(No Model.) 3 Sheets—Sheet 1.

H. FLAD.

SYSTEM OF RAPID TRANSIT.

No. 405,467. Patented June 18, 1889

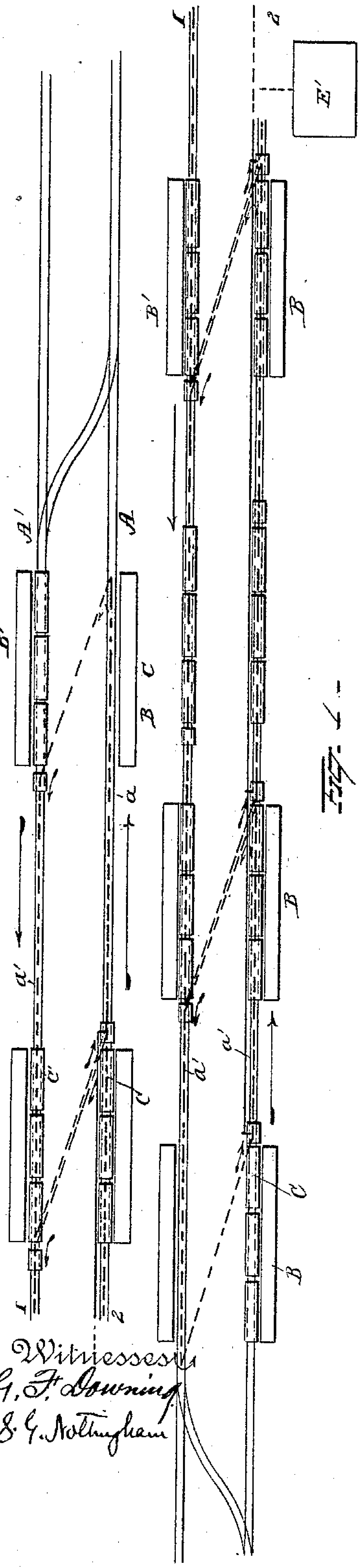

Fig. 1.

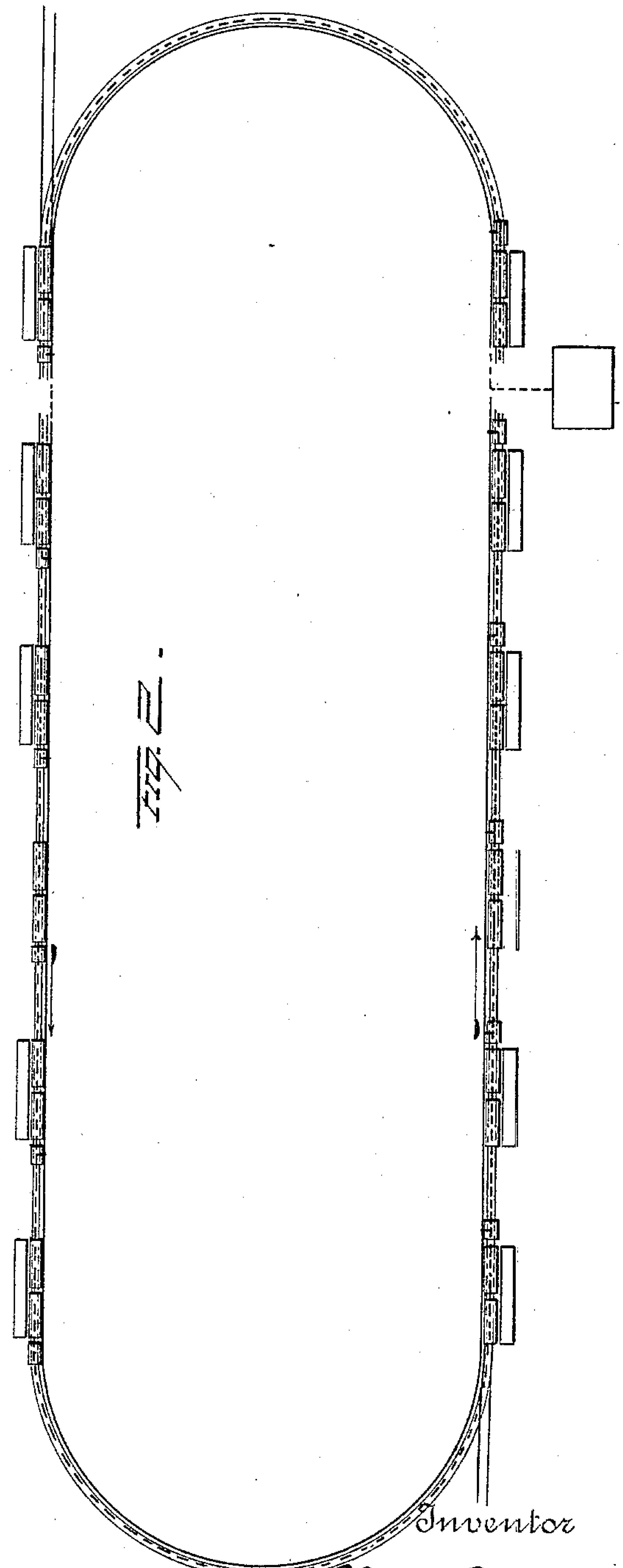

Fig. 2.

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(No Model.)

3 Sheets—Sheet 2.

H. FLAD.

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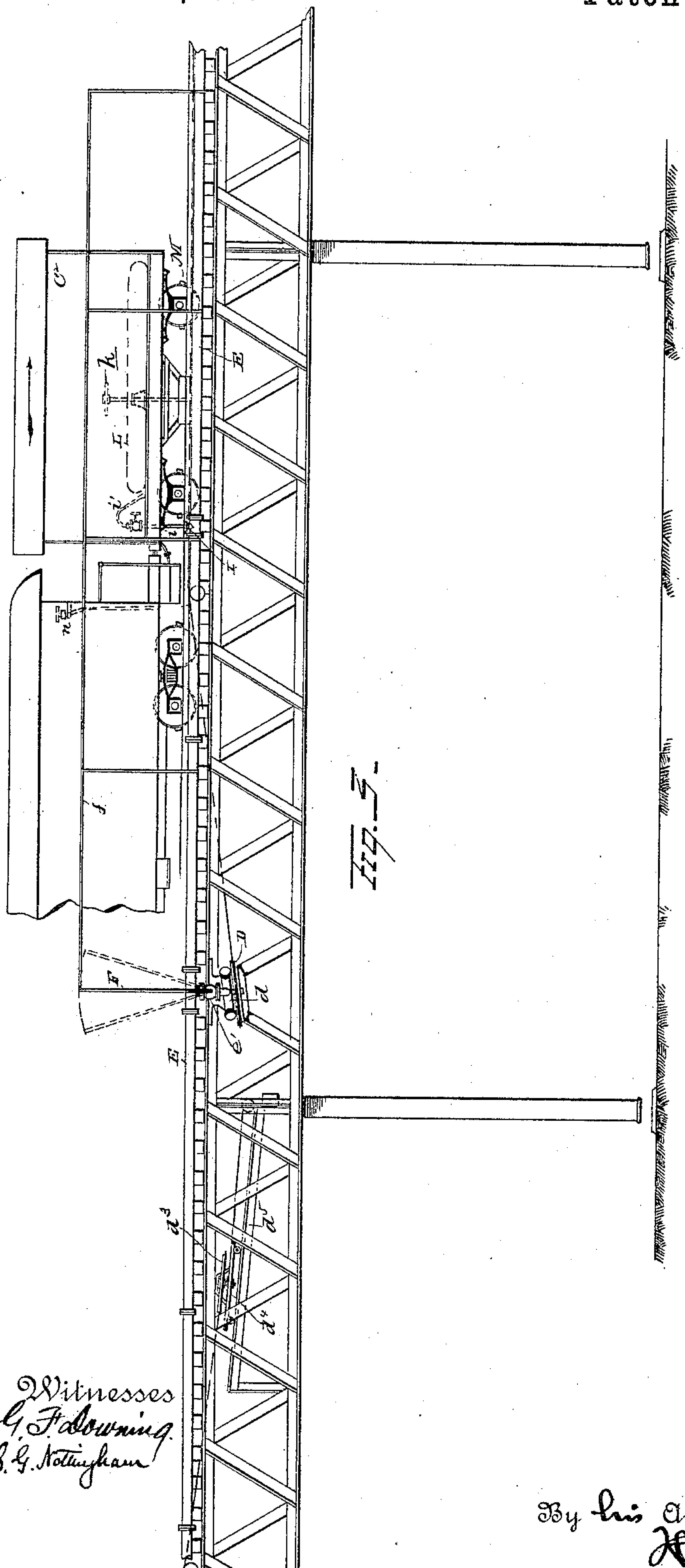

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3 Sheets—Sheet 3.

H. FLAD.

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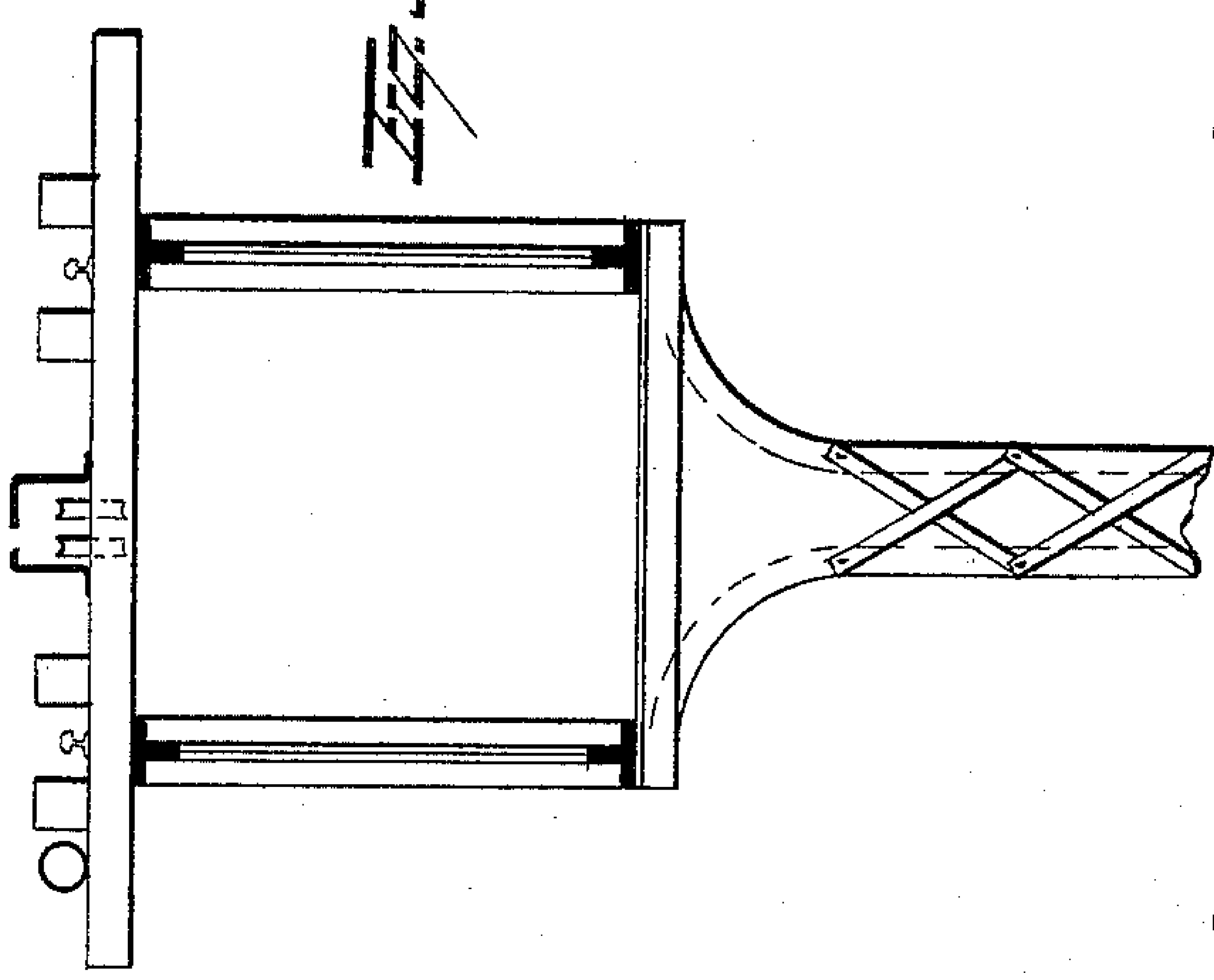

Fig. 5.

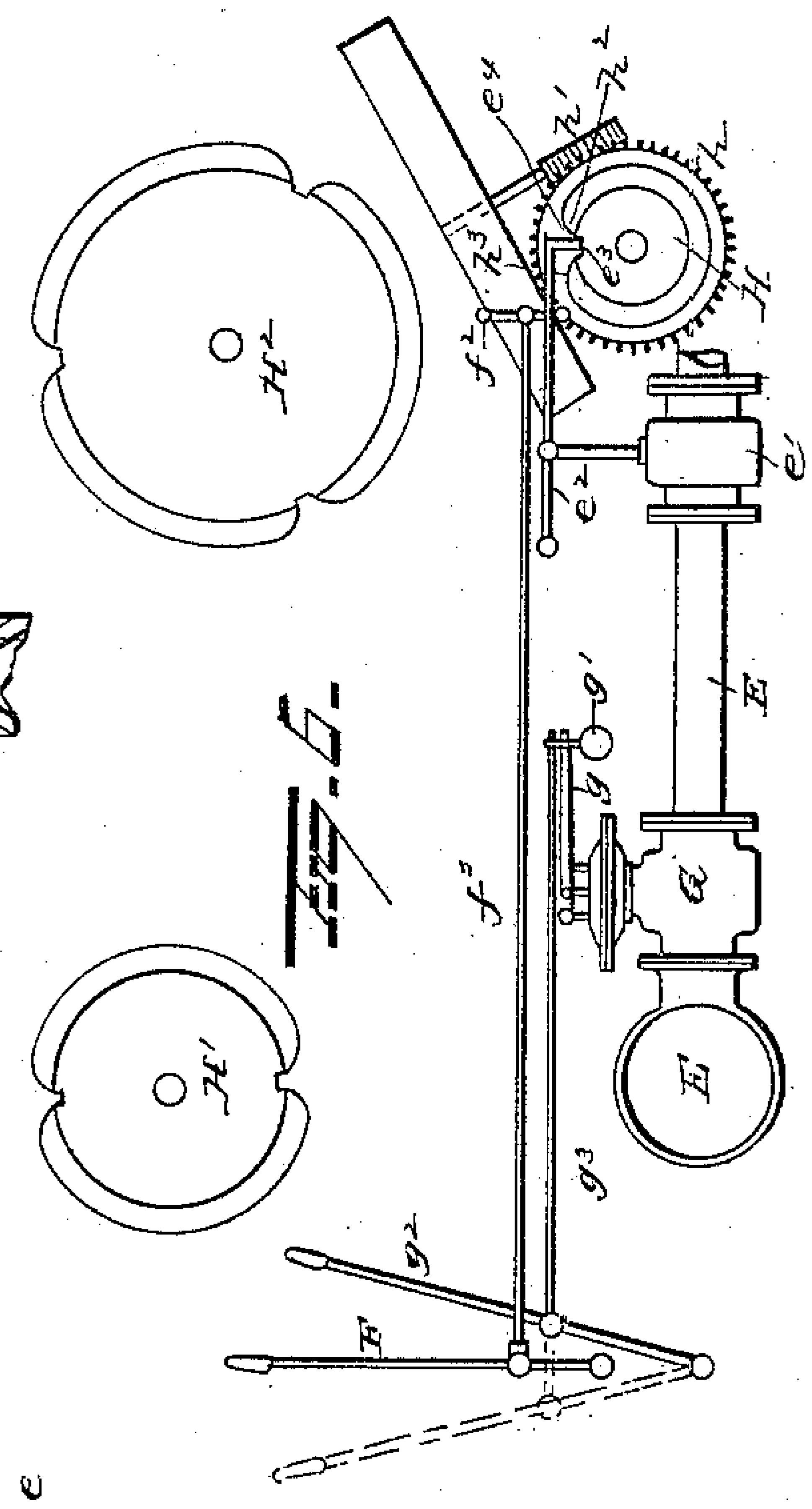

Fig. 6.

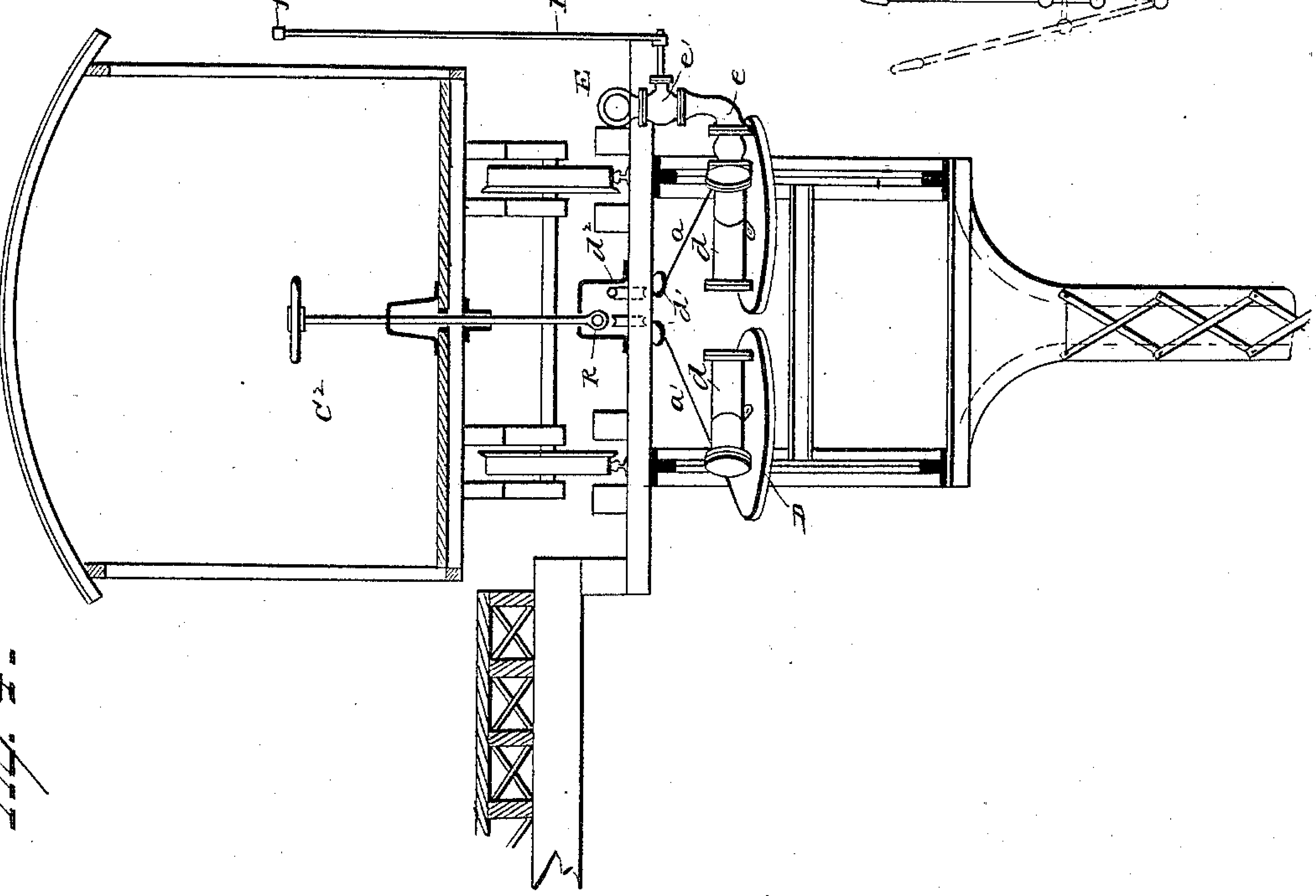

Fig. 4.

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UNITED STATES PATENT OFFICE.

HENRY FLAD, OF ST. LOUIS, MISSOURI.

SYSTEM OF RAPID TRANSIT.

SPECIFICATION forming part of Letters Patent No. 405,467, dated June 18, 1889.

Application filed June 16, 1887. Serial No. 241,518. (No model.)

To all whom it may concern:

Be it known that I, HENRY FLAD, of St. Louis, in the State of Missouri, have invented certain new and useful Improvements in Systems of Rapid Transit; 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 systems of rapid transit, and more particularly to that class of systems in which passenger-carriages are propelled by a cable driven by a suitable motor.

The general object is to provide economical means for transferring passengers from one part of a city to another in the shortest possible time, with the greatest degree of safety and comfort, and with the least possible interference with the ordinary traffic of the streets and with the rights of the residents. In order to attain this object it is important that there be a double track to accommodate simultaneously travel in opposite directions; that the tracks should be located on the same thoroughfare when possible, and when not that they should be as near each other as is feasible; that the stations should be located at such distances apart as to afford the greatest accommodation consistent with economy and speed; that the tracks should be located either above or below the surface traffic; that the motor employed should be of ample capacity to perform the maximum amount of work which may at any time be demanded of it; that the motive power should be selected and regulated with a view to obviating inconvenience or danger to either passengers or residents along the line, and that the first cost of the system, as well as the cost of operating it, should be reduced to a minimum.

With these ends in view my invention consists in certain features of construction and combinations of parts, as will be hereinafter described, and pointed out in the claims.

In the accompanying drawings, Figure 1 is a general plan view of the tracks, cables, power-conduit stations, and trains where the outbound and return tracks are located on the same street. Fig. 2 is a similar view where the outbound and return tracks are located on different streets. Fig. 3 is a view in side elevation showing the cable-motor at the end of one cable-section and the tension device at the adjacent end of an adjoining section, the power-conduit, and the grip-car in position to start from a station. Fig. 4 represents a vertical cross-section through road-bed and grip-car at the station-platform. Fig. 5 represents a similar view between stations. Fig. 6 represents mechanism for regulating the pressure of the power and speed of train.

Where the outbound and return tracks are located on the same street, as represented in Fig. 1, a single cable is employed to propel the cars in opposite directions between each two stations, or along what will be termed, for convenience, one cable-section of the road.

A and A′ represent, respectively, the outbound and return tracks, as indicated by the arrows, the point of starting being assumed to be the left-hand end of the road as a person faces the drawings.

The length of the track between stations is omitted, as shown by the broken lines, in order to show on a larger scale three successive stations on each of the tracks and the arrangement of the cables corresponding therewith.

The cables are represented by broken lines, the portion of each cable extending along the outbound track being represented by a and the portion of each extending along the return track being represented by a'. It will be observed that the portions a extend to points in front of or just beyond the ends of the platforms B which are toward the terminus of the track to which the train is advancing before they make a turn, and that the cable then turns and extends diagonally across to the return track A′, in position to be gripped by the advance or grip car of the return train as it stands in front of the opposite platform B′. Thus suppose outbound trains, as C, be at rest in front of the platforms B and return trains, as C′, be at rest in front of the platforms B′, the cables also being at rest. If now at a preconcerted signal the several trains be gripped to the cables and the cables be set in motion and caused to travel the distance between two successive stations, the several trains would be propelled thereby to their next station in order, each cable propelling two trains, one in each direction.

All the cables a a', whether they be employed to propel trains in opposite directions, as shown in Fig. 1 and above explained, or to propel trains in one direction only, as shown in Fig. 2, are supported and driven in substantially the same manner, and hence a detailed description of one will suffice for all.

A pair of driving-drums D are suitably mounted, preferably in vertical or slightly-inclined positions below the track, at a suitable distance from the point where it is desirable that the grip carried by the car should grasp it. The axle or shaft of each drum is provided with a crank connected with a shaft of a rotary engine d, which may be started and stopped at pleasure by the admission or cut-off of the motive power. The motive power may either be compressed air or electricity. If the latter be employed, the compressed engine would be replaced by an electromotor, and a suitable conductor would be provided. The engines d are connected with a supply-conduit E through branch pipes e, to which the compressed air is admitted by a valve e'. The supply-conduit E leads along the track to a centrally-located power-station E′, where it is kept charged with air under the desired pressure. The several engines or sets of engines located along the track are actuated by power from the common conduit E. The cable a a' passes around the outer faces of the drums D, as shown, and the two parts are then led along their respective tracks A A′, as shown in Fig. 1, or caused to converge toward the middle of one track, as shown in Fig. 4, by suitable guide-rollers d' and d^2—the former to determine its direction in a horizontal plane and the latter to determine its direction in a vertical plane. A suitable housing or conduit is provided for the cable along the track between stations, and may be of any well-known or approved form. At the opposite end of the cable-section the cable passes around a loose pulley d^3, which is conveniently journaled in a frame d^4 mounted on wheels, and continuously drawn down an inclined track d^5 by a weight d^6. The weight serves to regulate the tension of the cable, and may be increased or diminished at pleasure. An operating-lever F is attached to the valve e', and when the same cable is arranged to run trains simultaneously in opposite directions, as shown in Fig. 1, the said lever would be manipulated by the engineer or manager of one of the trains detailed for the specific purpose of starting trains; but when a single cable is employed to run trains in one direction only the lever F might be conveniently operated by the manager of each train, and for this purpose a rod f or its equivalent might be extended along the side of the track within easy reach of the manager when in position to start, and by its connection with the lever enable the manager to start the engine at pleasure. In both instances, however, it would be important that automatic means be provided for stopping the engines the moment the train released its hold of the cable in approaching a station, or soon thereafter, and to this end, as well as to secure an even pressure of the requisite degree, the following mechanism has been devised. The branch pipe which conveys the compressed air from the main pipe E to the engines d is provided between the valve e' and the main pipe with a diminishing valve G, controlled by a lever g, on which is placed a shifting weight g'. An operating-lever g^2 for sliding the weight g' on the lever g is connected with the weight by a rod g^3. The operating-lever g^2 is intended to be within reach of the train-manager or of the independent train-starter. The graduation of the lever g should correspond with the greatest number of cars of which the train is composed. Placing the limit at five, the manager would, at the moment of starting from a station, throw the lever g^2 into such a position as to adjust the weight g' to a point on the lever g which would allow a pressure sufficient to propel one, two, three, four, or five loaded cars, as the case might be, and the manager of the following train would readjust the weight g', if necessary, to suit his train.

The valve e' is here represented as balanced, and the rod or lever e^2 which controls it is provided with a projection e^3 at its end, adapted to engage a notch e^4 in the face of a cam-wheel H. The end of the lever e^2 is caused to press, either by gravity or other means, on the face of the cam-wheel, and thereby to follow its contour. When the projection is seated in the notch e^4, the valve e' will entirely cut off the supply of air from the engines, and will be caused to admit more or less air to them, according as the end of the lever is forced farther away from or allowed to approach to the center of the cam-wheel.

The cam-wheel H is rotated by means of a toothed wheel h, fixed on the same shaft with the cam-wheel and actuated by a worm h' on the shaft of one of the driving-drums. Each revolution of the drum is calculated to rotate the toothed wheel the distance of one tooth, and the number of teeth on the wheel corresponds to the number of revolutions which the drum is required to make to run the cable a distance equal to that between two successive stations, so that when the lever e^2 is disengaged from the notch in the cam-wheel and the cable thereby started the end of the lever e^2 may be allowed to rest on and follow the face of the cam-wheel, and will thereby automatically fall into the notch after the cam-wheel has completed one revolution, and will thereby shut off the power and stop the engines as the train reaches or approaches the station, and the cable will remain at rest until the lever e^2 is again positively disengaged from the notch on the cam-wheel. The face of the cam-wheel is preferably inclined quite abruptly, as shown at h^2, on the side of the notch on which the end of the lever travels in starting, in order that the maximum speed may be attained gradually and at the same time without unnecessary delay, and a more gradual incline, as shown at h^3, is provided on the side of the notch on which the end of the lever travels in stopping, in order that the cut-off of the power may be gradual. Between the two inclined portions the face of the cam-wheel is at a uniform distance from the center, and the maximum speed is retained while the end of the lever e^2 is traversing such portion.

There are several feasible devices which may be employed to lift the end of the lever e^2 out of the notch in the cam-wheel in starting. For example, the starting-lever F might be connected with a swinging arm f^2 by a rod f^3 and the lower end of the arm f^2 be constructed to engage the under side of the lever e^2 and lift it out of the notch when the lever F was thrown back, the parts being constructed to assume their normal positions by gravity or spring-power; or a plunger might be placed within reach of the manager and have a communication with a plunger to lift the lever e^2 through a pipe filled with glycerine or the like, whereby a pressure on the plunger by the manager would lift the lever e^2, and the parts would assume their normal positions by gravity as soon as the pressure was removed from the operating-plunger; or a branch pipe of compressed air might lead from the main power-conduit and be provided with a piston at its end, the piston being so connected with the lever e^2 that when actuated by the compressed air let into the branch pipe by the manager it would lift the lever out of the notch, the parts being allowed to assume their normal positions by providing a leak in the branch pipe sufficient to waste the compressed air before the cam-wheel shall have completed a single revolution.

The cam-wheel H, when a single train only is to be propelled in one direction at any one time, is provided with only one notch, and the cable moves continuously while the train is traversing the distance between two stations. When, however, it is found desirable to place any two successive stations a double or triple distance apart, the said cam-wheel would be provided with two or three notches, as shown in diagrams H′ H^2, respectively. The train or trains running between stations would in these instances be brought to a standstill once or twice, as the case might be, between the stations, while the following train or trains about to leave the preceding station attached their grips.

A separate car C^2, which is conveniently referred to as the "grip-car," is constructed to carry the grip R and grip-operating mechanism k, and also storage-reservoirs L for compressed air to be employed in applying brakes, manipulating car-doors, and as a general source of power in managing the details of the train.

Opposite the points where the grip-car stops at the several stations, or at such stations as may be found expedient, the main pipe is provided with branch pipes I, to which are attached hose i, adapted to be coupled onto a nozzle of a pipe i', leading to the storage-reservoirs in the grip-car. The pipes I and i' are each provided with a suitable valve, by manipulating which the engineer or manager is enabled to refill the storage-reservoirs as they may require. In practice the storage-reservoirs should be constructed to hold a sufficient amount of air, so that refilling would not be necessary excepting at such stations where the stops were somewhat longer than ordinary.

The several cars which compose the train are provided with air-brakes M, adapted to be coupled in communication with the storage-reservoirs in the grip-car in any well-known or approved manner.

As the car approaches a station, and when within such distance from its stopping-point that the brakes will without doubt effect a stop, the engineer or manager releases the grip and turns on the brakes. The two operations may be accomplished simultaneously by connecting the brake-valve with the grip-operating wheel in any one of several well-known forms, and such construction is considered preferable. The grip may also be automatically released from the cable at the proper moment by some well-known device. In case of an obstacle or danger, or when it is found desirable from any other cause to stop the train between stations, the grip may be released and brakes applied. When the danger is over and it is desirable to advance the train to the station, it must remain until the cable has come to a stop to allow the manager to attach the grip.

In supplying the compressed air to the several engines, to the grip-cars, and to the stations, it will suffice to run a single conduit along the tracks where they are located on the same thoroughfare; but when located on different thoroughfares it would be advisable to run the conduit along both the outgoing and return tracks. The main supply-pipe, as well as its branches, should be boxed and protected against changes of temperature by some non-conducting material. A large boiler placed at the central station, into which the air-compressors deliver the air, would serve to reduce the fluctuations in pressure; but to maintain a uniform pressure to be delivered to the several engines along the line it would be necessary to maintain such a degree of pressure at the central station that the air at the most remote engines would be above the greatest pressure required for driving them.

The movement of trains must be governed by signals, the last car of a train automatically changing a signal of danger into one of safety for the train following it when it has passed a certain point on the line, and also automatically changing signals of safety into signals of danger when passing them.

If it should be considered objectionable to slacken speed between stations on long sections, two or three parallel cables might be run, each by an independent engine, in which case each grip-car would have to be provided with two or three clutches—the central one to be employed on sections of ordinary lengths, while the central together with the outside clutches could be employed, as required, on the longer sections.

If at any point between stations—on curves, for instance—a speed less than the maximum is desired, the reduction may be readily provided for by making a suitable indentation in the face of the cam-wheel H. Where electricity is employed as the motive power, the power and speed of the motor are regulated by varying the size of the conductors conveying electricity from the main conductor to the motor and back, and by increasing or diminishing the resistances.

At points on the line where cars are to be taken out of the train or added to, usually at the termini, the switch-tracks are provided, and the switching performed by switching-engines driven by independent cables generally much shorter than the cables on the line-sections.

As above constructed each cable is required to pull only one, two, or, in extreme cases, three trains, and hence may be made very light, reducing the dead-weight to be carried and the friction on the pulleys. The clutch being attached to the cable only when the latter is at rest, there is no danger of its being broken or injured by the contact.

When the same cable is employed in running trains in opposite directions, the balancing of the trains on steep grades effects a great saving in power.

The jerking of the cars is avoided by the automatic control of the engines, and the speed may be made much greater than on ordinary cable roads because of the small amount of work to be done by each cable.

The expenditure of motive power is also directly proportional to the work, and inspection and repairs are easy. The weight of steam-locomotives, as well as the dust, smoke, and cinders from them, is avoided, and the viaducts may be constructed much lighter and cheaper than where constructed to support both locomotive and train.

It is evident that many slight changes might be resorted to in the construction and arrangement of the several parts described without departing from the spirit and scope of my invention, and hence I do not wish to limit myself strictly to the construction herein set forth.

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

1. In a cable-railway system, the combination, with a series of endless cables arranged in succession, the two strands of each endless cable being located between the stations, of independent motors for actuating each cable, a source of supply common to all the motors and constructed and arranged to supply power to all of said motors, and mechanism combined with each motor, whereby the cable is caused to travel a distance sufficient to propel the cable from one station to another and then to automatically stop both the cable and car, substantially as set forth.

2. In a cable-railway system, the combination, with a double track and a series of endless cables arranged successively along the line of both tracks, one strand of each cable extending from one station to another on one track, and the other strand of the same cable extending from one station to another on the other track, of independent motors for actuating each cable, a source of supply common to all the motors and constructed and arranged to supply power to all of said motors, and mechanism combined with each motor for causing the cable to propel the car from one station to another on each track, and then to automatically stop both the cable and car, substantially as set forth.

3. In a cable-railway system, the combination, with several cables located one after another along the track, independent motors for actuating the cables, and a common power-supply to the several motors, of a power-regulator between the power-supply and the motor, whereby the force of the motor is proportioned to the load, substantially as set forth.

4. In a cable-railway system, the combination, with an endless cable, a motor for driving the cable, and a power-supply to the motor, of a power-regulator located between the supply and the motor, and a regulator-operating device under the control of the train-manager, whereby the force of the motor may be regulated to suit the load, substantially as set forth.

5. In a cable-railway system, the combination, with several endless cables located one after another along the track, independent motors for actuating the cables, and a common supply of compressed air to the several motors, of a pressure-regulating valve located between the supply and the motor, and a valve-operating lever under the control of the train-manager, substantially as set forth.

6. In a cable-railway system, the combination, with several endless cables located one after another along a track, motors for actuating the cables, and a common power-supply, of starting mechanism under the control of the train-manager, and mechanism actuated by the motors and adapted to automatically

shut off the power from the motor as the train nears the end of the cable-section, substantially as set forth.

7. In a cable-railway system, the combination, with several endless cables located one after another along a track, motors for actuating the cables, and a common supply of compressed air to the several motors, of a valve to admit the compressed air to the motors, a valve-operating lever under the control of the train-manager, and a cam-wheel driven by the motor and adapted to hold the valve open and allow the valve to close at the desired intervals, substantially as set forth.

8. In a cable-railway system, the combination, with the series of endless cables, the independent motors, and the common supply of compressed air to actuate the motors, of the valve to regulate the pressure and the valve to start and stop the motor, the said valves being located between the common supply and the motor, and mechanism for operating the valves, substantially as set forth.

9. In a cable-railway system, the combination, with the series of endless cables, the independent motors, and the common power-supply, of the valve to admit the power to the motor, a cam-wheel, a toothed wheel on the cam-wheel shaft, a worm driven by the motor and adapted to mesh with the toothed wheel, and a valve-operating lever in engagement with the face of the cam-wheel, substantially as set forth.

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

HENRY FLAD.

Witnesses:
EDWARD F. FINNEY,
ARCHIE MCL. HAWKS.