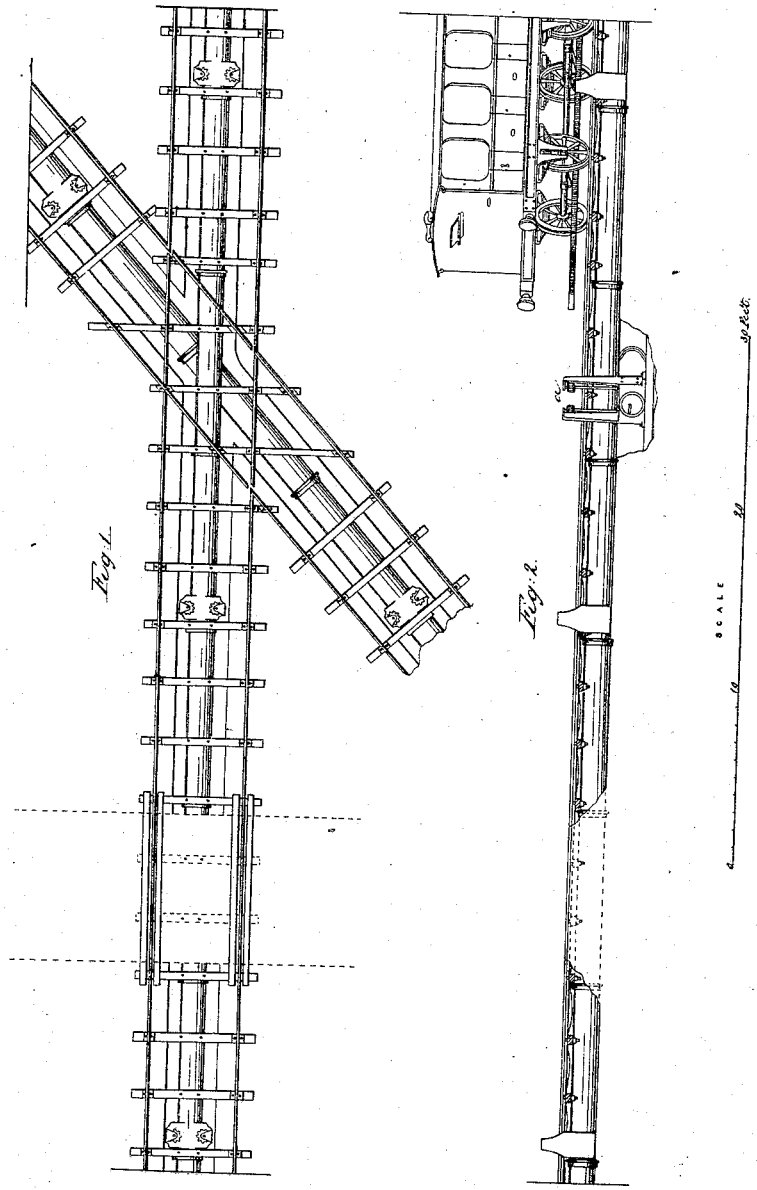
Sheet 1, 3 Sheets.

J. Pilbrow

Pneumatic Railway.

No. 4,124. Patented Jul. 26, 1845.



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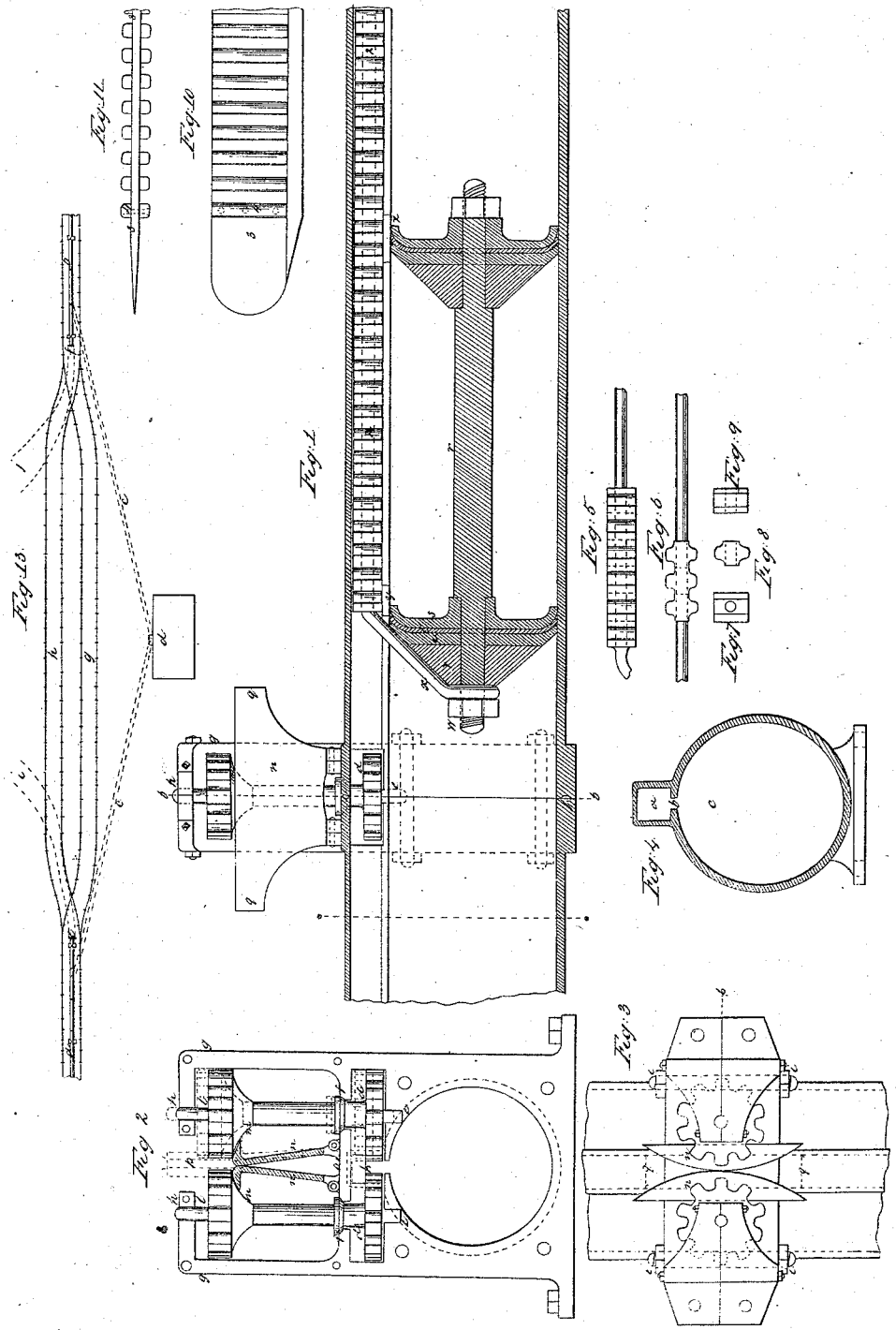
Sheet 2, 3 Sheets

J. Pilbrow.

Pneumatic Railway.

No. 4,184. Patented Jul. 26, 1845.

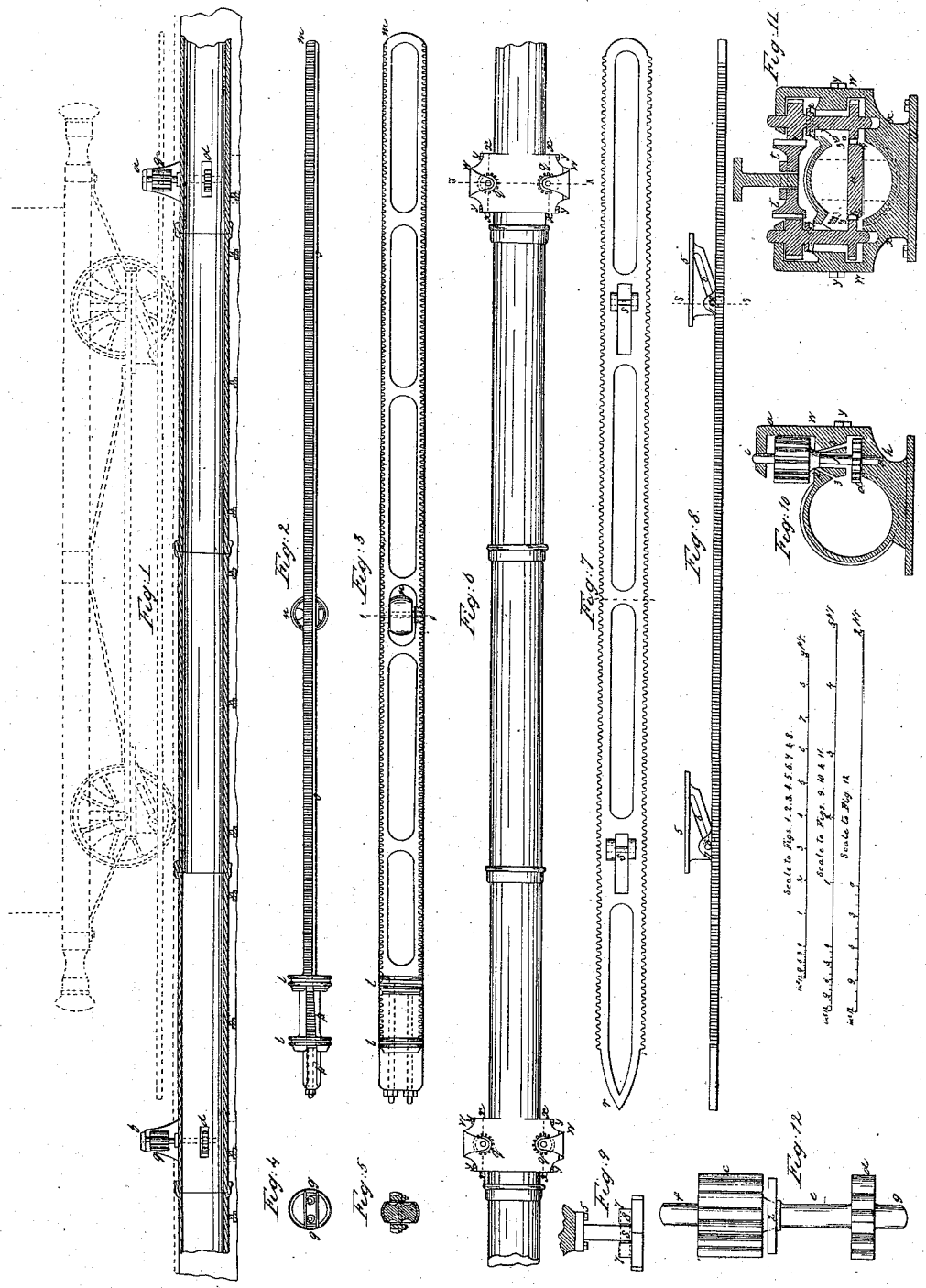


THE GRAPHIC CO. PHOTO-LITH. 39 & 41 PARK PLACE, N.Y.

J. Pilbrow.

Pneumatic Railway.

No. 4, 124. Patented Jul. 26, 1845.



THE GRAPHIC CO. PHOTO-LITH. 39 & 41 PARK PLACE, N.Y.

UNITED STATES PATENT OFFICE.

JAMES PILBROW, OF TOTTENHAM, ENGLAND.

ATMOSPHERIC RAILWAY.

Specification of Letters Patent No. 4,124, dated July 26, 1845.

To all whom it may concern:

Be it known that I, JAMES PILBROW, a subject of the Queen of Great Britain, now residing at Tottenham, in the county of Middlesex and Kingdom of England, civil engineer, have invented certain improvements in the machinery for or a new method of propelling carriages on railways and common roads and vessels on rivers and canals; and I do hereby declare that the following is a full and exact description of the mode of carrying my invention into operation.

Figure 1 (Drawing A) represents part of a pipe or tube (in section) supposed to be lying along a railway between the rails, similar to the tube as well known in the various plans hitherto devised for the propelling of carriages or trains on the "atmospheric principle" but here it is proposed it shall lie in a hollow or channel dug in the earth and fastened also in any convenient manner to the sleepers. At intervals say at 30 feet or nearer along this tube there are affixed pinions or small cogged wheels or wheels with roughened surfaces as shown at *a* and *b* and better described by reference to the larger drawing of one such pinion, Fig. 12 made or cast in one solid piece of iron the upper portion *c* having cogs or teeth around it any convenient number say 10 or 12 and the lower portion *d* being made the same, so that the cogs or teeth may correspond both in situation size and number. A like end may be attained by roughening the surfaces of the wheels or pinions to be employed in place of teeth; the tail of the piston and also the rod that is connected to the carriages must also be toothed, grooved, or roughened, in a corresponding manner, the portion *e* between these cogged portions forms a spindle or axis of connection between them and projecting as shown at each end top and bottom as at *f* and *g* forming centers or pivots to work in bearings as after explained; by reference now to Fig. 10 which represents the tube or pipe in section it will more easily be seen how this pinion is placed and how it acts, the tube has a projection cast or otherwise made upon it at the required places proposed to place these pinions and also has an opening in it to allow of the lower portion of the pinion *d* to enter and project a short distance into the hollow of the tube the upper and lower end of the spindle or the pivots of the pinion working in holes or bearings made for that purpose in this projecting case or box as at *h*, *i* the box having a support carried up as at *a*. That part of the spindle or axis between the toothed portions does not touch, but passes through a hole or passage made in the tube and "box" which is larger than the spindle as at *j*; but there is a flat or conical part as at *k* which is allowed to touch as will be explained hereafter. These pinions therefore are free to turn when acted upon in any proper manner for that purpose and are partly inside the tube and partly out I propose then a piston to be made (which shall hereafter be more particularly described) to fit as nearly airtight as possible into this tube, and having attached to it behind a long bar or piece or pieces of iron or other suitable material having cogs or teeth or indentations along its edge or edges to correspond and fit the cogs or teeth or indentations of the pinions or grooved wheels. Figs. 2 and 3 represent such a piston and appendage which I term the "piston rack" here shown as a double one that is having cogs on both edges. Fig. 2 shows a side view and Fig. 3 a plan or top view; *l*, *l* represents the piston head and from thence to *m*, the line of cogs and teeth; *n* is a wheel or roller placed near the center of the rack, to support it in its proper place and to obviate friction in its progression.

Fig. 4 represents the front end view of the piston and Fig. 5 a section of the rack and wheel *n* at the dotted line φ φ. The cogs are not continued the whole width of the rack but at the lower part there is a plain piece as shown at *o*, *o* which at the piston end, declines or approaches the bottom forming a small inclined plane as shown at *p p'* there being no cogs at the very commencement *p'*. This "piston rack" is to be sufficiently long to reach two or more of the pinions in the tube that it may never be entirely free that is will touch one before it leaves another; the pinions then being so arranged that they project at about the middle or horizontal diameter of the tube and the rack being arranged in the same position as to the piston, so that when the piston is placed in or allowed to pass along the tube the "rack" or cogged edges

will act upon, and be in gear with that part of the pinion at *d* and if a vacuum be formed by pumping out, or exhausting the air from the front of the piston in the usual and well known manner by air pumps worked by steam engines or otherwise, the pressure of the natural atmosphere wil urge the piston and its rack onward toward the vacuum. If permitted to do so and the "rack" being in gear with the pinions *d* will as it passes cause them to revolve and also the pinions which are outside the tube as at *q*, *q* Fig. 1. There may be pinions on each side of the tube opposite each other as shown in Fig. 6 if advisable which will render it necessary that the "rack" should be double or cogged on both edges as shown; and hereafter I shall describe and consider this to be the case throughout the following description as being the most comprehensive form although single "racks" and "pinions" may be found generally the better plan in practice when the difference is merely the use of one pinion instead of two as before described and the "racks" being cogged only on one side of the "carriage rack" in this case having a guide to keep it to the pinion, which guide may be a plain upright or a plain or uncogged pinion in the place of the pinion so removed.

Fig. 6 is a top view of the tube and shows two pairs of pinions *q*, *q*, *q*, *q* which pinions must be kept as nearly as possible at equal and the same distances laterally. To the under part of a railway carriage in any convenient manner will be attached a rack similar to the "piston" rack but without the piston or plain part as at *o*, *o* in Fig. 2, called the "carriage rack" and shown in plan at Fig. 7. The front end *r* is tapered or pointed to render easy its entrance between the pinions it is made as also the piston rack as light as consistent with the necessary strength by being in the form of framework or hollowed as represented; *s*, *s* are places where the rack is attached to the carriage as after described. Fig. 9 represents the rack in front view. This carriage rack is made precisely to correspond with the internal or "piston rack" and will be the exact width the pinions are apart so as to be in gear like the "piston rack" with the two opposite pinions at one and the same time, it is also the length of the other so that it may reach two or more of the pinions or pairs of pinions at once. Fig. 8 represents a side view of the "carriage rack" and Fig. 11 a transverse section of the tube with opposite pinions (supposed to be taken through the dotted line λ, λ of Fig. 1,) showing also a section of the carriage rack at *t*, *t* (as cut through the dotted line *s*, *s* Fig. 8) and a section of the "piston rack" at *u* both racks being in gear respectively with the pinions at *v*, *v*, *v*, *v*. Therefore by placing the rack as represented by Fig. 7 upon Fig. 6, in the position they are there separately shown and in such a manner as to place the pinions in gear with the cogs on each side of the rack and that the ends of the "piston rack" inside the tube and the carriage rack outside shall correspond, will be the relative position in which it is intended to place them. The boxes or projections *w*, *w*, *w*, *w* which contain the lower part of the pinions will have a hollow or chamber to permit the said pinion to revolve freely but to be made and put on to the tube airtight having but one opening into the inner part or chamber viz. at *j* (Figs. 10 and 11) through which the spindle of the pinion passes. To admit of the pinion being put into its place the box must be made to separate and to go together air tight at the dotted lines *x*, *x*, *x*, *x*, *x*, *x*, *x*, *x*, *x*, *x*, by bolts as shown by the letters *y* (Figs. 6, 10 and 11). To make the passage of the spindle from exterior to interior of the tube airtight when required to be so I make or turn upon the spindle of the pinion (below the upper cogged part) a flat shoulder or a conical or beveled one, at an angle of about 45° as shown at *k* (Fig. 10) and the upper edge of the passage through which the spindle *j* passes. I form also beveled and truly grind the conical part of the spindle to this part, so that when down in its place, the conical part of the spindle fits and becomes air tight in the manner of the common valve known by the name of the "spindle or conical valve" and thus prevents the passage of air through or by this passage; or instead of making the part conical I make a simple flat shoulder ground true to the edges (horizontally) of the upper part of the passage. Another method is a combination of these two as shown by Figs. 11 and 12 where instead of the flat shoulder is a flat plate or disk through which the spindle passes, having a conical part ground to a corresponding surface in the plate as at *z* Fig. 12. This modification is for the purpose of preventing much friction when the passage is required to be large in case of the pinions turning around when pressure is upon them, thus permitting the smaller circumference of the two (the conical) turning instead of the larger flat one at its outer edges where it will lie upon the "pinion box" at 2, 2, 2, 2, Fig. 11. That the pinions may be lifted up and therefore the valve part also from its seat, (as shown by the pinions in Fig. 11). The pivots are made long enough and the "chamber" in the tube and "box" large enough to permit of it. When the pinions are lifted up, a free passage is allowed for the ingress of air into the tube and to make this passage under these circumstances as large and free as possible several side passages may be made also as

shown at 3, 3, 3, 3 (Figs. 10 and 11). When the "piston rack" is within the tube in its desired situation and the cogs of the pinions in gear with those of the rack the lower surface or end of the pinion cogs 4, 4 Fig. 11 will rest upon the plain piece (before explained) on the "piston rack" which makes a kind of shelf or ledge for the cogs or teeth; and thus if this rack be so arranged as to move in a line rather higher than that in which the pinions are placed when down (as in Fig. 10) it will cause them to be lifted up when it passes them thereby avoiding the friction of the airtight shoulders and permitting air to enter into the tube during this action as may be essential to the efficacy of the apparatus as will be further explained hereafter.

If preferable the upper part of the pinions may be constructed shallower and therefore lighter than is shown at *c*, Fig. 12 in the manner represented at Fig. 11 but in this case the edges or cogged part of the "carriage rack" must be made deeper as shown by the section Fig. 11 at *t*, *t*, to allow for the raising of the pinions and any small irregularity of the level of the rack in working or of the carriage or rails of the railway.

The carriage rack may be attached to the under part of any railway carriage (the first carriage of a train) by any suitable means; but I prefer the following mode of doing it, which will be understood by reference to Figs. 7 and 8, Drawing A. The two parts 5, 5 (Fig. 8) I firmly fasten to the under part of the carriage or to a piece of timber supported by and suitably attached to the axles of the carriage, (see also the dotted drawing Fig. 1, in the under part of these supports is formed a groove or slot 6, 6 (Figs. 7 and 8) and upon the rack are fixed suitable projections 7, 7, through which bolts 8, 8, are passed, going also through the slot in the support. These bolts, then, resting at the bottom of the slots, support the rack in the horizontal position shown; a little lateral play being allowed. By this arrangement the rack, if meeting with any resistance suddenly in any of the pinions in passing them, (the momentum of the carriage urging it on) would be pushed up these slots, and thereby getting above the pinions (is made sufficiently effective for this purpose) would be enabled to pass the obstruction without concussion to any part of the apparatus outside the tube.

Another arrangement and modification of this method of propulsion, and the one I give the preference to (it being more simple) I will now describe reference being had to the figures on Drawing B, the principle having been now generally explained and understood by the foregoing description &c. The tube or main in this arrangement being cast or formed with a square hollow channel or passage on its upper part as shown in section at *a*, Fig. 4, (as cut through the line ⊕, ⊕, Fig. 1) and running its entire length having an opening or slit of communication *b*, betwen the square hollow and the interior of the main *c*. As before described this "main" is to have, at intervals of twenty or thirty feet pinions, but not to reach lower than the square hollow upon the main, and fixed and inclosed, as will be understood by the following, and reference to Figs. 1, 2 and 3. The main will be formed as usual of lengths of pipe joined together by socket joints and cement, except that I here propose to cast upon one end of a certain and convenient number of these lengths a more solid portion which will form one half of the inclosure for a pair of pinions with their supports &c., such an end is represented in end view at Fig. 2, with the pinions &c. in their places and two such ends when brought together are represented in top view at Fig. 3 and in section of main at Fig. 1. Through this more solid part the square hollow and the main passage pass as through the other portions, this simply being for the placing of the pinions, and therefore in it are made two hollows *d*, *d*, Fig. 2, for the reception of the lower part of them as shown, having also bearing holes at *e*, *e*, for the lower pivots or centers to work in, (but deeper than the pivots are long, that the pinions may rest upon the shoulders at *f*, *f*,) and a passage to permit the spindle or axes of the pinions to pass through at *f*, *f*. Also the supports *g*, *g*, having bearing holes for the upper pivots as at *h*, *h*. All these will be in each portion a half of the necessary whole, as cut through their diameter (as by the lines σ σ σ σ Figs. 1 and 3) so that when two are brought together as in Figs. 1 or 3 they will form a complete whole, and inclose the pinions as desired, the parts being bolted together by screw bolts, as at *i*, *i*, *i*, *i*, in Fig. 3 and made air tight by cement or by a little packing laid in a hollow, which may be made to run around as shown at *j*, Fig. 1. All the other joints of the main may be the common "socket joint" and I propose there should be one or two such joints between every two of these pinion joints when, if each length of pipe be ten feet, it will make the pinions twenty or thirty feet apart. It will be seen, then, that the lower parts of the pinions here are not to enter the "main" tube at all, but to project in a similar manner into the square passage as at *k*, Fig. 2, and therefore the pinions (both top and bottom) will approach each other more nearly than when they enter the main tube. A sufficient space is to be allowed at *d*, *d* and *l*, *l*, to permit the lifting up of the pinions, and the pasages through which the axes pass as at *f*, *f*, are to be made somewhat larger, that when the shoulder or conical seats are

thus lifted away, a free passage may be made for the ingress of the air. The pinions are formed as before described, with the exception that the under part of the upper cogged portion is circularly formed, as represented at *m*, *m*, Fig. 2. Between each pair of pinions are fixed, by hinges on the top of the pinion chamber, two pieces of iron, in the manner and form as represented by the sections at *n*, *n*, Fig. 2 and side and top views as at *n*, *n*, Figs. 1 and 3 which are so made and arranged that their center of gravity will be on the side nearest each other, so causing them to fall and touch together at top as shown in Figs. 2 and 3, and having a stop at the bottom near the joint at *o*, (Fig. 2) to prevent either of them falling past the center of the tube. The upper part of these which I call "guides" are circularly formed in two ways as shown in section at *m*, *m*, Fig. 2 and longitudinally as *n*, *n*, Fig. 3. These "guides" then, having liberty of movement backward or toward the pinions, if any substance be forced in between they will separate, and the part *m*, *m*, (Fig. 2) would be pressed against the circular part of the pinions, and would therefore lift them up; this action and situation are shown by the dotted lines in Fig. 2 of one pinion only, the part *p*, being a sectional representation of the substance or body between the pinions that is, the "carriage rack" as after described. These guides, then, serve two purposes—they project diverging from each other on either side of the pinions, as *q*, *q*,—Figs. 1 and 3 forming guides for the entrance of the point of the carriage rack between the pinions, and also by being pressed back by the same will lift the pinions up.

In Fig. 1 the piston is represented in section having attached to it the "rack" or cogged part. The mode of constructing this piston I will now proceed to explain. Upon a strong iron bar *r*, having shoulders and screws at each end as shown I place in the order represented several disks of iron wood and leather. Thus I form the disk *s*, as shown by the sectional figure given, of iron, having a hole through the center to fit to the smaller part of the bar *r*, and to go home to the shoulder; this disk is made at its extreme edge or point, the diameter of the main or nearly so. Next to this I place a disk of thick leather or other suitable material *t*, of rather larger diameter. Again to this I place another disk of iron *u*, formed in the shape shown in section that is, dished or concave, on the inner side to correspond with the convexity of the disk *s*, which also having a hole in the center, and being placed upon the bar and pressed up will cause the leather or other material *t*, to take the form shown; this disk will be nearly the diameter of the hollow of the "main." Before the disk *u*, may be placed a conical block of wood *v*, and these several pieces being screwed up together by the nut *w*, will form the one part of the piston, the leather expanding against the inside of the tube and rendering it air tight, or nearly so. At the other end of the bar the same arrangement is repeated in the manner shown making a double piston, for greater security in passing the pinions, and steadiness of traveling. (In the piston of the former plan as represented at Figs. 2 and 3, Drawing A, the leathers and disks are so arranged as to form and only occupy the space of a cog of the rock, so being capable of passing the projecting pinions in the main; this arrangement of parts and general form is shown at *l*, *l*, *g*, *g*, *l*, *l*, where there are intended to be four leathers to the complete piston, and two bars and nuts to keep them all steady together, but I prefer the plan above described.)

Returning now again to Drawing B, the manner in which I here form the piston rack, and attach it to the piston is thus. I have a rod of iron or steel of suitable strength, rather longer than the space between two pairs of the pinions on the "main" so that it may be between or in contact with one pair before leaving the other. This rod having a strong "eye" formed at one end, and bent down, as shown at *x*, Fig. 1 (Drawing B) and the eye placed upon the end of the bar *r*, and fastened up firmly to the wooden cone *v*, by the nut *w*, the principal part of the rod itself will be in the square channel upon the main passing up through the slit or opening. Upon this rod I place a number of pieces of iron wood and caoutchouc or other material (to fill up its entire length) of the shape shown by three views in Figs. 7, 8 and 9 each having a hole through it the size of the steel rod, which when placed regularly against each other, as shown by Fig. 5 (side view) and Fig. 6 (top view) will form a double line of cogs being made the proper size and shape to match the pinions. When a sufficient number of these are placed upon the rod to make the required length they are all secured on and kept up tightly together by a nut screwed on and secured to the extreme end of the rod, which then forms the "piston rack" and the same being very nearly the size of the square channel on the main will pass along when dragged by the piston and come into contact and gear with the lower portions of the pinions as they pass between them. The first few cogs, say six, at the end *y*, Fig. 1, I would make of caoutchouc or other elastic and rough material to prevent concussion, &c., and rather larger than the others, so that they might nearly fill the square channel, thus making it partially air tight and forming as it were a piston to this channel. The first one or

two cogs should have a part projecting downwards through the slit as at *y*, to fill up the slit and rest upon the top of the piston, the same may be repeated over the hinder part of the piston at *z*. Next to these six elastic cogs I would place about 9 cogs of tough wood and then fill up the rest of the rod with iron ones unless wood should be found preferable. This then forms what I call my piston and "piston rack" as represented in its place in Fig. 1, so much of the "rack" 2, 2, being shown as the drawing would allow. The manner in which I form my "carriage rack" (for this plan) is shown by Figs. 10 and 11 (Drawing B), Fig. 10 being a side view of a portion of it, and Fig. 11 a top view; 3, 3, 3, is a plate or thin bar of iron, of suitable width and thickness, being pointed and rounded at its ends as shown in those figures, and being long enough to reach at least two pairs of the pinions on the "main" at once. On each side of this plate are to be riveted pieces or iron or other suitable material, in the form of cogs as shown at 4, 4 at equal and proper distances apart to correspond with the pinions the rivets are represented by the dotted lines at 4, 4 as running through and fastening two opposite cogs at once. This forms what I call my "carriage rack" and may be attached to the under part of the railway carriage or axles in a similar manner to that before described (having however two portions beneath at each place instead of one with the slot or channel 6 Fig. 8, Drawing A so that the carriage rack may ascend between them when necessary the "rack" being here too narrow to admit of the other arrangement. By a simple arrangement the "guard" or "brakesman" may have power at will in an emergency of lifting this "rack" out of gear thus disconnecting the train from the influence of the motive power.

The Figs. 1 and 10 (Drawing B) show the intended relative situation of the "piston rack" and "carriage rack" the piston being a little in advance of the latter. If desirable every carriage in a train behind the piston may have a suitable bar of wood, attached in a similar manner as the rack is upon the first carriage to act like it upon the guide to keep up the pinions a longer time thereby giving greater access to the atmosphere behind the piston. This arrangement also may be made with single pinions and racks though here explained as double and in many cases with the advantages of simplicity efficiency and cheapness when the only difference will be as before explained in the former arrangement. This "method of propulsion" may be further modified by substituting ropes, bands of leathers, or other material in place of the "racks" as described varying the surface accordingly, but I prefer the manner above explained.

The operation of this invention or manner of its working is as follows: A pipe or tube as before described of sufficient diameter being laid along in a hollow between the rails of a railway and being exhausted of air by suitable means as are well known and having the pinions arranged as described at intervals throughout its length the piston with its "rack" attached is placed in this tube in the manner before explained at the farther end from whence the air has been or is being exhausted or withdrawn the "piston rack" being in gear with the pinions inside the tube. A railway carriage having a "carriage rack" attached to it as described being placed upon the rails, as shown by the dotted figure at Fig. 1, drawing A and this "carriage rack" being in gear with the upper part of the same pinions as the "piston rack" the one rack cannot move backward or forward without the other rack moving also in the same direction. Thus the carriage would be propelled and others if attached to it. As it is necessary and important that the atmosphere should be admitted as nearly behind the piston as possible, the pinions are lifted up by the advance of the "piston rack" in the first plan, and by the "carriage rack" in the second plan as described before and the air will enter through the space allowed by the lifting of the conical or flat portion of the arbor or axis of the pinion, as described, thus would there always be at least two or more such passages open, as the rack acts upon the one before it leaves the other. After the rack has passed onward, the pinions by their own weight fall into their places, and thus make an air tight tube ready for the next exhaustion, when, if an air pump be set to work at the other end, and the direction of the piston and rack changed, and placed again as before into proper gear, the carriage would return in like manner.

Drawing C represents at Fig. 1 a plan or birds-eye view of a portion of an atmospheric railway of this description, crossed on a level by a roadway, and by another line of atmospheric railway, and Fig. 2 a longitudinal elevation and section of such an arrangement by which it will be seen that there is plenty of space between the pairs of pinions for the crossing; and that the mains being sunk beneath the surface of the ground or under the sleepers of the rails, they are entirely out of the way, the carriage rack passing on from one pinion to another over such roads without interferring. Where it may happen that two tubes are required to cross each other one will pass beneath the other, the upper one keeping its level course, the lower one taking a

gradual descent or dip under it, the pinions keeping their necessary level at the upper part by being lengthened, at such a locality, in the axes and supports as shown at *a* Fig. 2. The first or "rack carriage" of a train, is shown advancing upon this cross line as it would appear just previously to its taking the pinions at *a*. This drawing represents the first plan described; the latter would differ in having the "channel" along the top of the "main" and having the pinions closer together (laterally), &c. As there will not be on this plan, even in a single line of rails any discontinuance of the main tube but a place arranged for trains to meet and cross, which will always be at a station (and for general purposes not less than twenty miles apart) it will be only at such places that the main will require any kind of valve to close its open end. Fig. 13, Drawing B, represents such a crossing, *a* and *b* are the mains connected with the air pumps by pipes under ground, as at *c*, *c*. *d* is the situation of the engine, &c; the means being discontinued at *e* and *f* and the rails made to take the direction as shown, that the trains arriving here would each take one of the sidings, *g* or *h* and thus pass each other. The end of the main would simply require a disk of iron or wood placed against the open end, with a little composition to make an air tight joint, when the vacuum is to be made by the air pump at *d*, which disk or valve will fall or be pushed aside when the piston arrives at the end and will require no more attention, excepting being replaced or closing by the time this engine (*d*) is again required to work. The piston would when it arrives here, either partially or wholly leave the tube, after displacing the disk or door at *e* or *f* by its remaining momentum and the train with the "carriage rack" will pass on, and take one of the sidings *g* or *h* and be stopped by the attendants by "brakes" as usual; but the operation of the stopping would have been begun before arriving here, the train now only moving slowly and with sufficient momentum to carry it to the place required, or middle of the siding. When the piston and rack reach the end of the main, and are withdrawn therefrom I propose there shall be placed at each of the two ends of the mains *e* and *f* (and all similar ends), a receptacle or trough mounted upon four wheels or rollers so that the piston coming on to it could be immediately removed for inspection, &c., and another piston newly greased, &c., brought and placed (by the same means) with its head in the tube ready for the next returning train. The trains having both arrived, each train would be (by any suitable means) urged on to the commencement of the opposite "main" where the fresh pistons having been already inserted (and held by any convenient contrivance) and the vacuum formed, the carriage rack coming into gear with the first pair of pinions near *e* or *f* and the piston released, the train would start on its journey. Thus the pistons would never leave the main, or enter another but at a very slow pace, and at a place for stopping. The dotted lines from *e* to *i* and from *f* to *j* represent the continuance of the hollows or channel in the ground turning to one side running under the rails, and ascending to the surface level, by which the pistons are removed and replaced. Several other arrangements might be adopted for the foregoing purposes, but the one here described may be as good as any. I also should prefer that the pinions situated near the crossing stations should not be lifted up for the admission of air, as the others, and therefore they would not require the apparatus or parts *n*, *n*, Figs. 1, 2, and 3 (Drawing B), for that purpose; by this arrangement the piston would be impelled with less force for the air behind it not continuing to enter, that which is in would be rarified or attenuated and thus not only would the speed be checked but so much would be done toward the next exhaustion which is immediately to be made (if a valve were introduced to shut off for this purpose) thus economizing time and power. When this method of propulsion is used upon common roads, the tube will be sunk or buried along the side or center of the road, and its operation would be as before described there merely being the absence of the rails.

When used as a means of propulsion upon rivers or canals, the tube may be smaller, and laid either at the edge of the water, or upon piles or posts along its center, the "rack" being affixed to the lows or side of the vessel to be propelled to which may be attached any others that are intended to be drawn with it, thus making as it were a train of vessels. The general operation in other respects would be the same as described for carriages upon railways.

I claim as my invention—

1. The employment of a series of tubes or pipes having projections, and pinions (with or without teeth) placed at intervals along the length of pipes or tubes as above described and a piston having a "rack" attached and a "rack" attached to the carriage or carriages or vessel or vessels to be propelled or any like or similar arrangements of a "rack" or "band" or "rope" which might be made to act in like manner upon the said pinions or upon each other to produce the effect as above described upon an atmospheric railway.

2. I do not claim any of the spearate parts of my apparatus, all or some of them being well known, but I claim the same in combi-

nation for the purpose of carrying out practically and efficiently my method of propelling by the effect of the natural atmosphere; but I do not confine myself to the precise arrangements above set forth, as some may be found superfluous in practice or modifications of them may be desirable.

3. I claim the use of the flat or conical seat on the axis of my pinions to form a valve for the admission of air and for making an air tight joint in combination with my main pipe, or tube, as set forth.

In witness whereof I, the said JAMES PILBROW, have hereunto set my hand and seal this third day of April, 1845.

JAMES PILBROW. [L. S.]

Witnesses:
W. E. NEWTON,
JOSEPH MARQUETE.