(No Model.) 2 Sheets—Sheet 1.

G. WESTINGHOUSE, Jr.

Block Signaling Apparatus.

No. 240,628. **Patented April 26, 1881.**

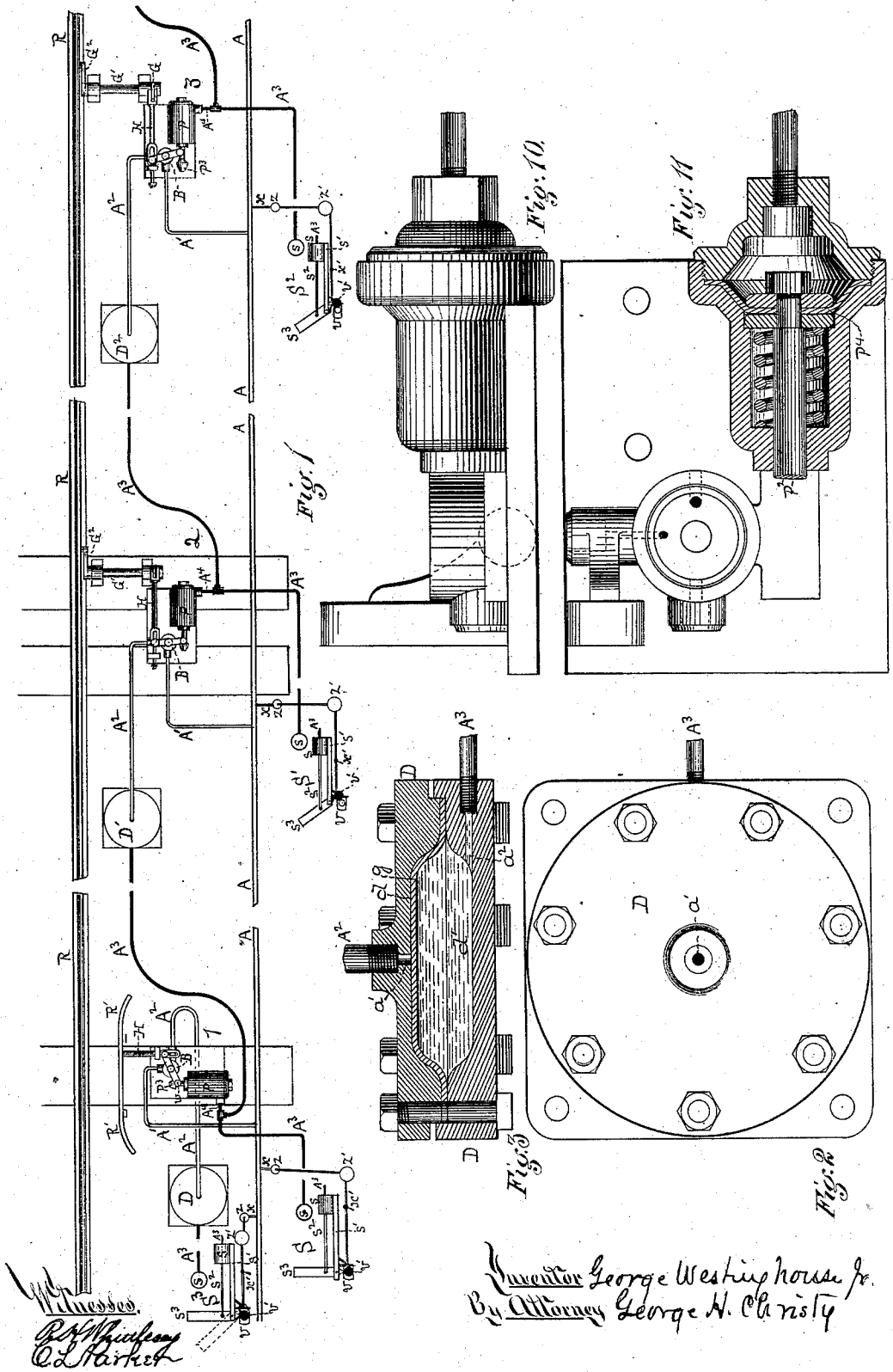

Fig. 1

Fig. 10

Fig. 11

Fig. 3

Fig. 8

Witnesses.
R. F. Whitehead
C. L. Parker

Inventor George Westinghouse Jr.
By Attorney George N. Christy

(No Model.) 2 Sheets—Sheet 2.

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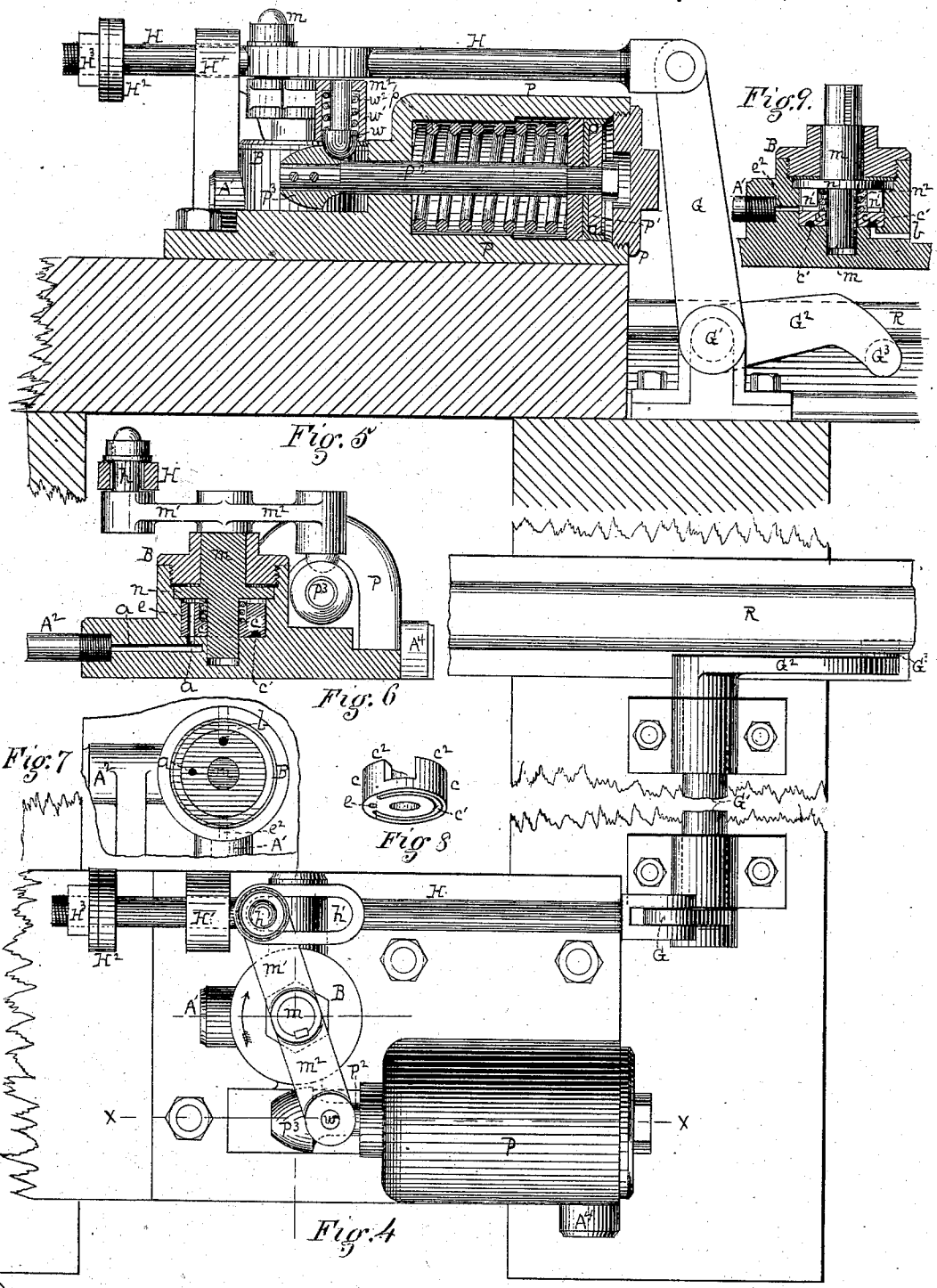

Witnesses
C. F. Shipley
E. L. Parker

Inventor George Westinghouse Jr.
By Attorney George H. Christy

UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., OF PITTSBURG, PENNSYLVANIA.

BLOCK SIGNALING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 240,628, dated April 26, 1881.

Application filed December 20, 1880. (No model.)

To all whom it may concern:

Be it known that I, GEORGE WESTINGHOUSE, Jr., of Pittsburg, county of Allegheny, State of Pennsylvania, have invented or discovered a new and useful Improvement in Block Signaling Apparatus; and I do hereby declare the following to be a full, clear, concise, and exact description thereof, reference being had to the accompanying drawings, making a part of this specification, in which—like letters indicating like parts—

Figure 1, Sheet 1, shows a diagram or plan view of a system of block signaling apparatus as applied to a railway-track, and showing the outside or adjacent rail of the track. The other figures show details of the apparatus to an enlarged scale, Fig. 2 being a top or plan view of the diaphragm-box; Fig. 3, a vertical sectional view thereof. Fig. 4, Sheet 2, is a plan view of the apparatus by which, at each block-station, the direction of the fluid-pressure action is changed through the action of the train. Fig. 5 is a vertical sectional view through *x x* of Fig. 4, looking toward the track. Fig. 6 shows an end view of the cylinder of Fig. 4, an elevation of the crank, and a vertical section of the valve-box and valve. Fig. 7 is a top or plan view of the valve-box with the cap, wrench, and valve removed, so as to show the valve-seat. Fig. 8 shows the valve in perspective. Fig. 9 is a vertical sectional view of the valve-box and valve in a plane at right angles to that of Fig. 6; and Figs. 10 and 11 of Sheet 1 show side and sectional views of a diaphragm-cylinder as a substitute for or equivalent of the piston-cylinder of the other figures.

In the operation of railways the block system has, to a limited extent, been introduced into this country, and while in many respects it has been found to be an important element in the running of trains in close succession on the same track with comparative freedom from danger, the principal objections to it arise from the cost and expense of putting it up and operating it. By my present invention I reduce materially these expenses, particularly the operating expenses, and also make provision for its automatic operation to the extent that the signals shall be shifted from "safety" to "danger," and vice versa, by the action of the trains themselves, so as to dispense with operators at the several block-stations and render unnecessary any manual labor or personal attention, except such as may be necessary to see that everything is kept in good order and condition.

In my improved system of operation I employ compressed air as the motive power in operating the signals, and also use a hydraulic line or column as the means of transmitting and applying the power. I also provide for using compressed air from the same main or supply as that which furnishes the signal motive power by passing it through a carburetor, so as to get a ready, cheap, and convenient material for signal switch, station, and other lights, such as are required along the track of a railway or at places conveniently contiguous thereto; and while my improvements may be applied on either single or double track lines, I will first explain them as applied to or along one track of a double-track line, and one rail (preferably the outside one) of such a track is represented at R.

Along the entire line of road, or along a part or section thereof, or along the entire line in separate sections, (so far as the block system is to be established,) I lay a main supply-pipe, A, Fig. 1, of the proper capacity, which is to be charged and kept charged with compressed air of such density as the work to be done may require. The line or section is to be laid off into blocks in the usual way, and of such length as may be desired, according to the minimum distance apart at which trains of the same class are to be run. In the drawings I have shown three block-stations, numbered 1, 2, and 3. At or in convenient proximity to each block-station is a signal-post and signal, S S′ S^2; and while I do not limit myself to any particular style or form of signal, I will describe my invention as the same is to be used in operating semaphore-signals, it then being within the skill of the mechanic to adapt it to either day or night signals.

At a distance back of block No. 1 equal, or about equal, to the distance between two blocks I place a signal apparatus, S^3, and for the purposes of the present case I assume this signal S^3 to be at or near the starting terminal of the train, or at the beginning, on the line of the block system.

In connection with each signal S S′, &c., I have shown the hydraulic pipe terminating in

a signal-cylinder, and, besides, I have shown at each signal-station, in elevation, so much of a signal-post, cylinder, and piston-stem as is necessary to illustrate the movements of the signals. At each of the block-stations on the line I make a connection by a branch pipe, A′, from the main pipe A to a valve-box, B, wherein is a valve which is actuated, as presently to be described, by the train itself, or by an attachment thereto, in such manner as in one adjustment to make an open communication from the branch A′ through the valve-case, as presently to be described, to a side port, *a*, Fig. 6, from which latter a pipe, A^2, leads to a diaphragm-chamber, D, or D′, or D^2, all being of like construction, and so as in another adjustment to close this line of communication and open another from the port *a* to an escape or waste port, *b*, the latter being closed or cut off in the adjustment first above referred to. Each diaphragm-chamber is arranged at any convenient point, and preferably at or not far from the block-station to which it belongs. It is divided transversely by a flexible diaphragm, *g*, Fig. 3, which may be made and connected in any of the ways known to the art, and on one side, *d*, of this diaphragm the pipe A^2 is connected, as by port *a′*, and from the other side, *d′*, by port a^2, a pipe, A^3, leads to a signal-cylinder, *s*, arranged at or on a signal-port, *s′*. From the signal-cylinder *s* a stem, s^2, leads to a signal, s^3, which may be a semaphore-light or other known form or style of signal, and the connections are such, according to the style of signal employed and motions desired, as will, under hydraulic pressure, give the signal the adjustments desired. Instead of a cylinder, *s*, with piston therein, a chamber with a flexible diaphragm may be employed as the mechanical equivalent thereof. The space *d′* of the diaphragm-chamber D, the pipe A^3, and the signal-cylinder *s* are to be charged with suitable non-freezing liquid, such as water and glycerine, wood-alcohol, or petroleum.

Returning now to the valve-box B, any suitable form of valve may be employed; but the one shown consists of a disk, *c*, Figs. 6 to 9, circularly grooved on its under face, as at *c′*, far enough around to give the communication desired, and having on its upper face two or more chuck-like projections, c^2. It also has a port, *e*, distant from the adjacent end of the groove *c′* equal, or about equal, to the length of the rotary-valve motion desired. This port *e*, in one adjustment of the valve, registers with the side port, *a*, in the valve seat and case, and through which connection is made with the pipe A^2 leading to the diaphragm, so as to supply air-pressure thereto, which air-pressure enters the valve-case, into the space just above the valve, by a port, e^2, Fig. 9, at which the pipe A′ is connected. Then, to shut off the supply or air pressure and open the escape or exhaust, the valve is rotated slightly in the direction indicated by the arrow, Fig. 4, as a result of which the port *e* ceases to register with the port *a*, and the end of the groove *c′*, made in the bottom face of the valve, then registers at one end with the port *a*, and at its other end, or between its ends, with the escape or waste port *b*, made in the valve-seat, and which leads to the open air.

The relative arrangements and forms of the ports and connections may be varied at pleasure, provided only they are so proportioned and arranged that in one adjustment of the valve the port *e* shall register with the port *a* and all communication between *a* and the waste or escape port *b* shall be cut off, and in another adjustment the port *e* shall be cut off and the groove *c′* shall make an open communication between *a* and *b*.

The disk *c* is rotated by a counter chuck or disk, *n*, having lugs *n′*, which fill the spaces between and engage the projections c^2, of the disk *c*. The two are kept at a little distance apart by a spring, n^2, and the port e^2, from branch pipe A′, opens into this intermediate space, so that compressed air may always be supplied to the port *e*, but in no case from e^2 to *b*.

The proper packings for securing tight joints are to be added as the constructor may desire or find necessary. The disk *n* has a stem, *m*, which projects through the cap of the valve-box, and a crank, *m′*, is affixed thereon. For the purpose of operating this valve (by which I mean the disk *c*) by the action of the train, any suitable means may be employed, such that the train in passing shall shift some device the motion of which shall be communicated to the valve-stem. For example, a movable bar may be set beside the rail, so that it shall be engaged by the wheel or wheels of the train, or by some part thereof, so that, being shifted laterally or tilted or otherwise moved, it shall communicate motion through suitable interposed connections to the valve; but as the result to be obtained by the movement of the valve is that one signal shall be shifted to "danger" and another set to "safety" it may sometimes be preferred to actuate the valve from the last car of the train, so that the signals shall not be so shifted until the train has fully passed into the next block. In the drawings I have illustrated both methods, the latter at station 1 and the former at stations 2 and 3, and in Figs. 4 to 6 by details. In this latter construction the wrist-pin *h* of the crank *m′* is connected by a slot, *h′*, with the connecting-rod H, which is guided at one end by suitable bracket, H′, which also acts as a stop to motion in one direction, and a nut, H^3, and gum washer H^2, operating as a stop to motion in the other direction. The opposite end of the connecting-rod H is connected to a crank-arm, G, fixed on a rock-shaft, G′, and the latter, arranged at or about the track-level and at right angles to the rail R, extends over to the rail, and carries on its end a knee-shaped crank-arm, G^2, so constructed and arranged that it will lie sufficiently close to the side of the rail to be passed over by the wheel or some part thereof, as illustrated in Figs. 1 and 4, and also so that

in one adjustment a portion of its upper edge will project above the upper surface of the rail, as in Fig. 5, and by the action of the wheel thereon may be depressed to the level of the rail, and so that such motion, operating through the described line of connection, will give to the valve *c* the length of motion or throw desired. The downward curve or slope on the end of G^2 is made partly to prevent accident from a train running back or in the opposite direction and partly to provide means for attaching a wrist, G^3, which, by engaging the under side of the tread or the top of the base of the rail, prevents the knee-crank G^2 from moving too far in either direction.

In my apparatus, and as a part thereof, I also make use of a cylinder, P, provided with a piston, P′, packed as against fluid-pressure in one direction and operated by a spring, *p*, in the other direction. The stem P^2 of this piston has a head, P^3, beveled in both directions, and the inside bevel engages the rounded end of a spring wrist-pin, *w*, which is connected with the end m^2 of the valve-operating crank. This spring or compound wrist-connection is made by the pin *w* playing in a socket, *w′*, forming part of the crank-arm m^2, and the pin *w* is pressed outward with a limited range of motion by the spring w^2. The rounded end of the pin, in connection with the beveled head P^3 and spring w^2, makes a slip-joint, such as will hold or preserve a working connection as against ordinary strain, but such that, as against a strain liable to produce breakage, will give way by the compression of the spring, so as to let the pin *w* slide over the head P^3 in breaking the connection or back in restoring it. From the pipe A^3 a branch, A^4, leads to the forward end of the cylinder P.

At station 1, Fig. 1, I have shown a modified form of device for operating the valve. It consists of a curved bar, R′, arranged in such position relative to the track-rail R that it may be engaged and pressed or forced back a short distance by means of a striker-arm or other suitable device affixed for such purpose to any suitable part of the train, and by preference to the last car, for a reason already stated. The pushing back of this bar operates the valve-moving rod H in like manner and for like purposes as in the other figures, the valve-box B and its connections being in this case properly shifted or turned around, so as to secure the desired effect from the motion described; and while showing these different devices for shifting the valve by the action of the train, or some part thereof or attachment thereto, I do not limit myself thereto, but include herein any device or apparatus suitable for the purpose, such that, being engaged by the train or some part thereof, or by a suitable device attached thereto, it will be shifted or changed in position, and by virtue thereof the motion desired in the valve will by suitable connections be transmitted to such valve.

To further illustrate or show the operation of this system of apparatus, I will assume that a train starts from the left-hand end of Fig. 1 and that all signals on the line are up or at "safety," as indicated at station 3; but I should first state that this position of the signals is secured by the application of fluid-pressure on top of the diaphragms *g* in the boxes D to D^2. This is the normal position or condition of the apparatus, and is secured by compressed air from main supply-pipe A, which passes by branch A′, through port e^2, Fig. 9, into the valve-box, thence by ports *e* and *a*, Fig. 6, into pipe A^2, into the top of the diaphragm-boxes D to D^2, so as to depress the diaphragms *g*, Fig. 3, and thereby in each case to force the fluid out by port a^2, into and along pipe A^3, to the lower end of the signal-cylinder *s*, so as by hydraulic action to raise the piston therein and raise the signal to "safety." In this (which is the normal) position of the valve, the waste is cut off, as already described; also, the same hydraulic pressure acts through the branch pipe A^4 on the front end of the piston P′, compressing the spring *p* and forcing out the stem P^2, so that the head P^3 will project beyond the wrist-pin *w* and be in a position about as illustrated at station 3. The train, after starting, passes the signal-station S^3, the signal being at "safety," as indicated by dotted lines. The distance from S^3 to station 1 is supposed to constitute the first block. The train, in passing station 1, by a suitable striker attachment, shifts the bar R′, (if that be the device preferred,) and by the connection described turns or shifts the valve *c* in the valve-box B so as to cut off the port *e* from registering with *a*, but causes the groove *c′* to make communication from *a* to the waste-port *b*. The positions of the devices are then substantially as represented at station 2. The result at station 1 is that compressed air escapes from diaphragm-box D, (above the diaphragm *g*,) passing out by the pipe A^2, port *a*, groove *c′*, and escape-port *b*. The fluid in the signal-cylinder *s* at signal-station S^3 then flows back by pipe A^3, or is forced back by counter-weights, or by the semaphore, or by spring in the cylinder, as in cylinder P, or by other like means, into the diaphragm-box D, so as to cause the signal to come down to "danger," as indicated by full lines at S^3. Block No. 1 is then guarded as against a following train until the first train comes to station 2. Here the wheels of the train, in passing over the knee-crank G^2, depress it, so as by the described connection to shift the valve, as before described, and with its valve-crank arms in the position shown. The supply-port *e* is then cut off and the waste-port *b* is opened. The escape of compressed air from D′ allows, in the manner already set forth, the signal at station 1 to come down to the "danger" position as shown at S, and thereby block No. 2, or between stations 1 and 2, is guarded as against a following train. But it is important that at the same time the next rear signal, as at S^3, should be shifted to "safety," so that a train may follow on block No. 1. For this purpose I use the cylinder P. The escape

of pressure from D′, whereby a back flow of fluid is provided for from the signal at station 1, so as to shift it to "danger," also allows of a back flow of water from the cylinder P of station 1, so that the spring *p* may give a back-stroke to the piston P therein. As this is done the head P^3 on the end of the stem engages the wrist-pin *w* with sufficient force to move the valve-crank $m' m^2$, restore the valve *c* to its normal position, whereby the waste-port *b* is cut off, and the port *e* again registers with *a*, and the compressed air again passes through A^2 to D, and by displacing the fluid in D, or forcing it along A^3 to S^3, raises the signal at S^3 to a "safety" position. A train following may then run to station 1, where it is arrested by the danger-signal at that station. The first train goes on to station 3 under the protection of the danger-signal at station 1. The operation already described is here repeated. The valve at station 3 is shifted so as to close the supply and open the waste. Air-pressure escapes from D^2, which results in the lowering of the signal at station 2 to "danger;" also, the back flow of the fluid used from the cylinder P of station 2 results in the back-stroke of the piston therein, so as to restore the valve of station 2 to its normal position, and thereby, again turning on the pressure to D′, shifts the signal of station 1 to "safety" and projects piston P, station 1, forward to its normal position, and the train following may then proceed over block No. 2 to station 2. Thus the operation goes on from block to block.

Of course, ordinarily, the signal of each back station will be cleared before the following train arrives; but I have, for clearness of description, assumed that the second or following train was following as closely as possible. It should also be stated that the back-stroke of the piston P′ in each case, acting through the cranks $m' m^2$ and the connecting-rod H, restores the bar R′ in the one case or the knee-crank G^2 in the other to the proper position to be engaged and operated by the next following train; but other means may be added, as a spring, for doing this work.

For ordinary purposes I prefer to locate the signal of each station so far back of the station that an approaching train may "sight" it and have time to stop (in case it be at "danger") before reaching shifting-bar R′ or knee-crank G^2 or other valve-shifter; but in case the train should overrun a little, so as to strike or engage the valve-shifter, it would be liable to break the connection of the crank m^2 with the piston-stem P^2, if this were a fixed connection, since it will be observed that in such case the piston-stem P^2 is back with its head P^3 in engagement with the wrist-pin *w*, as shown at station 1, Fig. 1. Hence I use the devices described, constituting a slip-joint, though other form of slip-joint may be substituted. In the contingency supposed the pin *w* would readily slip over the head P^3 without injury, and on the next outward stroke of the piston-stem, which must take place in shifting the supposed danger-signal to "safety," the head P^3 would pass under and again engage the pin *w*, and thus restore the connection. Also, as there is liable to be a rebound in the valve-shifter resulting from the necessarily violent action of the train thereon, provision may be made therefor by the slot *h′* in the connecting-rod H, so that the rod H can move the valve only in one direction, and a rebound will work no injury.

In connection with the described system of apparatus, I also provide for operating the signal-lights required along a line of railway-track by means of carbureted air. To illustrate this I have represented a signal light or lantern, *v*, on each signal-post *s′*, and the usual colored lens is to be added to the semaphore, as at *v′*. A branch pipe, *x*, is taken from the air-main A at each signal-station, which passes through a pressure-regulator, *z*, and carburetor *z′*, both of the usual or any known construction, to the burner. The carburetor is to be buried beneath the surface or otherwise protected from the cold, and in other respects these devices are to be made and fitted up in accordance with the rules well known in the art. Preferably these lights are to be kept burning continuously; but they may be turned off during the day if so preferred. A cock, *x′*, is to be added, within convenient reach of the ground, so that the track-walkers, under direction of the proper officer, and while attending to their other duties, may turn the lights down or up or out and relight, as may be directed; but it is better that this cock be so constructed that the light cannot be turned entirely out, so that if the track-walker neglects his business of turning it up a light will still be in place as a guard against accident.

Instead of the valve *c*, other suitable form of valve of like function may be employed. Nor, in so far as relates to the use of a diaphragm-box and flexible diaphragm in combination with a compressed-air supply on one side of the diaphragm and a hydraulic column on the other for actuating signals by or from the train itself, do I limit myself to the described arrangement of the signals in blocks, since the same devices may be employed in like manner to shift any signal at any point or for any purpose.

By the use of compressed air applied through comparatively short lines of pipe to put the hydraulic column in motion, and by the use of a hydraulic column, where a long distance intervenes and a positive motion or certain length of stroke or motion is essential, in connection with a flexible diaphragm at the meeting-points of the two lines or columns of fluid, I combine, in what I believe to be the most effective way, the advantages of each with a minimum of their disadvantages.

Compressed air, applied and exhausted through long lines of pipe of small diameter, works slowly, and, on account of its great compressibility, acts with too little certainty, whereas on a short line it may be used quickly

and with comparative certainty; and the use of hydraulic power alone for doing all the work would necessitate a pump or other means of getting a head at each station and a considerable quantity and some waste of a non-freezing liquid. In my apparatus a fixed quantity of such non-freezing liquid is required at each station, and this may be supplied or waste by leakage provided for without a pump or other like costly appliances; also, the hydraulic column is believed to be best means for transmitting motion described through a long distance with certainty of result. The air-main A, being of considerable diameter and subject to but inconsiderable loss of pressure at any one time, can be readily kept charged through a long distance with a practically constant pressure by the use of suitable air-compressing apparatus at any desired point or points on the line.

It should also be noted that in order to get the best results the space d' of the diaphragm-box should, when the corresponding signal is down and the piston P′ is back, be filled with the non-freezing liquid, so that at such period of the operation the diaphragm g shall, by closing the port a', act as a check-valve thereto, and, resting against the top face of the box, be relieved from all strain; and the space d' should also be at least large enough to hold the amount of fluid which flows back under the conditions stated, and it should be made enough larger to make provision for expansion or loss by leakage. The use of the diaphragm-box and diaphragm is also of especial value along grades. As, for illustration, suppose any one block to be on a downgrade, then, when the air-pressure was released from a box at the foot or anywhere down the grade, the liquid in the pipe A^3 would be liable to run out into the pneumatic pipe and escape through b, were it not that the diaphragm effectually closes the port a' and prevents all back flow. Hence this hydraulic column may be defined as a close column.

In order to guard against undue elongation and contraction of pipe-connections, the pipes should, so far as practicable, be placed under ground, and U-shaped or coil connections or any desired form of expansion-joint may be added, as may be found desirable, either above or below ground; also, other appliances, such as are known in the art to be necessary or desirable, may be added at pleasure.

It will be within my invention to apply the apparatus and mode of operation described to moving signals in the opposite or reverse order—that is, so that when the air-pressure is on the corresponding signal shall be at "danger," and when the air-pressure is off the signal shall come to "safety;" but as a guard or protection against accidents the described construction and operation are believed to be preferable.

If it is desired at any time to put all signals at "danger" and arrest all travel for a temporary purpose, it may be done by allowing air-pressure to escape from the air-main A to such extent that an operative pressure cannot be drawn therefrom sufficient in amount to put the hydraulic columns in motion, or to counterbalance their back-acting force under the influence of the counter-weights or springs employed.

In the practical arrangement of the block stations it would be preferable, on some accounts, to locate one at each railway-station on the line, and others between, at intervals of a mile or every half-mile or two miles, more or less, as may be desired. Then, when a train of one class takes a siding to let another train pass, it, in again taking the main track, will throw the next rear signal to "danger," if it be not already there, and so protect itself.

Instead of the cylinder P, with its single piston and spring, a differential piston and cylinder may be employed, by which I mean a cylinder having a larger bore at one end than the other, with pistons of correspondingly-different areas and means of applying a continuously-acting pressure or force to the smaller piston to press it in one direction, and an intermittently-acting pressure to the larger piston to force it in the other direction the latter pressure acting with the greater power. Also, in lieu of the cylinders P, pistons P′, &c., the device shown in Figs. 10 and 11 may be employed as the mechanical equivalent thereof, where P^4 represents a flexible diaphragm having like motions under like conditions and for like purposes as the pistons P′.

Station-lights, switch-lights, and other lights necessary or desirable along a line of railway may be supplied with carbureted air in like manner as the signal-lights; but in so far as these are the subject-matter of invention they are or will be included in other applications.

In so far as relates to the general use of compressed air and a close hydraulic column, separated from each other by a flexible diaphragm, as a means of actuating the movable parts or appliances of a railway-track, such as signals, switches, and gates, the same, with the method of operation therein involved, forms a part of the subject-matter of another application, and the present application involves or is intended to cover such features only so far as they enter into combination with other operative parts of a signaling system actuated by or from a passing train.

The same system of apparatus may be used on a single-track line by duplicating it (reversed in direction) on opposite sides of the track; but in such case, as a means of actuating the air-valves, the curved bar R′ should be employed, or some equivalent device, suitably arranged, so as not to be engaged by the train itself, but by a "striker" device capable of being attached to the side of the train on which the block signaling action is desired and removed from the other side.

I claim herein as my invention—

1. In a block signaling apparatus, a valve-moving mechanism adapted to be operated by the train, a compressed-air main, A, passing

from station to station, a branch, A′, at each station to the valve box or case, a pipe, A^2, leading from the valve-box to a diaphragm-box, D, on one side of the diaphragm, and a valve adapted in one position to make an open port from A′ to A^2 and in another position to open an exhaust, in combination with a hydraulic pipe, A^3, leading from the opposite side of the diaphragm to the signal-operating device, substantially as set forth.

2. In a block signaling apparatus, the combination of a diaphragm-box, D, containing a flexible diaphragm, and an air-valve actuated by or from the train, by which air-pressure supply and exhaust are regulated on one side of the diaphragm, a hydraulic column leading from the other side of the diaphragm to a signal-operating mechanism, and a signal operated thereby, substantially as set forth.

3. In a combined compressed-air and hydraulic signaling apparatus, a diaphragm-box and flexible diaphragm, arranged at the meeting-points of the hydraulic and pneumatic columns, whereby the compressed air is caused to put the hydraulic column in motion for actuating the signal, in combination with an air-valve actuated by or from the train, substantially as set forth.

4. In a block signaling apparatus, the combination of a valve-shifter actuated by or from the train, an air-valve receiving therefrom a motion or throw in one direction to exhaust compressed air from a diaphragm-box on one side of a diaphragm therein, a hydraulic column leading from the other side of the diaphragm to a cylinder at the next block, and connections therefrom, whereby the exhausting of air at one block shall shift a valve and turn on air at another block, substantially as set forth.

5. In a series of signaling block-stations, a continuous air-main, an air-valve at each station, a diaphragm-box in the line of connection between each two stations, a compressed air-pipe connecting the diaphragm-box with the forward station, and a hydraulic column leading to the back station and a reversing-cylinder, P, at each station, in combination, substantially as set forth, whereby the actuating of a valve at any one station causes the shifting of a signal at one back station to "danger" and at another to "safety."

6. A close hydraulic column, A^3, terminating in one direction in a signal-actuating mechanism and a valve-reversing mechanism and at its other end in a diaphragm-box having a flexible diaphragm, as a part of a block signaling apparatus, substantially as set forth.

7. The valve *c*, with its port *e* and groove *c′*, in combination with valve-box B, having ports *a*, e^2, and *b*, substantially as set forth.

8. The valve *c*, clutch-wrench *n*, and crank *m′*, in combination with rod H, having slot *h*, substantially as set forth.

9. The double crank *m′* m^2, operating the valve *c*, and receiving motion in one way from the action of the train directly transmitted through suitable connections, and in the other direction by variations of fluid-pressure induced at another point and by another action of the train, substantially as set forth.

10. The knee-crank G^2, shaft G′, crank G, and rod H, having a provision for rebound without injury in the line of connection, in combination with air-valve and reversing-piston, substantially as set forth.

11. In combination with a series of pneumatico-hydraulic block-station signals, a series of carburetors and regulators, taking their supply of air from the same air-main which supplies the signal-actuating mechanism of the several block-stations, substantially as set forth.

In testimony whereof I have hereunto set my hand.

GEORGE WESTINGHOUSE, JR.

Witnesses:

R. H. WHITTLESEY,

GEORGE H. CHRISTY.