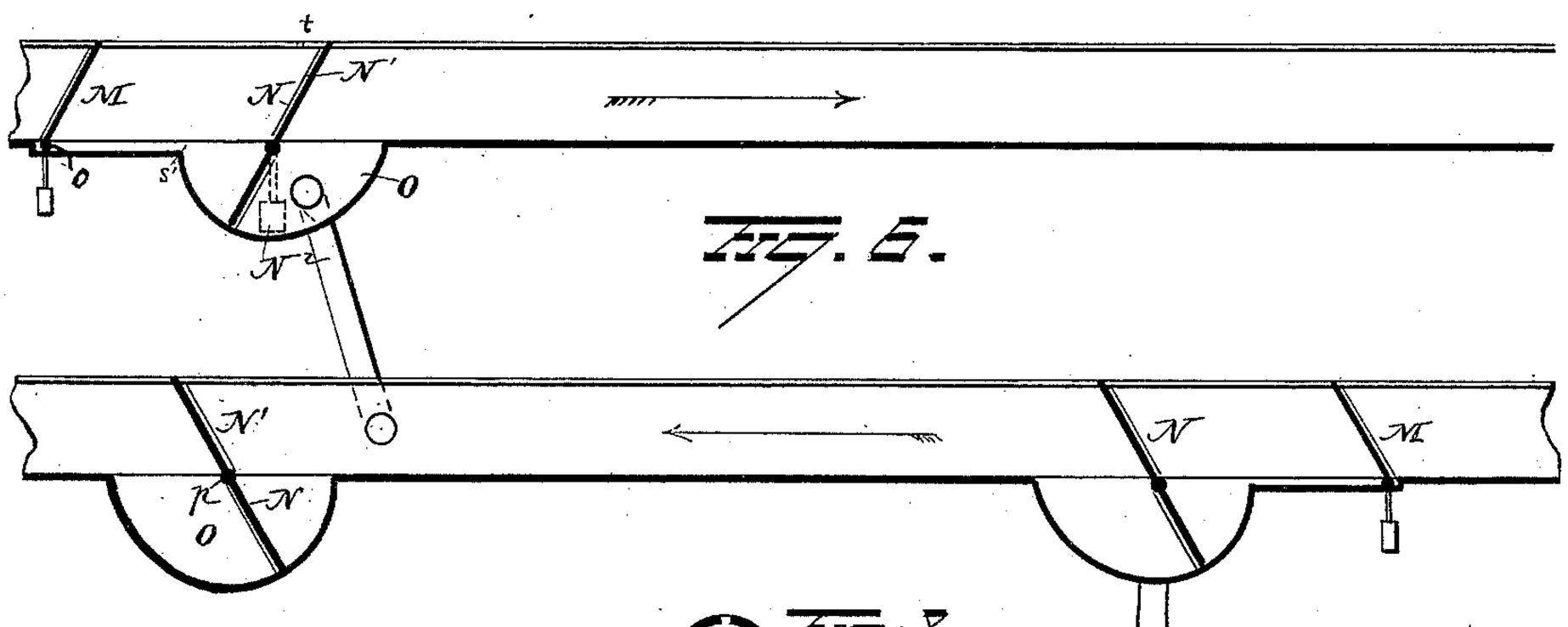

Fig. 6.

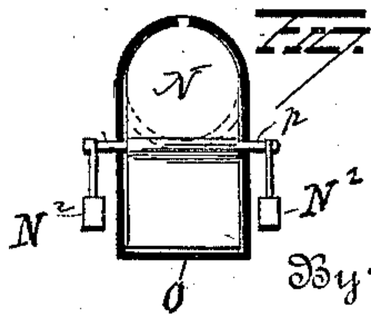

Fig. 8.

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(No Model.) 3 Sheets—Sheet 3.

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PNEUMATIC RAILWAY SYSTEM.

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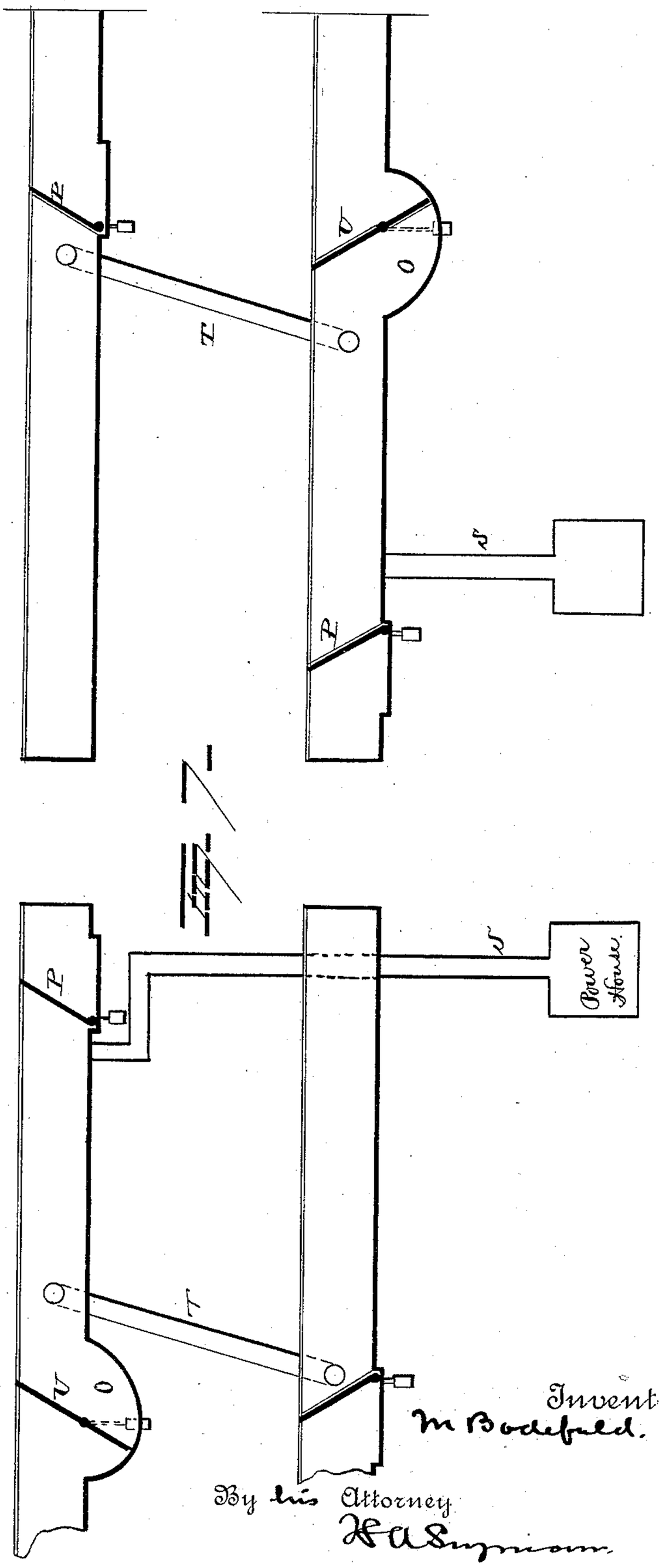

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UNITED STATES PATENT OFFICE.

MEINOLPH BODEFELD, OF ST. LOUIS, MISSOURI.

PNEUMATIC-RAILWAY SYSTEM.

SPECIFICATION forming part of Letters Patent No. 409,769, dated August 27, 1889.

Application filed September 20, 1888. Serial No. 285,915. (No model.)

To all whom it may concern:

Be it known that I, MEINOLPH BODEFELD, a resident of St. Louis, in the State of Missouri, have invented certain new and useful Improvements in Pneumatic-Railway Systems; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to an improvement in pneumatic railways, the object being to provide simple and efficient devices that will coact to move cars in either direction on suitable tracks by the propelling-power of a partial vacuum or the projecting force of compressed air.

With these objects in view my invention consists in the construction and combination of parts, as will be hereinafter described, and pointed out in the claims.

Referring to the drawings, Figure 1 is a transverse section of a road-bed with the conduit-tube and other parts of the propelling mechanism in position; also a drain-pipe below the conduit-tube. Fig. 2 is a side elevation, in section, of the conduit-tube, drain-pipe, and parts in connection with the tube and pipe. Fig. 3 is an enlarged transverse section of a portion of the conduit-tube and attachments that adapt said tube for service when the motive force is afforded by a partial vacuum established in the conduit-tube. Fig. 4 is an enlarged cross-section of a conduit-tube that is provided with appliances for propelling cars by compressed air. Fig. 5 is a cross-section of the connecting-arm that moves the car by its attachment to it and a propelling device located in the conduit-tube, which device receives its impetus from pressure of compressed air or the draft force of a partial exhaustion of normal air-pressure on one end of the same. Fig. 6 is a diagram of two conduit-tubes that are arranged parallel to each other, said view being partially in plan and also in elevation, the pair of tubes being connected and adapted to move cars on two tracks in opposite directions by the force of air-pressure. Fig. 7 represents two conduit-tubes that are arranged to operate cars on two tracks in opposite directions by the induced force resulting from air-exhaustion in the conduit-tubes. Fig. 8 is a cross-section of a conduit-tube, showing a valve and its means of pivotal attachment.

It should be stated that this system of railways is designed mainly for use in the propulsion of street-cars, two tracks being located parallel to each other in sections of proper length, terminating at stations where the power is produced. Cars are intended to move upon the track in any suitable number proportioned to the power employed, the direction of travel of said cars being opposite on the two adjacent track-lines. As the appurtenances for moving cars are alike on each parallel track-line of the system, a description of those applied to one line will suffice for both, such parts as connect the two lines together being also described.

A represents a metal conduit-pipe, which extends continuously from end to end of a section, and is made cylindrical in cross-section, except at points near the end of the sections, where variations therefrom are made, as will be described in proper order. The metal conduit-tube A should be true on its interior surface, and is slotted through the body on its top side from end to end of a section. As the conduit-tube A is intended to be located beneath the road-bed in a vault or sub-chamber, there is a suitable bed provided for its support and retention in alignment with the track-rails B^2. This bed consists of transverse ties A′ or wooden timbers, which are properly bedded and spaced apart to afford a substantial foundation for the conduit-tube A.

In order to support the conduit-tube A in position, there are annular ribs C, formed in pairs on the outside of the tube, a proper space intervening between the ribs of each pair of ribs, for a purpose that will be explained, and each pair is located over one of the transverse timbers or bed-pieces A′, so that the flattened bases C′ of these annular ribs may be firmly attached to the bed-pieces by spikes or other similar means, as shown in Fig. 1.

Surrounding the conduit-tube A, and concentric with it, there is an enveloping case or jacket D provided, that is of such diameter relative to the conduit-tube and the ribs, taken together, that it will have contact with

the ribs and be there held by the pressure of surrounding earth which is filled in closely against it. This jacket may be made of wood or metal. In line with and directly below the conduit-tube A the drain-pipe D′ is situated, and may be made of any material that will be durable, the preferred position being such that proper-sized spaced openings *f* will lie between the bed-timbers A′, so that the dished depressions E′, made between the lower edges of the jacket-plates D, will convey all water that may enter between the conduit-tube A and jacket D into the drain-pipe D′ and thence to proper points of discharge.

Supported on the bed-timbers A′, near their ends, is a series of upright columns of wood or metal B′, sufficiently substantial to support the track-rails B^2, said rails being preferably made of steel and heavy enough to dispense with the usual string-timbers. The columns B′, being spaced apart at a suitable distance, afford the necessary foundation for the track-rails.

In order to secure the columns B′ in upright positions and prevent lateral displacement, rods or braces B^4 are attached at one end to the uprights and at their other ends to the flanges C of the tube A.

As my system of construction for pneumatic propulsion of street-railway cars contemplates the employment of air-exhaustion, and also air-compression, by a slight change in construction of parts, I will, to render the use of these two means of propulsion plain, describe each plan of construction separately. In the employment of compressed air, which is introduced into the conduit-tube A near one end at *z*, as shown in Fig. 6, there is a peculiar device provided to close the slot A^2 of the conduit-tube in a manner to permit an arm which reaches down into the tube from a railway-car to move along in the slot air-tight, or nearly so, thus permitting a piston on the end of the arm within the tube to transmit its progressive movement to the car, which device will now be described. The edges of the continuous slot in conduit-tube A are rounded to remove their sharp corners, as shown in Fig. 4, and on the outer surface of the tube, adjacent to the slot A^2, the gum-flaps *a* are placed, these flaps being continuous throughout the length of a tube-section, and projecting within the slot, so as to bear against each other yieldingly. Upon the gum-flaps *a* bearing clamp-plates *b* are superimposed, which plates are secured in place by set-bolts *a*′. Above the slot A^2 and the gum-flaps *a* just mentioned there is a protecting slot-cover A^3, secured by one of its edges to the conduit-tube A. Said slot-cover is made of stout elastic material, preferably a compound of gum and textile fabric that will be durable to withstand exposure to wear and the elements, and at the same time yield to permit the arm G, attached to a car, to project through the slot A^2 into the conduit-tube A, the cover A^3 lifting up and the gum-flaps *a* yielding as it moves along the slot, and closing hermetically around its body, the cover A^3 resuming position automatically by reason of its weight and spring-tension. The arm G, which connects the car with the piston, is of such thickness as to pass freely through the slot A^2, and preferably of the form in cross-section shown in Fig. 5, having flat side faces beveled at both ends to produce edges X. By this construction it will be seen that as the arm G passes through the slot A^2 of tube A the parting of the flaps *a* will be gradual as the arm advances, and that they will gradually come together after said arm passes, thus preventing any material escape of air. The annular ribs C, formed on the tube A, as previously stated, are cut apart on the upper side, as shown in Fig. 1, immediately above the slot A^2 of the conduit-tube A, the ribs having upwardly-flanged extensions B^3 formed on them to afford a bearing for retention of the wearing-plates F F′, which are adapted to contract the upwardly-extended throat a^4 between the flanges B^3, and thus produce a narrow slit in the road-bed, through which the arm G may slide freely, these wearing-plates being made of metal suitable for their use.

It will be seen in Fig. 1 that the wear-plate F′ on one side of the throat-slot formed in the road-bed is wider than the parallel plate F, and this wider plate is removable, which provision is made to permit the plates F′, that are of convenient length, to be removed at any point on the track-line to afford access to the upper surface of the conduit-tubes A, so that any repairs necessary may be made with regard to the cover A^3 or flaps *a*, located below the wear-plates F F′.

It will be noticed in Fig. 2 that the car-propelling arm G is provided with flanges G′, curved on their lower surfaces to have a bearing on the tubular piston H, to which they are fastened by bolts or other means. The tubular piston H is of such diameter relative to the internal diameter of the conduit-tube A that it may loosely slide therein, and to effect a proper air-tight joint between said piston and the cylindrical conduit-tube A packing-rings J are seated in annular grooves cut in the body of the piston near its ends. The rings J are made semicircular, of metal, two pairs being employed and located side by side in the grooves, and so disposed therein that they will break joints, and thus taken together form a continuous expansible ring at each end of the piston H.

It is important that the sectional packing-rings J should be held in place properly and afforded vertical spring movement, and to effect said desideratum there are certain spring appliances located within the tubular piston, the construction of which will be explained.

As shown in Fig. 1, four cylindrical spools *k* are provided—one for each segment of the packing-ring. Each spool *k* is provided at its inner end with an annular flange *k*′ and bears loosely at its upper end against a disk k^2. A

stud m, secured at one end to the spool k, projects outwardly through perforations in the disk k^2 and piston H and secured at its outer end to a segment of the packing-ring. A spring m^2 is coiled about the spool k, bearing at one end against the flange k' and at the other end against the disk k^2. Thus it will be seen that the spring m^2 will be normally compressed and hold the packing-ring in position. Each disk k^2 will preferably be provided near its periphery with a series of perforations, in which a series of rods or bolts k^3 are secured, the opposite ends of said rods being secured to a disk m', thus forming a cage for the spring m^2 and spool k.

At proper points in the interior of the tubular piston, at equal distances from the open ends of said piston, there are two disk-valves I, pivoted at n to the body of the piston, so as to permit them to vibrate or rock on these journaled centers, the valves I having a bearing-contact with the segmental ribs I', that are formed on the interior of the piston. The valves I are intended to swing outwardly in opposite directions, and thus afford a free vent for air through the piston at times during the operation of the system, as will be further explained, and it is important that there should be means provided for the manual operation of the valves I to open or close them.

There is a vertical perforation made in the body of the propelling-arm G entirely through it, and a shaft G^2 is inserted in said hole, its lower end being stepped in a spindle-box or pivot-hole made for its reception in the body of the piston H in alignment with the hole in the arm G, thus permitting the shaft to be rotated by a hand-wheel G^3, placed on top of the shaft G^2, which latter is extended within the car to render the operation of the hand-wheel convenient. Two lateral arms G^4 are extended on opposite sides of the shaft G^2 at a proper distance above the foot of the shaft, and to the outer ends of said arms the connecting-rods K are loosely attached by their inner ends, the opposite terminals of said rods being shackled to the valves I, thus adapting the shaft G^2 by its revoluble movement to actuate the valves on their pivot-centers to open or close them. There are projecting bracket-arms L formed on each end of the tubular piston H, that extend in advance of said ends to engage valves in the conduit-tube A and open them, thus preventing an abrupt contact of the piston, as will be more fully explained in the description of said conduit-valves. The conduit-tubes, which are located in parallel planes below the roadbed of a street-railway, and which are intended to convey compressed air from a source of supply near terminals of a section or entire lines of the system, are furnished with guard-valves M, which are inclined within the tubular conduit, as shown in Fig. 6, the arrangement of the same being such that they may be opened by contact of either of the bracket-arms L formed on the tubular piston H when said piston is introduced within the end of the conduit-tube, and it will be noticed that these outer guard-valves M are located at opposite ends of the parallel conduit-tubes of a section. Valves M are furnished with tongues or integral projections from their upper edges, which tongues enter the slots in the conduit-tubes and by abutment against their walls close up the same from escape of air. The ends of the conduit-tubes A, where the valves M are located, are provided with a flat bottom and parallel sides that extend to about the center of the conduit-tube. Above the center said tube is rounded to conform to the cylindrical shape of the conduit proper, this form of construction being necessary to allow the valves M to rock on the bearings of the cross-shaft o which support them; and to insure the proper closure of these valves the shafts o are extended outside the conduit-tube, as shown for valves N in Fig. 8, and have arms o' affixed at right angles to their bodies, to which arms the graduated weights o^2 are suspended, which provision will effectually close the valves when they are free to move on their pivots.

Adjacent to the guard-valves M, on the receiving ends of tubes A, other valves N are pivoted within the tubes A, and it will be noticed that a depending chamber O is formed on the lower side of the conduit-tubes to afford a cavity of proper form to receive the lower half of the valves N, which are pivoted in the side walls of the conduit-tubes A. (See Fig. 6.) It is preferred to construct the chambers O of such depth relative to the diameter of the conduit-tubes that the valves N at the receiving ends of the track-line and conduit-tubes, when pivoted on or about on a line with the bottom of the conduit-tubes, will have greater length from the pivots p to the upper edges of the valves, where they bear on the conduit-pipes proper, than the portions of the valves that hang below the pivots p, and are in bearing-contact with the wall of the sub-chambers O, so that a slight preponderance of air-pressure will be exerted on the upper portion of the valves to close them when they are not in engagement with the moving piston H. Each of the valves N is provided with abutments N', that are formed on the walls of the conduit-pipes and the sub-chambers, as shown in Fig. 6, said abutments being intended to limit the rocking movement of the valves when they are in closed position and have their peripheral edges in contact with the walls of the tubes and the sub-chambers O. Where the valves N are located the interior dimensions of the tube may be made slightly greater than the main portion of the tube to accommodate the flanges N'; or, if desired, said flanges or abutments may be dispensed with within the tube, and that portion of the flanges which project within the chamber O depended on to limit

the movement of the valve. To insure the positive closure of the valves N, they are each furnished with weights N^2, which latter are suspended from arms which are attached to the pivot-shafts *p* of the valves, so as to add their ponderance to the reflex pressure of condensed air in the conduit-tubes, and thus cause the instant closure of the valves when they are not impinged upon by the piston H.

At one end of the section or entire line of a railway an adequate air-compressor is located alongside of the track, (not shown,) which may be of any approved form having adequate capacity to fill the tubes. The compacted air is introduced through the pipe Z, which extends from the air-compressor to enter the sub-chamber O on the inner sides of valve N, so that air-pressure thus introduced into the pipes will close the valves N, and in order to introduce air from the tube first receiving it into the parallel mating tube a cross-branch pipe *q* is placed between the two conduit-tubes and in open connection with the sub-chamber of the second conduit-tube, so that equal pressure in both tubes will result, both valves N being normally held shut by the compressed air.

In operation of the system by air under compression the tubes A are provided with the air under pressure and a proper pressure always maintained. Now, there may be several stations along the length of a railway-line and between the ends of a tube-section, the tube-sections being separated a proper distance to allow the introduction of air at the relay-stations along the line. When a car is started on one line, its connected arm G enters the slot of the conduit-pipe, raises the cover A^3, and its attached piston opens the guard-valve M by contact of the bracket-arm L with this valve, pushing it down, the piston moving over the depressed valve. It is necessary for the proper action of the system that there should be a sufficient distance between the guard-valves M and the main valves N that the piston H may be received between these valves. Said piston when brought into contact with the valve N will rock it on its journaled bearings and afford room for the onward travel of the piston and attached car, the guard-valve closing tightly before the main valve N is opened.

It is essential for the sure operation of the compressed-air plan of propulsion that the space between the edges of the sub-chambers O be so proportioned to the length of the piston H that the ends of the latter will span the chamber O and lie on the surface of the conduit-pipe itself, so as to form a tight joint when the piston is entered and depresses the valve N, and it will be seen that this valve when it is depressed to lie in alignment with the lower surface of the conduit-tube will leave an opening at *s'*, so that air-pressure introduced in the sub-chamber O will exert force on the end of the piston nearest the guard-valve M to propel said piston forward.

A provision must be made to allow the air-pressure between the valves M and N to be removed to permit the introduction of the piston within the conduit-pipe between the valves; and to this end there are small orifices *t* formed in the walls of the conduit-tube A, above and near to the valve N, so that only normal pressure of the atmosphere will exist in the chamber between the valves N M on the receiving end of the tubes A, and it is evident that when the piston is introduced and the valve N depressed the orifice *t* will be closed by the body of the piston until said piston clears the valve N by its progressive motion, when the latter will be closed by pressure of air on it.

When the car is started from either terminal end of the track, it may be pushed by any suitable means until its piston H is in the conduit-tube A, and has passed the main valve N, which when closed will act as an abutment for the air-pressure, and the valves I of the piston being closed by the revoluble movement of the shaft G^2 said piston will receive impetus from the compressed air entering between one of its valves and the main conduit-valve N, thus propelling the car to the opposite end of the section, providing there is no occasion for stoppage of the car, a suitable outlet being provided at the forward end of each section of the conduit.

To instantly arrest the propulsion of the car, it is only necessary to open the valves I in the piston H, which will permit a free passage of condensed air through the barrel of the piston and thus enable ordinary brakes to quickly stop the car for reception or discharge of passengers.

It will be apparent that the direction of travel will be as indicated by arrows in Fig. 6; and it may be here mentioned that the distance between the terminal ends of tube-sections on a long line of railway is such that the impetus or momentum of the car received from the section it leaves will propel it across the space between sections and cause it to open both the guard-valve and main valve, as before explained.

It has been stated that the valves N, which are located in the sub-chambers O at the receiving ends of the track-line and conduit-tubes, are longer from their pivots *p* to their upper edges than from these pivots to their lower edges, thus affording increased area for air-pressure on the upper portion of the valves N. At the discharge end of said tubes the lower ends of the valves are given increased area, for the evident purpose of insuring their immediate closure when the piston H passes them.

When cars have reached the terminals of the track-lines at either end, they may be transferred by an ordinary switch (not shown) from one track to the other, so that a return trip may be made in an obvious manner.

It may be here stated that it is not essen-

tial that there be relay-stations along the line of railway to supplement power or introduce increments of air under pressure, as it is apparent that an ordinary air-conduit main may be provided which may lie parallel to the conduit-tubes A. Said air-conduit main, extending from air-compressors at each terminal of the line, may be tapped at stations between these ends and thus supply the necessary air-pressure to the different sections along the line of railway, this conduit-main being shown at V, Fig. 1.

To utilize the system and apparatus hereinbefore described for pneumatic propulsion of cars by exhaustion, the flaps on the conduit-tube H are reversed in position, as shown in Fig. 3, so that the two flaps *a* will in this case project upwardly outside of the conduit-tube and come in contact, as shown, they being adapted to close the slot and prevent the introduction of air when the same is being exhausted from the conduit-tubes by any proper apparatus located at the stations or ends of the lines, in lieu of the air-compressors that are employed to compact air when such a means of propulsion is used.

It is evident that the piston H will move in the tubes A with the same precision as when compressed air is used as a motive power, and that the opening of the valves I will arrest the progress of the car by permitting the exhaustion of air through it while the piston remains stationary.

In the conduit-pipes where exhaustion of air is employed there is no necessity for the employment of a separate guard-valve M at one end of conduit-tube, as a single valve P will be sufficient to close the conduit-pipe at one end. Larger valves U, working in sub-chambers O and the conduit-pipe, as have before been described in connection with the compressed-air power, are located at the opposite ends of conduit-tube sections, the exhaust-pipes S and cross-branch pipes T being located between these valves to provide for the rapid and effectual exhaustion of the air from both tube-sections that are located in parallel lines, so that cars may be propelled in opposite directions on the parallel lines of track and arrested at will of the operator of the valves in the piston H.

Many slight changes of form and combinations of parts might be made in this device without departure from the spirit or exceeding the scope of my invention; hence I do not desire to limit myself to the exact forms and combinations of parts herein shown; but,

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

1. In a pneumatic-railway system, the combination, with two conduit-tubes adapted to receive air under pressure, of a set of guard-valves and a set of main valves, the main valves being adapted to be opened by the piston of the car after the guard-valves are closed, substantially as set forth.

2. In a pneumatic-railway system, the combination, with two tubes, of a guard-valve at one end of one tube, the other tube being provided at one end with a guard-valve and at the other end with a main valve, all of said valves being adapted to be opened by the piston of the car, a pipe connecting one of said tubes with the power-house, and a pipe connecting the tubes, substantially as set forth.

3. In a pneumatic-railway system, the combination, with two conduit-tubes, a cross-branch pipe, and a pipe connecting one of said conduit-tubes with the power-house, of a set of guard-valves, a set of main valves, weights to close these valves, a hollow piston provided with valves, an arm to connect the piston with a car, and a device to open and close the valves in the piston, substantially as set forth.

4. In a pneumatic-railway system, the combination, with a conduit-tube, ribs formed at intervals on the conduit-tube, and a jacket bearing on these ribs, of a drain-pipe located below the conduit-tube and adapted to receive water that enters between the jacket and conduit-tube and convey it away, substantially as set forth.

5. In a pneumatic-railway system, the combination, with a conduit-tube having a slot on its upper side, two flaps that are elastic, and cap-plates that bear on these flaps, all being secured to the tube, of a yielding cover that is secured by one edge to the conduit and located over the flaps, substantially as set forth.

6. The combination, with a tube having a longitudinal slot therein and integral ribs projecting from the tube, by which the latter is secured, of two elastic flaps adapted to close the slot, and a cover fastened to the tube above the flaps and adapted to bear thereon, substantially as set forth.

7. In a pneumatic-railway system, the combination, with a conduit-tube having a slot, of an arm, a movable piston attached to the arm, two gum-flaps that engage the arm and are adapted to close the slot of the conduit-tube, integral ribs formed on the conduit-pipe at intervals of its length, flanges on these ribs, and wear-plates that form a throat for the arm to move in, substantially as set forth.

8. In a pneumatic-railway system, the combination, with a conduit-tube having a slot, two gum-flaps that close the slot and yield to pressure, of an arm, a piston affixed to the arm and provided with spring-packing valves in the piston, a shaft that is located in the arm and engages the piston, devices to connect the arm with the piston, and a means of revolving the shaft to open and close the valves in the piston, substantially as set forth.

9. In a pneumatic-railway system, the combination, with a conduit-tube having a slot on its upper side, two gum-flaps fastened to the

tube to close the slot, a piston having spring-packing at its ends, an arm that is attached to the piston and works in the slot, a shaft that is located in a longitudinal hole in the arm, valves in the piston, and a device that is attached to the arm and valves to operate the valves, of a series of integral ribs formed on the conduit-tube, flanges formed on these ribs that are adapted to support wear-plates that form a throat-slot above the conduit-slot, and two opposite wear-plates, which are placed in line with the road-bed and permit the piston-arm to travel between them, substantially as set forth.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

MEINOLPH BODEFELD.

Witnesses:
R. S. FERGUSON,
GEO. F. DOWNING.